CHARACTERISTICS ASSOCIATED WITH UNPLANNED EXTUBATION IN AN INTENSIVE CARE UNIT IN NAIROBI, KENYA

by

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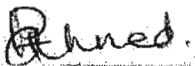## SUPERVISIOR: PROF SP HATTINGH
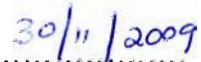
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DECLARATION

I declare that **CHARACTERISTICS ASSOCIATED WITH UNPLANNED EXTUBATION** is my own work and that all the sources used or quoted have been indicated and acknowledged by means of complete reference.

Ahmed.

SIGNATURE
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$30/11/2009$

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CHARACTERISTICS ASSOCIATED WITH UNPLANNED EXTUBATION

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ABSTRACT

Unplanned extubation is premature removal of endotracheal tube, is an adverse event; which can either, be accidental during a nursing procedure or self-deliberate by the patient. The AACN Synergy Model for Patient Care was used as conceptual model for this study. A retrospective descriptive design revelaed that over a period of two years, 327patients admitted to the intensive care unit required intubation of which 40.4% were self-deliberate extubation and 59.4% accidental extubation. Of the accidental extubated patients, 29.8% had physical restraints, 57.6% received sedation, 43.9% had analgesic infusion and 38.9% were on neuromuscular blockade. A mean Glasco Coma Scale was 9.4 and 56% of the patients were reported as being. Most patients (89.9%) required re-intubation. The findings also revealed that 49.1% of the nurses who cared for the patients when the extubation occurred had one patient at the time. Also, 84.2% of nurses had 0-6 years of nursing experience and 74% of nurses had less than five years of ICU experience.

Keywords: unplanned extubation, accidental extubation, self-deliberate extubation, sedation, physical restraints, nursing education and experience in intensive care unit, AACN Synergy model of patient care.

ACKNOWLEDGEMENTS

DEDICATION

I dedicate this research project to my husband Mr. Hanif and children, Rezvan and Fazeela.

It is comforting to know that you are always there,
Showing me how much you all care,
Therefore, I just want to say,
Thank you for always being there, Parin.

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List of abbreviations

AACN	American Association of Critical Care Nurses
AIDS	Acquired Immune Deficiency Syndrome
AIMS	Australian Incident Monitoring System
APACHE	Acute Physiological and Chronic Health Evaluation
BGA	Blood Gases Analysis
BScN	Baccalaureate of Science in Nursing
CCCN	Chapter of Critical Care Nurses
CCU	Critical Care Unit
CNS	Clinical Nurse Specialist
EN	Enrolled Nurse
GSC	Glasgow Coma Scale
GOK	Government of Kenya
HCO_3	Bicarbonate
HIV	Human Immunodeficiency Virus
ICU	Intensive Care Unit
ICN	International Congress of Nurses
JCAHO	Joint Commission on Accreditation of Health Care
NNAK	National Nurses Association of Kenya
NCK	Nursing Council of Kenya
PaO_2	Partial Pressure of Oxygen in Arterial blood
PEEP	Positive end –expiratory pressure
pH	The power of Hydrogen
PO_2	Partial Pressure of Oxygen
RN	Registered Nurse
RSS	Ramsay Sedation Scale

List of abbreviations

SaO$_2$	Saturation of Oxygen
SPSS	Statistical Package for the Social Sciences
UNISA	University of South Africa
UK	United Kingdom
USA	United States of America
V/Q	Ventilation/Perfusion
WHO	World Health Organization

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CHAPTER 1

Orientation to the study

1.1   INTRODUCTION

Normal cellular function depends on adequate supply of oxygen being delivered to the cells to meet their metabolic needs (Marieb & Hoehn 2007:8). The goal of oxygen therapy is to provide a sufficient concentration of inspired oxygen to permit full use of the oxygen-carrying capacity of the arterial blood (Urden, Stacy & Lough 2006:657). When ventilation is severely compromised in critically ill or injured patients, life-saving measures need to be applied which include, amongst others, intubation to ensure that oxygen reaches the lungs and is transported via the bloodstream to the vital organs.

Breathing can also be compromised in patients because of injury, damage to the lung tissue or ventilation insufficiency due to diseases, respiratory muscle weakness or drugs such as opiates, which cause depression of the respiratory centre (O'Connor & Ovassaplan 2005:465).

Critically ill or injured patients require intubation for

- airway protection in an unconscious patient or severe head injury
- ventilation failure, such as in stroke, myasthenia gravis and Guillain Barre syndrome
- oxygen failure in diseases such as pulmonary embolism, pneumonia, hypovalemia and pulmonary oedema (O'Connor & Ovassaplan 2005:467).

Endotracheal intubation is a life-saving intervention for patients admitted to the intensive care units (ICU) to protect their airway, facilitate mechanical ventilation and provide adequate gas exchange (Waltz, Zayarunzy & Heard 2007:608). Once a patient is intubated, the maintenance and care of the endotracheal tube for tube patency, securing, and ensuring placement is the responsibility of the nurses, medical doctors and paramedics (Richmond, Jarog & Hanson 2004:32). Unplanned extubation is sometimes inevitable, which has serious consequences for the patient. Curry, Cobb,

Kutash and Diggs (2008:46) define unplanned extubation as "premature removal of the endotracheal tube and could be either accidental or self-deliberate extubation".

Accidental extubation may occur due to nursing procedures, such as changing the tape that holds the tube in place or during mouth care or positioning of the patient. Self-deliberate extubation may be due to a patient who removes the tube; for example, a patient who is not well sedated, irritated by the tube or confused, either pulls out the tube or coughs the tube out (Kapadia, Bajan & Raje 2000:659). Unplanned extubation has been associated with serious complications such as arrythmias, haemodynamic instability, aspiration pneumonia and even death (Bhattacharya, Chakraborty & Argawal 2007:107; Chatterjee, Islam & Divatia 2004:37; De Lassence, Alberti, Azoulay, Le Miere, Cheval, Vincent, Cohen, Garrouste-Orgeas, Andrie, Troche & Timsit 2004:148; Holzapfel 2003:348).

Although endotracheal intubation is a life-saving procedure, it is associated with complications and even death if the right procedure is not followed or if the tube is prematurely removed. Complications can occur at the time of endotracheal tube placement, during the time the tube is in place and at the time of extubation, which can be planned or unplanned (Holzapfel 2003:348). However, the risk of these complications can be reduced when extubation is planned by assessing patient readiness for weaning by assessing the patient's respiratory status and giving daily spontaneous breathing trials. Curry et al (2008:45) found that each unplanned extubation costs one thousand American dollars extra in health care, increases patients' length of stay in hospital, and increases patients' and their families' level of anxiety.

The American Association of Critical-Care Nurses (AACN) Synergy Model for Patient Care states that nurses' objectives are to ensure that intubated patients are safe and develop no complications. A nurse who creates a compassionate and caring, therapeutic environment for promoting the patient's comfort and safety prevents unnecessary suffering (Ecklund & Stamp 2002:60). Anticipating hazards and promoting safety, care and comfort throughout transitions along the health care continuum are achieved by the nurses' competence (Hardin & Kaplow 2005:71). In order to prevent adverse effects in critically ill patients, it is necessary to first identify the associated risk factors.

The AACN (2005:187) identifies six essential standards for establishing and sustaining a healthy work environment. The AACN further recognises that complex link exists among quality of work environment, excellent nursing practice and patient outcomes. AACN also states that nurses' outcomes are ensuring patients' safety and preventing complications. Adverse events such as unplanned extubation are negative nurses' outcomes. By creating a safe, compassionate and therapeutic environment for the patient by promoting comfort and prevent suffering is the purpose of caring practices. Anticipating hazards and promoting safety, care and comfort throughout transitions along the health care continuum are nurses' competence (Hardin & Kaplow 2005:71). In order to prevent adverse effects in critically ill patients there is a need to first identify the risk factors associated with it.

This study assessed the patients' and nurses' characteristics associated with adverse effects of unplanned extubation in an ICU at a selected hospital in Nairobi, Kenya. Risk factors such as use of physical restraints, level of sedation, agitation, and nurse-to-patient ratio, nurse formal training and nursing experience were investigated. Based on the findings recommendations were made for reducing the incidence of unplanned extubation at the selected hospital in Nairobi, Kenya.

1.2   BACKGROUND TO THE STUDY

Critically ill patients in ICU are a vulnerable population; elucidate underlying physiological and psychologically mechanisms that contribute to symptoms, functional status, perceived health status and quality of life. These patients also have additional needs, which require appropriate trained competent staff to recognise these needs and provide quality patient care, which is their fundamental right.

Collins and Strother (2008:E1) report that to meet the needs of patients, the Joint Commission on Accreditation of Healthcare Organisation (JCAHO) requires the healthcare organisation to provide effective staffing; appropriate in number and with right competencies. The AACN (2003:154) concurs and states further that critically ill patients require "heightened vigilance and complex sophisticated care from highly trained and skilled nurses". Critically ill patients require quality care, safe passage through health care and above all need positive outcomes.

1.2.1 Patient safety

Patient safety is an important component of health care quality, which is also the fundamental right of the patients in ICU. The World Health Organization (WHO) (2009:5) estimates that one in ten patients in the developing countries is harmed while receiving care in hospitals. The healthcare industry appears to be far behind industries such as aviation and product manufacturing in ensuring basic safety to patients (Stelfox, Palmiani, Scurlock, Orav & Bates 2006:174).

According to Steiner (2006:96), the JCAHO emphasises promoting patient safety through a variety of mechanisms, including the reporting and analyzing of incidences. The JCAHO's basic principle is "do no harm".

According to a report by the Institute of Medicine (IOM) in 1999, an estimated one million adverse preventable events to patients occur every year in the USA, of which 44 000 to 98 000 are fatal (Leape 2002:1633). This report was a revelation to healthcare industry, who responded immediately with a wide range of patient safety efforts. Page (2003:23) points out that the IOM report helped health care workers in the USA and other countries to better understand the thousands of errors and adverse events that occur to patients. Furthermore, nurses play a central role in the health care industry by providing direct care to patients. Their primary activity involves patient surveillance, assessment, evaluation and monitoring, which are important mechanisms of detecting and prevention of adverse events (Page 2003:32).

The AACN Synergy Model for Patient Care proposes that the patient's needs drive the nurse's competences and both need to work in mutual harmony to promote safety of the patient thus enhancing better patient outcomes (Hardin & Husseny 2003:5).

Carayon and Gurses (2005:264) maintain that the two main reasons for errors in ICU are inappropriate staff for current patient workload and staff inability to respond to increased unit activity. Gurses and Carayon (2007:185) conclude that the ICU environment can create obstacles for the nurse thus compromising the safety of the patient.

In order to promote the safety of the patient in ICU, quality care needs to be provided, and errors and adverse events identified. Analysing the adverse events, establishing the root causes and setting benchmarks in nursing care will improve patient outcomes as well as increase safety of the vulnerable critically ill patients. Positive patient outcomes further motivate the nurse and give job satisfaction.

- **Nurses in ICU**

According to the AACN Synergy Model for Patient Care, nursing characteristics are considered as competencies that are essential for those providing care to the critically ill. The eight competencies reflect the integration of the nurse's knowledge, skills and experience (Hardin & Kaplow 2005:5). The continuums are derived from patients' needs and range from level 1 to level 5, from an entry-level competent nurse to a proficient and an expert nurse (Kaplow & Reed 2008:19).

Kendall-Gallagher and Blegen (2009:112) refer to mounting evidence that the "competency of the ICU nurses is an important factor in both prevention and creation of adverse events". Kendall-Gallagher and Blegen add that certification of registered nurses is associated with expertise in a specialised area of practice. The AACN (2003:154) adds that the first step to have competency developed in nurses is to ensure that they have a practicing licence and certification in critical care, which requires obtaining specialised knowledge and skills that have been formally assessed and validated beyond the minimal entry-level standard of licensure. The nurse licensure assures the public that a nurse has the adequate knowledge and skill to care for patients.

Carayon and Gurses (2005:264) maintain that in an era of challenges of dramatic new treatment, increased technology, changing healthcare delivery models and ever-increasing diversity among patients, nurses simply must know more and have specialized knowledge in order to deliver safe and effective care that meets the each patient's unique needs.

Aiken, Clarke, Cheung, Sloane and Siler (2003:1617) found a ten percent increase in the proportion of nurses holding bachelor's degrees in nursing in surgical units was associated with a five percent decrease in patient mortality.

According to Savitz, Jones and Bernard (2005:375), the IOM report emphasised the urgent need for understanding and measuring adverse events, and the taxonomy of quality attributes for health care is interdisciplinary education for all health care workers. Nurses represent the largest component of health care forces and the greatest amount of direct contact with patients. Therefore, the quality indicators are associated with the nursing profession and have evolved from nursing-sensitive to adverse event-sensitive (Savitz et al 2005:375).

The present study took place in a selected Level 1 hospital in Nairobi, Kenya. The following section briefly discusses the country as a whole, focusing on the health care system within the country and then describes the ICU in which this study was conducted.

1.2.2 Kenya

In Kenya, the rates of unplanned extubation are not known. The study was conducted in a selected Level 1 hospital in Nairobi, Kenya in order to explore this problem.

The Republic of Kenya is a country in East Africa (see figure 1.1). Kenya is bordered by Tanzania in the south, Sudan in the northeast, Uganda in the west, Somalia in the northeast, Ethiopia in the north and the Indian Ocean in the southeast (Kiima, Njenga, Okonji & Kigamwa 2004:48).

In December 1963 Kenya gained independence and ceased to be a British Protectorate, thereby becoming the thirty-fourth independent nation in Africa. Kenya is a member of the Commonwealth of Nations and of the East African Community. Kenya has a surface area of 582,644 square kilometres and 13,400 kilometres of coastline and the capital city is Nairobi (Broberg 2000:4).

Figure 1.1   Map of Kenya

Source: Cautsoukis (2000:1)

Nearly three-fifths of northern Kenya is desert-like and unable to sustain large populations while two-fifths of southern Kenya has a mild climate and high rainfall. This part of the country is home to 85% of the population and the hub of economic activities (Broberg 2002:8).

Kenya has four distinct geographical regions, namely the south-eastern coast at sea level facing the Indian Ocean; the inland area surrounding the capital city Nairobi, reaching a plateau of 1 524 metres; the northern arid area above the equator, which ranges 152 metres above sea level on the eastern side to 1 524 metres on the western side, and finally the region west of the plateau, known as Kenya's highlands, consisting of a series of higher plateaus ranging from 900 to 2000 metres (Bindloss, Parkinson & Fletcher 2003:18). Dissected from north to south by the Eastern Rift Valley, the Kenyan Highlands are divided into the Mau Escarpment on the east and the Aberdare Range on the west, ranging between 3 048 and 3 353 metres. Kenya also has numerous extinct volcanoes. Mount Kenya (the largest at 5 199 metres) and Mount Elgon (4 321 metres) on the western border mark this range (Broberg 2002:8).

Kenya's different topographical regions experience distinct climates. The coastal region is mostly humid and wet; the low plateau is the driest part of the country. Average temperatures range from 14° to 34° Celsius. Rainfall occurs seasonally throughout Kenya with two rainy seasons: the "long rains" roughly from March to June, and the "short rains" approximately from October to December (Saffer 2001:9).

Kenya has over forty-two ethnic tribes and nearly all have their own language, thus creating considerable linguistic diversity in the country. The official languages are English and Swahili, which are both used for communication between members of different groups (Otieno-Abinya & Githanga 2007:1; Saffer 2001:43).

Kenya is divided into eight provinces and 210 constituencies, with Nairobi as the capital city. Kenya has an estimated population of 37 953 838, the majority of whom (60%) live in rural areas mainly concentrated in the fertile southern half of the country (Government of Kenya, 2008). According to Hugenberg, Anjango, Mwita and Opondo (2007:411), the average life expectancy is 56.64 years, with 56.42 for males and 56.87 for females. The birth rate is estimated at 38 per 1 000 and the death rate at 10 per 1,000.

1.2.2.1 *Nairobi*

Nairobi, in the Nairobi Province, is the capital of Kenya and the financial and service hub for East Africa. Nairobi is situated between Kampala (Uganda) and Mombasa (Kenya), with Mount Kenya towards the north and Mount Kilimanjaro in the south-east. Nairobi, one of the fastest growing cities in Africa, is the regional headquarters for several international companies and has many tourist attractions (Renuka, 2007).

Nairobi has various tribes and races and an estimated population of over 3.3 million. The climate is fairly moderate and from December to March, it is very sunny with average temperatures in the mid-twenties (Chelogoy, Anyango & Odembo 2004:5).
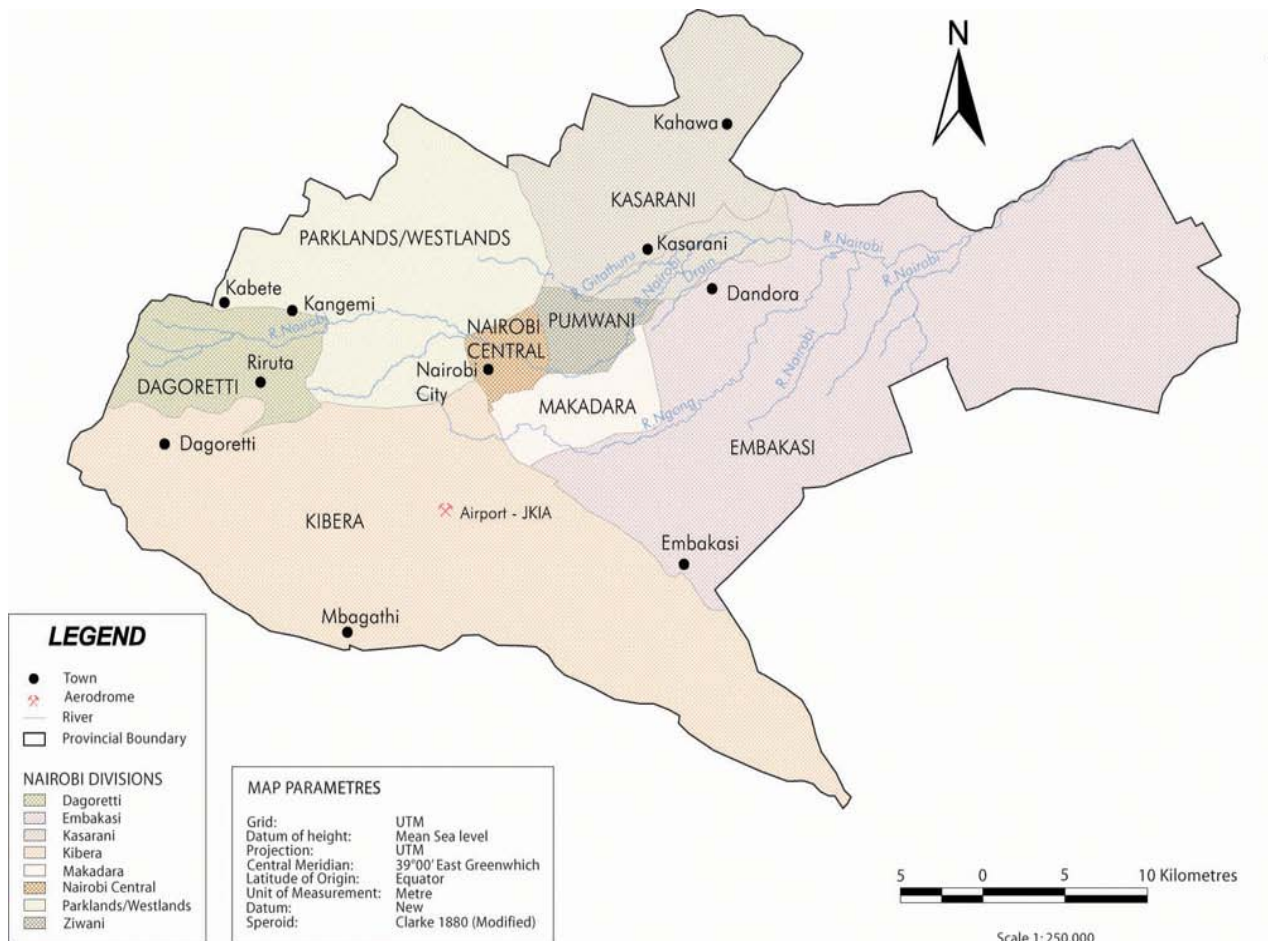
Figure 1.2   Map of Nairobi

(http://www.unep.org/roa/Nairob_River_Basin/Images/maps/NairobiAdministration-map.jpg)

1.2.3   Healthcare systems in Kenya

Healthcare systems in Kenya are a mixture of both public and private providers. In the public sector, there are two national referral hospitals, one in Nairobi and the other in Eldoret, seven provisional general hospitals, over 50 district hospitals and over 100 other lower-level health care services, also known as dispensary services.

The public sector is managed by the Ministry of Health and the Ministry of Public Health, with decentralisation at the district level. There are also many private and missionary level 1 and level 2 hospitals in the country.

After Independence in 1963 up to 1989, the people of Kenya could get free access and treatment in any of the public health care centres. Changes in the public health care system occurred gradually and in 1989 people were required to pay a nominal fee for health care services (Bedi, Kimalu, Kimenji, Manda, Mwabu & Nafula 2004:24). Opposition led to the suspension of this system and in 1990 free health care services were once again available to all. New cost-sharing fees, applicable to everyone using the public health sector's health care services, were introduced in 1992. Civil servants, military personnel and the unemployed were the only people exempted from paying these fees. Bedi et al (2004:25) found that most people rely on non-government health services rather than those provided by the government health care services as they perceive quality of care to be superior in private services. Furthermore, some people seek alternative treatment either by self-treatment or buying drugs from pharmacies (Bedi et al 2004:25). Educated people, however, are less likely to resort to self-treatment and would rather seek professional services (Bedi et al 2004:28).

Regarding the quality of care and access to patients after road traffic accidents in Kenya, Macharia, Njeru, Muli-Mussime and Nantulya (2007:118) found that the quality of private health care is more advanced and perceived as "better" than that provided in the public health care system, both in availability of resources and timely care.

Most public health care facilities do not have a 24-hour service and doctors are often absent from them, which places an added burden on the nurses working there (Siringi 2001:481). Moreover, many public hospitals do not have the infrastructure, including clean water and waste management; doctors often omit to recap used needles, and health care workers are ignorant about the disposal of sharps and other risky contaminants, which exacerbates poor practice (Siringi 2001:481).

Most Kenyans have no medical insurance and health care especially medication, which is mainly imported, is very expensive.

Ndirangu and Kimalu (2004:9) report that an average Kenyan spends about 5 252 Kenyan shillings on medication and 13 804 Kenyan shillings on hospitalisation (75 to 198 US dollars) per month. The National Health Insurance Fund (NHIF) is the most common health insurance programme, and people who earn minimum wages or are unemployed cannot afford even it.

Alliance Worldwide Care (2009:1) reports that under-financing of the health care sector reduces the government's ability to provide adequate health services which, in turn, renders the government dependent on donor agencies to support these programmes. Furthermore, poor management of resources, the burden of diseases, population growth and other factors also contribute to inadequate health care provision.

1.2.3.1 Disease pattern and injury profile of the country

- **Tropical diseases**

Tropical diseases such as malaria and tuberculosis have long been a public health care problem in Kenya (WHO 2006:4; 2007:5). According to Opiyo (2004:58), in 1999, malaria was the leading cause of death (38%) in children between ages of 0 to 5 years, but this has changed over the years.

In a study on the risk of self-diagnosed malaria in informal settlements in Nairobi, Kenya, Ye, Kimani-Murage, Kebaso and Mugisha (2007:71) found that malaria was the leading cause of illness perceived by the residents and the second highest morbidity in Nairobi, accounting for 10.6% after respiratory disease.

According to the United States Agency International Development (USAID) (2009:5), Kenya has a high burden of tuberculosis (TB), ranks thirteenth in the list of 22 high-burden countries and the fifth highest in Africa. Kenya has more than 132,000 new TB cases with an incidence rate of 142 per 100,000 people. Of reported new cases there is a 48% incidence of TB with co-infection with Human Immunodeficiency Virus (HIV) and it is difficult to treat (USAID 2009:5).

- **HIV and Immune Deficiency Syndrome (AIDS)**

In recent years, infection with HIV which causes AIDS has become a serious healthcare concern in Kenya. Cheluget, Baltazan, Orege, Ibrahim and Stover (2006:i21) state that HIV/AIDS in adults decreased from 10% in 1990 to 7% in 2003. According to the WHO (2006:5), the leading cause of death in all ages is HIV/AIDS, followed by lower respiratory tract infection and diarrhoeal diseases. Despite HIV/AIDS being the leading

cause of death in Kenya, the HIV burden in Kenya population decreased from 10% in 1999 to 7% in 2003 (WHO 2006:5; Opiyo 2004:58).

- **Road accidents**

According to the Library of Congress Report (2007:1), Kenya has the highest number of deaths related to road traffic accidents, namely 510 deaths per 100,000 vehicle accidents per year. Macharia, Njeru, Muli-Mussime and Nantulya (2009:118) found that the estimated rates of road traffic accidents increased by 57.8% between 1962 and 1992, the rate rising from 7.3 to 8.6 per 100,000 population. Furthermore, the fatality rate on the major rural roads is much higher than the urban areas, one reason being the unavailability of trauma care and specialist doctors at the district level.

- **Malnutrition**

Kwena, Terlouw, Devlas, Phillips-Howard, Hawley, Freidman, Vulule, Nahlen, Sauerwein and Terkuil (2003:94) found that 36% of children under five in the rural areas are underweight. In a demographic and health survey in 2003, the Kenya Central Bureau of Statistics found that the most important health and welfare problem affecting women and children in particular is poor nutritional status.

The government is working towards reducing malnutrition and the deficiency diseases in children by the introduction of food programmes in schools. The major problem remains protein deficiency in children especially in the north eastern of the country.

Table 1.1 shows the top ten causes of death in all ages, 2002.

Table 1.1   Top ten causes of death, in all ages

No	Disease/Condition	% of total deaths reported
1	HIV/AIDS	38
2	Lower respiratory disease	10
3	Diarrhoeal disease	7
4	Tuberculosis	5
5	Malaria	5
6	Cerebrovascular disease	4
7	Ischaemic heart disease	4
8	Perinatal conditions	4
9	Road traffic accidents	2
10	Chronic obstructive disease	2

Source: WHO (2006:3)

(http://www.afro.who.int/dnc/infobase.kenya.pdf)

As shown in table1.1, in 2002, the leading cause of death was HIV/AIDS at 38% followed by respiratory tract infections at 10%.

1.2.3.2   Hospitals in Kenya

There are many hospitals in Kenya. The largest referral hospital was opened in 1901, and the hospital where the study was conducted opened in 1957 (Otieno-Abinya & Githanga 2007:1).

The first ICU was opened at the largest referral centre in Nairobi in 1970 and soon thereafter most major private hospitals had an ICU. In the public hospitals, however, only the referral centres have ICUs. The opening of these ICUs also increased health care workers' awareness that nurses who specialise in critical care were required to care for critically ill or injured patients, therefore the critical care nursing diploma and a certificate course were introduced in various teaching hospitals.

1.2.3.3   Nurses in Kenya

In Kenya, the Nursing Council of Kenya (NCK), which is affiliated to the International Council of Nurses (ICN), introduced a practice licence for all nurses in 2000 which is valid for three years. In order to retain practising status, nurses have to show evidence of yearly education of 20 credit hours. This education can be either from attendance at

workshops and conferences or any in-house training. The NCK sets no standards on the type or quality of this education requirement, consequently each institution has a different understanding and format of education. All nurses are members of the National Nurses Association of Kenya (NNAK) and pay annual membership fees. Nurses can also become members of the Chapter of Critical Care Nurses (CCCN), which is a branch of NNAK, by paying annual fees. The criterion for CCCN membership is either by interest or working in ICUs. No assessment or certification is required, neither is it mandatory for all nurses working in ICU to enrol as members of the CCCN.

Riley, Vindigini, Arudo, Waundo, Kamenyu, Ngoya, Oywer, Rakuom, Salmon, Kelley, Rogers, St Louis and Marum (2007:1398) found a total of 39 280 nurses of all categories in Kenya. Furthermore, there was a high staff turnover, as nurses were targeted for affluent countries, which offered better competitive salaries, had better resources and working conditions, provided professional growth and had a decreased patient workload. Riley et al (2007:1398) found that over a five-year period there was an increased outward migration of nurses from Kenya to developed countries.

1.2.4   The setting

The study was conducted in the ICU of a selected hospital in Nairobi, Kenya. This institution is one of the leading hospitals in the country where patients from Rwanda, Burundi, Tanzania and other neighbouring countries are referred. The 254-bed capacity is being expanded to over 300 beds. The ICU is an open multidisciplinary unit, which admits both adult and paediatric patients with medical, surgical, burn, trauma, gynaecology, obstetrics and neurological conditions. The unit has eight beds, including two isolation rooms; an eight-bed high dependency unit with ventilator support facilities, and four beds in the newborn neonatal ICU. Primary nursing is practised in this unit.

Critically ill patients are admitted to the ICU directly from the emergency department, transferred from the wards, private consultant clinics, flown in from different parts of the country and from neighbouring countries. An average of 45 patients is admitted per month, of who 40 to 50 percent require intubation and need ventilator support (Hospital Records 2009:5). The average bed occupancy is 95%, average length of stay in ICU is 10 days, and average ventilated days range from seven to 10 days. The average

monthly mortality rate is 10% to 15%. Tracheostomy is planned from the seventh ventilated day onwards for patients who may require long-term ventilator support.

The management of endotracheal tubes is an important aspect of intubated patient care. This management includes endotracheal suctioning, oral care, and clearance of oral/nasal secretions and care of equipment. The endotracheal suctioning practised at the ICU is open system, whereby the ventilator is disconnected, suction catheter introduced into the endotracheal tube and applied for suctioning of the trachea. All endotracheal intubated patients are prescribed four-hourly chest physiotherapy and motion exercises twice a day by the physiotherapist. Weaning from the ventilator is determined by the attending physician, and the ICU nurse implements the weaning process using the weaning protocol.

1.2.4.1 Adverse events in ICU of the selected hospital

In the ICU, the data collected and recorded in the admission book upon admission of a patient include date of admission, age, gender, primary diagnosis, and route of endotracheal intubation, date of ventilation started, invasive central catheter, skin assessment and urinary catheter. This data is updated if any incident occurs.

The preferred route of endotracheal intubation is oral tracheal. The endotracheal tube is secured with cotton tape tied around the neck. A heat moisture exchange filter is used as humidifier and changed every 24 hours.

Mechanically ventilated patients are sedated with continuous infusion of midalazom and morphine is the drug of choice to prevent pain. For patients who are on mandatory control mode ventilation, neuro-muscular blockades such as Propofol, Nimbex, Remifantyl are prescribed by the physician and given by continuous infusion. Meanwhile the use of wrist and finger restraints on agitated/confused patients is left to the nurse's discretion. In Kenya, there is no policy on physical restraints.

For quality improvement, this academic institution aims to ensure that the safety of the patient is fundamental. Incident reports are emphasised, and morbidity and mortality data collected to monitor patient outcomes. Quality indicators are determined, which in turn are used to measure the performance of care, and used as tools for clinical audits.

The following quality indicators were measured in 2006/2007 at the ICU related to this study (Hospital Records 2006:2):

- Days patients are endotracheal intubated
- Date and time of unplanned extubation
- Date and time of re-intubation

Unplanned extubation of patients is regarded as an adverse event at the ICU. Nurses are expected to complete an incident report form for a patient who has had unplanned extubation. The incident report form is then forwarded to the risk manager.

The risk manager analyses the data of the incidents report form. The analysis is done by the total number of unplanned extubations over the total number of intubated patients during that period. These reports are then forwarded to the ICU on a quarterly basis. Based on the findings of the reports for 2006 and 2007, unplanned extubations ranged between three and nine percent of the total intubated patients.

Table 1.2 summarises the incident reports on unplanned extubation received from the risk manager in 2006 and 2007.

Table 1.2   Summary of incident reports of unplanned extubation at the ICU

Year	Total number of patients	Total number of intubated patients	Number of unplanned extubations reported	Percentage of unplanned extubation
2006	500	185	7	3.7%
2007	450	172	16	9.3%
2006/2007combined	950	357	23	6.4%

Source: Hospital ICU and Risk Manager Records (2006/2007)

According to table 1.2, a total of 23 patients had reported incidences of unplanned extubation; 3.7% of total intubated patients in 2006 and 9.3% of total intubated patients in 2007. The combined overall incidence rate for 2006/2007 was 6.4%.

The percentage formula used by the risk manager is as follows:

$$\frac{Total\ number\ of\ unplanned\ extubation}{Total\ number\ of\ intubated\ patients} \times 100 = Percentage\ of\ unplanned\ extubation$$

In the researcher's experience, however, the rate could be higher, as not all unplanned extubations are reported. Moreover, all reported unplanned extubations are reported as accidental extubation and there is no differential data available between accidental and deliberate extubation. Data collected on the incidents report form revealed no reports on the risk factors associated or the outcome of the unplanned extubation. There is also no data on the nursing workload or the ICU acuity collected at the time of the incident of unplanned extubation.

Risk factors in unplanned extubation include physical restraint use, sedation, improved levels of Glasgow Coma Scales, patients with medical problems, patient workload and nursing experience (Curry, Cobb, Kutash & Diggs 2008:46; Krinsley & Barone 2005:564; Yeh, Lee, Ho, Chiang & Lin 2004:255; Moons, Sels, De Becker, Geest & Ferdinande 2004:1348).

In Canada, Ayman, Ron and Claudio (2006:74) found no association between nursing workload and rates of unplanned extubation. In fact, their 1.1% rate of unplanned extubation was even lower than other reported studies.

1.2.4.2   *Nursing staff in the ICU*

In 2004, the nursing department of the academic institution introduced a clinical career ladder, using the Benner (1984:5) model, which ranges from novice to expert nurse according to the nurses' clinical experience. The novice nurse is a nurse who has only educational knowledge and no clinical experience; the advanced beginner is a nurse with two years' clinical experience; the competent nurse has four to six years' clinical experience; the proficient nurse has six to eight years' experience and the expert nurse has more than eight years' experience in nursing.

A total of 30 nurses were allocated to the ICU in 2006/2007. Of these, 24 were registered nurses (RN), two had a Baccalaureate of Science in Nursing (BScN) and four were enrolled community nurses (ECN). In 2008/2009, 26 were RNs, as two of the

ECN nurses had upgraded to RN, therefore only two were still ECN although these nurses were enrolled in the RN training programme (see table 1.3).

Table 1.3   ICU nurses in 2006/2007 with their training background

Clinical experience in ICU	RN	BScN	ECN	Total
Novice (less than 2years)	2			2
Advance Beginner (2 to 4 years)	8		2	10
Competent (4 to 6 years)	7		2	9
Proficient (6 to 8 years)	5	1		6
Expert (more than 8 years)	2	1		3
Total nurses	**24**	**2**	**4**	**30**

Source: Hospital ICU Staff Records (2006:2; 2007:2)

Table 1.3 lists the number of nursing staff with their qualifications during the study period from 2006 to 2007. Further analysis of table 1.3 shows that 6.6% of the nurses had less than 2 years' experience, 33.3% had 2 to 4 years' experience, 30% were competent nurses with 4 to 6 years' experience, 23.3% were proficient nurses with 6 to 8 years and 6.6% were expert nurses with over 8 years' experience as a nurse.

The nurses working in the ICU were not all critically trained nurses; some had been trained on the job while others had done formal critical care training. Table 1.4 shows the numbers of qualified nurses who had three to six months' critical care nursing training in 2006/2007 during the study period.

Table 1.4   Nurses who were critical care trained nurses in 2006/2007

	RN	BScN	ECN	Total
ICU training (certificate; 3 to 6 months' in-house training)	11	1	0	12

Source: Hospital ICU Staff Records (2006:2; 2007:2)

As shown in table 1.4, only 40% of ICU nurses had formal in-house training in ICU nursing in 2006/2007, while the remaining nurses had gained knowledge of caring for critically ill patients through experience by working in the ICU. The nurses' experience in ICU ranged between one and eighteen years. There was also a high turnover of nurses in ICU who left for better prospects either by going abroad or to different institutions in Nairobi. There was also a high demand for ICU nurses, both locally and abroad, with

better salaries and career growth (Riley et al 2007:1398). Every year an average of 20% of ICU nurses leaves the academic institution for the aforementioned reasons (Hospital Records 2007:3). Acquiring an experienced nurse for the vacated position is difficult therefore new recruits without ICU training or experiences are hired. By means of the "buddy" system, these nurses learn the skills required to care for critically ill patients from preceptors, who are experienced nurses, for a minimum of one month to three months during their orientation in ICU, after which they are allocated to care for critically ill patients.

All nurses in ICU undergo annual training and recertification of basic life support and advanced cardiac life support. The nurses work 12-hour shifts with six nurses on duty, and on days when nursing staff are either on sick leave or short-staffed, then temporary nurses who work in other ICUs in Nairobi are called on duty. Nurses work a maximum of three consecutive 12-hour shifts.

The Nurse Manager in the ICU is in charge of the administration of patients, nurses and doctors in ICU while the clinical practice educator is responsible for ensuring standardised orientation of newly employed nurses, teaching and assessing the knowledge, skills and competences of the ICU nurses, including intubations, suctioning techniques, care of the ventilator, basic life support, cardiac resuscitation, mouth care, skin care, care of arterial lines and blood glucose measurement. The ICU nurses at the academic hospital where this study was conducted were responsible for sedation protocol, ventilator care and weaning parameters of the ventilator. An ICU doctor was on call with 24-hour consultant cover. The physiotherapists working at the hospital assisted the ICU nurse in physiotherapy for critically ill patients.

There was a 1:1 ICU nurse-to-patient ratio for the first six to 12 hours after admission for a mechanically ventilated patient, thereafter the ratio was one nurse to two patients. All nurses in ICU undergo annual training and recertification of basic life support (BLS) and advanced cardiac life support (ACLS). These courses are internally recognised courses focusing on life-threatening emergencies. Six nurses are allocated to each 12-hour shift. When nurses are sick or on leave, there are staff shortages. Agency nurses who work in other ICU's in Nairobi are called to assist. The ICU nurse-to-patient ratio during the study period (2006/2007) was one nurse to one patient for the first six to 12 hours after

admission for a mechanically ventilated patient, and thereafter the ratio was one nurse to two patients.

The Nurse Manager in the ICU is in charge of the administration of patients, nurses and doctors in ICU while the clinical practice educator is responsible for ensuring standardised orientation of newly employed nurses, teaching and assessing the knowledge, skills and competences of the ICU nurses. Some of the competences regularly assessed are related to endotracheal intubations, endotracheal suctioning techniques, nursing care of the mechanically ventilated patient, BLS, ACLS, importance of mouth care and skin care in acute settings, care of arterial lines and blood glucose measurement. The ICU nurses at the hospital are responsible for administering analgesia/sedation and implementing the sedation protocol, overseeing the mechanical ventilator care and weaning patients from the mechanical ventilator. There is a medical doctor on call in the ICU with a 24-hour consultant available. The physiotherapists work in collaboration with the ICU nurse to ensure appropriate physiotherapy for the critically ill patients.

In September of 2006, oral intubation policy, sedation and nurse-led weaning process protocols were introduced by the ICU team which comprised the clinical director, ICU nursing manager, ICU team leader, clinical nurse instructor and the ICU doctors. The Ramsay Sedation Scale (1974) to control sedation levels and manage the haemodynamic parameters of patients in ICU is used in order to continuously assess sedated patients in ICU and patients' ability to be liberated from the mechanical ventilator (Curry et al 2008:45). The weaning process was led by the ICU nurse, following an assessment and prescription by an ICU doctor. This active participation in the care of critically ill and mechanically ventilated patients empowered and increased the ICU nurses' assertiveness. However, the rate of unplanned extubation appeared to have increased since the implementation of this policy and protocols although there had been no formal investigation into this perception.

The researcher observed the following challenges at the academic institution's ICU:

- The actual unplanned extubation rate was unknown, as not all unplanned extubations were reported as incidents, especially if the accidental extubation

happened during a nursing procedure or if the tube was dislodged from the trachea.

- An inadequate nurse/patient ratio of 1 to 2 which, in turn, led to uncompleted documentation and unreported incidents of unplanned extubation.

- The incident report form specified all unplanned extubation as accidental extubation only. The incident report indicated only immediate outcome and no follow-up data, whether there was need for re-intubation or any complications after the unplanned extubation.

- The incident report did not indicate how many days a patient had been endotracheal intubated, whether the patient was mechanically ventilated and on ventilation support, and the data was only analysed as a percentage of the total number of ventilated patients per month.

- Data was analysed as a percentage of total number of ventilated patients per month and the density of unplanned extubation (per 100 ventilated days) was unknown (Sadowski, Dechert, Bandy, Juno, Bhatt-Mehta, Custer, Moler and Bratton 2004:628).

Based on the background and the literature reviewed, it was evident that a clinical audit was necessary in order to identify the rates of unplanned extubation in the ICU of the selected hospital, and the predisposing risk factors leading to the unplanned extubation and outcome of patients. This study also wished to identify the timing and the primary nurses' experience in ICU when unplanned extubation occurred. The findings of this study should enable the ICU nurses to plan actions for the identified predisposing factors to decrease the rates of unplanned extubation in the ICU and thus increase patients' safety.

1.3   RESEARCH PROBLEM

Optimal care for critically ill, mechanical ventilation patients with best possible practices and outcomes is ensured by retaining the endotracheal tube till the patient gets better and is no longer required to be mechanically ventilated. Unplanned extubation is a potential risk to patients, and increases nosocomial infections and other complications, the length of stay in the ICU and health care costs (Curry, Cobb, Kutash & Diggs 2008:45). Yet positive patient clinical outcomes in endotracheal intubated mechanical ventilation cannot be expected when there is a lack of awareness of the actual numbers

of unplanned extubations, patients' and nurses' characteristics and the importance of reporting adverse events. The ICU nurse uses strategies to integrate the patient as a "whole person" (Benner 2004:188). The core practice of ICU nursing is achieving and sustaining the balance between these two.

The ACCN synergy model of patient care draws on the patient's and nurse's resources to match the patient's needs and characteristics with the nurse's competencies to achieve a positive clinical outcome. The model also provides guidelines for nurses in ICU to collect data on the patients, characteristics of mechanical ventilated patients and their needs thus allowing early identification of risk factors associated with unplanned extubation.

The problem was thus that the actual rates of unplanned extubation were not known, as not all incidences are reported and there was a need for clarity on whether the extubation was self-deliberate by the patient or accidental during nursing actions. The data on the current incident report form was vague with no details of whether a patient was on ventilator support and if weaning process had been commenced. There was also no follow-up of the incident report on the patient's condition and the final outcome. The nurses' workload and patients' acuity was not part of the data collected on the incident report.

The vague data on the incident report form, unreported cases and the perception of increased number of unplanned extubations therefore needed to be audited to improve the safety of intubated patients in ICU and the synergy between the patient, the nurse and the system in striving towards optimal care.

1.3.1 Research questions

The background and the reference to the AACN Synergy Model for Patient Care raised the following questions:

- What were the characteristics of the patients who had unplanned extubations?
- What were the characteristics of the nurse caring for the patient who had unplanned extubations?
- What were the contributory factors leading to unplanned extubation?

- What recommendations can be made to prevent unplanned extubations?

1.4   AIM OF THE STUDY

Based on the AACN Synergy Model for Patient Care, the overall aim of this study was to identify synergy between the characteristics of patients and the competencies of the nurse and the support of the system associated with unplanned extubation of patients in an ICU of a selected hospital in Kenya.

1.4.1   Research purpose

The overall purpose was to identify the characteristics of both patient and nurse associated with unplanned extubation, contributing factors associated with unplanned extubation, the nurses' experience in nurse and in the ICU, re-intubation rates and the final outcome of the patient.

1.4.2   Objectives of the study

With reference to patient and nurse characteristics described in the AACN Synergy Model for Patient Care, the research objectives of the study were to:

- Identify the characteristics of patients who had unplanned extubation.
- Identify the characteristics of the nurse responsible for the patient who had unplanned extubation.
- Identify the contributing factors leading to unplanned extubation.
- Make recommendations to enhance synergy in effort to prevent unplanned extubation.

1.5   SIGNIFICANCE OF THE STUDY

All health care workers, including ICU nurses, are concerned with safety of patients. One way of addressing this concern is by monitoring the clinical performance of care given to patients who were intubated and mechanically ventilated. One clinical performance measure identified by the researcher is to monitor the outcome of the intubated patient. The study therefore wished to identify gaps in the care of patients who

had been intubated and design interventions to further enhance the safety of patients who are mechanically ventilated. Patients who have unplanned extubation are further prone to complications such as premature discontinuation of mechanical ventilation, leading to respiratory acidosis, and the risks associated with re-intubation, such as aspiration pneumonia, nosocomial infections and increased stay in ICU. Skilled, knowledgeable and clinically competent nurses are required for the management of endotracheally intubated patients including for procedures, such as chest physiotherapy and suctioning of the endotracheal tube, clearance of oral and nasal secretions, oral care, positioning the patient, and changing the endotracheal tube tape. Weaning from the ventilator also needs vigilant care and frequent monitoring of the patient by the nurse. As sedation is decreased, the patient becomes more alert to the surroundings and discomfort from the endotracheal tube and could pull the tube out prematurely.

An additional challenge is during the weaning process. Weaning from the mechanical ventilator needs vigilant care and frequent monitoring of the patient by the nurse. As the sedation is decreased, the patient becomes more alert to the surroundings and discomfort from the endotracheal tube. The risk then increases for self-deliberate unplanned extubation.

This study will add to the existing body of knowledge on unplanned extubation; identify the characteristics of patients who had unplanned extubation; examine whether the contributing factors are identical to those in the literature in order to identify appropriate measures to reduce the rates of unplanned extubation. Planning and implementing actions to address these challenges may lead to decreased rates of unplanned extubation. This, in turn, will assist in designing inventions to further enhance the safety of patients and improve the quality of care rendered to patients in ICU.

The application of the AACN Synergy Model for Patient Care in this study will further assist in identifying risk factors associated with unplanned extubation; if there is need of change of any practice to reduce the rates of unplanned extubation and improve quality of care and safety of the patients.

The study will provide statistical evidence identifying the patients' and nurses' characteristics, nursing workload, formal training in critical care and years of nursing experience and their association with incidences of unplanned extubation.

The findings should highlight the importance of having nurses with formal critical care training in regard to the safety outcome of the patient.

1.6 DEMARCATION OF THE STUDY

The study was conducted at one ICU of the selected hospital in Nairobi, Kenya. The target population comprised all patients admitted to the ICU during January 2006 to December 2007 and the nurses who took care of them during admission. The respondents were all patients admitted to ICU in 2006 and 2007 who required intubation, the ICU nurses, and the primary nurses identified from the medical records. The data was collected retrospectively by means of document analysis. The analysis of the records was done using a clinical audit checklist developed to achieve the research aim and objectives of the study (see chapter 4).

1.7 CONCEPTUAL FRAMEWORK

The AACN Synergy Model for Patient Care was used as the conceptual framework for the study. This model focuses on ICU patient safety and outcomes, and the nurses' competences, skills and knowledge required to care for critically ill endotracheal intubated patients in ICU. The combined efforts of patients, nurses and the health care system in ICU promote and facilitate positive clinical outcomes.

Hardin and Kaplow (2005:5) define the AACN Synergy Model for Patient Care as "a patient-focused model centred on the core concept that the characteristics of patients and their families drive competences of the nurses who care for them". The model matches the patients' needs with the nurses' characteristics and competences. The patients' characteristics associated with critical events are resiliency, vulnerability, stability, complexity, resource availability, participation in care, participation in decision making, and predictability (Becker, Kaplow, Muezen & Hartigan 2006:131). Each characteristic exists on a continuum from low to high. The eight nurse's characteristics are clinical judgment, advocacy and moral agency, caring practices, collaboration, system thinking, response to diversity, clinical inquiry and facilitator of learning. Becker et al (2006:132) state that synergy occurs and optimal outcomes may result when the nurse's competences complement the patient's needs. Becker et al (2006:132) describe the AACN Synergy Model for Patient Care as congruent with outcomes derived from three sources, namely the patients, the nurses and the healthcare system.

The patient outcomes include functional changes, behavioural changes, trust, satisfaction, comfort and quality of life. Outcomes from nurses and nursing competences include physiological changes, presence or absence of complications, and goals of treatment achieved. The healthcare system outcomes are readmission rates, length of stay and cost utilisation per patient. The AACN Synergy Model for Patient Care specifically describes relevant aspects of nurse-patient, nurse-nurse and nurse-systems relationships. Therefore, it is important that the nurse in ICU address all three areas in order to provide excellent, safe, quality care to all patients in ICU and establish synergy between the patient, the nurse and health care system.

According to Hardin and Kaplow (2005:5), the AACN Synergy Model for Patient Care is an ideal patient-centred framework to organise the nurses' work and provide effective excellent quality care to the patients in ICU. The model describes the characteristics of patients, nurses and the health care system in which care is given as well as how patient care can be organised to ensure and provide patients' safety needs throughout the health care system.

This study focused on the patients' characteristics and outcomes and the nurses' competences associated with unplanned extubation in ICU. The researcher considered the model appropriate as a framework for patients' assessment, nurses' competences and collaboration within the health care system (see chapter 2 on the AACN Synergy Model for Patient Care).

1.7.1 Assumption underlying the study

Five of the assumptions of the AACN Synergy Model for Patient Care used as the conceptual framework to guide this study were applicable to this study, namely

- Patients can be described by the number of characteristics that connect and contribute to each other. Characteristics cannot be looked at in isolation.
- Nurses can be described on a number of dimensions. The interrelated dimensions paint a profile of a nurse. The goal of nursing is to restore a patient to an optimal level of wellness as defined by the patient.

- The goal of nursing is to restore a patient to an optimal level of wellness as defined by the patient. Death can be a possible outcome, in which the goal of nursing care is to move patient and family towards peaceful death.
- Nurses may work to optimize outcomes for patients, patients' families, healthcare providers, and the healthcare system/organization.
- Nurses bring their background to each situation, including various levels of education/knowledge and skills/experience (Becker et al 2006:133).

As per the AACN Synergy Model for Patient Care assumptions the nurse in the ICU is expected to be knowledgeable, with right skills and competencies and to ensure that the critically ill patient has a safe passage through the healthcare system.

1.8   RESEARCH METHODOLOGY

The choice of appropriate research methods is essential (Bowling 2002:143). Therefore each study has its own research design and method, depending on the nature of the research.

Research methodology refers to "the techniques and methods that a researcher uses to structure a study and to gather and analyse information in a systematic fashion" (Polit & Beck 2004:15). According to Burns and Grove (2003:223), the research methodology encompasses "the entire strategy of the study from identification of the problem to the chosen methods of data collection". The research methodology is a blueprint for the intended research process. It describes the kind of tools and procedures that will be used, the specific tasks that need to be accomplished, the individual steps in the research process, and the methods that the researcher intends to guarantee reliability, objectivity, validity and freedom from personal bias(Mouton 2001:75).

1.8.1 Research design

Burns and Grove (2007:553) define a research design as "a blueprint for conducting a study that maximizes control over factors that could interfere with the validity of the findings, guides the planning and implementation of a study in a way that is most likely to achieve the intended goal". Polit and Beck (2008:765) add that the research design

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constitutes "the overall plan for addressing the research question, including specifications for enhancing the study's integrity".

A quantitative, descriptive, retrospective design was used to identify, describe and explore risks factors that were associated with unplanned extubation, using an audit method.

1.8.1.1   *Quantitative*

A quantitative design is aimed at describing variables and examining relationships. This approach also incorporates logistics and deductive reasoning as researchers will examine the data collected and draw generalisations from it. Macnee (2004:24) describes quantitative research as focusing "on understanding and breaking down different parts of factors of phenomena under study to see how they are connected".

1.8.1.2   *Descriptive*

Polit and Beck (2004:192) state that descriptive studies provide accuracy in that they describe what exists, the frequency with which it exists, assign new meaning to the phenomenon and put information into categories. Burns and Grove (2007:25) point out that descriptive research is an exploration and description of phenomena in real-life situations. Furthermore, descriptive studies have as their main objective the portrayal of that which is being studied; be it persons, situations or groups (Burns & Grove 2007:25).

1.8.1.3   *Retrospective*

A retrospective research design was chosen. According to Burns and Grove (2007:249), this is probably the best method to use as it focuses on a phenomenon that occurred in the past and its outcomes and also tries to ascertain the contributing factors that may have caused it. LoBiondo-Wood and Haber (2006:247) point out that "the additional benefit of a retrospective design is that it offers a higher level of control".

1.8.2 Research methods

Polit and Beck (2008:765) describe research methods as the techniques used to structure a study and to gather and analyse information in a systematic fashion. The research method is a process that includes specific steps linked logically to investigate the phenomenon under study (Burns & Grove 2007:28).

1.8.2.1 *Population*

Burns and Grove (2007:40) define a population as "all the elements, individuals, objects, events or substances that meet the study criteria". Polit and Beck (2004:289) refer to a population as "the entire aggregation of cases that meet specific criteria".

In this study the population referred to all the patients admitted to ICU between 1 January 2006 and 31 December 2007 and all the nurses caring for patients who were intubated during this period (see chapter 4).

1.8.2.2 *Sample*

Polit and Beck (2004:291) define a sample as a "subset of population elements". The elements are the basic units and can either be people, objects or individuals about which information is collected for a study (LoBiondo-Wood & Haber 2006:263).

In this study, the researcher used purposive and convenience sampling by selecting patients who were admitted to ICU from 1 January 2006 to 31 December 2007, and who required intubation. The purposive method of sampling assisted the researcher identifying the medical records of the patients who met the following criteria:

- Patients admitted into ICU from 1 January 2006 to 31 December 2007.
- Patients who required endotracheal intubation.
- Patients who were intubated for more than six hours.
- Nurse caring for the patient when unplanned extubation occurred.

1.8.3 Data collection

Polit and Beck (2004:36) describe data collection as the method used to gather pieces of information required to conduct the research. According to Burns and Grove (2007:41), data collection is "the precise, systematic gathering of information relevant to the research". Furthermore, the research objectives in a quantitative study must be accomplished by the data collected (Burns & Grove 2007:41).

1.8.3.1 *Data-collection instrument*

In this study, the data-collection instrument used was a clinical audit checklist. The clinical audit checklist was developed to obtain the study objectives of identifying patients' and nurses' characteristics of unplanned extubation. Ideas were obtained from previous studies of self- deliberate extubation conducted by Curry et al (2008:45) and Moon et al (2004:1350). With input from the ICU consultant, nursing manager and clinical practice educator, the clinical audit checklist was modified to include all unplanned extubation; both self-deliberate and accidental, the nurses' educational background, their nursing and ICU experience and presence at the bedside. The clinical audit checklist was further modified with input from the study leaders. The clinical audit checklist was divided into the following sections:

Section A: Patient's profile
Demographic data of patient, age, gender
Medical history, intubation

Section B: Patient's intubation and treatment history
Days intubated, ventilation and unplanned extubation
Use of sedation, neuromuscular, analgesics and physical restraints
Condition of the patient, outcome of patient

Both these sections were based on the literature review and the conceptual framework used for the study, namely the AACN Synergy Model for Patient Care, to obtain the patients' characteristics.

Section C: Nurse's characteristics

Nurses' workload, highest nursing education of primary nurse, critical care training, experience as nurse and in ICU.

This section was based on the AACN Synergy Model for Patient Care to obtain the nurses' characteristics and workload.

1.8.3.2   Reliability of the instrument

Reliability refers to the extent to which a measure can be relied on consistently to give the same result if the aspect being measured is not changed (Macnee 2004:167). In this study, internal consistency and equivalence were relevant aspects of reliability. An instrument is said to be reliable if all the sub-parts measure the same characteristics in repeated administration of the same instrument (Macnee 2004:173).

To ensure reliability, only questions relevant to the subject of the investigation were included in order to enhance the reliability of instrument. In addition, the clinical audit checklist was used for a pre-test on records of ten patients and comparison scores measured thus further enhancing the stability of the instrument.

1.8.3.3   Validity of the research instrument

Validity refers to the ability of the instrument to measure correctly and accurately what it was intended to measure (Macnee 2004:168). Content validity, which is a concern of sampling adequacy of the items being measured, was enhanced by the literature review on unplanned extubation (Curry et al 2008:47; Moons et al 2004:1350). The instrument was sent to the study supervisors and a group of ICU staff for review and comment. Three anaesthetists and three critical care nurses with five and ten years' experience evaluated and documented the content validity of the clinical audit checklist.

They identified important items of primary nurse location at the time of unplanned extubation which were subsequently included in the clinical audit checklist.

1.8.4 Data analysis

Data analysis refers to putting information into constituent parts to obtain answers to the questions, test the hypothesis and present a clear picture of the information collected (Macnee 2004:21).

In this study, a statistician at the institution analysed the data using the Statistical Package of Social Sciences (SPSS) version 13 and the Excel (Microsoft Office version 2007) computer program. Frequency tables with accompanying percentages were used to gain insight into distributions of patients' and nurses' characteristics. These methods of data analysis were used because the study wished to identify and describe the patients' and nurses' characteristics in association with unplanned extubation.

1.8.4.1 Pre-testing of the research instrument

Polit and Beck (2004:727) refer to pre-testing of a research instrument as "a small-scale version, or trial run, done in preparation for the major run".

In this study, the clinical audit checklist was tested on medical records data of ten patients who were intubated in 2006. The data collected during the pre-test were then analysed carefully to determine whether or not they answered the research questions. The results were used to modify the clinical audit tool (see chapter 5). These patients were not included in the statistics of the main study.

1.9 ETHICAL CONSIDERATIONS

Ethical standards and measures direct research in order to ensure high standards,. Burns and Grove (2001:191) emphasise that in order to maintain a high standard of research, "the conduct of nursing research not only requires expertise and diligence but also honesty and integrity". In addition, ethical research is essential to generate sound knowledge for practice. Polit and Beck (2004:90) point out that ethical guidelines are set to direct researchers.

This study was non-therapeutic research which Burns and Grove (2007:199) describe as "conducted to generate knowledge for a discipline; the results of the study might benefit future patients but probably will not benefit those acting as research subjects". The three ethical principles which guide any study are respect for persons, beneficence and justice (Burns & Grove 2007:201) (see chapter 4).

As this study was a retrospective audit of past medical records of patients, informed consent from both patients and nurses was not necessary. The researcher respected the subjects by protecting their privacy, not disclosing the information for other than its intended use for this study. Permission to conduct the study was requested and obtained from the Research and Ethics Committee of the hospital (see Annexure A) and the Ethics and Research Committee of the University of South Africa (UNISA) (see Annexure B). Moreover, the rights of the hospital were protected by not disclosing the name.

1.10   SCOPE AND LIMITATIONS OF THE STUDY

The study was conducted in only one ICU in a selected hospital in Nairobi, Kenya consequently the findings cannot be generalised to any other ICU in the country. In addition, the study was retrospective, which meant that the data were obtained from patients' medical records and could not give the true nurses' workload or patients' activities at the time of unplanned extubation. Finally, although used and approved for nursing practice, the AACN Synergy Model for Patient Care has not been tested for reliability and validity in the developing world or Kenya.

1.11   DEFINITIONS OF TERMS

For the purposes of this study, the following terms were used as defined below:

- **Intubated patient**

Intubation refers to a procedure of inserting a tube directly into the trachea. The endotracheal tube may be placed through the nose or mouth (St Jones 2004:93).

A patient is "a person receiving medical treatment" (*Collins Dictionary and Thesaurus* 2002:553).

For the purpose of this study, an intubated patient refers to a critically ill patient for whom an endotracheal tube was inserted either orally or nasally to maintain a patent airway and/or assist with mechanical ventilation in order to promote adequate gas exchange in a selected ICU in a hospital in Nairobi.

- **Unplanned extubation**

Unplanned refers to "not intended to or unintentional" (*The American Heritage Online Dictionary of English Language* 2009:1).

Extubation refers to "the removal of a previously inserted tube used for respiratory support or gastric feeding" (McGraw-*Hill Concise Online Dictionary of Modern Medicine* 2002:1).

Moons, Sels, De Becker, De Geest and Ferdinande (2004:1349) define unplanned extubation as "a process of premature removal of the endotracheal tube either by action of the patient that is self-deliberate extubation or accidental extubation; premature removal during nursing procedure and manipulation of the patient".

For the purpose of this study, unplanned extubation refers to either accidental extubation during nursing care, procedure or movement and self-deliberate by the patient by either pulling or coughing out the tube.

- **Intensive care unit (ICU)**

Webster's New College Online Dictionary (2009:1) defines intensive as "increasing or causing to increase in degree or amount; of or characterised by intensity; thorough, profound, and intense; concentrated or exhaustive".

Care is defined as "the services rendered by members of the health professions for the benefit of a patient" (*Dorland's Medical Online Dictionary for Health Consumers* 2007:1).

Unit is defined as "an area of a hospital that is staffed and equipped for treatment of patients with a specific condition or other common characteristics" (*Mosby's Medical Online Dictionary* 2009:1)

An intensive care unit (ICU) is a hospital unit in which patients requiring close monitoring and intensive care are kept. An ICU contains highly technical and sophisticated monitoring devices and equipment and is staffed by personnel trained to deliver critical care. A large tertiary care facility usually has separate units specifically designed for the intensive care of adults, infants, children, or newborns or for other groups of patients requiring certain kinds of treatment (Online *Mosby's Medical Dictionary* 2009:1).

For the purpose of this study, the ICU is a speciliased unit equipped with high technological equipment in which critically ill or injured patients are admitted.

- **Quality indicator**

Mitchell (2005:1) defines quality as "an optimal balance between possibilities realized and a framework of norms and values".

An indicator is "a measuring instrument or show of reading" (*Collins English Dictionary* 2002:392).

A quality indicator refers to "a quantitative measure that can be used to monitor and evaluate the quality of important governance, management, clinical, and support functions that affect patients' outcomes" (Mainz 2003:524). In this study, a quality indicator referred to a nursing measurement tool for quality of care in ICU also known as a clinical indicator, which is a measure which monitors outcomes of endotracheal intubated patients. The relevant measures were unplanned extubation and re-intubation rates.

- **Adverse event**

Adverse is defined as "unfavourable or antagonistic or hostile" (*Collins English Dictionary* 2002:14).

An event is defined as "occurrence, episode, happening" (*Collins English Dictionary* 2002:264).

An adverse event refers to injuries or events that are due to health care management rather than underlying disease and that result in prolonged hospitalization or some disabilities (Choboyer, Thalib, Foster, Ball & Richards 2008:255).

For the purpose of this study, the adverse events are also known as incidents to the patient, which are recorded in a tool known as an incident report form and forwarded to the risk manager. Incidents reported in the ICU pertaining to this study are accidental extubation and re-intubation rates.

- **Nurses**

A nurses is a "person educated and licensed in the practice of nursing, one who is concerned with" the diagnosis and treatment of human responses to actual or potential problems" (*Mosby's Medical Online Dictionary* 2009:1).

In this study, nurses refers to those who have been trained as RN, BScN, ECN, and critical care nurse and have been licensed by NCK to practise nursing.

An RN or BScN is a nurse who has undergone either a diploma training which is 3 years or a degree in nursing which is 4 years of training in the University, and passes the prescribed exams sat by the Kenyan Nurses Council. In order to qualify for intake the graduate should have achieved above B in the final examination of Form IV or A levels.

The ECN is a nurse who has undergone 2 years of formal training at a community hospital and sits for the nursing council exams. The nurse has achieved below B and above D+ [average] in the final examinations of the Form IV.

A critical care nurse is one has undergone formal training in critical care after the basic nursing diploma/degree training.

- **Glasgow Coma Scale**

The Glasgow Coma Scale (GCS) refers to a "patient assessment tool for evaluation of three categories, eye opening, verbal response and motor response" (Urden, Stacy & Lough 2002:647).

For the purpose of this study, the GCS referred to neurological assessment done to assess the consciousness by checking the pupils for reaction, response to verbal commands and motor response of the limbs.

- **Sedation**

Sedation refers to "an act of calming by administration of sedation. Sedation is a medication that commonly induces the nervous system to calm, induces sleep and minimizes anxiety" (Hosfo & Coyer 2007:250).

For the purpose of this study, sedation refers to medication given to induce calmness and sleep used on patients who are intubated.

- **Ramsay Sedation Scale**

The Ramsay Sedation Scale (RSS) was the first scale to be defined and was designed as a test of rousability. The RSS scores sedation at six different levels, from level 1; patient is restless, agitated or confused, through a continuum of sedation to level 6 where patient is unresponsive. It is an intuitively obvious scale and therefore lends itself to universal use, not only in the ICU, but wherever sedative drugs or narcotics are given (Stawick 2007:10).

For the purpose of this study, the Ramsay sedation scale is used in all patients receiving sedation from level I where patient is anxious, restless or confused to Level 6 where patient is unresponsive.

- **Physical restraints**

Physical is defined as "of relating to the body as distinguished from mind or sprit or relating to material things" (*The American Heritage Medical Online Dictionary* 2007:1).

Restraint is defined as "something that restrains or controls" (*Collins English Dictionary* 2002:649).

Restrain is defined as "hold (someone) back from action" (*Collins English Dictionary* 2002:649).

Physical restraints refer to "a mechanical means applied on the patient in order to interfere with his/her mobility, including vest, waist ,wrist and ankle restraints to restrict free movement of patients with behavioural or physical problems, who may cause harm to themselves or others" (Laurin, Voyer, Verreauk & Durand 2004:5).

For the purpose of this study, physical restraints refer to cloth devices used to restrict patient movement by tying one or both of the patient's wrists to the side of the bed rails or cover the patient's fingers with a cotton bandage to prevent self-harm or treatment interference. This is also done to prevent semi-conscious patients from self-extubation.

1.12 OUTLINE OF THE STUDY

The dissertation consists of six chapters:

- Chapter 1 briefly discusses the purpose, objectives, research design and methodology of the study and defines key words.

- Chapter 2 describes the conceptual framework used for this study.

- Chapter 3 covers the literature review conducted for the study.

- Chapter 4 describes the research methodology, including the validity and reliability of the research instrument, ethical considerations and limitations of the study.

- Chapter 5 discusses the data analysis and interpretation, and the findings, with reference to the literature review.

- Chapter 6 presents the conclusions of the study and makes recommendations for practice and further research.

1.13 CONCLUSION

This chapter outlined the background to the study, including a brief description of Kenya, the hospital under study and the ICU where the study was conducted. The purpose, objectives and significance of the study, research design and methodology, and ethical considerations were discussed, key terms defined, and an outline of the study presented.

Chapter 2 discusses the conceptual framework of the study.

CHAPTER 2

Conceptual framework

2.1   INTRODUCTION

A conceptual model is a set of abstract related constructs that broadly explains the phenomenon of interest, expresses assumptions, and reflects a philosophical stance (Burns & Grove 2005:128). According to Polit and Beck (2004:115), a conceptual framework or model represents a less formal attempt at organising phenomena than theories.

Conceptual models provide an infrastructure that decreases variations among nurses as well as the interventions they would choose to improve patient outcomes. Conceptual models that guide practice act as guardrails that keep an organisation focused on its core mission of care giving (Kerfoot, Lavandero, Cox, Trola, Pacini & Hanson 2006:21). The conceptual framework or model supports safe, high quality care, treatment and services. Consistency among nurses is developed and maintained because orientation, continuing education, performance evaluation, speciality certification, career advancement and future planning are directly related to that mission and the work that must be done to achieve successful patient outcomes (Kerfoot 2005:335). In research a conceptual framework forms a basis and guide to develop new knowledge that will contribute to practice (Green 2006:277).

In order to identify the characteristics of patients who had been accidentally unplanned extubated, it was necessary to identify and select a conceptual framework most appropriate to form the basis or framework of this study. Creswell (2003:127) maintains that a conceptual framework enables readers to clearly distinguish this section from other components of the research process and indicate how a chosen conceptual framework is used or relates to the study.

In this study, the researcher chose the AACN Synergy Model for Patient Care as a conceptual framework to form the basis from which the characteristics of the patient, the nurse and the system associated with unplanned extubation could be explained.

Chapter 1 briefly outlined the conceptual framework. This chapter describes and discusses the model as conceptual framework in relation to the characteristics of the patient, nurse and system associated with unplanned extubation (Kaplow & Reed 2008:17).

2.2   WHAT IS SYNERGY?

Synergy is defined as "a mutually advantageous conjunction or compatibility of distinct business participants or elements (as resources or efforts)" (*Merriam Webster's Online Dictionary* 2007:1). Synergy is an evolving phenomenon that occurs when individuals or groups work together utilizing innovative, grounded and holistic thinking towards a common goal (Curley 1998:64).

The AACN Synergy Model for Patient Care reflects nursing care that integrates knowledge, skills, experience and attitudes to meet the needs of patients and families (Ecklund & Stamp 2002:60). The model sets a clear path to identify patients' unique care needs, the competencies nurses require to meet those needs and the qualities of the environment where they do so. Conversely, the absence of synergy results in unsafe care such as, for example, accidental extubation of a patient, implying that a safe passage through the healthcare experience can no longer be ensured. The AACN Synergy Model for Patient Care specifically describes relevant aspects of nurse-patient, nurse-nurse, and nurse-system relationships (Curley 2004:64).

2.3   AACN SYNERGY MODEL FOR PATIENT CARE

The American Association of Critical Care Nurse Certification (AACN 1998:64) designed a model that described nursing practice based on the needs and characteristics of patients and the channels that the healthcare system or the environment predicted for the future. If patients' characteristics and nurses' competencies match and synergise, the result is optimized patients' outcomes. Optimal outcomes are evaluated based on those derived from the patient, the nurse and the healthcare system. This model is

known as the "AACN Synergy Model for Patient Care" (Curley 1998:64). The AACN Synergy Model for Patient Care is widely accepted as a viable model for professional nurses (Kaplow & Hardin 2007:3). The model is simple, identifies the patient as the central focus, describes the patient's needs and the skill required by the nurse to best meet these needs (Kaplow & Hardin 2007:3).

Although the model has been theoretically validated, its use in practice continues to evolve. The model also provides a functional approach to educational programming and development that transcends customary approaches to nursing education and broadens the ability to respond to the needs of patients and their families (Kaplow & Hardin 2007:8).

The AACN Synergy Model for Patient Care is congruent with the outcomes derived from three sources, namely the patients, nurses, and the healthcare system. It can be applied in various ways to foster the development of nurses' competencies and to ensure an optimal match to the individual needs of a patient. It matches the patients' needs and characteristics with the nurses' competencies as well as the contribution of the healthcare system to reach synergy of care.

The AACN Synergy Model for Patient Care enables the nurse in the critical care unit to identify the unique needs of individual patients and the characteristics of the nurse and the healthcare system. It also enables the unit manager to describe how these patients' unique needs can be met, what competencies and technical skills of the nurse are required, and the healthcare environment in which the nurse will practise to meet the needs of the critical ill patients. A synergy between the patient-nurse and the healthcare system will result in safe care and satisfaction of the patient and family. The absence of the required synergy will result in unsafe practices and adverse events (Kaplow & Reed 2008:19).

Figure 2.1   The AACN Synergy Model for Patient Care
Source: Curley (1998:69)

2.3.1 Patient characteristics

Nursing practice is based on eight patient characteristics and spans the health-illness continuum (Kaplow & Reed 2008:19). The patients' characteristics consistently associated in critical events are resiliency, vulnerability, stability, complexity, resource availability, participation in care, participation in decision-making and predictability. Each characteristic exists on a continuum from low to high (Hardin & Kaplow 2005:4).

2.3.1.1 Resiliency

Resiliency refers to the ability of a person to recover easily and quickly from shock, illness, injury, or hardship. Resiliency is patients' capacity to return to a restorative level of functioning using a compensatory coping method. The level of resiliency assessed in

patients often depends on their ability to rebound after an insult. This ability can be influenced by several factors including age, co-morbidities, and compensatory mechanisms intact (Kaplow & Reed 2008:19).

The use of a resiliency scale reveals a positive relationship between resiliency and physical health, morale and life satisfaction, and a negative relationship with depression (Hardin & Kaplow 2005:14) (see table 2.1).

Table 2.1   Resiliency

Level 1	Level 3	Level 5
Minimal resiliency Unable to mount a response Failure of compensatory/coping mechanisms Minimal reserves and brittle	Moderate resiliency Able to mount a moderate response Able to initiate some degree of compensation and moderate reserves	Highly resiliency Able to mount and maintain a response Intact compensatory/coping mechanisms, strong reserves and patient has endurance

Source: AACN Certification Cooperation (2006:2)

As shown in table 2.1, the patient with minimal resiliency is unable to mount a response and has less coping mechanisms, while a patient with high resiliency has strong coping mechanisms.

According to this assumption, patients with high resiliency in ICU are able to mount and maintain a response, and to cultivate strength to meet challenging situations or conditions, while patients with low resiliency are very brittle and fail to mount and maintain response to critical illness (Hardin & Kaplow 2005:14).

2.3.1.2 Vulnerability

Kaplow (2003:27) defines vulnerability as "susceptibility to actual or potential stressors that may adversely affect patient outcome". This outcome can be impacted by patients' physiological and psychological characteristics of health behaviours. Vulnerability is the level of susceptibility to actual or potential stressors that may adversely affect patient outcomes.

The patient is also affected by the competency of the nurse. A slow response from the nurse makes the patient more vulnerable. Vulnerability can be impacted by the patient's physiological characteristics and health behaviours (Kaplow 2003:27).

Table 2.2   Vulnerability

Level 1	Level 3	Level 5
Highly vulnerable Susceptible Unprotected and fragile	Moderately vulnerable Somewhat susceptible Somewhat protected	Minimally vulnerable Safe; out of the woods Protected and not fragile

Source: AACN Certification Cooperation (2006:2)

As shown in table 2.2, a highly vulnerable patient is susceptible to more stressors compared to the patient with moderate and minimal vulnerability. A patient with minimal vulnerability has a chance of safe outcomes while one with high vulnerability, who has high levels of stressors, is very liable to unpredictable outcomes.

A patient can be vulnerable just by being admitted to the ICU. McKinley, Nagy, Stein-Parbury, Bramwell and Hudson (2002:27) found that the feeling of vulnerability diminished when the care they were about to receive was explained to patients in the presence of their families and relatives.

2.3.1.3 Stability

Stability is the quality, state, or degree of being stable (*Merriam Webster Online Dictionary 2007:1*). Stability refers to the patients' ability to maintain a steady state of equilibrium (see table 2.3). Response to therapies and nursing interventions can impact the stability of the patient (Hardin & Kaplow 2005:5).

Table 2.3   Stability

Level 1	Level 3	Level 5
Minimally stable Labile Unstable Unresponsive to therapies High risk of death	Moderately stable Able to maintain steady state for limited period of time Some responsiveness to therapies	Highly stable Constant Responsiveness to treatment and low risk of death

Source: AACN Certification Cooperation (2006:2)

As shown in table 2.3, patients who are minimally stable are unstable, respond poorly to treatment while patients with high stability respond well to treatment, have good outcomes and low risk of complications. Hardin and Kaplow (2005:23) state that patients' level of stability during hospitalisation has been used to predict morbidity and mortality rates.

2.3.1.4   Complexity

Complexity is the intricate entanglement of two or more systems. Systems refer to either physiological or emotional states of the body, family dynamics or environmental interaction with the patient. The more systems involved, the more complex the patterns displayed by the patient (Hardin & Kaplow 2005:5).

Table 2.4   Complexity

Level 1	Level 3	Level 5
Highly complex Intricate Complex patient/family dynamics Ambiguous/vague Atypical presentation	Moderately complex Moderately involved patient and family dynamics	Minimally complex Straightforward Routine patient/family dynamics Simple/clear cut Typical presentation

Source: AACN Certification Cooperation (2006:2)

Based on the AACN Synergy Model for Patient Care, a level 1 patient is highly complex and intricate and has complex patient family dynamics. A level 3 patient is moderate while a level 5 patient is simple, uncomplicated, has a clear-cut presentation and has routine family dynamics (Hardin & Kaplow 2005:28).

2.3.1.5 Resource availability

Resource availability refers to "the extent of resources brought to the situation by the patient, family and community" (Brewer, Wojne-Alexandro, Triola, Pacini, Cline, Rust and Kerfoot 2007:158). The resources can be present as technical, fiscal, personal, psychological, social, or supportive in nature. The more resources a person brings to the healthcare situation, the greater the potential for a positive outcome (Hardin & Kaplow 2005:5).

Table 2.5   Resource availability

Level 1	Level 3	Level 5
Few resources Necessary knowledge and skills are not available Necessary financial support not available Minimal personal/psychological supportive resources Few social resources	Moderate resources Limited knowledge and skills available Limited financial support available Limited personal/psychological supportive resources Limited social systems resources	Many resources Extensive knowledge and skills available and accessible Financial resources readily available Strong personal/psychological supportive resources Strong social systems resources

Source: AACN Certification Cooperation (2006:2)

A patient's clinical situation can be impacted by availability of resources, such as personal, financial, social, psychological, and technical. Limited availability of resources can constrain a patient's recovery from a critical illness (Hardin & Kaplow 2005:34).

2.3.1.6 Participation in care

Participation in care is the participation by the patient and family engaged in the delivery of care. Patient and family participation can be influenced by the patient's educational background, resources availability and cultural background (Hardin & Kaplow 2005:5).

Table 2.6   Participation in care

Level 1	Level 3	Level 5
No participation Patient and family unable or unwilling to participate in care	Moderate level of participation Patient and family need assistance in care	Full participation Patient and family fully able to participate in care

Source: AACN Certification Cooperation (2006:2)

Table 2.6 indicates that the patient participation in care depends on the level of the patient and family. In level 1 both the patient and family are either unable or unwilling to participate in the care; in level 3 there is moderate level of participation by patient and family, and in level 5 there is full patient and family participation in care.

Participation in care reduces anxiety, enhances decision-making and quality of life, and increases patients' satisfaction (Curley 1998:66).

2.3.1.7 Participation in decision-making

Participation in decision-making is the level of engagement of the patient and the family in comprehending the information provided by healthcare providers and acting upon this information to execute informed decisions. Patient and family engagement in clinical decisions can be impacted by patients' knowledge level, their capacity to make decisions given the insult, their cultural background and their inner strength during crisis (Hardin & Kaplow 2005:5).

Table 2.7   Participation in decision-making

Level 1	Level 3	Level 5
No participation Patient and family have no capacity for decision making Require surrogacy	Moderate level of participation in decision making Patient and family have limited capacity Seek inputs/advice from others	Patient and family have capability Make own decisions

Source: AACN Certification Cooperation (2006:2)

Saino, Lauri and Erickson (2001:97) found that factors that impaired patients' participation in decision-making included poor health, ignorance, anxiety, and age; time pressures from the staff; high staff turnover, and poor interactive relationships between nurse and patient.

2.3.1.8 Predictability

Predictability is the characteristic that allows people to expect a certain course of events or course of illness (Hardin & Kaplow 2005:5). Use of clinical pathway and weaning protocols enhance efficiency, decrease costs and improve quality and outcome of care (Hardin & Kaplow 2005:51).

Table 2.8   Predictability

Level 1	Level 3	Level 5
Not predictable Uncertain, uncommon patient illness Unusual or unexpected course Does not follow the critical pathway or no critical pathway developed	Moderately predictable Wavering Occasionally noted patient population/illness	Highly predictable Certain Common population/ illness Usual and expected course Follows critical pathway.

Source: AACN Certification Cooperation (2006:2)

In ICU, use of clinical guidelines such as intubation, weaning and sedation protocols and informed consent all assist in achieving the maximum level of safety of patients.

2.3.2.9 Summary of patient characteristics

The eight patients' characteristics of the AACN Synergy Model for Patient Care, namely resiliency, vulnerability, stability, complexity, resource availability, participation in care, participation in decision making and predictability, are connected and contribute to each other and cannot be looked into isolation (Kaplow & Reed 2008:20). These characteristics are the needs of the patients and exist in a continuum of low, moderate and high. According to Becker et al (2006:131), on a 5-point Likert scale to rate patient characteristics, the level 1 patient is the most compromised; the level 3 patient is

moderately compromised, and the level 5 patient is the least compromised. Becker et al (2006:131) add that "depending on the needs of the patient, certain competencies of nurses providing care to critically ill patients and their families are required".

This study did not focus in detail on the above patients' characteristics in patients who had unplanned extubation, but was rather a clinical investigation and focused on the risk factors and nurses' competences associated with unplanned extubation.

2.3.2 Nurses' competencies

The eight nurses' characteristics or competences required are clinical judgment, advocacy and moral agency, caring practices, collaboration, systems thinking, response to diversity, clinical inquiry and facilitator of learning (Hardin & Kaplow 2005:4).

The AACN Synergy Model for Patient Care defines the competences and leads to the ability to capitalise on nurses' individual strengths and to match those strengths to patients' needs. Although the model has been theoretically validated, its use in practice continues to evolve. It also provides a functional approach to educational programming and development that transcends customary approaches to nursing education and broadens the ability to respond to the needs of patients and their families (Kaplow & Hardin 2007:8).

Table 2.9   Nursing competencies at different levels of clinical experience according to the AACN Synergy Model for Patient Care

Level 1: competence	Level 3: proficient	Level 5: expert
0 to 2 years to maximum of 5 years of clinical experience with certain population of patients. Stage of experience development, performance is based on goals, principles, protocol and guidelines.	Generally more than 2 to 3 years of clinical experience with certain population of patients. Nurse is in experiential development stage; makes decision based on concrete experience, can tailor specific responses to individual patients. Nurse is flexible, can focus on future learned trajectories, can anticipate in familiar situations. The nurse notices subtle changes in patients and takes a stand in a situation, acts as an agent for the patient and the patient's family.	More than 5 years of clinical experience with certain population of patients. The nurse progresses from experiential development to proficiency. Has exceptional, intuitive, immediate grasp of clinical situation and what is best for specific situation. Nurse is highly attuned and able to recognise and respond to any complex and difficult situation. Has strong moral agency, is fully involved and engaged with patient and family in a flexible way.

Source: Brewer, Wojne-Alexandro, Triola, Pacini, Cline, Rust and Kerfoot (2007:158)

As shown in the table 2.9; the nurses' competencies depend on the years of clinical experience and the individual nurses' clinical expertise and the number of years worked in a particular clinical setting. Brewer et al (2007:158) point out that when introduced to a new clinical setting or newly graduated, nurses will be at the level of an advanced beginner for six months as they gain knowledge of the new surroundings. At this level the nurse is enthusiastic, focuses on learning, with more attention to utilisation of protocols, principles, and has formal scientific knowledge to guide practice.

These nurses' characteristics or competences are further derived from the needs of individual patients and vary depending on the technical skills, knowledge and interpersonal skills and the healthcare system.

2.3.2.1   Clinical judgment

Clinical judgment is "the application of information based on actual observation of a patient combined with subjective and objective data that lead to a conclusion" (*Mosby's Medical Dictionary Online Dictionary* 2009:1).

Clinical judgement is the clinical reasoning utilised by the nurse in the delivery of care. It consists of critical thinking and nursing skills that are acquired through a process of integrating education, experimental knowledge and evidence-based guidelines. The integration of knowledge leads to clinical decisions made during the course of care provided to the patient (Hardin & Kaplow 2005:6).

According to Tanner (2006:204), clinical judgment is also known as clinical reasoning and refers to the processes utilised by the nurse in the delivery of care. It consists of critical thinking and nursing skills acquired though a process of integrating education, experimental knowledge and evidence-based guidelines.

It is important for a nurse in ICU to develop clinical expertise in solving patients' problems. To become expert in critical care nursing requires knowledge, competency and skills. Patient-centred care should be delivered through understanding the patient. Nurses should also know how to use the latest technology to ensure safe patient care. As a nurse gains experience in practice, clinical judgment is further honed. A level 1 nurse is capable of collecting and interpreting basic data. As nurses acquire more experience in caring for the critically ill, they develop clinical judgment and rely less on expert nurses' input (Green 2006:279; Hardin & Kaplow 2005:59).

2.3.2.2   Advocacy and moral agency

Advocacy refers to the act or processes of advocating or supporting a cause or proposal (*Merriam-Webster Online Dictionary 2009:1)*.

Moral agency is a person's capacity for making ethical judgments (AACN 2008:39).

Advocacy means working on another's behalf when the other is not capable of advocating for him- or herself. The nurse serves as a moral agent in identifying and helping to resolve ethical and clinical concerns in the clinical setting (Hardin & Kaplow 2005:6).

The role of nurses as patients' advocates requires commitment, caring, compassion, integrity, competence, spirit of inquiry, confidentiality, responsibility, values-based decision making and respect of person (ICN 2006:1).

Based on the tenets of the AACN Synergy Model for Patient Care, a nurse at level 1 competency works on behalf of the patient, begins to self-assess personal values, and is aware of patients' rights and ethical conflicts. A level 3 nurse considers the patients' values and incorporates these into the care, even if these values differ from her own. At level 5 nurses are capable of advocating for the patient, family and community, irrespective of whether their personal values are congruent with the client's (Hardin & Kaplow 2005:66).

2.3.2.3 Caring practices

Caring practices are the constellation of nursing interventions that create a compassionate, supportive and therapeutic environment for patients and staff, with the aim of promoting comfort and healing and preventing unnecessary suffering. Caring behaviours include compassion, vigilance, engagement and responsiveness to the patient and family (Hardin & Kaplow 2005:6).

The five 'Cs' of caring are compassion, competence, confidence, conscience, and commitment. According to the AACN Synergy Model for Patient Care, creating a compassionate and therapeutic environment for promoting comfort and prevent suffering is the purpose of caring practices. Anticipating hazards and promoting safety, care and comfort throughout transitions along the healthcare continuum is competence (Hardin & Kaplow 2005:71). A level 1 nurse focuses on patients' basic needs without anticipating future needs. A level 3 nurse responds to subtle patient changes in a compassionate manner. A level 5 nurse has developed heightened awareness that allows her to interpret the needs of patient and family and promotes dignity in the care provided (Green 2006:279; Hardin & Kaplow 2005:72).

2.3.2.4 Collaboration

Collaboration refers to the nurse working with others to promote optimal outcomes. The patient, family and members of various healthcare disciplines work towards promoting optimal and realistic patient goals (Kaplow &Reed 2008:22; Hardin & Kaplow 2005:77).

Collaboration is a developmental process that occurs and matures over time. Collaboration relationships are less effective in high usage of temporary staff. Level 1 nurses are willing to be taught, coached and mentored. Level 3 nurses seek opportunities to be taught, coached and mentored, elicit others' advice and perspectives; initiate and participate. Level 5 nurses seek opportunities to teach, coach, and mentor and facilitate active involvement and complementary contributions from others (Kaplow & Reed 2008:22; Green 2006:280).

2.3.2.5 Systems thinking

Systems thinking comprises the tools and knowledge that the nurse utilises to recognise the interconnected nature within and across the healthcare or non-healthcare system. The ability to understand how one decision can impact the whole is integral to systems thinking (Hardin & Kaplow 2005:6).

Systems thinking is a way of viewing the world by looking at the structures, patterns and events of an issue rather just the issue. These principles emerge over time as nurses' level of expertise increases (Kaplow & Reed 2008:22). Level 1 nurses use a limited array of strategies, are often unclear on steps to resolve a problem and will use previously learned processes. Level 3 nurses have the ability to recognise and react to patients' needs and use the resources available. Negotiation skills are utilised to provide best practices. Level 5 nurses develop, integrate and apply a variety of strategies that are driven by the needs and strengths of patients and families. They are able to develop ways to navigate through the system and use systems thinking on behalf of clients to ensure safe passage (Hardin & Kaplow 2005:86).

2.3.2.6 Response to diversity

Response to diversity is the sensitivity to recognise, appreciate and incorporate differences into the provision of care. Nurses need to recognise the individuality of each patient while observing the patterns that respond to nursing intervention (Hardin & Kaplow 2005:6).

The first skill nurses require in providing culture-specific care is personal awareness of their own cultural assumptions and those of the healthcare culture which impact patients and families (Hardin & Kaplow 2005:91). Nurses must recognise that different generations and individuals within the same family may have different values and beliefs. Level 1 nurses assess cultural diversity; provide care based on their belief systems, and learn the culture of healthcare environment. Level 3 nurses inquire about cultural differences and consider their impact on plan of patient care, incorporate differences, and consider specific interventions. They also work to educate the patient and family about the healthcare system. Level 5 nurses respond to, anticipate and integrate cultural differences in the patient and family plan of care (Kaplow & Reed 2008:22).

2.3.2.7 Clinical inquiry

Clinical inquiry is the ongoing process of questioning and evaluating practice, providing informed practice and innovating through research and experiential learning. Clinical inquiry evolves as the nurse moves from novice to expert. At the expert level, the nurse improves, deviates from and/or individualises standards and guidelines to meet the needs of the patient (Hardin & Kaplow 2005:6).

Clinical inquiry begins with a clinical problem that requires a solution. Nurses who are less experienced often ask basic questions while more experienced nurses ask outcomes-based questions. Level 1 nurses follow standards and guidelines established by the healthcare organisation, and recognise the need for further learning. Level 3 nurses will question the appropriateness of policies and guidelines; question current practices, and compare and seek possible alternatives. They seek advice, resources

and information thus improving the patient care. Level 5 nurses will improve, deviate from, or individualise standards and guidelines for particular patient situations. They review literature, research and acquire knowledge and skills required to address questions arising in practice and improve patient care (Kaplow & Reed 2008:23).

2.3.2.8 Facilitation of learning

Facilitation of learning means that the nurse facilitates learning for the patients, families, nursing staff, physicians and other healthcare disciplines and community through formal and informal facilitation of learning. Education should be provided based on individual strengths and weakness of the patient and family. The educational level of the patient should be considered in the plan of educating the patient and family to ensure informed decisions (Hardin & Kaplow 2005:6).

Hardin and Kaplow (2005:103) describe learning as "a change in behaviour resulting from practice and experience. Teaching is a plan of action to bring about learning." Moreover, learning and teaching are not separate entities but are synergized in nature and interactive (Hardin & Kaplow 2005:103). Level 1 nurses follow planned educational programmes; see patient/family education as a separate task from delivery of care, and have limited knowledge of the totality of educational needs. Level 3 nurses adapt planned educational programmes, and recognise patients' needs and level of understanding. They begin to see that the patients have input into goals; begin to develop educational goals given the individualistic needs of care (Kaplow & Reed 2008:23; Hardin & Kaplow 2005:106).

All eight competences are essential for a nurse in ICU in order to meet the needs of the critically ill patient. In order to achieve synergy, the patients' needs and characteristics should match with the nurses' competences and the healthcare environment to be conducive for safe patient outcomes (Kaplow & Reed 2008:23).

Table 2.10 shows the eight nurse competencies with different levels of clinical competences of which the nurse is capable depending on the clinical experience in the particular population of patients. The levels range from level 1 to level 5. The nurse in level 1 is a novice nurse who has the knowledge required but lacks the clinical

expertie; the nurse in level 3 is a proficient nurse, and the nurse in level 5 is an expert nurse.

Table 2.10   Nurses' competencies of concern to patients and systems

Clinical judgement: clinical reasoning, which includes clinical decision-making, critical thinking, and a good global grasp of the situation, coupled with nursing skills acquired through a process of integrating formal and informal experiential knowledge and evidence-based practice guidelines

Level 1	Level 3	Level 5
Collects basic data; follows algorithms, decision trees, and protocols with all populations and is uncomfortable with deviating from them; matches formal knowledge with clinical events to make decisions; questions the limits of one's ability to make clinical decisions and delegates the decision making to other clinicians; includes extraneous detail.	Collects and interprets complex patient data; makes clinical judgments based on immediate grasp of the whole picture for common or routine patients' populations; recognises patterns and trends that may predict the direction of illness; recognises limits and seeks appropriate help; focuses on key elements of case, while sorting out extraneous details.	Synthesises and interprets multiple, sometimes conflicting, sources of data; makes judgment based on an immediate grasp of the whole picture, unless working with new patient populations; uses past experience to anticipate problems; helps patient and family to see the "big picture", recognises the limits of clinical judgment and seeks multidisciplinary collaboration and consultation with comfort; recognises and responds to the dynamic situation.

Advocacy and moral agent: working on another's behalf and representing the concerns of patient/family and nursing staff; serving as a moral agent in identifying and helping to resolve ethical and clinical concerns within and outside the clinical setting.

Level 1	Level 3	Level 5
Works on behalf of the patient; self-assesses personal values; aware of ethical conflicts/issues that may surface in clinical setting; makes ethical/moral decisions based on rules; represents patient when patients cannot represent themselves; aware of patients' rights	Works on behalf of patient and family; considers patient values and incorporates in care, even when differing from personal values; supports colleagues in ethical and clinical issues; moral decision making can deviate from rules; demonstrates give and take with patient's family, allowing them to speak for/represent themselves when possible; aware of patient's and family rights.	Works on behalf of patient, family and community; advocates from patient/family perspective, whether similar to or different from personal values; advocates ethical conflicts and issues from patient/family perspective; suspends rules; patient and family drive moral decision making; empowers the patient and family to speak for/represent themselves; achieves mutuality within patient/professional relationships.

Response to diversity: the sensitivity to recognize, appreciate and incorporate differences into the provision of care. Nurses need to recognize the individuality of each patient while observing the patterns that respond to nursing intervention

Level 1	Level 3	Level 5
Assesses cultural diversity; provides care based on own beliefs; learns the culture of healthcare environment.	Inquires about cultural differences and considers their impact on care; accommodates personal and professional differences in plan of care; helps patient/family understand the culture of healthcare systems.	Responds to, anticipates, and integrates cultural differences into patient/family care; appreciates and incorporates differences, including alternative therapies, into care; tailors healthcare culture, to the extent possible, to meet the diverse needs and strengths of patient/family.

Caring practices: nursing activities that create a compassionate, supportive, therapeutic environment for patients and staff, within the aim of promoting comfort and healing and preventing unnecessary suffering. Includes, but not limited to, vigilance, engagement and responsiveness of caregivers, including family and healthcare personnel

Level 1	Level 3	Level 5
Focuses on the usual and customary needs of the patient; no anticipation of future needs; bases care on standards and protocols; maintains a safe physical environment; acknowledges death as potential outcome.	Responds to subtle patient and family changes; engages with patient as a unique patient in a compassionate manner; recognises and tailors caring practices to the individuality of patient and family; domesticates the patient's and family's environment; recognises that death may be an acceptable outcome.	Has astute awareness and anticipates patient and family changes and needs; fully engaged with and sensing how to stand alongside the patient, family and community; caring practices follow the patient and family lead; anticipates hazards and avoids them; and promotes safety throughout patient's and family's transitions along the healthcare continuum; orchestrates the process that ensures patient's/family's comfort and concerns surrounding issues of death and dying are met.

Facilitation in learning: facilitates learning for the patients, families, nursing staff, physicians and other healthcare disciplines and community through formal and informal facilitation of learning. Education should be provided based on individual strengths and weakness of the patient and family. The educational level of the patient should be considered in the design of plan of educating the patient and family to ensure informed decisions

Level 1	Level 3	Level 5
Follows planned educational programmes; sees patient/family education as a separate task from delivery of care; provides data without seeking to assess patient's readiness or understanding; has limited knowledge of totality of educational needs; focuses on the nurse's perspective; sees the patient as a passive recipient.	Adapts planned educational programmes; begins to recognise and integrate different ways of teaching into delivery of care; incorporates patient's understanding into practice; sees overlapping of educational plans from different healthcare providers' perspectives; begins to see the patient as having input into goals; begins to see individualism.	Creatively modifies or develops patient/family education programmes; integrates patient/family education throughout delivery of care; evaluates patients' understanding by observing behaviour changes related to learning; is able to collaborate and incorporate all healthcare providers' and educational plans into the patient/family educational programme; sets patient-driven goals for education; sees patient/family as having choices and consequences that are negotiated in relation to education.

Systems thinking: the tools and knowledge that the nurse utilizes to recognize the interconnected nature within and across the healthcare or non healthcare system. The ability to understand how one decision can

impact the whole is integral to systems thinking.

Level 1	Level 3	Level 5
Uses a limited array of strategies; limited outlook – sees the pieces or components; does not recognise negotiation as an alternative; sees patient and family within isolated environment of the unit; sees self as key resource.	Develops strategies based on needs and strengths of patient/family; able to make connections within components; sees opportunity to negotiate but may not have strategies; developing a view of the patient/family transition process; recognises how to obtain resources beyond self.	Develops, integrates, and applies a variety of strategies that are driven by the needs and strengths of the patient/family; global or holistic outlook – sees the whole rather than the pieces; knows when and how to negotiate and navigate through the system on behalf of patients and families as they move through the healthcare system; utilises untapped and alternative resources as necessary.

Collaboration: working with the others to promote optimal outcomes. The patient, family and members of various healthcare disciplines work towards promoting optimal and realistic patient goals.

Level 1	Level 3	Level 5
Willing to be taught, coached and/or mentored; participates in team meetings and discussions regarding patient care and/or practice issues; open to various team members' contributions.	Seeks opportunities to be taught, coached and/or mentored; elicits others' advice and perspectives; initiates and participates in team meetings and discussions regarding patient care and/or practice issues; recognises and suggests various team members' participation	Seeks opportunities to teach, coach, and mentor and to be taught, coached and mentored; facilitates active involvement and complementary contributions of others in team meetings and discussions regarding patient care and/or practice issues; involves/recruits diverse resources when appropriate to optimise patient outcomes.

Clinical inquiry: the ongoing process of questioning and evaluating practice, providing informed practice and innovating through research and experiential learning. Clinical inquiry evolves as the nurse moves from novice to expert. At the expert level, the nurse improves, deviates and/or individualises standards and guidelines to meet the needs of the patient

Level 1	Level 3	Level 5
Follows standards and guidelines; implements clinical changes and research-based practices developed by others; recognises the need for future learning to improve patient care; recognises obvious changing patient situation(e.g., deterioration, crisis); needs and seeks help to identify patient's problem.	Questions appropriateness of policies and guidelines; questions current practice; seeks advice, resources or information to improve patient care; begins to compare and contrast possible alternatives	Improves, deviates from or individualises standards and guidelines for particular patient situation or populations; questions and/or evaluates current practice based on patient's responses, review of literature, research and education/learning; acquires knowledge and skills needed to address questions arising in practice and improve patient care (the domains of clinical judgment and clinical inquiry converge at expert level; they cannot be separated).

Source: American Association of Critical Care Nurses Certification Corporation (2006:2)

(http://www.aacn.org/Desktop/Modules/Certification/pages/Certifications/general/synmodel.aspx \Nurse)

2.3.2.9 *Summary of the nursing characteristics*

The AACN Synergy Model for Patient Care outlines the nursing characteristics that provide a comprehensive and contemporary view of the work of the nurses (Curley 1998:66). These eight characteristics provide a framework to articulate the integration of the nurse's knowledge, skills, experience, critical thinking skills, technical skills and interpersonal skills that are needed in a nurse to meet the needs of the critically ill patient in the ICU (Wysong & Driver 2009:28).

The nurses' characteristics are the competencies and vary from level 1 to level 5 according to the clinical experience, technical knowledge and interpersonal skills of individual nurses. Wysong and Driver (2009:31) maintain that although the nurse's competences of clinical judgment, advocacy, caring practices, collaboration, system thinking, response to diversity, clinical inquiry and facilitation of learning of the AACN Synergy Model for Patient Care are important, the nurse also needs interpersonal skills, critical thinking skills and the caring skills. In order to synergise with the patient's needs and the system's characteristics, the nurse should have the right competencies along the continuum. As they gain experience, intuition and skills, nurses move from level 1 (competent nurse) to level 3 (proficient nurse) and level 5 (expert nurse).

2.3.3 Healthcare system

The healthcare system is the third component of the AACN Synergy Model for Patient Care, which facilitates a safe environment for the patients' needs to be fulfilled and the nurse to practise. In any healthcare environment, the system facilitates the achievement of a patient's needs and the nurse's professional practice environment (Reed, Cline & Kerfoot 2005:4) (see figure 2.1). The AACN Synergy Model for Patient Care further emphasises that the successful outcome of the patient depends on the nurses' competencies and the healthcare care system. According to Kaplow and Reed (2008:23), the characteristics of a good healthcare system are the ones which incorporate patient-centred policies.

Kerfoot et al (2006:24) assert that unhealthy and inadequate work environments contribute to medical errors and ineffective delivery and increase the levels of conflict and stress among health professionals. Successful outcomes for the patient and the nurse depend on the characteristics of the healthcare system and the nurse's ability to create and support the characteristic features of an efficient system (Reed et al 2005:4). The AACN (2003:24) recognises that there is an indisputable logical connection between excellent nursing practice, the quality of the work environment and acceptable levels of patient care. The essential characteristics of such a system include a patient-centred philosophy, shared decision making, professional development opportunities, sound interdisciplinary relationships, the recognition, rewarding and valuing the individual contributions of professionals, the evaluation of outcomes and constant concern for patient safety and well-being (Kaplow & Reed 2008:23).

2.3.4 Underlying tenets of the ACCN Synergy Model for Patient Care

According to Kaplow and Reed (2008:19), the underlying tenets of the synergy model of patient care are:

- Patients' characteristics are of concern to nurses.
- Nurses' competencies are important to the patients.
- Patients' outcomes result when the patients' characteristics and nurses' competencies are synergised.
- Patients' outcomes are enhanced by safe passage through the healthcare systems that allow nurses to contribute significantly to quality of patient care.
- When the patients' characteristics and the nurses' competencies match and synergise, outcomes for patient care are optimal.

Outcomes are patient conditions measured along a continuum. The six major quality outcome indicators (Hardin & Kaplow 2005:4) are:

- Patient and family satisfaction
- Rate of adverse incidents
- Complication rate
- Adherence to the discharge plan

- Mortality rate
- The patient's length of stay

The patients' outcomes include functional changes, behavioural changes, trust, satisfaction, comfort and quality of life. Nurses' outcomes are nursing competences which include physiological changes, presence or absence of complications, and goals of treatment achieved.

The healthcare system outcomes are limiting of re-admission rates, limiting the patient length of stay and best option of cost utilisation per patient. The AACN Synergy Model for Patient Care specifically describes relevant aspects of nurse-patient, nurse-nurse and nurse-systems relationships (Hardin & Kaplow 2005:8) (see figure 2.2).
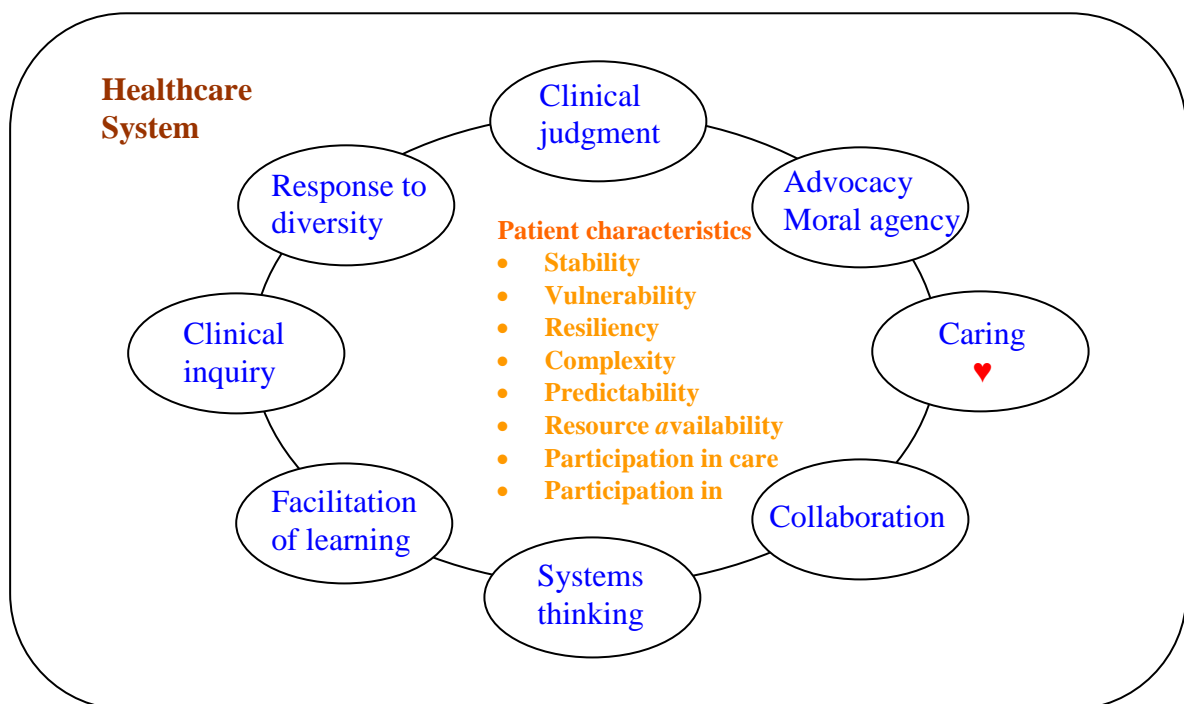
Figure 2.2   AACN Synergy Model for Patient Care
Source: Chesnay and Anderson (2007:414)

Although the American Association of Critical Care Nurses Certification Corporation developed the AACN Synergy Model for Patient Care, its concepts are relevant to the entire nursing profession (Harman 1999:101). Furthermore, nurses and educators can

apply the AACN Synergy Model for Patient Care in their practice settings and in educational institutions.

Regarding the use of the AACN Synergy Model for Patient Care in contemporary practice, Maloney-Harmon (1999:102) points out that it provides a useful means to describe clinical nurse specialist (CNS) practice in the new healthcare environment. Furthermore, it takes into account not only the needs of the patients and families, but also of healthcare providers and organisations.

With regard to the use of the AACN Synergy Model for Patient Care in progressive care, Eklund and Stamps (2002:60) point out that matching the knowledge, skills and competencies of the nurse with the complexity of patient care ensures the best patient care outcomes. The mixing of team nursing according to the complexity of the patient contributes to the synergy of holistic care. The AACN Synergy Model for Patient Care was successfully used to develop the new CNS role and assist a group of CNS to determine positive patient outcomes and maintain fiscal responsibility (Cohen Crego, Cuming & Smyth 2002:436). Consequently, the AACN Synergy Model for Patient Care can be applied in a contemporary multi-system practice.

Markey (2001:72) found that the application of the AACN Synergy Model for Patient Care in clinical practice with case examples helped to achieve the best patient outcomes. Moreover, in today's healthcare environment, with increased patient acuity levels, nurses with increased competencies enhance the chances of safe passages for patients.

Mullen (2002:66) maintains that the use of the AACN Synergy Model for Patient Care during nursing rounds could help nurses to articulate their patients' and families' characteristics and identify their own nursing competencies.

In applying the AACN Synergy Model for Patient Care to nursing education, Kaplow (2002:77) found that the nurse educator assumed the responsibility of working with the nurses to develop critical thinking, clinical decision-making and psychomotor skills. The competencies most significant for nurse educators were collaboration, facilitation of learning, caring practices, clinical judgment, advocacy and moral agency. These

activities were enhanced when the nurse educator involved herself in direct patient care.

Wysong and Driver (2009:36) state that measurement of outcomes has always been a challenge in activities like nursing care and technical skills. In a study in the USA on patients' perception of nursing skills, Wysong and Driver (2009:36) found that patients perceived the nurse's interpersonal skills, critical thinking and caring practices rather than the nurse's technical skills.

Measurement of outcomes has always been a challenge in nursing care. The overall improvement in patient satisfaction and the general feeling of nurses together with all those involved in the activities can be measured by follow-up interviews with all or most of those concerned. The effects of the AACN Synergy Model for Patient Care include a significant improvement in patients' outcomes expressed in terms of patient and family satisfaction (Mullen 2002:66; Reilley & Humbert 2007:32; Wysong & Driver 2009:36).

A key component of the AACN Synergy Model for Patient Care is that the patients become truly central to the nurses' practice. When nurses' characteristics or competencies match patients' characteristics or needs, then the optimal patient outcomes occur. Furthermore, as patients move along the continuum of health and illness, they are influenced by the nurses' caring for them. The components of the AACN Synergy Model for Patient Care can be incorporated into nursing school curricula, practice and research supporting various components of the nurse and patient characteristics (Brewer et al 2007:158).

2.3.5 Assumptions guiding the ACCN Synergy Model for Patient Care

The AACN Synergy Model for Patient Care is based on nine assumptions. The first five were identified in 2000 and the last four were added by the AACN Certification Corporation four years later (Becker, Kaplow, Muenzen & Hartigan 2006:133). Most of these assumptions relate to the patient and the nurse, although the hospital system is addressed directly and indirectly in the same assumptions (Alspach 2006:11). The following assumptions guide the AACN Synergy Model for Patient care.

- Patients are biological, psychological, social and spiritual entities who present at a particular development stage. The whole patient (body, mind and spirit) must be considered. The patient, family, and community all contribute to providing a context for the nurse-patient relationship.

- The patient, family and community contribute to providing a context for nurse-patient relationship.

- Patients can be described by a number of characteristics that connect and contribute to each other. Characteristics cannot be considered in isolation.

- Nurses can be described on a number of dimensions. The interrelated dimensions paint a profile of a nurse.

- The goal of nursing is to restore a patient to an optimal level of wellness as defined by the patient. Death can be a possible outcome, in which the goal of nursing care is to move a patient and family towards a peaceful death.

- Nurses create the environment of care of patients. The context or environment of care also affects what a nurse can do.

- Impact areas are interrelated; the nature of interrelatedness may change as a function of experience, situation, or setting changes.

- Nurses may work to optimize outcomes for patients, patients' families, healthcare providers, and healthcare system/organisation.

- Nurses bring their background to each situation, including various levels of education/knowledge and skills/experience (Becker et al 2006:133).

2.3.6 The AACN Synergy Model for Patient Care applied to unplanned extubation

The safety of patients in an ICU is fundamental, and in order to provide safe care to patients it is necessary to first identify the risk factors associated with unplanned extubation. The patient who has been intubated is already highly vulnerable, and unplanned extubation makes this patient more vulnerable (see figure 2.3). Unplanned extubation is a life-threatening emergency especially if the patient required mandatory ventilation and weaning has not been commenced, and this patient will require immediate reintubation (Eryuksel, Karakurt & Cerikel 2009:18; Lavery & McCloskey 2008:2170). However, the frequency of unplanned extubation in an ICU can be reduced by good nursing practices and sound healthcare systems.

The AACN Synergy Model for Patient Care states that in order to maintain the continuum of care the patients' characteristics have to synergize with the nurses' characteristics. All patients bring with them a unique set of characteristics based on their needs, and certain nurses' competences are required to provide safe care. The nurses' competences complement the intubated patients' needs. Nurses should report all adverse events immediately and implement evidence-based practices. The healthcare environment should be safe to both patients and nurses for quality care for critically ill patients. To provide a safe environment, the healthcare should monitor the quality indicators, and be systems oriented so that incidents are reported in time and analysed to improve the standards of care.

Nurses need to continuously upgrade their skills and knowledge in order to advance from level 1 (competent nurse) to level 5 (expert nurse). Managers also need to support the synergy of care by enhancing capabilities of competent nurses to self-development/training of required skills and knowledge in caring for critically ill patients and families. The nurse manager when recruiting new nurses for ICU should ensure that they have knowledge/training in critical care nursing. The nurse leader should ensure a balance in nursing staffing/allocation, provision of mentorship and supervision of competent nurses and give guidance as and when required. The healthcare system includes a safe environment, identifying adverse events, implementing changes for positive patient outcomes. This involves methods of reporting and analysing adverse events and creating an environment for the healthcare worker to feel safe in reporting such adverse events.

The researcher used the AACN Synergy Model for Patient Care to guide this study because it is a patient-centred model which integrates nursing practice and the healthcare environment and is applicable to patients in ICU. The AACN Synergy Model for Patient Care links nurse practice required to reduce the rates of unplanned extubation and is a continuum; any deviation in patients' characteristics or nurses' competences or the healthcare environment increases the risk factors of unplanned extubation.

Nurses should evaluate the patients' needs in relation to set nursing competences for optimal outcome. Kaplow and Reed (2008:19) maintain that the patients' characteristics

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emphasise patient centrality and the need to know the patient, as well as facilitate the development of nursing practices that are grounded in nurse-patient relationship.

In addition to the patients' characteristics, biological, economic, social and psychological factors make each patient unique. The risk factors identified in unplanned extubation are age, medical illness, agitation, sedation, physical restraints and delirium, nurses' experience and patient workload (Curry et al 2008:45; Ream, Mackey, Leet, Green, Andreone, Loftis & Lynch 2007:366).

Figure 2.3 depicts how patients' characteristics, nurses' competences required and the healthcare environment are identified, and how each interrelates for better, positive patient outcomes.

ACCN Synergy Model for Patient Care

Patient characteristics
1. Vulnerability
2. Resiliency
3. Stability
4. Complexity
5. Resource availability
6. Participation in care
7. Participation in decision making
8. Predictability

Healthcare system/environment
Quality indicators: measures of outcomes, Adverse events: reporting and analysis, nurse-to-patient ratio, professional development, reward and support

Nurses' characteristics /competency
1. Caring practices
2. Clinical judgement
3. Advocacy and moral agency
4. Collaboration
5. Systems thinking
6. Response to diversity
7. Clinical inquiry

UNPLANNED

SELF-DELIBERATE EXTUBATION

EXTUBATION

ACCIDENTAL EXTUBATION

Factors
Biological
Economic
Social
Psychological

POSITIVE SAFETY PATIENT OUTCOMES

Outcome
Physiological changes
Presence or absence of complication
Goals of treatment

Endotracheal intubated patients' safe passage and outcomes depend on their age, medical illness, type of personality, use of sedation and physical restraints.

Patient safe passage depends on patients' needs, nurse competence and healthcare system to synergise for
1. improved quality care
2. early identification of contributing factors
3. reduced unplanned extubation
4. reporting and analysing adverse events
5. absence of complications
6 staff training further enhances safe of patient outcomes.

Nurses' training, experience, knowledge, skills and competency in ICU enhance the safety of endotracheal intubated patient

Figure 2.3   Conceptual framework guiding the study on unplanned extubation, patient and nurse characteristics: 0ptimising endotracheal intubated patients' safety outcomes in ICU

The conceptual framework was the AACN Synergy Model for Patient Care as applied to unplanned extubation of critically injured or ill patients. The patients' needs, nurses' competences and healthcare systems are all interlinked and have to synergise in order for patients to have positive outcomes.

There are eight patients' characteristics, which are also the patients' needs, and are in continuum. The biological, economic, social and psychological factors are different for each patient. These characteristics are the risk factors which are age, agitation, use of physical restraints, and medical illness associated with self-deliberate extubation (Curry et al 2008:45; Yeh et al 2004:255; Moons et al 2004:1415).

The healthcare system, also known as the healthcare environment, is in the middle and indicates the systems present in healthcare. These are nurse-to-patient ratio, quality indicators, reporting and analysing adverse events, policies and protocols, professional development of staff, reward and support to promote a safe healthcare environment (Hanneman 2004:70; Aiken, Clarke, Cheung, Sloane & Silber 2003:1617).

Thirdly there are the eight nurses' characteristics or competences, which are a continuum. These competences are different in each individual nurse according to the education, skills and clinical competences (Benner 1984:5). Nurse characteristics in unplanned extubation include nursing education, clinical and ICU experience, patient workload and their presence at the bedside as the risk factors (Aiken et al 2003:1617; Chaterjee et al 2004:36; Curry et al 2008:45; Yeh et al 2004:25).

Unplanned extubation can be either deliberate/self-extubation by the patient or accidental by the nursing staff or any healthcare worker during a procedure. The patients' characteristics, nurses' competences and healthcare system are all interlinked hence any deviation in any direction will increase the risk of unplanned extubation.

2.3.7 Patients' characteristics based on the ACCN Synergy Model for Patient Care

Patient characteristics referred to in the AACN Synergy Model for Patient Care in critically ill patients in ICU are the vulnerabilities that patients may present during their critical illness/situation. The patient and the family are unique and have various

capacities for coping with illness and health in general. Patients' capacities of health are the genetic, biological, economic, and social support by the family, healthcare system and the community. Moreover, each patient brings a unique set of characteristics which are consistently seen in patients who experience critical events. All these patients' characteristics are connected and contribute to each other and cannot be considered in isolation (Kaplow & Reed 2008:20).

2.3.7.1 *Patients' characteristics in ICU patients*

Patients admitted to ICU are highly vulnerable, with low stability and decreased resilience due to the nature of their critical illness. The AACN Synergy Model for Patient Care describes the characteristics as interlinked and cannot be looked upon individually. These characteristics are also from level I to level 5, which explains why not all intubated patients have unplanned extubation. At any point, patients may fluctuate in their positions along these eight continuums, which can change within minutes. Assessing patients' needs along the eight continuums enhances the development of nurse communication via nurse-to-nurse reports, documentation systems and articulation of patients' acuity (Kaplow & Hardin 2007:5).

To provide adequate information between caregivers and across practice settings, nurses must first have in-depth knowledge of their patients and families. The AACN framework provides a means of organising subjective and objective data about patients so that their needs are consistently identified and continuity of care is maintained throughout the episode of illness (Kaplow & Hardin 2007:7). Table 2.11 is an example of patients' characteristics expected in critically ill patients in ICU who are mechanically ventilated.

Table 2.11   Patients' characteristics to be expected in an ICU mechanically ventilated patient

Characteristics	Definition
Vulnerability: Susceptibility to actual or potential stressors that may adversely affect the outcome	Level 1 highly vulnerable, as admission to ICU and intubation are stressors; communication and patients' ability to make decisions are all compromised.
Complexity: The intricate entanglement of two or three systems (body, family, therapy)	Level I highly complex as two or more systems are involved, cardiopulmonary systems, family and therapy.
Stability: The ability to maintain a steady state of equilibrium	Decreased, as respiratory failure leads to low cardiac output, liable.
Resiliency: The capacity to return to a restorative level of functioning using compensatory coping mechanisms; the ability to bounce back quickly after an insult	Level 1 minimally resilient, failure of compensatory coping mechanisms, as affected by the respiratory function and other co-morbidities the patient has.
Predictability: A characteristic that allows one to expect a certain course of events	Decreased stability and complexity of the illness cause uncertainty in the patient's and family's life.
Participation in decision-making and care: Extent to which patient and family participate in decision making and care	Level 1 or uncertain, as patient may be sedated. Family engagement in clinical decisions can also be impacted by their knowledge, capacity to make decisions, cultural background and inner strength during crisis.
Resource availability: Extent of resources (technical, fiscal, personal, psychological and social) that patient, family bring to the situation	Uncertain and depends on the personal, psychological, and social support of the family. Healthcare costs are also increased.

Source: Kaplow and Hardin (2007:7)

Table 2.11 summarises the patients' characteristics, although dependent on where the patient is on the continuum of illness, which an ICU nurse should expect in an intubated patient. The patients' characteristics vary in each individual patient, with levels ranging from high through moderate and low on a scale of 1, 3 and 5. The patients' characteristics also depend on the severity of illness and the co-morbidities present. These characteristics combined with the patients' biological, social, economic and physiological factors are the patients' needs which when matched with the appropriate nurses' characteristics make a positive clinical outcome.

2.3.8 Nurses' characteristics of the AACN Synergy Model for Patient Care

The AACN Synergy Model for Patient Care indicates the work of the nurses, and leads to the ability to capitalise on the nurses' strengths to the patients' needs. The nurses' practice can be plotted along the continuum based on competencies. According to Benner (1984:5), this continuum is characterised by different stages moving from novice

to expert by gaining clinical experience. The AACN Synergy Model for Patient Care incorporates the notion that nursing knowledge is unique to the professional practice of individual nurses (Kaplow & Hardin 2007:8). The competences expected of an ICU nurse are clinical judgment, advocacy and moral agency, caring practices, collaboration, system thinking, response to diversity, clinical inquiry and facilitator of learning. These eight competencies reflect the integration of knowledge, skills and experience of the nurse (Hardin & Kaplow 2005:5).

The competences continuum is derived from patients' needs, ranging from level 1, level 3 to level 5. At level 1, the novice nurse is at entry level, with limited and inflexible behaviour and no clinical experience of the situation, and is known as a competent nurse. Level 3 is an experienced nurse in ICU, able to abstract and analyse but lacking the speed and flexibility, and is known as a proficient nurse. At level 5, the nurse is expert and has enormous background of experiences and deep understanding of the situation (Kaplow & Reed 2008:19). The nurses' characteristics are further delineated and expanded through the development behaviours for entry-level nurse, competent and expert critical care nurses (Hardin & Kaplow 2005:9). The nurses' competences of concern to patients and systems are described in table 2.3. Depending on the level of clinical experience and competences gained, the nurse moves from level I to level 5.

Table 2.11   Nurses' competences of concern to mechanical ventilated patients and systems

Characteristics of nurse	Nurse competency required according to patient needs
Clinical judgement: clinical reasoning, which includes clinical decision-making, critical thinking, and a good global grasp of the situation, coupled with nursing skills acquired through process of integrating formal and informal experiential knowledge and evidence-based practice guidelines.	The clinical judgment is also the clinical reasoning, decision making, problem solving skills the nurse acquires through experience in nursing and is highly indivualised (Tanner 2006:205). The nurse in caring for the endotrachael intubated and ventilated patient should have the ability to record and interpret multiple data, such as ventilator data, tidal volume, pressure, different curves, cardiac output, blood gases analysis, Glasgow Coma Scale, and vital signs.. The nurses should be able to bring her previous experience and knowledge on care of patients who were intubated and ventilated. The nurse uses her clinical judgment skills by interpreting, analysing and making decisions. In clinical judgment the nurse uses analytic process, intuition and narrative thinking (Hardin & Kaplow 2005:59). According to Tanner (2006:206),

Characteristics of nurse	Nurse competency required according to patient needs
	clinical judgments are influenced by the culture of the nursing unit. Based on her knowledge and skills, the nurse makes decisions on care provided to the patient such as physiotherapy, suctioning, mouth care, change of body position. Nurse competency required to care for ventilated patient is from Level 3 and above
Advocacy and moral agent: working on another's behalf and representing the concerns of patients/family and nursing staff; serving as a moral agent in identifying and helping to resolve ethical and clinical concerns within and outside the clinical setting.	Advocacy and moral agent are the most important characteristics of a nurse. Hanks (2005:75) states that "advocacy for clients is an important aspect in professional care and is considered a fundamental value in nursing". The nurse caring for the vulnerable critically ill intubated and ventilated patient in the ICU, who is unable to communicate or unable to participate in decision making, provides information to family and allows them to make the decisions on the patient's behalf. The nurse is expected to support the family decision, respect patients' rights, and assist in advocating the best ethical and legal decision (Tanner 2005:206). According to Hanks (2005:75), the nurse should understand the patient's needs and speak on behalf of the patient. Nurse competence required at level 3 and above.
Response to diversity: the sensitivity to recognise, appreciate and incorporate differences into the provision of care. Nurses need to recognise the individuality of each patient while observing the patterns that respond to nursing intervention.	Response to diversity is to recognise, appreciate and incorporate differences in culture into provision of care (Smith 2006:45) The nurse in the ICU should be able to support the religious and cultural beliefs of the ventilated patient. The nurse should support the cultural and religious beliefs, and facilitate and allow patients to practice these beliefs in the ICU without any prejudice (Smith 2006:45) Nurse competence required at level 3 and above.
Caring practices: nursing activities that create a compassionate, supportive, therapeutic environment for patients and staff, within the aim of promoting comfort and healing and preventing unnecessary suffering. Includes, but is not limited to, vigilance, engagement and responsiveness of caregivers, including family and healthcare personnel	Caring practice according to the AACN Synergy Model for Patient Care is to create a compassionate therapeutic environment while promoting comfort and preventing suffering (AACN 2002). The nurse caring for a mechanically ventilated patient should be able to provide comfort, compassionate care. The nurse anticipates adverse events in mechanically ventilated patients, such as unplanned extubation and ensures patient safety at all times. The nurse further ensures that evidence-based protocols are adhered to; sedation protocol, restraints guidelines, hand hygiene is practised by all healthcare workers, mouth care, care of ventilator tubing and endotracheal cuff pressure is measured to keep pressure below 25mmHg. Nurse competence required at level 3 and above.
Clinical inquiry: the ongoing process of	According to Hardin and Hussey (2003:75), clinical

Characteristics of nurse	Nurse competency required according to patient needs
questioning and evaluating practice, providing informed practice and innovating through research and experiential learning. Clinical inquiry evolves as the nurse moves from novice to expert. At the expert level, the nurse improves, deviates from and/or individualises standards and guidelines to meet the needs of the patient.	inquiry means observing, questioning, smelling, sensing intuitively, listening, and integrating findings into oneself for the benefit of the patient. Cox (2003:229) reports that a nurse in ICU who is well trained uses clinical inquiry to evaluate the clinical care and constantly re-evaluate the effectiveness of interventions. For the care of the ventilated patient the nurse uses clinical inquiry on the benefits/harm of normal installation during suctioning practice (Kurikose 2008:17) Nurse competency required at level 3 and above.
Systems thinking comprises the tools and knowledge that the nurse utilises to recognise the interconnected nature within and across the healthcare or non healthcare system. The ability to understand how one decision can impact the whole is integral to systems thinking.	According to the AACN Synergy Model for Patient Care, systems thinking illustrates the nurse independent knowledge and promotes holistic approach (Curley 1998:68). Hardin and Kaplow (2003:6) add that systems thinking is understanding the structure, process and even In caring for the ventilated patient, this competence in the nurse is important as the nurse can identify the availability of resources which are easily available, and ensure that an extra set of intubation is kept at the bedside to be used in case of emergency. The nurse can further evaluate the care given by the other healthcare workers; such as chest physiotherapy, and if open suctioning is up to the standard of care and the patient is safe through these procedures. Nurse competency required above level 3.
Collaboration: the nurse working with the others to promote optimal outcomes. The patient, family and members of various healthcare disciplines work toward promoting optimal and realistic patient goals	Desprins (2009) reports that collaboration is the relationship between nurse and physician team members; the collaboration and patient safety are interconnected. This collaboration amongst healthcare providers promotes formal team training, decision making processes, good communication and acknowledges decisions clearly. The outcome of all this is safe optimal care to patient and family. The nurse in ICU collaborates with the doctors, anaesthetist, physiotherapist, and nutritionist in providing safe care to the ventilated patient. Nurse competency required above level 3.
Facilitation in learning: means that the nurse facilitates learning for the patients, families, nursing staff, physicians and other healthcare disciplines and community through formal and informal facilitation of learning. Education should be provided based on individual strengths and weakness of the patient and family. The educational level of the patient should be considered in the design of the plan for educating the patient and family to ensure informed decisions	According to Becker, Kaplow, Muenzen and Hartigan (2006:139), as facilitator for learning, the nurse conducts needs-based assessment for the patient/family and promotes evidence-based safe practices. As the patient who is mechanically ventilated has complex needs, the nurse should be capable of planning and facilitating teaching the patient (if not sedated) the importance of the endotracheal tube. The nurse can also ensure that evidence-based practices such as "ventilator care bundle" are practised to promote safe practices and

Characteristics of nurse	Nurse competency required according to patient needs
	prevent complications such as deep venous thrombosis (Couchman et al 2007:12). Nurse competency required: level 3 and above.

Source: American Association of Critical Care Nurses Certification Corporation (2006:4)

(http://www.aacn.org/Desktop/Modules/Certification/pages/Certifications/general/synmodel.aspx\Nurse)

The nurses' characteristics or competences in table 2.11 vary from level 1 to level 5 according to the experiences, knowledge and skills of individual nurses. In order to synergise with the patient's needs and the system's characteristics, the nurse should have the right competences and characteristics along the continuum.

2.3.8.1 Nurse's characteristics in unplanned extubation

The nursing characteristics in unplanned extubation are described as ICU experience. The AACN Synergy Model for Patient Care describes nurses' characteristics as competences (Kaplow & Hardin 2007:8). In addition, nurses' competences increase with their clinical experience in the different stages from novice to expert and finally proficient nurse (Benner 1984:5).

In a study in a paediatric ICU in the USA, Ream et al (2007:366) found a positive association between unplanned extubation and patient-to-nurse ratio and with higher patient acuity levels, the more incidences of unplanned extubation. Aitken et al (2003:1617) found a decrease in surgical patients' mortality rates with BScN nurses.

Ream et al (2003:2239) point out that nursing workload is "more time consuming to quantify, lacks an accepted definition and measurement standard and often involves some measures of the volume and level of nursing work". In addition, work "is usually gauged by patients' acuity and/or amount of task-oriented activity performed".

In India, Chartterjee et al (2004:36) found that most unplanned extubations were accidental during nursing care rather than self-deliberate extubation by patients. Risk factors identified were blocked tubes, patients' agitation, and poor communication by medical personnel especially when the patient's condition was improving. Curry et al

(2008:45) found that nursing experience plays an important role in preventing unplanned extubation; the more experienced the nurse, the less incidences of unplanned extubation. In Taiwan, Yeh et al (2004:257) reported that experienced nurses had fewer incidences of unplanned extubation; 2.6% compared to 72.9% of incidences took place with nurses who had less than four years' experience in ICU.

2.3.9 Healthcare system/environment

According to the AACN Synergy Model for Patient Care used as the conceptual model for this study, which addresses patients' and nurses' characteristics of unplanned extubation, the healthcare environment is also important to synergise the needs of patients with the competencies of the nurse. However, in this study the characteristics of the healthcare environment were not under investigation, so the ideal healthcare environment in an ICU setting will only be described briefly.

The healthcare environment addresses the context in which the patients' needs and the nurses' competencies come together (Kaplow & Reed 2008:26). The resources provided by the healthcare are equipment, nurse-to-patient ratio and budget for delivery of safe care to patients. The physical environment influences the patients' and nurses' vulnerability.

Good practices in ICU, the use of clinical guidelines such as intubation, weaning and sedation protocols, informed consent, reporting of adverse events, and analysing incidences all assist in achieving the maximum level of patient safety. According to Hanneman (2004:70), healthcare systems that have good practices, such as use of sedation and weaning from ventilator protocols, ensure safe and better clinical outcomes for the patients. In addition, focus group interviews rather than the traditional method of safety report forms are effective strategies for reporting system failures.

In Australia, Beckmann, Bohringer, Carless, Gilles, Runciman and Pronovost (2003:1006) found incident reporting useful in identifying quality problems. Supplementary selective audits of medical records in order to detect problems not reported well in the incident report forms are quality improvement techniques in ICU.

Greene (2006:82) emphasises that nurses are the key players in hospital initiatives, using their skills of collaboration, clinical reasoning, inquiry and further are able to plan, organise and implement multisystem and interdisciplinary system changes.

2.4   THE AACN SYNERGY MODEL FOR PATIENT CARE IN PRACTICE

Wysong and Driver (2009:24) state that the core concept of the AACN Synergy Model for Patient Care is that "the need of the patient promotes the expected competences of the nurse". According to Smith (2006:42), the AACN Synergy Model for Patient Care is emerging as the accepted standard conceptual framework for acute and critical care nursing. The synergy model provides the framework for nurses to manage complex clients experiencing acute exasperation of their illness and to work towards reducing trajectory of the illness (Hardin & Hussey 2003:73). It is also viable as a basis for professional practice, a "safe passage" through the system, delivering care within a framework of clinical effectiveness, career advancement for the nurse and the organisation of a healthcare system through its ability to provide high-quality cost-effective care (Kerfoot 2002:2).

In the USA, Collins and Strother (2008:E1) used the AACN Synergy Model for Patient Care to develop a competence audit tool for all clinical staff for safe patient outcomes. After introducing and implementing the competency tool in the cardiology service and moderate sedation, two clinical indicators improved.

The AACN Synergy Model for Patient Care has been used in various clinical settings. Wysong and Driver (2009:24) conducted a study using the AACN Synergy Model for Patient Care on patients' perception of the nursing skills. Wysong and Driver (2009:24) found that the patient's perceptions of nursing skills were more focused on the nurses' interpersonal skills, critical thinking skills and caring practices than their technical skills. In addition, the seven nurse characteristics of the AACN Synergy Model for Patient Care measured by the patients were the clinical judgment, advocacy/moral agency, caring practices, collaboration, systems thinking, response to diversity and facilitator of learning to judge if the nurse was skilled or unskilled. The only characteristic not measured by the patients was clinical inquiry, which Wysong and Driver (2009:24) attribute to occurring outside direct interaction with the patients.

Reilly and Humbrecht (2007:22) used the AACN Synergy Model for Patient Care to improve telemetry services by developing two sets of criteria from differentiating intermediate care patients from remotely monitored patients to telemetry. This was a nurse-managed model whose goal was to create better flow for telemetry patients, which evolved into better patients' outcomes and a healthier work environment. There was also better collaboration between the medical-surgical nurses and telemetry nurses, more trust and better safety in patient care.

In a study on the effects of saline instillation on endotracheal suctioning in the USA, Kuriakose (2008:10) found that the AACN Synergy Model for Patient Care was an excellent framework for nurses to evaluate evidence-based practices in ICU. One of the nurses' competences of clinical practice is clinical inquiry, which by investigating and changing practices can further promote safety in ICU patients.

Kaplow and Reed (2008:17) found that two hundred hospitals in the USA and one in Australia had been awarded "magnet status" for the delivery of excellent patient outcomes. Magnet status "is awarded to hospitals that satisfy a set of criteria designed to measure strength and quality in health professionals". In addition, these magnet institutions used the AACN Synergy Model for Patient Care as their professional model of care (Kaplow & Reed 2008:17).

Brewer, Wojne-Alexandro, Triola, Pacini, Cline, Rust and Kerfoot (2007:158) found the patient characteristics of the AACN Synergy Model for Patient Care reliable in adult and paediatric patients. In the expert nurse group, the support of evidence of construct validity was present but the naïve nurse group showed mixed results.

Becker et al (2006:130) used the AACN Synergy Model for Patient Care to evaluate the roles of clinical nurses and acute care practitioners. The clinical nurse specialists were found to be more experienced than the acute care practitioners in clinical judgment and clinical inquiry.

Graham-Garcia, George-Gay, Heater, Butts and Heath (2006:29) found the AACN Synergy Model for Patient Care effective in caring for surgical patients who were smokers, both in counselling and in evaluating when centred on patients' needs.

In Florida, the AACN Synergy Model for Patient Care was successfully used to develop the role of clinical nurse specialist from traditional unit-based practices to contemporary multisystem practices (Cohen, Crego, Cuming & Smyth 2002:436). Better patients' outcomes and changes in the system were also enhanced by changes in nursing practices.

Although the AACN Synergy Model for Patient Care is an excellent model and has been used in various developed countries, the model has not documented substantially in studies in Africa. Balyejjusa (2007:14) used the AACN Synergy Model for Patient Care in Uganda to assess the safety of injections and Chokani-Namame (2005:10) used it in Botswana to examine acute coronary syndrome patient characteristics of pre-hospital care environment.

2.5 JUSTIFICATION FOR CHOOSING AACN SYNERGY MODEL FOR PATIENT CARE

The conceptual model chosen was considered appropriate to support the focus of this study, and most importantly provided the framework within which the characteristics of patients' and nurses' competences associated with the incidences of unplanned extubation were identified. According to Hardin and Hussey (2003:73), the AACN Synergy Model for Patient Care is readily adaptable to any ICU setting and the nurse links her competences to the patients' characteristic. All patients have similar needs and experiences, although these needs vary across wide ranges or continuums from health to illness, and the biological, genetic, social and psychological factors for each patient differ. The more compromised the patients, the more severe or complex their needs. The dimensions of the nurse's practice and competences are driven by the needs of a patient and family. This requires the nurse to be more proficient in the multiple dimensions of nursing continuums (Kaplow & Reed 2008:21).

The selected hospital in Nairobi where the study was conducted uses the Benner model to group their nurses according to their clinical skills and experience. The AACN Synergy Model for Patient Care nursing competences levels are identical consequently the researcher considered it the most appropriate and ideal model for this particular study of patients' and nurses' characteristics of unplanned extubation.

2.6   CONCLUSION

This chapter discussed the conceptual model used as the basis for the study and pointed out its relevance in providing nursing care. Patients' needs should synergise with nurses' competences. The AACN Synergy Model for Patient Care further identifies the characteristics of critically ill patients and what competences an ICU nurse should bring to the bedside to have positive patient outcomes.

Chapter 3 discusses the literature review undertaken for the study.

CHAPTER 3

Literature review

3.1   INTRODUCTION

Chapter 2 described the AACN Synergy Model for Patient Care and its application to this study. This chapter discusses the literature review conducted on unplanned extubation, accidental extubation, self-deliberate extubation, re-intubation, sedation, Glasgow Coma Scale, Ramsay Sedation Scale, physical restraints, nurses' formal training and ICU experience, nurses' workload and incident reporting.

According to Burns and Grove (2001:107), the literature review is a critical step in the research process. Polit and Beck (2004:89) state that reviewing literature "enables the researcher to identify what aspects of the topic have been covered, the magnitude of the problem being studied, how it is being managed globally, the need to replicate prior studies or with different population, the theory or conceptual framework relevant to the topic and assists in interpreting study findings".

The researcher obtained literature relevant to unplanned extubation, associated factors and the outcome of patients from various sources. The purpose of the literature review for this study was to examine the existing information on knowledge of respiratory failure, intubation, unplanned extubation, risk factors associated and the outcome of patients. The review also assisted in providing direction and guidelines for the development of an effective instrument related to the topic.

3.2   PATIENTS' CHARACTERISTICS

According to the ACCN Synergy Model for Patient Care, the conceptual framework used for the study, patients' characteristics are a unique set of characteristics each patient brings to the ICU, also known as patients' needs. The patients' characteristics consistently associated with critical events are resiliency, vulnerability, stability, complexity, resource availability, participation in care, participation in decision-making

and predictability. Each characteristic exists on a continuum from low to high (Hardin & Kaplow 2005:4). All the patients' characteristics are connected and contribute to each other and cannot be considered in isolation (Kaplow &Reed 2008:20). The patients' outcome includes functional changes, behavioral changes, trust, satisfaction, comfort and quality of life.

In order to understand what endotracheal intubation entails and why it is important for a critically ill patient to maintain intubation until ventilation is no longer required or the condition improves, it is necessary to discuss intubation, respiratory system, respiratory airways, work of breathing, arterial blood gases and respiratory failure.

3.2.1 Intubation

Intubation provides an artificial airway for patients in ICU for protection of their airway and for management of respiratory failure, hypoxia and clearance of tracheal secretions (O'Connor & Ovassapian 2005:467). An artificial airway can be provided by an endotracheal tube through the oral/nasal route or tracheostomy. The first tracheostomy was performed in 2000 BC (Ezri, Evron, Haddad & Roth 2005:891). Tracheostomy and endotracheal tubes were widely used during the First World War (1914-1918). At that time, they were used only during surgery, but with the opening of respiratory units during the polio endemic, they were used in patients who required ventilation (Ezri et al 2005:891). Intubation and artificial manual ventilation were initially introduced in 1776 by Cullen, who inserted a crooked tube directly into the glottis and trachea in drowned and seemingly dead men (Vukmir 2001:87).

In 1880 the modern description of endotracheal intubation was used by Macewen, who compared the clinical efficacy of the oral tube to the then current intervention of tracheostomy. Prolonged intubation was first introduced by Macewen who used an endotracheal tube for more than 36 hours (Macewen 1880:122). Widespread use of endotracheal intubation started in 1907 (Vukmir 2001:87). Complications of endotracheal tubes focused on damage to the trachea and glottis. After 1950 prolonged endotracheal intubation became the standard of patient care in respiratory units and during surgical procedures (West 2005:224).

In 1950 and 1960 endotracheal tubes were of a high pressure, low volume design that caused pressure to the trachea where the cuff contacted the tissue. New endotracheal tubes with low pressure, high volume cuffs were introduced in the mid 1970s to reduce complications of laryngeal stenosis. With improved technology and changes in disease patterns, critically ill patients required mechanical ventilation for longer periods (Vukmir 2001:88).

3.2.2 Respiratory system

The respiratory system is divided into the conducting portion and the respiratory portion. The conduction portion starts with the nasal cavities and ends with the terminal bronchioles. The conducting portion only conducts air into the lungs; no blood-air exchange gas exchange occurs.

Air flows through the conduction systems as follows: nasal cavities ⟶ nasopharynx ⟶ oropharynx ⟶ larynx ⟶ trachea ⟶ bronchi ⟶ bronchioles ⟶ terminal bronchioles (Dudek 2005:41) (see figure 3.1).

Figure 3.1   Inside the lungs and airways

Source: Porter and Kaplan (2006:38)

(http://www.merck.com/mmhe/sec04/ch38/ch038d.html)
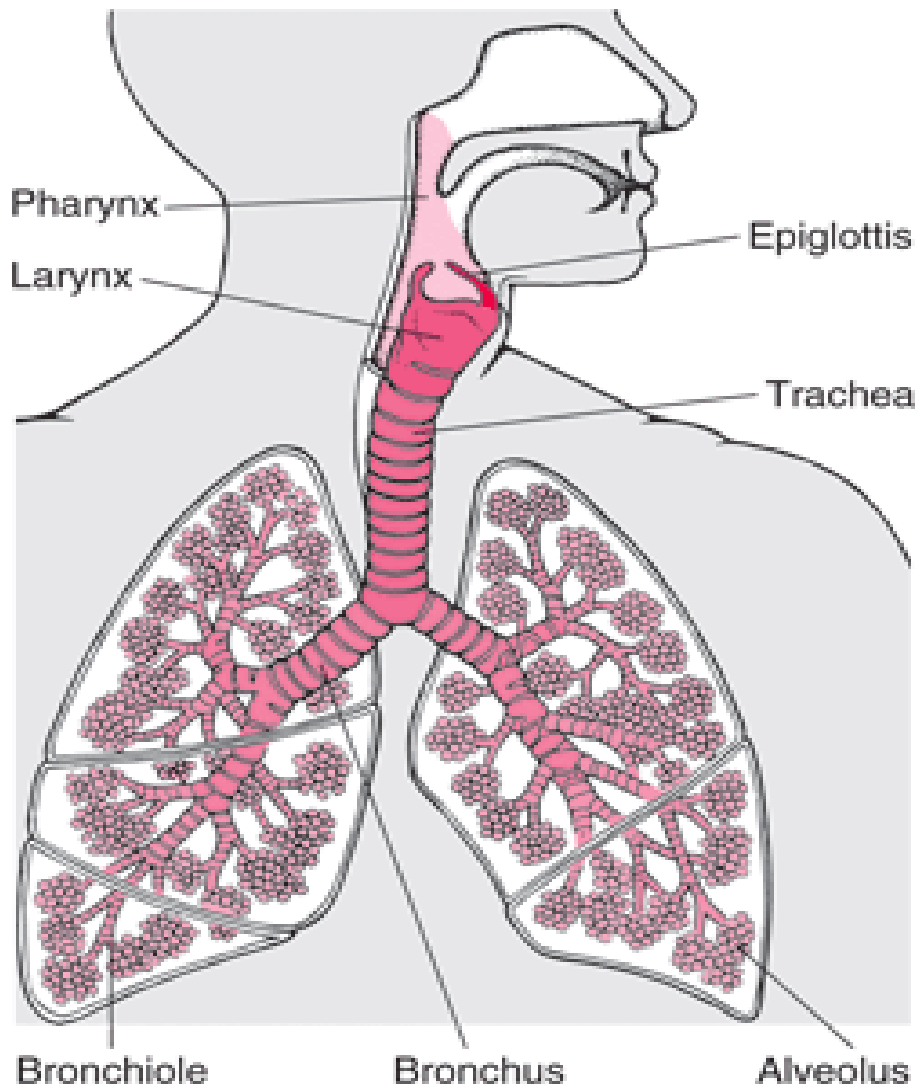
The respiratory portion of the respiratory system begins with the respiratory bronchioles and ends with the alveoli (Dudek 2005:42). This is where the blood-air exchange occurs. Airflow through the respiratory portion follows this route: respiratory bronchioles to alveolar ducts alveoli (Dudek 2005:41). A pulmonary lobule consists of terminal bronchiole, respiratory bronchioles, alveolar ducts and alveoli (Dudek 2005:41; Williams & Hopper 2007:549) (see figure 3.2). The trachea and the bronchial tree, which are organised into a mucosa, muscular layer, submucosa, and adventitia, are the conducting portion of the respiratory system. The thoracic cage consists of the lungs, pleura and the muscle of ventilation. As the airway gets progressively smaller down to the alveoli, the components of the wall change significantly, and the organisation is lost

(Dudek 2005:41). Figure 3.2 represents the respiratory system with both the conducting portion and respiratory portion.

Figure 3.2 labels:
- Nasal cavities, Nasopharynx, Oropharynx, Larynx
- Trachea
- Main bronchus
- Lobar bronchus
- Segmental bronchus
- Alveolar duct
- Alveoli
- Conduction
- Respiratory
- Pulmonary Acinus
- Pulmonary Lobule
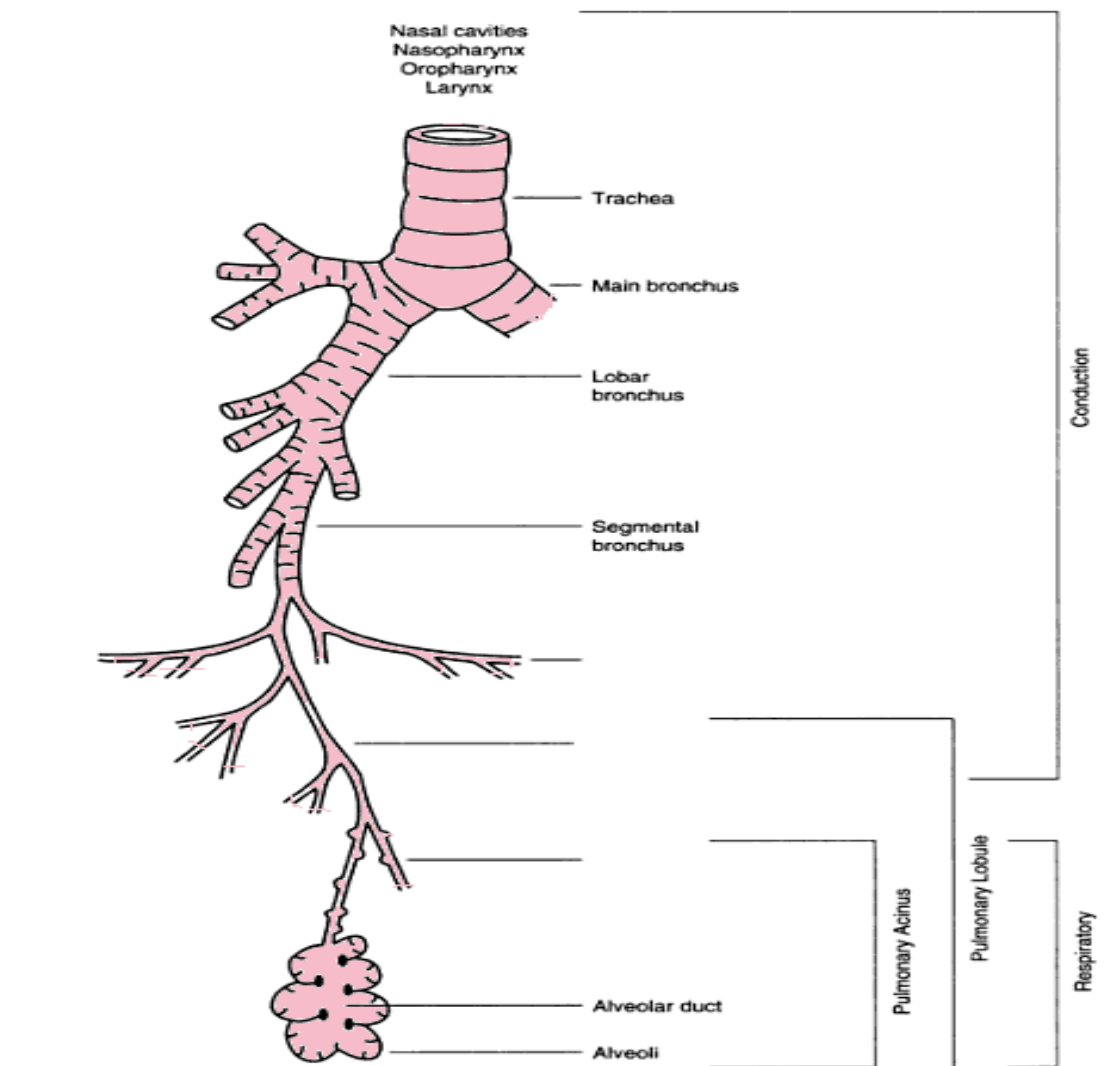
Figure 3.2   Respiratory system

Source: Dudek (2005:42)

3.2.2.1   *Respiratory portion of respiratory system*

Respiratory airways are the respiratory bronchioles and the alveoli, also known as respiratory units or pulmonary acinis. The primary function of the respiratory portion of the respiratory system is gas exchange. Oxygen and carbon dioxide are exchanged via the respiratory system to provide adequate oxygen to and remove excess carbon dioxide from the cells (Sole, Klein & Moseley 2005:159).

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3.2.2.2   Terminal bronchioles

Terminal bronchioles are the most distal part of the conducting airway. Each of the terminal bronchioles divides to form the respiratory bronchioles (see figure 3.3).
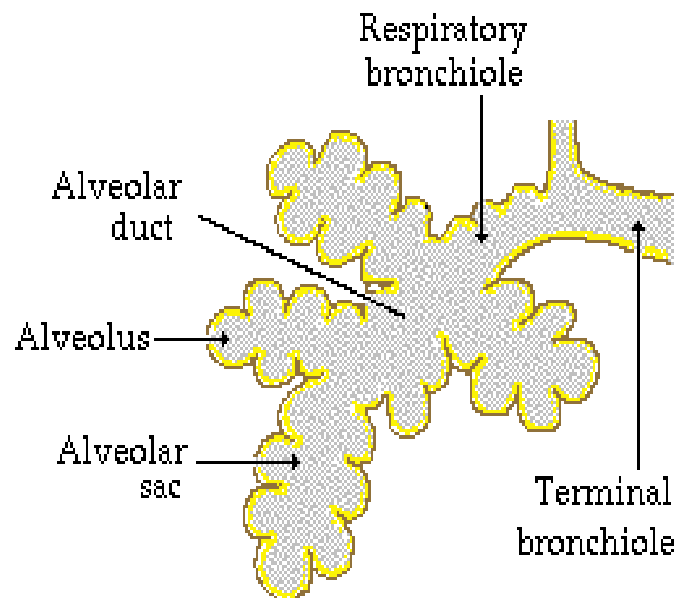
Figure 3.3   Respiratory bronchioles
Source: Dudek (2005:43)

3.2.3   Respiratory bronchioles

The respiratory bronchioles are branches of the terminal bronchiole, which first branches into two, then further into four. These form the transition zones of the lungs, and act as conducting airways and gas exchange units. The alveolar pouching on the surface allows the gas exchange to take place (Sole et al 2005:161).

3.2.3.1   Alveoli

The alveoli are small clusters from the alveolar duct of the respiratory bronchioles; each alveolar duct has clusters of 10 to 16 alveoli. This is the end point of the respiratory tract and where the gas exchange takes place. There are about 300 million alveoli in the two lungs. The alveoli are composed of several types of cells, including type 1 and type 11 alveolar epithelial cells and alveolar macrophages (Urden, Stacy & Lough 2004:503).

3.2.3.1.1 Type 1 alveolar epithelial cell

The type I alveolar epithelial cells comprise 90% of the alveolar surface in the lungs (Urden et al 2004:503). These alveolar cells play a major role in the maintenance of the gas barrier and gas exchange. These cells are susceptible to injury and become inflamed when exposed to inhaled toxins. Varieties of collateral air passages are located in the lower regions of the lungs, such as pores of Kohn, within the walls of type 1 cells, and allow collateral movement of air between the alveoli. The canals of Lambert, which exist between the alveoli, respiratory and terminal bronchioles, are another (Urden et al 2004:503).

3.2.3.1.2 Type 11 alveolar epithelial cells

Type 11 alveolar cells are more numerous but much smaller in size than type I alveolar cells. The most important function of these cells is their ability to produce, store and secrete pulmonary surfactant. The surfactant is a phospholipids compound of fatty acids bound to lecithin. The function is to lower the surface tension of the alveoli. This stabilises the alveoli, increases lung compliance and eases the work of breathing. When there is pulmonary disease, there is disruption of normal synthesis and storage of surfactants, which leads to alveolar instability and impaired gas exchange. After injury, the type 11 cells rapidly divide to line the surface and later transform into type1 alveolar cells (Urden et al 2004:503).

3.2.4 Pulmonary blood and lymph supply

The pulmonary circulation is the vascular system that forms the gas exchange network surrounding the alveoli. The bronchial circulation perfuses the tracheobronchial tree which consists of both the conducting portion and the respiratory portion of the respiratory system (Sole et al 2005:161) (see figure 3.4).

3.2.4.1 Alveolar capillary membrane

The alveolar capillary membrane forms a network around each alveolus that is so dense that it is almost a continuous sheet of blood covering the alveoli. Both the alveoli and

alveolar capillaries are only a cell thickness, which allows oxygen and carbon dioxide to diffuse without passing through significant amounts of plasma. Each alveolus is lined with a thin layer of tissue fluid that is essential for gaseous exchange. Certain alveolar cells secrete pulmonary surfactant that decreases the surface tension in the alveolus and permits inflation. Oxygen and carbon dioxide traverse easily across the layers, which have no barriers (Williams & Hooper 2007:550; Urden et al 2004:505)

3.2.4.2   Bronchial circulation

Bronchial circulation, also known as systemic blood supply to the lungs, perfuses the trachea-bronchial tree, visceral pleura, interstitial and connective tissues, some arteries, veins, lymph nodes and the nerves in the thoracic cavity. The left side of the thorax is perfused by the bronchial arteries and the right side by the inter-coastal, subclavian or internal mammary artery. The venous blood returns to the right side of the heart and some venous blood returns to the pulmonary veins and left atrium (Urden et al 2004:505).

3.2.4.3   Physiologic shunting

The left atrium normally contains pure oxygenated blood with a saturation value of 100%, but due to the mixing of venous blood from the bronchial circulation, the saturation is decreased to a range of 96% to 99%. This is why the saturation of arterial blood is less than 100%. This dumping of venous blood is known as anatomic shunt. The thebesian veins from the coronary circulation also drain venous blood into the left atrium and the normal anatomic shunt comprises 3% to 5% of total cardiac output (Urden et al 2004:505; Berry & Pinard 2002:24).

3.2.5 Lymphatic circulation

The lungs are supplied with more lymphatic tissue than any other organs; these vessels run parallel to the pulmonary vasculature and the tracheobronchial tree to the level of the terminal and respiratory bronchioles. The lymphatic system is part of the immune system (Williams & Hooper 2007:550) and is responsible for

- removing foreign particles

- producing antibody cell-mediated immune response

- removing fluid from the lungs and keeping alveoli clear

3.3   GAS EXCHANGE IN RESPIRATORY SYSTEM

The process of gas exchange consists of four steps: ventilation, diffusion at pulmonary capillaries, perfusion and diffusion at the cells (Sole et al 2005:162).

3.3.1 Ventilation

Ventilation is the movement of oxygen and carbon dioxide in and out of the alveoli (Sole et al 2005:162). It is regulated by the autonomic nervous system, namely the brain stem, the medulla oblongata and pons also known as the respiratory regulatory centre. Impulses are sent for the muscles of ventilation to contract, the thorax and the lungs to expand and the intrapulmonary pressure falls. When the pressure is below the atmospheric pressure, air enters the lungs and continues until alveolar pressure equals atmospheric pressure, also known as inhalation. At the end of inhalation the ventilation muscles relax, the thorax contracts and the lungs are compressed and the intrapulmonary pressure rises. Exhalation occurs when the intrapulmonary pressure rises above the atmospheric pressure (Urden et al 2008:577; Williams & Hooper 2007:550).

3.3.2 Diffusion at pulmonary capillaries

The movement of gases in and out of cells is by diffusion. It occurs at the pulmonary capillary level. Gases move from areas of high concentration to areas of low concentration. The alveoli contain higher levels of oxygen than capillaries, thus causing oxygen to diffuse from alveoli to capillaries. Carbon dioxide levels are higher in the capillaries thereby causing carbon dioxide to diffuse into the alveoli and be eliminated from the lungs (Sole et al 2005:162). Figure 3.4 represents the diffusion of oxygen and carbon dioxide.

3.3.3 Perfusion

The oxygenated blood from the pulmonary capillaries is transported via the pulmonary vein to the left side of the heart and then the oxygenated blood is perfused or transported to the tissues (Sole et al 2005:163).

3.3.4 Diffusion of gases

Diffusion of oxygen and carbon dioxide occurs at the cellular level dependent on the concentration gradients. Berry and Pinard (2002:24) point out that the concentration of gases in atmospheric air is as follows: partial pressure of oxygen is 159.6mmHg and partial pressure of carbon dioxide is 0.3mmHg. In the alveolar air, the concentration of both oxygen and carbon dioxide are of a different concentration from the atmospheric air. Oxygen diffuses across the alveolar membrane till the partial pressure of oxygen in the capillary is the same as the alveoli, approximately 103mmHg. The carbon dioxide diffuses in the same way; the concentration of carbon dioxide is 40 mmHg in capillary blood and 0.3 mmHg in alveoli thus it diffuses from capillary to alveoli (Berry & Pinard 2002:24).
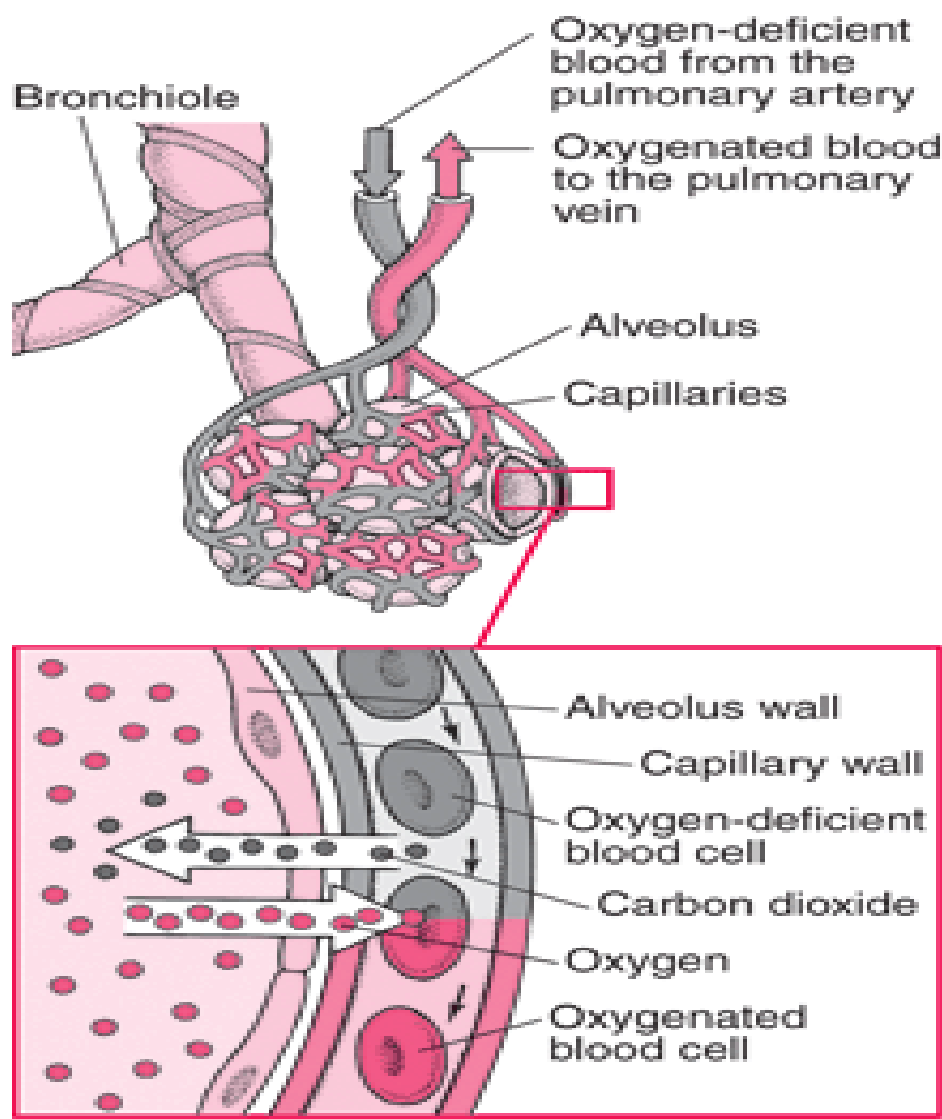
Figure 3.4 Gas exchange between alveolar spaces and capillaries
Source: Porter and Kaplan (2006:42)
(http://www.merck.com/mmhe/sec04/ch038/ch038d.html)

3.3.5 Gas transport

Gas transport is the movement of oxygen and carbon dioxide to and from the tissues. Inhaled oxygen enters the lungs and reaches the alveoli. Oxygen passes quickly through the air-blood barrier into the blood in the capillaries. Oxygenated blood travels from the lungs through the pulmonary veins and into the left side of the heart, which pumps the blood to the rest of the body. Similarly, carbon dioxide returns to the right side of the heart through two large veins, the superior vena cava and the inferior vena cava. Then the blood is pumped through the pulmonary artery to the lungs, where it picks up oxygen and releases carbon dioxide and is then exhaled (Urden et al 2004:512).

Gas transport also depends on an intact nervous system, compliant lungs, a sufficient number of alveoli, alveolar-capillary membrane and haemoglobin, good cardiac output and patent pulmonary vessels (Sole et al 2005:163). It also depends on the ability of the blood to carry oxygen and the ability of the circulation to transport blood to muscle (Urden et al 2004:512).

3.3.5.1 Oxygen transport in the blood

Oxygen is transported and delivered to the tissues either by dissolving in plasma or bound to the haemoglobin molecules. While most of the oxygen is transported by haemoglobin, 3% of the total oxygen is dissolved in the plasma. The pressure exerted by the oxygen is important as this oxygen diffuses across the capillary membrane into the cells and serves as the vehicle to unload oxygen from the haemoglobin. A pressure

gradient must exist between oxygen in the capillary and oxygen level in the cells (Urden et al 2004:512).

3.3.5.2   *Carbon dioxide transport in the blood*

Carbon dioxide is a product of aerobic cellular metabolism and is produced within the cells. It is transported within the plasma and erythrocytes to the lungs; 5% dissolves into the plasma, 10% binds to the multiple amino groups of haemoglobin and 80% is carried as bicarbonate ions. In the lungs it leaves the plasma and erythrocytes by diffusion from the capillary to the alveoli and is exhaled during expiration (Urden et al 2004:512).

3.3.6   Work of breathing

The work of breathing is the amount of effort required for the maintenance of a given level of ventilation (Sole et al 2005:163). The respiratory pattern changes to assist with the work of breathing, and depends on lung compliance and resistance. The pulmonary system requires 1% to 2% of basal oxygen consumption during normal quiet breathing. During exercise, the amount of energy required by the pulmonary system is greater. Therefore, for patients with pulmonary disease the work of breathing can be a factor. Thus pulmonary diseases that reduce the lung compliance, increase airway resistance or decrease lung recoil can increase the work of breathing and one third or more of body energy is used by ventilation (Sole et al 2005:163; Urden et al 2004:508 Williams & Hooper 2007:551).

3.3.6.1   *Respiration*

Respiration is the movement of oxygen and carbon dioxide (Urden et al 2004:511).

3.3.6.2   *Ventilation/perfusion relationships*

Ventilation and perfusion should be equally matched at the alveolar capillary membrane level for optimal gas exchange to take place, the normal alveolar ventilation is 4litres/min and capillary perfusion is 5 litres/min. The normal ratio is 4.5 or 0.8 (Urden et al 2004:511; Woodrow 2006:33).

3.3.6.3 Ventilation/perfusion mismatching

Various factors affect the matching of ventilation to perfusion in the lungs and are considered in the continuum. The alveolus receiving ventilation but not receiving perfusion and unable to participate in gaseous exchange is known as alveolar dead space. The alveolus receiving perfusion but not receiving ventilation and thus unable to participate in gas exchange is known as intrapulmonary shunting. The blood is returned to the left side of the heart unoxygenated. Major ventilation/perfusion mismatching leads to severe hypoxia (Urden et al 2004:511).

3.3.6.4 Hypoxic vasoconstriction

The distribution of perfusion is also affected by the amount of oxygen in the alveoli. When the PaO_2 is less than 60mmHg the pulmonary vessels constrict while the rest of the blood vessels dilate, which is thought to be a compensatory response to limit the unoxygenated blood from returning to the left side of the heart. When this is prolonged the effect is generalised in bothl the lungs and leads to pulmonary hypertension (Urden et al 2004:512)

3.3.7 Acid-base balance

Acid is a by-product of cell metabolism. In order to maintain normal enzyme activity and the chemical reaction in the body fluids, the narrow to normal range of pH range should be maintained (Cooper, Forrest & Cramp 2006:36). The normal pH is 7.35 to 7.45 and is maintained by

- intracellular buffers (proteins and phosphates)
- extracellular buffers (plasma proteins haemoglobin and carbonic acid/ bicarbonate)
- the excretory functions of lung and kidneys

The pH value outside the normal range indicates serious acid-base imbalance (Berry & Pinard 2002:27). Without any interventions or compensatory mechanisms there will be cellular dysfunction and death may occur (Berry & Pinard 2002:28).

3.3.7.1 Acid-base disorders

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Common acid-base disturbances and change in pH are due to abnormal respiratory function, abnormal renal function and a high acid-base load the body cannot cope with (Cooper et al 2006:39).

There are four possible primary causes of acid-base disorders (Cooper et al 2006:41), namely

- respiratory acidosis caused by ineffective ventilation
- respiratory alkalosis caused by over-ventilation
- metabolic acidosis caused by overwhelming acid load, kidney failure
- metabolic alkalosis caused by overwhelming base load, dehydration

Table 3.1 lists the causes of acid-base disorders.

Table 3.1   Common acid base disorders and their causes

Acid base disorder	Possible causes
Respiratory acidosis is caused by alveolar hypoventilation. It occurs when there is retention of carbonic acid.	Acute respiratory acidosis is due to an imbalance between respiratory muscle strength and load. Chronic respiratory acidosis is due to chronic obstructive pulmonary disease (COPD).
Respiratory alkalosis is caused by alveolar hyperventilation.	Shock. Lung causes: pneumonia, pneumothorax, pulmonary embolism Central nervous system causes: meningitis, intra-cerebral haemorrhage. Metabolic causes: fever, hyperthyroidism Psychogenic causes: pain, anxiety
Metabolic acidosis is caused by overwhelming acid-base load. The most common cause is tissue hypoperfusion. There are two types of metabolic acidosis: with increased anion gap and with normal anion gap.	Metabolic acidosis with increase anion gapis due to -Ingestion of exogenous acid: Salicylate tricyclic or ethanol poisoining, -Lactic acidosis type A: anaerobic tissue metabolism in states of hypoperfusion -Lactic acidosis type B: reduced lactate metabolism in the liver, ketoacidosis from insulin deficiency or starvation. -renal failure -massive rhabdomyolysis. Metabolic acidosis with normal anion gap is due to -renal tubular acidosis -diarrhoea, fistula, ileostomy -acetazolomide therapy.
Metabolic alkalosis is caused by excessive vomiting. Two types: saline responsive and saline unresponsive.	Saline responsive due to dehydration, excessive vomiting. Saline unresponsive is caused by renal problems such as high blood pressure, high doses of penicillin, ingestion of exogenous alkali.

Source: Cooper, Forrest and Cramp (2006:41)

3.3.7.2 *Arterial blood gases*

Arterial blood gases (ABG) measure the acidity and the levels of oxygen and carbon dioxide in the blood (Cooper et al 2006:36). Acid is a by-product of metabolism; however, the body has to maintain a narrow range of Ph values necessary for normal enzymic activity. This is maintained by the intracellular and extracellular buffers and then by the kidneys and lungs. The most important buffer system is the carbonic acid-bicarbonate system. The excretory functions of lungs and kidney are connected by carbonic acid known as respiratory- metabolic link (Cooper et al 2006:89).

3.3.7.2.1 Blood gas analysis

Blood gas analysis measures the partial pressures of oxygen and carbon dioxide in the blood as well as oxygen content, oxygen saturation, bicarbonate content and blood pH (Willams & Hooper 2007:73).

- *Oxygen*

Oxygen in the lungs is carried to the tissues through the blood stream, but only a small amount of this oxygen can actually dissolve in the arterial blood. It depends on the partial pressure of oxygen (PaO_2), the pressure that the gas exerts on the arterial wall. Normal values of PaO_2 are 75 to 100 mm Hg. The oxygen, which dissolves in the blood, combines with the haemoglobin, the oxygen content measurement (O_2CT), is normal value is 15-23%. Oxygen saturation (SaO_2) measures how much haemoglobin in the red blood cell is carrying oxygen. Normal values are 95% to 100% (Berry & Pinard 2002:25).

Oxygen saturation (SaO_2) measures how much haemoglobin in the red blood cell is saturated with oxygen. The oxygen saturation is measured either by a pulse oximeter or arterial blood gases and is a part of patient assessment and not a substitute of PaO_2 (Schutz 2001:77).

The measurement of saturation of oxygen by a non-invasive device, a pulse oximeter, is known as SpO_2 while the measurement of saturation by blood gases analysis is known as SaO_2 (Razi & Akbari 2006:43). Moreover, pulse oximetry work is based on two physical principles: one is the absorption of light at two different wave lengths and the second is the two different wave lengths have a pulsatile component that can distinguish between a changing arterial blood beat (Razi & Akbari 2006:43).

Scultz (2001:77) points out that SpO_2 accuracy depends on various physiological variables such as body temperature, placement of the pulse oximetry, haemoglobin level, arterial blood flow to the vascular bed, patients' ability to oxygenate, percentage of inspired air, venous return to the probe area, amount of light seen by the pulse oximetry and discolouration of nail bed with either nail polish or injury.

In addition, the "tissue oxygen is not reflected by oxygen saturation" (Schutz 2001:77). The affinity of the haemoglobin to the oxygen may impair or enhance oxygen released to the tissue level. Normal values of both SaO_2 and SpO_2 are 95% to 99% (Berry & Pinard 2002:25; Schutz 2001:77).

- *Carbon dioxide*

Carbon dioxide dissolves more readily in the blood than oxygen, forming primarily bicarbonate and smaller amounts of carbonic acid. In normal amounts, the ratio of carbonic acid to bicarbonate creates an acid-balance in the blood keeps Ph at a level where the body's cellular functions are efficient. The lungs and kidneys both participate in maintaining the carbonic acid-bicarbonate balance; the lungs control carbonic acid while the kidneys control bicarbonate balance. An acid-base imbalance occurs when either the lungs or kidneys are not functioning well. A capnometer provides numerial values of end-tidal carbon dioxide levels (Couchman, Wetzig, Coyer & Wheeler 2007:10) The normal values are (Berry & Pinard 2002:28):

- partial pressure carbon dioxide, ($PaCO_2$) is 35 to 45 mmHg
- pH are 7.35 to 7.45
- bicarbonate (HCO_3) is 22 to 26 mmols/L.

- *The anion gap*

Measuring the anion gap in any metabolic acidosis is important as it narrows down the possible causes. The anion gap is calculated by (sodium + potassium) minus (chloride + bicarbonate). The normal range is between 10 and 16 mmol/L. An increased anion gap with metabolic acidosis is caused by excess acid production or inability to excrete the acid in diseases like renal failure (Cooper et al 2006:41) (see table 3.2). Table 3.2 shows the changes in pH, $PaCO_2$ and bicarbonate in respiratory and metabolic alkalosis and acidosis.

Table 3.2   Changes in pH, PaCO$_2$ and standard bicarbonate in different acid-base disturbances

	pH	PaCo$_2$	Standard bicarbonate
Respiratory acidosis	Low	High	Normal - high
Respiratory alkalosis	High	Low	Normal - high
Metabolic acidosis	Low	Normal- low	Low
Metabolic alkalosis	High	Normal	High

Source: Berry and Pinard (2002:28)

3.4   RESPIRATORY FAILURE

Respiratory failure is a syndrome in which the respiratory system fails in one or both gas exchange functions: oxygenation and carbon dioxide elimination. Respiratory failure is defined as a PaO$_2$ value of less than 60mmHg on room air or a PaCo$_2$ of more than 50 mmHg. Acute respiratory failure is characterised by a life-threatening derangement in arterial blood gases and acid-base imbalance, while chronic respiratory failure manifestation is less dramatic (Sharma 2006:1)

- **Classification of respiratory failure**

Respiratory failure is classified as hypoxemic or hypercapnic and may be acute or chronic.

Hypoxemic respiratory failure Type 1

Hypoxemic respiratory failure is characterised by a PaO$_2$ less than 60mmHg with a normal or low PCO$_2$. It is the most common respiratory failure, associated with all acute diseases, which generally involve fluid filling or collapse of the alveolar units. Some of the causes are cardiogenic, non-cardiogenic such as pulmonary oedema, pneumonia and pulmonary haemorrhage (Cooper 2006:41).

Hypercapnic respiratory failure Type II

Hypercapnic respiratory failure is characterised by a PCO$_2$, of more than 50 mmHg. Hypoxemia is common in patients' breathing room air. Some of the causes are drug

overdose, neuromuscular diseases, chest wall abnormalities and asthma (Urden et al 2006:617; Woodrow 2006:32).

- **Distinctions between acute and chronic respiratory failure**

Acute hypercapnic develops over minutes to hours, therefore, pH is less than 7.3. Chronic respiratory failure develops over several days or longer, allowing renal compensation and increase in bicarbonate concentration, pH is slightly decreased. Distinction between acute hypoxemic or chronic cannot readily be made on the basis of arterial blood gases, but the clinical marker of chronic hypoxemia is polycythemia, or corpulmonale (Urden et al 2006:617; Woodrow 2006:32).

3.4.1 Pathophysiology of acute respiratory failure

The hallmark of acute respiratory syndrome is "hypoxemia as a result of impaired gas exchange" (Urden et al 2004:515). Furthermore, Type 1 respiratory failure usually results from ventilation and perfusion mismatching and intrapulmonary shunting while Type II respiratory failure results in alveolar hypoventilation, which may be accompanied by ventilation to perfusion shunting and intrapulmonary shunting. The causes of hypoxemia are alveolar hypoventilation, ventilation/perfusion mismatch and intrapulmonary shunting.

- **Alveolar hypoventilation**

When the amount of oxygen brought to the alveoli is insufficient for the metabolic needs of the body and leads to decreased ventilation, this is known as alveolar hypoventilation (Urden et al 2004; Woodrow 2006:32).

- **Ventilation/Perfusion (V/Q) mismatching**

Ventilation perfusion mismatch occurs when ventilation and blood flow are mismatched in various regions of the lung in excess of what is normal. This can be due to hypoxemia, which leads to alveoli partially collapsed or filled with fluid (Urden et al 2004:551).

- **Intrapulmonary shunting**

Intrapulmonary shunting is the extreme form of VQ mismatching, which occurs when blood reaches the arterial system without participating in the gas exchange. The reason for this can be either a portion of lung is not ventilated due to alveoli collapse secondary to atelectasis or alveoli flooding with pus, blood or fluid. This mixing of the unoxygenated blood lowers the average level of oxygen present in the blood (Urden et al 2004:551).

3.4.2 Complications of acute respiratory failure

Appropriate levels of oxygen are vital for cell respiration, in which glucose molecules are converted to energy. Bateman and Leach (1998:798) state that the delivery of oxygen depends on three systems: adequate ventilation, gas exchange, and circulatory distribution. When inadequate oxygenation is present, tissue hypoxia occurs within four minutes of failure of any of these systems and the oxygen reserves are very small in the tissues and lungs.

Some cells in the body can produce energy without oxygen (anaerobic metabolism) for only a short time but brain cells can only produce energy with a continuous oxygen supply (aerobic metabolism) for their survival (Hall, Schmidt & Wood 2005:417). Both heart and brain cells are very sensitive and require oxygen to produce energy; lack of oxygen can cause irreversible damage to the brain cells and can stop the heart from functioning within minutes (Law & Bukwirwa 1999:1). Some of the causes of lack of oxygen deficiency or tissue hypoxia are breathing an hypoxic of mixture of gases either in high altitude or fire; inability of lungs to oxygenate blood; interference with oxygen delivery to the tissues; inability of tissue to use the oxygen, and a decrease in the oxygen content of blood in anaemia (Berry & Pinard 2002:24).

The immediate signs exhibited due to lack of oxygen deficiency are drowsiness or loss of consciousness, hypotension, and tachycardia and if no action is taken then bradycardia, and within a few minutes there is complete stopping of cardiac activity. When there is a failure to deliver oxygen to the body systems, the heart stops functioning, also known as cardiac arrest, which further stops pumping blood to the lungs. Immediate measures to restart the heart are required by means of cardio

pulmonary resuscitation ensuring patient clear airway. Manual artificial breathing and chest compression are required, otherwise the patient could have irreversible damage or even die (Goodrich 2009:373).

If the hypoxemia is allowed to progress it can result in a deficit at cellular level as the oxygen demand continues and the supply diminishes, an imbalance occurs and tissue hypoxia occurs. This leads to impaired tissue perfusion and the development of lactic acidosis and multiorgan dysfunction syndrome (Urden et al 2004:552).

3.4.3 Medical management of acute respiratory failure

Patients with respiratory failure are susceptible to anaerobic metabolism due to either inadequate delivery of oxygen to systemic organs or because their tissues develop an abnormal inability to extract oxygen from blood (Wood et al 2005:417).

Therefore the main aim of medical management is to treat the underlying causes, promote adequate gaseous exchange, and correct acidosis. The most important intervention for promoting gas exchange is to improve oxygenation and ventilation (Urden et al 2004:552).

- **Oxygenation**

The purpose of oxygenation is to correct hypoxemia and to keep arterial haemoglobin oxygen saturation above 90%. Supplement oxygen is effective in treating hypoxemia related to alveolar hypoventilation and V/Q mismatching. Supplement oxygen is ineffective in pulmonary shunting where positive pressure is necessary to open the collapsed alveoli and facilitate adequate gaseous exchange (Pertab 2009:916).

- **Mechanical ventilation**

Mechanical ventilation is a life-saving therapy used for supporting the respiratory functions in the critically ill ICU patient. Pertab (2009:915) explains that mechanical ventilation is the appropriate treatment for patients with respiratory failure and patients unable to maintain adequate level of breathing. Mechanical ventilation is initiated to improve gaseous exchange, reduce the work of breathing and reduce cardiac work load

in patients with cardiac failure. There are two types of mechanical ventilation: negative pressure ventilation, which is outdated, and positive pressure ventilation. Positive pressure ventilation involves positively forcing air into the patient's airways with either mechanical ventilation, referred to as invasive ventilation, or with bag-mask-valve circuit, referred to as non-invasive ventilation (Pertab 2009:916). In order to initiate positive pressure mechanical ventilation the patient needs to first be intubated with either a nasotracheal or orotracheal tube (Urden et al 2004:552).

3.4.4 Endotracheal intubation

Endotracheal intubation carries a higher rate of complications in general units than in operating theatres and is associated with high mortality (Benetto, Hess, Gettings, Bigatello, Toon & Hurford 2007:20; Mort 2004:607). Tracheal intubation is the placement of a flexible plastic tube into the trachea to protect the patient's airway and provide a means of mechanical ventilation.

The most common tracheal intubation is orotracheal where the endotrachael tube with the help of laryngoscope, MacGill forceps, is introduced through the mouth, larynx and vocal cords into the trachea.

The cuff at the distal end of the tracheal tube is inflated to secure the tube and to protect the airway from secretions, blood or vomit. The other method is nasal-tracheal intubation where the tube is passed through the nose, larynx and vocal cords into the trachea (Urden et al 2004:591).

- **Preparation/Procedure of endotracheal intubation**

Walz, Zayaruzny and Heard (2007:608) describe the preparation/procedure as follows:

- Adequate personnel present to assist in positioning, applying cricoid pressure, suctioning oral cavity, and checking for tube placement
- optimal positioning to open airway
- good lighting to visualise the airway, and any foreign material in mouth
- requirements include 100% oxygen, a well-fitting mask with attached bag-valve device, suctioning equipment, a McGill forceps, endotracheal tube 7.5mm to

8.5mm diameter for an average adult patient. Page, Giehl and Luke (1998:27) state that for paediatric patients the formula used for endotracheal tube diameter size is:

$$\frac{age(years) + 4}{4} = diameter\ in\ millimeters$$

It is important to prepare for intubation to avoid unforeseen complications in the critically ill patient. Walz, Zayarwzny and Heard (2007:608) describe the preparation/procedure as follows:

Other requirements are a working laryngoscope with different types of blades, syringe, airways and cotton tape to secure the tube. The endotrachael intubation procedure is usually done by the anaesthetist and assisted by the nurse. The patient is positioned in a supine position and the neck is flexed (ruled out in patients with the C-spine fracture/injury).

Pre-oxygenation with 100% with bag-valve device is necessary, but in patients with cardiopulmonary disease there might not be adequate response. The patient is either given intravenous sedation or muscle relaxant or both prior to intubation. This is known as rapid sequence intubation. The oral cavity is opened using the laryngoscope; the lubricated endotracheal tube is introduced into the trachea, while the nurse applies cricoid pressure to avoid the regurgitation of gastric contents into the lungs (Walz et al 2007:608).The endotracheal tube placement is checked by bagging with bag-valve bag and listening to the breathing sounds from apex to base and for equal air entry to both lungs. The cuff of the endotracheal tube is then inflated with air as per the recommended amount by the manufacturer. The tube is tied around the neck with the cotton tape. The patient is connected to the mechanical ventilator if prescribed or bagged till awake from the sedation and able to breathe independently (Walz et al 2007:608).

- **Sedation/ analgesia/neuromuscular blockade**

Patients who are endotracheal intubated are anxious and in pain. Sedation and analgesia are commonly used to relieve anxiety and pain. According to Hofso and

Coyer (2007:251), sedation produces calm and cooperation, induces sleep, and minimizes anxiety and pain. However, over sedation causes depression of the cardio-respiratory function, decreases gastrointestinal motility and increases the risk of ventilator-associated pneumonia (Hofso & Coyer 2007:251). Lack of sedation or low levels of sedation is often associated with unplanned extubation (Foster 2009:2). Under sedation is also associated with complications such as tachycardia, hypertension, increased cardiac contractility, afterload and arrythymias (Hofso & Coyer 2007:317). The other major complication is failure of ventilator-patient synchrony leading to hypoxemia (Hofso & Coyer 2007:317).

The patient's anxiety level and agitation is measured by various tools. The most commonly used in clinical practice is the Ramsay Sedation Scale (Coyer, Wheeler, Wetzig & Couchman 2007:77). The Ramsay Sedation Scale is "a six-point numerical scale of the motor response founded on depth of sedation" (Coyer et al 2007:77; Ramsay, Savage, Simpson & Goodwin 1974:656). According to Hofso and Coyer (2007:317), the use of sedation protocols in conjunction with the use of tools to measure sedation levels have demonstrated improved outcomes in critical care patients.

Patients who are intubated and mechanically ventilated experience pain and are managed by opioids. Coyer et al (2007:76) emphasise that as mechanically ventilated patients cannot verbalise their pain, the best method of pain measurement is by a visual analogue scale and numeric rating scale. Pain should be eliminated prior to commencing sedation. The other drug used on mechanically ventilated patients is neuro-muscular blockade. Neuro-muscular blockades are drugs that cause inhibition of muscular contraction by the nervous system possibly resulting in muscular weakness or paralysis (*Mosby Medical Online Dictionary 2009:1*).

These are drugs given intravenously to patients who require mandatory controlled mechanical ventilation, in which no patient effort is required (Pertab 2009:917). According to Couchman, Wetzig, Coyer and Wheeler (2007:7), neuromuscular blockade should be used partially rather than fully as there is increased risk of critical illness neuropathy. The level of paralysis is assessed with a nerve stimulator and the drug titrated accordingly.

Table 3.3 briefly describes some of the drugs used for rapid sequence intubation, sedation, pain management and neuromuscular blockade in patients who are intubated and mechanically ventilated. The side effects of these drugs are also highlighted.

Table 3.3   Drugs used for sedation/neuromuscular blockade for intubation and maintenance in ventilated patients

Drug name and description/uses	Presentation/dose/route//action	Effects/side effects/ contraindications
Suxamethonium also known as Succinylcholine The dicholine ester of succinic acid(equilavent to two acetyloholine molecules joined back to back) Whether rapid and profound neuromuscular blockade is required to facilitate tracheal intubation and modification of fits after electroconvulsive therapy.	Presentation: clear aqueous solution of suxamethonium chloride 50mg/ml: stored at 4° Centigrade Dose/route:Intravenous-1mg/kg –onset of action within 30seconds and last 3-5 minutes Action: neuromuscular blockade of brief skeletal muscle Mode of action: causes prolonged depolarization of skeletal muscles fibers to a membrane potential above which an action potential can be triggered	Effects: Repeated dosing causes bradycardia, apnea intracranial and intraocular pressures are both raised Side effects: brachycardia and other arrythmias may occur with single dosing or repeated dosing. Hyperkalemic response in patients with renal failure and burns may cause cardiac arrest. Also potent trigger for development of hyperthermia. Contraindications: patients with renal failure
Propofol Is a 2,6 –diisopropylphenol; a phenol derivative Used for induction, sedation and maintenance of general anaesthesia Also used for treatment of refractory nausea and vomiting in patients receiving chemotherapy Also used for treatment for *status epilepticus*	Presentation: white oil in water emulsion containing 1% or 2% of propofol in soybean oil, purified egg phosphatide and sodium hydroxide Dose/route: intravenous bolus dose 1.5mg-2.5mg/ml intravenously for induction and 4-12mg/kg/hour for maintenance-consciousness is lost in about 30 seconds and waking occurs after 10 minutes after single dose. Action:-hypotonic Mode of action: mode of action unclear; it potentiates the inhibitory transmitters glycine and GABA which enhances spinal inhibition during anaesthesia	Effects: produces 15-25% decrease in blood pressure and cardiac output reduces by 20%.profound bradycardia and asystole. Bolus doses causes apnoea and laryngeal reflexes. Long-term use may result in hypertriglyceridaemia. Side effects: pain on injection site, epileptiform movements, facial parasthesiae and bradycardia. May occasional cause green discolouration to the urine. Contraindications: in patients receiving atracium, and may increase the energy required for successful cardioversion.
Midazolam (Dormicum) A water soluble imidazabenzodiazepine It is used for induction of anaesthesia, sedation during endoscopy and procedures Also is hypotonic, used for pre-medication prior to general anaesthesia and for treatment for chronic pain	Presentation: a clear colourless solution of midazolam hydrochloride containing 1/2/5 mg/ml Dose: intramuscular for premedication is 0.07-0.08mg/kg; the intravenous dose for sedation is 0.07-0.1mg/kg titrated according to response; can be used intrathecally in an adult dose is 0.03-2mg or epidurally dose of 0.1-0.2mg/kg Action: hyponosis, sedation, anxiolysis, anterograde amnesia, anticonvulsant and	Effects: reduces systolic blood pressure, diastolic pressure by 10% and systemic vascular resistance falls by 15-33% and heart rate increases by 18%. It also decrease the tidal volume apnoea in 10-77% of patients, reduces renal and hepatic blood flow Side effects: occasional

Drug name and description/uses	Presentation/dose/route//action	Effects/side effects/ contraindications
including de-afferentation syndromes	muscular relaxation Mode of action: act via specific bendodiazepine receptors	discomfort at site of injection Contraindications: use with caution in renal and hepatic failure
Morphine An isphenanthrene derivative It is an analgesic used for premedication, treatment of left ventricular failure. It is also used as analgesia during terminal care And used with combination of kaolin in the symptomatic treatment of diarrhoea	Presentation: tablets 5/10/30/60/100/200mg, syrup containing 2/10/20mg/ml, suppositories of 15/30mg and clear colourless solution of 10/15/30mg/ml Dose: intramuscular dose or subcutaneously is 0.1-0.2mg/ml and intravenous dose is 0.05-0.1mg/ml. the peak effect analgesic effects is 30.60minutes after intramuscular injection and duration is 3-4 hours. Action:- analgesic and respiratory depression Mode of action: morphine ia an agonist at mu- and kappa–opoid receptors. It increases the intracellular calcium concentration-increases potassium conductance and hyperpolarisation of excitable cell membrane.	Effects: orthostatic hypotension, bradycardia, respiratory depression, brochoconstriction in high doses, drowsiness, relief of anxiety and euphoria. Side effects: respiratory depression, nausea and vomiting, hallucinations and dependence. Pruritis may occur after epidural or spinal administration of drug Contraindications:-use with caution in hepatic failure, hypopituitarism
Remifentanil A synthetic anilidopipedine derivative It is an analgesic used for general anaesthesia and ICU.	Presentation: a clear colourless solution containing remefentanil hydrochloride in glycerine buffer in 1/2/5mg vials for dilution prior to infusion Dose;-give intravenously bolus dose of 1ug/kg and infusion is 0.0125-1ug/kg/min. The peak effect occurs within 1-3 minutes Action: analgesia and respiratory depression Mode of action: is a pure mu-agonist; the mu-opoid receptor appears to involved in mediation of analgesia. It increases the intracellular calcium concentration-increases potassium conductance and hyperpolarisation of excitable cell membrane.	Effects: decrease mean arterial pressure and heart rate by 20%, myocardial contractility and cardiac output may also decrease, potent respiratory depressant, vagal activity, gastric motility Side effects: respiratory depression, bradycardia, nausea and vomiting Contraindication: use with caution in patients with renal failure
Racuronium a aminosteroid it is used to facilitate intubation and controlled ventilation	Presentation: a clear colourless solution containing 10mg/ml of rocuronium; available in 5 to 10ml ampoules. Dose;-give intravenously ;normal dose for intubation is 0.6mg/kg and infusion is 300-600ug/kg/hour. The recovery index is 8-17 minutes. Action: neuromuscular blockade Mode of action: acts by competitive antagonism of acetylchlorine at nicotinic	Effects: minimal cardiovascular effects, increase in heart rate and mean arterial pressure, leads to apnoea. Side effects: very rare reports analylactoid reactions. Cross sensitivity with pancuronium Contraindication: use cautiously with patients with

Drug name and description/uses	Presentation/dose/route//action	Effects/side effects/ contraindications
	receptors at the post synaptic membrane of neuromuscular junction	hepatic failure

Source: Sasada and Smith (2003:366)

- **Physical restraints**

Hoyso and Coyer (2007:319) state that use of physical restraints in ICU patients varies from country to country. It is widely used in the USA, Australia and Central Europe, but in the United Kingdom (UK) and Scandinavian countries it is not an acceptable practice. In the USA the use of physical restraints in critical care is restricted. According to Foster (2009:2), the use of restraints may be a marker of inadequate sedation. Nurses in the ICU use physical restraints to prevent patients from treatment interference. On the contrary, physical restraints may actually increase agitation in patients, powerlessness, and altered behaviour, and the chances of self-deliberate extubation occurring are high in these patients (Foster 2009:2). Adverse effects of physical restraints are agitation, withdrawal, immobility, impaired circulation, nerve injury and bone fractures (Hoyso & Coyer 2007:317).

3.4.5 Potential complications of intubation

Adam and Osborne (2005:90) describe the potential complications of intubation as

- inability by the nurse or doctor to intubate (limited knowledge and skills)
- aspiration of the gastric content
- bleeding due to trauma of the airway
- endobronchial intubation
- oesophageal intubation
- vocal cord damage
- hypotension or hypertension or brachycardia due to hypoxia
- dislodged teeth.

Adam and Osborne (2005:90) add that when a patient is intubated, there is always a risk of unplanned extubation, displacement of the tube, loss of cuff seal and pressure sores on ears and occiput from tapes used for securing the endotracheal tube.

- **Complications of intubation in reported studies**

In a study in the USA to determine complications and outcomes of urgent intubations, Benetto et al (2007:20) found that 27% of the patients who underwent urgent intubations had complications during intubation, including multiple attempts to intubate; incorrect placement of the tubes, for example during oesophageal intubation; regurgitation of fluids and stomach contents; traumatic intubation (bleeding) and dental injury. The study revealed a 48% mortality rate of all emergency intubated patients due to the patients' diagnosis and the skills/experience of the person who intubated them.

In Hong Kong, Tam and Lau (2001:305) found that 10% of the patients had complications, such as hypotension, bradycardia, and desaturation after intubation and 10% of the total intubations required second and third attempts. A further 10% had complications such as incorrect placement of the tubes in the oesophageal and one-sided bronchial intubation, soft tissue injury and arrythymias. In a study on the immediate complications after endotracheal intubations in seven ICU's in France, Jaber, Amraouri, Lefrant, Cohendy, Capdevita, Calvert, Capdevila, Mahamat and Eledjam (2006:2355) found that 75% of intubations were done in the first attempt; 13% required a second attempt; 9% required a third attempt, and 3% required a fourth attempt. It was noted that 38% of complications occurred when a senior physician with more than five years' experience attempted the intubation while 62% occurred when a junior physician with one to five years' experience attempted the intubation. The study revealed further that only 28% of the total intubated patients had at least mild, moderate to severe life-threatening complications. Severe complications included hypoxemia, cardiac arrest and death. Mild to moderate complications involved difficult intubation, cardiac arrhythmia, oesophageal intubation, agitation, aspiration and dental injury.

In Nigeria, Edomwonyi, Ekwere, Omo and Rupasinghe in (2006:64) collected data 24 to 36 hours after intubation over a period of 16 months to determine the rates of sore throat in patients who were intubated during surgery. Edomwonyi et al (2006:64) found

that although 63% of the patients reported sore throat after extubation, no other complications were reported.

Gil, Frutos-Vivar and Esteban (2003:226) found an association between ventilator-associated pneumonia and re-intubation in their study in Spain. The findings revealed that the mortality rate was higher in patients who had complications of upper respiratory obstruction within the first 12 hours of post extubation. In Australia, Beckman and Gilles (2001:538) found that out of 143 incidents of accidental extubation and re-intubation of patients, 17% required re-intubation due to malposition of the endotracheal tube; 16% had problems with the endotracheal tube cuffs; 14% had blocked airway/bent endotrachael tubes, and 17% had problems with securing the endotracheal tube. Furthermore, 25% had morbidity due to hypoxia; 12% had hypercarbic respiratory failure; 7% had aspirated and 6% experienced cardiac arrhythmias (Beckman & Gilles 2001:538).In a retrospective study in the USA, Mort (2004:508) found that 2% of patients had cardiac arrest during emergency endotracheal intubation.

3.4.6 Mechanical ventilation

According to Adams and Osborne (2005:93), the main objectives of mechanical ventilation are to
- decrease work associated with breathing
- reverse life-threatening hypoxaemia
- reverse acute progressive respiratory alkalosis

Urden et al (2006:670) point out that the clinical objective of mechanical ventilation is to improve oxygenation and carbon dioxide elimination. However, the selection of the ventilator mode and settings depends on the underlying cause, the severity of respiratory failure, and the body size of the patient (Urden et al 2004:552).The following are among the modes of ventilation:

- **Mandatory control ventilation**

Mandatory control ventilation requires no effort by the patient (Pertab 2009:917). Mandatory ventilation can either be volume control or pressure control.

- **Volume control/pressure control ventilation**

Volume/pressure control ventilation is the most common method of positive pressure lung inflation and involves the use of constant inflation volume (Pertab 2009:917). Patients receive preset tidal volume or pressure and are mechanically supported until their condition improves and they are able to resume spontaneous breathing. Urden et al (2008:672) point out that volume control is initiated in patients with weak respiratory muscle and pressure is used in patients with decreased lung compliance or increased airway resistance. According to Pertab (2009:917), this mode of ventilation is beneficial for patients with obesity, chest wall deformity and neuromuscular diseases.

- **Assist control ventilation**

In assist control ventilation the volume or pressure and inspiration and expiration duration are set and each breath is triggered by the patient (Pertab 2009:917). This uses constant/volume pressure to inflate the lungs. Should the patient fail to breathe, the ventilator automatically delivers the preset volume. When used with controlled ventilation, this mode is beneficial for patients who require high tidal volumes to compensate for air leaks.

- **Pressure-regulated volume control ventilation**

The pressure-regulated volume control delivers the preset tidal volume at the lowest possible airway pressure (Urden et al 2008:672). This mode of ventilation is beneficial for patients with rapid changing pulmonary mechanical ventilation

- **Inverse ratio ventilation**

Inverse ratio ventilation reverses the inspiratory time to expiratory time to the ratio of 2 to I, which means that the inspiratory time is prolonged. This may help prevent alveolar collapse. The patient with acute respiratory distress syndrome can benefit from this mode of ventilation (Marino 2007:480).

- **Synchronised intermittent mechanical ventilation (SIMV)**

SIMV is a weaning mode that creates 'gaps' between mandatory breaths, thus accumulating carbon dioxide which stimulates the respiratory centre in the brain. (Woodrow 2006:33). When pressure support is added to SIMV, it increases the size of triggered breaths, reduces the work of breathing and assists in weaning patients.

- **Pressure support ventilation**

In pressure support ventilation patients are able to receive breaths only they trigger the ventilator. Pressure support ventilation allows patients to enhance spontaneous breathing. This mode is used to wean patients from mechanical ventilation (Marino 2007:481).

- **Constant positive airway pressure (CPAP)**

In CPAP mode, the ventilator delivers a flow of air preset constant pressure during both inspiration and expiration (Pretab 2009:917). This mode is a spontaneous breathing mode used in patients to increase functional residual capacity and improve oxygenation. This mode is beneficial for patients who have subsegmental lung collapse, pneumonia, and acute respiratory distress syndrome.

3.4.6.1 *Complications of mechanical ventilation*

Although mechanical ventilation is a life-saving intervention, it is associated with complications. Carberry (2008:112) and Urden et al (2008:671-674) list the following complications:

- Malfunction of the ventilator or disconnection of the ventilator circuit
- Ventilator-associated pneumonia due to endotracheal tube bypassing or impairing the lung's normal defence
- Patient-ventilator dyssynchrony due to patient and ventilator not being in synchrony; patient fighting or bucking the ventilator, which causes auto-PEEP and psychological distress to the patient

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- Barotrauma or pneumothorax due to excessive pressure on the alveoli
- Decreased preload, cardiac output and increased overload and intracranial pressure due to positive pressure ventilation
- Gastric distension due to air leak around the endotracheal tube cuff
- Vomiting due to pharyngeal stimulation.

3.4.7 Nursing care of the endotracheal intubated and mechanically ventilated patient

The purpose of the nursing care of the intubated and mechanically ventilated patient is to provide and ensure patent airway and to maintain the patient's safety at all times.

Before discussing the nursing management of the intubated /mechanically ventilated patient it is necessary to discuss the nurse characteristics or competences required to care for this patient in ICU. According to the AACN Synergy Model for Patient Care (Kaplow 2003:28), the nurse's competences reflect the integration of knowledge, experience and skills required to synergise with the patient's needs to ensure positive outcomes for the patient. Intubated patients are more vulnerable and their needs have increased. The nurse should be competent and be able to match the needs of the patient. It is essential to establish the rating of the nurse's competencies, as a novice nurse placed on Level 1 competency might be a threat to an intubated patient, while a nurse rated on Level 5 is an expert and uses critical thinking thereby ensuring the patient's safety, which is fundamental in the provision of optimal quality care. Patients' characteristics drive nurses' competencies. Nursing practice based on the eight patient characteristics spans the health-illness continuum. The nurse brings her knowledge and skills to the bedside to provide quality care without complications.

Kaplow and Reed (2008:19) emphasise the eight patient's characteristics or needs, namely resiliency, vulnerability, stability, complexity, resource availability, participation in care, participation in decision-making and predictability. Each patient has unique characteristics and their needs can further be identified along the continuum of illness. The nurse in the ICU needs to understand these characteristics and recognise the needs of the endotracheally intubated patient. The nurse should also be skilled, knowledgeable, and competent to provide optimal care to the patient who has been endotracheally intubated and mechanically ventilated. The nurse's characteristics are

clinical judgment, advocacy and moral agency, caring practice, collaboration, systems thinking, response to diversity, facilitation of learning, and clinical inquiry (Mullen 2000:66). According to the AACN Synergy Model for Patient Care, to identify the competencies required by the ICU nurse to care for the patient with respiratory failure, who has been endotracheally intubated and mechanically ventilated, the needs of this patient should first be identified (Kaplow & Reed 2008:19). The needs of the mechanically ventilated patient are described below:

3.4.7.1   Needs of the mechanically ventilated patient

Couchman et al (2007:7) point out that "acute dysfunction in one or more body systems is the precursor to initiation of mechanical ventilation". The ICU nurse should access the needs of the ventilated patient by assessing all the body systems as artificial ventilation impairs the physiology functions.

- **Neurological system**

Various tools are available for the neurological assessment of the mechanically ventilated patient (Couchman et al 2007:7). The Glasgow Coma Scale (GCS) is the most common one in use. The GCS is used to assess the conscious level by arousal and verbal/physical response, pupil size and reaction. Although the GCS will be inaccurate in the mechanically ventilated patient as verbal response will be impacted due to sedation and neuromuscular blockade drugs, subjective data is used such as communications scoring systems like the non-verbal means. Pupil reaction and size is the most important focused neurological assessment.   However in sedated patients decreased level in consciousness is masked and late changes such as pupillary changes are few indications of the change of neurological status(Couchman 2007:7).

- **Respiratory system**

The respiratory system assessment consists of checking the artificial airway, airway patency and breathing.   According to Couchman et al (2007:7), the care of the endotracheal tube consists of checking and regular for placement by chest auscultation, securing the tube to prevent dislodgement and ensuring cuff pressures are below 25mmHg. The airway patency assessment consists of the lung secretions, management and the use of humidifiers. Breathing compromises adequacy of oxygenation and

ventilation. Monitoring the arterial blood gases is essential, and SpO_2 and capnometry must be assessed.

- **Cardiovascular system**

The patient who is on mechanical ventilation requires vigilant cardiac assessment to determine adequate cardiac output, heart rate, blood pressure, central venous pressure, peripheral perfusion, urine output, chest x-ray and serum electrolytes. Adequate fluid balance should be assessed and fluid management to reduce the pre-load. The other assessment is signs of deep venous thrombosis and implementing preventive measures (Couchman 2007:10).

- **Gastrointestinal system**

The gastrointestinal assessment is done and adequate nutrition support is started early to prevent malnutrition (Urden et al 2008:620). Both malnutrition and overfeeding can interfere with the pulmonary system. Malnutrion affects the ventilator drive and overfeeding increases the carbon dioxide production which, in turn, increases the muscle drive and results in respiratory muscle fatigue (Urden et al 2008:620). According to Couchman et al (2007:11), decreased cardiac output due to mechanical ventilation also results in compromised blood flow to the liver.

- **Renal system**

The renal assessment consists of monitoring the urine output and the blood electrolytes. Patients who have respiratory failure and are mechanically ventilated, have low cardiac output due to positive pressure ventilation and positive expiratory pressure which results in decreased blood flow to the kidneys. This may result in reduced urine output due to neural and or hormonal mechanisms (Couchman et al 2007:12; Stroud 2009).

- **Metabolic system**

The metabolic assessment consists of monitoring the temperature and the blood sugar of the mechanically ventilated patient. Elevated body temperature indicates signs of infection. Patients who are mechanically ventilated are at significant risk due to low immunity and the artificial tubes, such as endotracheal, urinary catheter and central venous catheter. These patients are also at risk of developing nosocomial infections (Couchman et al 2007:12).

- **Skin integrity**

Patients who are mechanically ventilated in the ICU need skin assessment due to their immobility associated with ventilation and sedation. They need frequent position changes and passive range of exercises (Clare & Hooper 2005:264).

3.4.7.2   Nurse competences required to care for ventilated patients

The patient who is mechanically ventilated has complex needs and these should be correlated with the nurse's competences and skills according to the AACN Synergy Model for Patient Care. The eight nursing competences are all important in providing care to the mechanically ventilated patient. In caring for the ventilated patient the competencies of clinical judgment, clinical inquiry, caring practices, collaboration and advocacy and moral agent nevertheless take priority.The nurse needs strong clinical judgment to interpret and make decisions based on the needs of the ventilated patient. The nurse also needs assessment skills and knowledge of how to care for mechanical ventilation, interpret blood gases, use sedation protocol, sedatives, analgesics and neuromuscular blockade drugs, and check vital signs including RSS and GCS. The nurse should also be able to use weaning protocols and to participate in liberating the patient from ventilator. The nurse competence of clinical inquiry in patients who are ventilated incorporates evidence-based guidelines, evaluates practices such as suctioning, instillation of normal saline, chest physiotherapy, mouth care, use of sedation protocols, use of physical restraints and preventing ventilation-related pneumonia.

The nurse's caring practices is also important. The ventilated patient is unable to communicate, participate in care and decision-making; needs total care, frequent body position change, and care of the ventilator. The nurse must be competent in providing this care and able to monitor any change in condition. The nurse should also involve the family in providing this care. The nurse should also be able to use non-verbal skills for better communication with the sedated ventilated patient.

Collaboration with the multidisciplinary team is important in caring for the ventilated patient. The nurse also needs to collaborate effectively, be able to use skills of advocacy and moral agent, be able to make the best decisions on the patient's behalf as patient is unable to participate or make decisions.

Table 3.4 depicts the expected characteristics of an intubated patient and the nurse's competencies required.

Table 3.4   Expected characteristics of the intubated patient and the nurse's competencies of concern to the patient and the system

Intubated patient's characteristics	Nurse's competences required
Vulnerability: susceptibility to actual or potential stressors that may adversely affect the outcome. Expected to be highly vulnerable, patient is fragile and unprotected as intubation is a stressor; communication and patient's ability to make decisions are compromised. Patient also has risk of complications of intubation such as infection, ventilation-acquired pneumonia, anxiety, pain and discomfort. Family will also have increased vulnerability as intubated patient is unstable, unable to communicate effectively and outcome is uncertain.	**Clinical judgement**: clinical reasoning, which includes clinical decision-making, critical thinking, and a good global grasp of the situation, coupled with nursing skills acquired through process of integrating formal and informal experiential knowledge and evidence practice guidelines. The nurse competency required for caring for the intubated patient should be at Level 3 or Level 5. Couchman et al (2007:7) states that care of ventilated patient is the core clinical practice in the ICU. Nurses should have competences to carry out primary and second surveys of patients; Airway, Breathing, Circulation and secondary survey is assessment of body systems. In a study in the USA on different products and techniques used to secure endotrachael tubes, Richmond, Jarog and Hanson (2004:32) found that with education and using commercial tube holders the rates of unplanned extubation were reduced from 2.34% to 0.9%. Chocker and Scholes (2009:289) stress that it is essential that the nurse should know her patient, be able to read the cues from the patient, detect early exhaustion, discomfort and anxiety during weaning patient from ventilation. Knowing the patient requires an expert nurse which is also related to positive patient outcomes. Burns (2005:14) points out that the use of protocols is linked to positive outcomes. The nurse should be aware that physical restraints can cause complications such as unplanned extubation and patient policy to prevent unplanned extubation (Foster 2009:4). Endotrachael tube tape is changed daily and when necessary. Ensure that the tube is tied securely around the neck and the lip is intact. Oral airway is used to prevent patient from biting on the tube (Adam &Osborne 2005:89; Kuriakose 2008:10). In order to avoid agitation, physicians usually prescribe sedation to allay anxiety and keep the patient calm and safe (Kuriakose 2008:10).

Intubated patient's characteristics	Nurse's competences required
Resiliency: the capacity to return to a restorative level of functioning using compensatory coping mechanisms; the ability to bounce back quickly after an insult.	**Clinical inquiry**: the ongoing process of questioning and evaluating practice, providing informed practice and innovating through research and experiential learning. Clinical inquiry evolves as the nurse moves from novice to expert. At the expert level, the nurse improves, deviates from and/or individualizes standards and guidelines to meet the needs of the patient.
Resiliency will be minimal, at Level 1 failure of compensatory coping mechanisms, as it is affected by the respiratory function and any other co-morbidities of the patient.	Nurse competency should be at Level 3 or Level 5.

The nurse incorporates questioning and evaluation of practice, such as suctioning practice and chest physiotherapy, sedation protocols and weaning protocols.

In a study in Brazil on the effects of saline instillation before tracheal suctioning, Caruso, Denari, Ruiz, Demarzo and Deheinzelin (2009:36) found that saline instillation decreases ventilator-associated pneumonia. However, Kuriakose (2008:10) reported that various reviewed reports indicated that saline instillations during endotracheal suctioning caused raised intracranial pressure, decreased oxygen saturation, dyspnoea, and pneumonia.

Day, Farnell and Wilson-Barnett (2002:79), Pedersen et al (2009:25) and Kurikose (2008:45) maintain that saline and respiratory secretions do not mix in vitro and there is no evidence they might mix in vivo, consequently they do not recommend saline lavage prior to endotrachael suctioning.

Chest physiotherapy and suctioning is done every four hours and when necessary (Swatz 2001:101).

Record the type, colour and amount of secretions in the nursing notes.

Regarding physiotherapy for critically ill patients, however, Gosselink, Bott, Johnson, Dean, Nava, Norrenberg, Schonhofer, Stiller, Van De Leur and Vincent (2008:1193) recommend that neither chest wall compression, or saline instillation and suctioning should be performed routinely. Just body positioning and mobilisation of the ICU patient is sufficient for airway clearance. |

Intubated patient's characteristics	Nurse's competences required
Complexity: the intricate entanglement of two or three systems (body, family, therapy). Will be at Level I highly complex as two or more systems are involved: cardiopulmonary systems, family and therapy.	**Caring practices**: nursing activities that create a compassionate, supportive, therapeutic environment for patients and staff, with the aim of promoting comfort and healing. Nurse competencies required are above Level 3. The nurse ensures patient assessments are done every 2-4 hourly and when necessary assess and validate the airway is patent by listening to the air entry which should be equal in both the lungs. • ensure ties/tapes are secured and clean. Check cuff pressure with manometer regularly; should not exceed 25mmHg, keep it low for a good seal (Mol, De Villiers & Claassen 2004:15; Urden et al 2008:667). • monitor complications of intubation measure and record the endotracheal tube length, lip to tip mark every 4 hours and when oral care is done or tape is changed (Adam & Osborne 2005:89). • Care of ventilator Vital signs are recorded as follows: • Continuous observations of cardiac rhythm, blood pressure, pulse, respiration, tidal volume, minute volume, end tidal carbon dioxide ($ETCO_2$), added oxygen amount and saturation (Adam & Osborne 2005:90) • Chest auscultation is done every two hours • Cardiopulmonary status is observed before, during and after suctioning (Kuriakose 2008:10) **Safety of patient:** Couchman, Wetzig, Coyer and Wheeler (2007:5) state that the essential nursing management of the mechanically ventilated patient is ensuring patient safety, patient comfort and management of stressors; assessing patient and equipment, patient comfort; patient position, hygiene, and management of stressors; pain and sedation management. Finally, to improve outcome of mechanically ventilated patients, the ICU personnel should implement the evidence-based practice known as the "ventilator care bundle", which are four interventions that promote safe outcome of the patient. These interventions are 30° elevation of the head of the bed; management of sedation including daily sedation vacation (daily interruption of sedation); peptic ulcer prophylaxis, and deep vein prophylaxis. Foster (2009:4) emphasises that the nurse should ensure safety of the endotracheal tube in securing the tube, especially when turning the patient, oral care and positioning the patient for procedures. Non-standardised and inadequate taping methods, as well as stretched and moistened tape have been associated with unplanned extubation (Foster 2009:4).
Stability: the ability to maintain a steady state of equilibrium. Level 1, decreased, as respiratory failure leads to	**Collaboration:** is the nurse working with the others to promote optimal outcomes. The patient, family and members of various healthcare disciplines work toward promoting optimal and realistic patient goals.

Intubated patient's characteristics	Nurse's competences required
low cardiac output, patient is liable. Mechanical ventilation also leads to increased intracranial pressure.	Nurse competency required is Level 3 and above. In Scotland, Reader, Flins, Mearnes and Cuthbertson (2007:347) found that communication amongst the nurses and physicians improves the daily goals of the patient.
Predictability: a characteristic that allows one to expect a certain course of events Level 1 decreased stability and complexity of the illness cause uncertainty in the patient's and family's life.	**Advocacy and moral agent**: working on another's behalf and representing the concerns of patients/family and nursing staff; serving as a moral agent in identifying and helping to resolve ethical and clinical concerns within and outside the clinical setting. Nurse competency required is Level 3 and above.
Resource availability: extent of resources (technical, fiscal, personal, psychological and social) that patient, family bring to the situation. Level 1 uncertain and depends on the personal, psychological, social and support of the family. Healthcare costs are also increased.	**Systems thinking:** the tools and knowledge that the nurse utilizes to recognize the interconnected nature within and across the healthcare or non healthcare system. The ability to understand how one decision can impact the whole is integral to systems thinking. Nurse competence required is Level 3 and above.
Participation in decision-making; extent to which patient and family participate in decision making on care. Level 1 or uncertain, as patient may be sedated. Family engagement in clinical decisions can also be impacted by their knowledge, capacity to make decisions, cultural background, and inner strength during crisis.	**Response to diversity:** the sensitivity to recognize, appreciate and incorporate differences in the provision of care. Nurses need to recognize the individuality of each patient while observing the patterns that respond to nursing intervention. The nurse competency required is Level 3 and above. In order to promote safety of an intubated patient, the nurse should ensure the following safety precautions are adhered to: Endotracheal tube same size and one size smaller with other reintubation equipment are kept at the bedside for emergency purpose. Bag-valve mask with the oxygen tubing.
Participation in care; extent to which patient and family participate in care Level 1 or uncertain, as patient may be sedated and cannot participate in care. Family engagement in care can also be impacted by stress of uncertainty of patients condition, their cultural background and the inner strength during crisis.	**Facilitation in learning:** the nurse facilitates learning for the patients, families, nursing staff, physicians and other healthcare disciplines and community through formal and informal facilitation of learning. Education should be provided based on the individual strengths and weaknesses of the patient and family. The educational level of the patient should be considered in the design of the plan of educating the patient and family to ensure informed decisions (Hardin & Kaplow 2005:6). Level 3 and competency is required.

As shown in table 3.4 the mechanically ventilated patient characteristics or needs as per the AACN Synergy Model for Patient are minimum resiliency Level 1; highly vulnerable Level 1; stability, Level 1, high level complexity; Level 1, resource availability; Level 1, participation in care; Level 1, participation in decision-making Level 1. For the care of the mechanically ventilated patient, the nurse should be competent, knowledgeable and highly skilled to care for the complex needs. According to the AACN Synergy Model for Patient Care, to care for the mechanically ventilated patient, the nurse should be a Level 3, proficient nurse to Level 5, expert nurse in all eight characteristics, in Scotland namely clinical judgment, advocacy and moral agency, caring practice, collaboration, systems thinking, response to diversity, facilitator of learning, and clinical inquiry.

If the patient's characteristics and the nurse's competencies match and synergise, outcomes for the patient care are optimal. In order for the patient's care to be synergized, the healthcare system should be conducive to healing by having systems which look at incidents as systems failure and ways of improving care. When the patient's characteristics, the nurse's competency and the healthcare system match, the patient has safe outcomes, with satisfaction to both patient and family, and lastly treatment is achieved without any interference such as unplanned extubation (Kaplow 2003:28)

3.4.8 Weaning patient from the ventilator

Weaning from the ventilator "should be commenced As soon the patient shows evidence of clinical improvement" (Marino 2007:481). Patients are given a trial of spontaneous breathing when haemodynamically stable with minimal or no vasopressor support. The criteria for weaning are:

- PaO$_2$ is above 60mmHg on FIO$_2$ of 40-60% and Positive end-expiratory pressure (PEEP) **to** of 5 to 8 cm of H$_2$O.
- PaCo$_2$ is normal or baseline expect in hypercarbic patients.
- Patient is able to initiate respiratory effort
- No evidence of myocardial ischaemia
- Heart rate is below 140 beats per minute.
- Blood pressure is normal without or with minimal vasopressor support.
- Patient is arousable with GSC of 13 and above.

- Patient is afebrile and has no significant electrolyte imbalance (Marino 2007:512).

In Sweden, Eckerblad, Eriksson, Karner and Edell-Gustafsson (2009:225) found that ICU nurses used three different decision-making strategies based on creating security of the patient, namely the

- Intuitive and interpretative strategy, based on the patient's individual capacity and the nurse's pre-understanding
- Instrumental strategy, which is knowledge of technology, patient physiology parameters, and guidelines on weaning
- Cooperative strategy, which is good collaboration within the team.

In Sweden, a survey of 92 ICUs on the use of weaning protocols revealed that weaning protocols were used in only three ICUs (Martensson & Fridlund 2002:219). Martensson and Fridlund (2002:219) developed guidelines for weaning patients from ventilatory support, emphasising that weaning "includes both physical and psychological training of the patient". Essential factors prior to weaning (Martensson & Fridlund 2002:219) include

- Good nutritional and metabolic status
- Pain relief and good night's sleep
- Communication between the nurse and the patient, including the constant presence of the nurse to reassure and allay anxiety
- A weaning method/protocol understood by the nurse
- A team approach as best practice.

According to Blackwood and Wilson-Barnett (2007:209), nurses appreciate "a definite protocol on weaning as it provides structured guidelines to follow and safe nursing practice particularly to the less ICU experienced nurse".

Furthermore, nurse-directed weaning protocols have the capacity to reduce mechanical ventilation time, allow nurses to use their clinical judgement which makes them more confident in caring for mechanically ventilated patients, encourages them to learn new

skills and gain knowledge, such as the different modes of ventilator parameters, and the ability to follow set guidelines of protocols.

Nurses working in the ICU who possess the appropriate clinical competencies are professionally well prepared to take a leading role in liberating critically ill patients from ventilation.

3.5   UNPLANNED EXTUBATION

Unplanned extubation is premature removal of the endotrachael tube either accidentally during a nursing procedure such as changing the patient's position or self-deliberate extubation action by the patient for example a patient who is not well sedated or confused. This leads to premature discontinuation of mechanical ventilation and can lead to hypoxia and ultimately brain damage and death.

Regarding the risks factors associated with unplanned extubation, Moons et al (2004:1348); Mpe, Moloto and Mphahlele (2004:17), and Yeh, Lee, Ho, Chiang and Ling (2004:255) found the rate of unplanned extubations to be between 3% and 22.5% in ICU. Unplanned extubations have gradually decreased through improved education of nurses and other healthcare professionals attending to the patient in ICU and by managing the risk factors associated with extubation.

Agitation, confusion, lack of sedation, use of physical restraints, blocked tubes, lack of nursing experience, and nurses' workload are among the risk factors of unplanned extubation (Kinsley & Barone 2005:560; Krayem, Butler & Martin 2006:71; Moons et al 2004:1348; Mpe et al 2004:17; Yeh et al 2005:255; Curry et al 2008:45; Ream, Mackey, Green, Andreone, Loftis & Lyetnch 2007:366; Mpe, Moloto & Mphahlele 2004:17; Chaterjee et al 2004:137; Chang, Wang & Chao 2008:460; Mion et al 2007:2714; Ream, Mackey, Leet, Green, Andreone, Loftis & Lynch 2007:366; Happ 2002:81)

Despite the knowledge of predisposing factors, there is still a prevalence of unplanned extubation worldwide (Ream et al 2007:366; Birkett, Southland & Leslie 2005:65; Beckmann 2001:539). However, the trends of unplanned extubation have gradually decreased by managing the risk factors associated with extubation as well as improved

education of nurses and other healthcare professionals attending to patients in ICU (Curry et al 2008:45).

Unplanned extubation is a real and potential risk to the patient, especially if the patient is on mandatory ventilator support. Unplanned extubation often leads to complications such as hypotension, tachycardia and a decreased level of consciousness due to hypoxia; increases the length of stay in ICU and thereby a further risk of hospital-induced infections, increased healthcare costs, and increased chances of aspiration pneumonia (Curry et al 2008:45).

Re-intubation has additional risks such as bleeding from injury to the airway, trauma to the airway, aspiration of secretions, and cardiac arrest (Bhattacharya, Chakraborty & Agarwal 2007:106; Chatterjee et al 2004:37).

Table 3.5 summarises studies on intubation/unplanned extubation from 2000 to 2009.

Table 3.5   Summary of studies on intubation/unplanned extubation conducted in Africa

Author/Country	Aim/type of study/sample size	Summary of study/findings
Edomwonyi, Ekwere, Omo and Rupasinghe (2006:24) in Nigeria	To investigate risk factors of short-term intubated patients	A prospective study on risk factors of short-term intubation; patients who were intubated during surgery; data collected 24-36 hours post intubation for 16 months. Findings were patients had a sore throat after intubation.
Adudu and Adudu (2004:67) in Nigeria	To investigate working practices of nurses and the associated outcomes of patients	A retrospective study of 15 years' review of patients: working practices and outcome of patients in ICU. According to the report not all patients admitted required ICU care; patients mean length of stay was 7.1days. They identified a need for a high dependency unit.
Mpe, Moloto and Mphahlele (2004:17) in South Africa	To investigate the rate of unplanned extubation in a critical care unit	A prospective observational study in ICU for six months. Study findings were that rate of unplanned extubation was 10.3%, of which 25% required reintubation. Unplanned extubation was attributed to the use of restraints, insufficient sedation, and oral intubation.
Mol, De Villers and Claassen (2004:14) in South Africa	ICU nurse knowledge on the use and care of endotracheal/tracheostomy tube	A two-week prospective study on staff knowledge on use and care of endotracheal/ tracheostomy tube cuff was conducted with a sample of 112 nurses working in 11 different ICU's in government and private hospital ICU's. The study findings revealed that the mean years of nursing experience was seven years in government hospitals and four years in private hospitals; 84% of staff in government hospitals and 57% in private hospitals were not aware of the specific protocol regarding care of tube cuffs; 76% of private hospital nurses compared to 7.5% in public hospitals were aware of the accurate way to measure cuff pressure. The overall finding of the study was that 38% of nursing personnel had misconceptions about the function of endotracheal tube cuffs, and accurate regulation was not a routine practice. Based on the findings of this study, a protocol for endotrachael/tracheostomy tube cuff care was developed.

Table 3.6   Summary of global studies on unplanned extubation

Author/year and country	Type of study	Purpose/objective	Sample size	Major findings
Eryuksel, Karakut and Celikel (2009:17) in Turkey	Observational study	An investigation into non-invasive positive pressure ventilation in unplanned extubation	Total number of 130 patients, of who 15 had been unplanned extubated	Study revealed that 11% patients had unplanned extubation. Of these 80% were males, and the mean age of unplanned extubated patients was 57 years. Study indicated that 100% (N=15) of unplanned extubated patients were on ventilator support; 33.3% required reintubation. All patients who had unplanned extubation were ventilated for more than three days.
Chang, Wang and Chao (2008:408) in Taiwan	Retrospective study, reviewing medical records and incidents reports of over 21 months	Objectives were to identify factors associated with increased unplanned extubation and to determine risk factors in patients for unplanned extubation with and without restraints in an adult ICU.	A total of 300 patients were used in this study of which 100 had unplanned extubations and 200 were used as control patients	Study revealed that the incidence of unplanned extubation was 8.7%. Of the 191 patients who had been restrained; 82 (32%) had unplanned extubation, the mean age was 66.2 years with a mean Glasgow coma scale of 10.1. In 29.3%of the patients nosocomial infection were reported, 90.2% had wrist restraints while 39% were sedated. Of the 300 patients in this study, 109 were without restraints; 18 patients (14.6%) had unplanned extubation with a mean age of 60.2 years, oral intubation was 94.4%, the mean GSC of 10.3, 27.8% were sedated. Nurses in ICU had more than two years' experience with a mean of 4.85 years of experience. Risk of unplanned extubation was reported as 6.28 times higher in patients who were restrained.
Curry et al(2008:45) in USA	Retrospective exploratory study	To explore patient and nurse characteristics of unplanned extubation in surgical ICU.	A total of 31 patients who had unplanned extubation	All 31 patients had self-deliberate extubation. This study only looked at self-deliberate extubation and excluded accidental extubation. Of the patients, 86% were men; 86% had been restrained; 87% had wrist restraints and 10% had bilateral restraints; 48.3% of unplanned extubated

Author/year and country	Type of study	Purpose/objective	Sample size	Major findings
				patients required re-intubation A Ramsay Sedation Scale mean score of 2.42 was reported. Of the nurses, 52% had baccalaureate degrees, a mean of 8.81 years of experience, and 51.6% had less than five years' experience in ICU while 89% of extubations occurred when nurses were absent from the patient's bedside.
Bouza, Garcia, Diaz, Segovia and Rodriguez (2007:270) in Spain	Prospective cohort study, over a 12 month period	Incidences, circumstances and outcome of unplanned extubation in orally intubated medical patients	The study consists of 344 intubated patients over a period of 3710 ventilated days	Overall incidence density included 92 of 100 days ventilation. 34 patients had unplanned extubation; 71% were self-extubated and 29% accidental. Of the patients, 91% were male, with a mean age of 63 years, 23% had been fullly ventilated and 29% were sedated. More accidental extubations occurred during day shifts and self-extubation more on night shifts. In 41% of the unplanned extubations, the care givers were at the bedside. In addition, 41% patients were re-intubated; of which 90% were accidental extubations, which led to prolonged length of stay and total days increase in intubation. Of the patients, 23% with reported unplanned extubation were linked to tube fixation problem and other nursing procedures.
Mion, Minnick, Leipzig, Catrambone and Johnson (2007:2714) in the USA	Prospective prevalence study in 49 adult ICUs from 39 hospitals in five states of the USA	To determine the prevalence of device removal, describe patients' contexts, consequences of extubations, and examine unit level risk factors.	Conducted over a period of 49,482 patient days and 18,308 ventilated days	Overall 9.9 self-extubation/1000 ventilated days. This study used 1000 ventilated days to calculate the density of unplanned extubation. 181 patients'had self-extubated; in the medical ICU the overall rate of self-extubation was 11.8; the general ICU rate was 10.4, and the surgical ICU rate was 6.8. The mean age of the patients was 63.6 years of which 57% were male. 70% of unplanned extubation patients received

Author/year and country	Type of study	Purpose/objective	Sample size	Major findings
				sedation and 44% extubated patients were restrained. The study concluded that there was no association between unplanned extubation found with patients being physically restrained, ventilator days or elderly patients.
Ream, Mackey, Leet,Green, Andreone,Loftis, and Lynch (2007:366) in the USA	Prospective cohort study over two year period.	To estimate nursing workload from the patient acuity level and to determine influence on unplanned extubation in a paediatric ICU	Conducted over a period of 1,919 medical and surgical patients, 739 patients were intubated, 6,636 ICU days and 2,193 nursing shifts.	The overall findings of the study were that 0.76 unplanned extubation/100 ventilated days. 5.4% of the ventilated patients had unplanned extubation, and 45% of unplanned extubated patients required re-intubation. Nurse-to-patient ratio of 1:1.5. Patient acuity level (PAL) of 12 measurements of nursing care intensity with acuity level ranging from 1 to 7. The patient workload and acuity level per shift yielded PAL of 5.8. Logistic regression revealed positive relationship between unplanned extubation and patient/nurse ratio and shift /nurse ratio.
Bhattacharya, Chakraborty and Agarwal (2007:105) in India	12 months prospective observational study	Comparison of outcomes of self-extubation and accidental extubation of patients in an adult ICU	Total of 556 intubated patients and 2243 intubated days	32 patients (1.42/100 tube days) had unplanned extubation, of which 26 were self-extubation and 6 were accidental extubation. 100% of accidentally extubated patients and 30.0% of self-extubated patients required re-intubation. In addition, 50% of accidentally extubated patients had hypoventilation, 50% had bradycardia and respiratory arrest, 15% had cardiac arrest, and 15% had aspiration pneumonia. The study also report that 75% of the self extubated patients had experienced transient desaturation and 30% had hypoventilation. The nurse to patient ratio

Author/year and country	Type of study	Purpose/objective	Sample size	Major findings
				was reported as 1:2 and 1:5.
Krayem , Butler and Martin (2006:71) in Canada	Retrospective case-control study in two teaching hospitals ICU's.	Determine the incidences and factors associated with unplanned extubation and relations to nursing workload	Total number of 100 patients, of which 50 had unplanned extubation and 50 used as controls patients, and total 6,223 ventilated days	66 patients had 68 episodes of unplanned extubation; rate of 1.1% of unplanned extubation in 6223 ventilated patients. Mean age was 62.9 years; 80% received sedation; 80% had agitation/confusion, and 14% were restrained prior to unplanned extubation. However, no association found between unplanned extubation and the nursing workload.
Krinsley and Barone (2005:560) in the USA	Retrospective case-control study	To assess the consequences of unplanned extubation	A total of 300 patients were used in this study of which 100 patients had unplanned extubation and 200 patients used as control group.l	Overall rate of unplanned extubation was 6.6%. 17% of the patients who had unplanned extubation were under the age of 17 years and 44% were above the age of 70 years Of the patients, 57% were males. 72% of unplanned extubated patients were admitted due to medical illnesses, 16% with surgical-related conditions, and 12% with trauma. 56% of the patients required re-intubation.
Marcin, Rutan, Rapetti, Brown, Rahnamayi and Pretziaff (2005:254) in the USA	Four year case-control study	Association of nursing staffing to unplanned extubation in a paediatric ICU.	A total of 220 patients were used in this study; of which 55 patients had unplanned extubation and 165 patients were used as a control group Conducted over period of 1,004 ventilated patients and 5,828	55 (5.5%) patients had unplanned extubation at a rate of 0.94 per 100 ventilated days; 60% of unplanned extubations occurred during the weaning period and 38% of the patients required re-intubation within two hours of extubation. The mean age of patients who had unplanned extubations was 39.4 months. 60% of patients who had unplanned extubation were restrained and 78% of patients were on continuous sedation; 56% of patients who had unplanned extubations were reported to be agitated at the time of extubation compared to 35% in the control patients.

Author/year and country	Type of study	Purpose/objective	Sample size	Major findings
			ventilated days	The mean years of nursing experience was 7.8 years in unplanned extubated patients compared to 7.0 years in control patients; the nurse-to-patient ratio was 1 to 1.4. The association of agitation and unplanned extubation increased when the nurse-to-patient ratio was 1:2.
Birkett, Southerland and Leslie (2005:65) in Australia	Seven clinical audits each lasting 12 months in a 22 bed ICU comprising of 12 general beds and 10 surgical beds.	To determine the frequency and risk factors associated with reported unplanned extubation in general and surgical ICU	An average of 1500 ICU patients per year were admitted of which 75% required intubation and ventilation.. Of these patients, a total 129 had unplanned extubations over the seven-year period.	Clinical audits were conducted on a yearly basis; the first audit was done to improve nursing and medical practice. First survey revealed that the rate of unplanned extubation was 1.06% per 100 intubated patients; 50% were medical and 50% surgical patients. In addition, 7% were accidental extubation and 93% were self-deliberate extubation. The median age of the patients was 53.78 years in a range of 18 to 87 years. 93% airway incidents were related to the endotrachael tube while 7% were associated with the tracheostomy. Of the patients, 21% required re-intubation. After the first survey; additional data was collected including the chemical/physical restraints, position of patient and method of tube stabilization. In addition, an anonymous reporting system was also introduced. Subsequent six surveys revealed unplanned extubation rates of 1.35% to 4.86% per 100 intubated days, of which 72% to 90% were for medical patients compared to 10% to 28% in surgical patients. Overall, a total of 129 patients had unplanned extubations; that the rate of unplanned extubation was 2.6 per 100 intubated days, of which 85.2% were self-deliberate and 14.72% were accidental extubation. Overall, 78.2% were medical patients and 21.7% were surgical patients.

Author/year and country	Type of study	Purpose/objective	Sample size	Major findings
Marcin, Rutan, Rapetti, Brown, Rahnamayi and Pretziaff (2005:254) in the USA	Four year case-control study	Association of nursing staffing to unplanned extubation in a paediatric ICU.	A total of 220 patients were used, of which 55 had unplanned extubations, and 165 patients were used as a control group

Conducted over period of 1,004 ventilated patients and 5,828 ventilated days | 55 (5.5%) patients had unplanned extubation at a rate of 0.94 per 100 ventilated days; 60% of unplanned extubations occurred during the weaning period and 38% of the patients required re-intubation within two hours of extubation. The mean age of patients who had unplanned extubations was 39.4 months.

60% of patients who had unplanned extubations were restrained and 78% were on continuous sedation; 56% of patients who had unplanned extubations were reported to be agitated at the time of extubation compared to 35% in the control patients.

The mean years of nursing experience was 7.8 years in unplanned extubated patients compared to 7.0 years in control patients; the nurse-to-patient ratio was 1 to 1.4.
The factors associated with unplanned extubations were agitation and the nurse-to-patient ratio of 1:2. |
| Chatterjee, Islam, Divatial (2004:36) in India | Seven and half month prospective, observational non-interventional in ICU | Airway accidents in ICU; to identify rates between short term and long term intubation | Conducted with 781 patients who required either intubation or tracheostomy over 1440 intubated days | A total of 55 airway incidence of 7.04% and 3.82 per 100 intubated days. These were further defined as short-term intubation as patients required intubation for less than 24 hours and long-term intubation as patients requiring tube for over 24 hours.

The rate of unplanned extubations in short-term patients was 4.02% and 4.02/100 tube days and long-term patients had 32.14% and 3.63/100 tube days.

56.36% of unplanned extubations were due to blocked tube; 34.55% were either patient related or care giver related and 3.64% were misplaced tubes.
The nurse-to-patient ratio 1:2 to 1:4. |
| Sadowski, Dechert, Bandy, Juno, Bhatt-Mehta, Custer, Mohler | Five year prospective study in a 16 bed medical and surgical | Quality Improvement in reducing unplanned extubation in a paediatric | Conducted over a period of 2192 intubated | 141 patients had 164 episodes of unplanned extubation; that is, 6% of total patients had unplanned extubation. |

Author/year and country	Type of study	Purpose/objective	Sample size	Major findings
and Bratton (2004:628) in USA	paediatric ICU	ICU	patients and 13,630 airway (intubated) days	A total of 88% patients had one episode of unplanned extubation, 9% had two episodes, 1% had three episodes and 1% had four episodes. 77% of patients who had unplanned extubations presented with medical illnesses. Overall, the rate of unplanned extubations decreased by 2.1% in the first year to 1.0% in the fifth year due to nurses' increased awareness of the causes of extubation. 74% of extubations were patient related and 26% were care giver related. In addition, 52% of the patients required re-intubation, of which 100% were on neuromuscular blockade and 65% had received sedation two hours prior to the extubation. 60% of unplanned extubation patients were restrained and 38% were agitated. The outcome of the study was that a weaning protocol was introduced in the first year.
Moons, Sels, De Becker, Geest, Ferdinande (2004:1349) in the Neitherlands	A three-month nested control study in four surgical ICU's, one Coronary Care Unit and one emergency department	Risk stratification for deliberate self-extubation	A total of 72 patients were used in this study of which 26 patients had unplanned extubation and 46 randomly selected control patients. During the study period 627	The overall rate of unplanned extubation was 4.25% and a rate of 0.68 per 100 ventilated days. 76.95% were self-deliberate extubations and 23.1% were accidental extubations. 73.1% were male with a median age of 64.2 years; the rate of unplanned extubation in the medical ICU was 9.5% and surgical ICU was 2.6%.. 15.4% of the patients were on complete mechanical ventilation and 84.6% were partially ventilated.

Author/year and country	Type of study	Purpose/objective	Sample size	Major findings
			patients were ventilated and with total of 3829 ventilated days	The nurse-to-patient ratio was 1:2. Complications: 7.7% of patients had laryngeal oedema, 3.8% had aspiration pneumonia, and 7.7% died (unrelated to unplanned extubation). The risk of unplanned extubation correlated with higher level of consciousness of patients. The ICU's had no uniform sedation or weaning protocols Based on the findings, a risk stratification tool for self-deliberate extubation was developed.
Yeh, Lee, Ho, Chiang, and Lin (2004:260) in Taiwan	An 18 months prospective study by structured questionnaire filled by nurses in 11 ICU	Implications of nursing care in occurrence of unplanned extubation	Total patient admited in 11 ICU were 6,672 patients admitted, of which 1175 patients were intubated	265 patients (22.5%) had unplanned extubations, of which 91.6% were self-extubation and 8.3% had accidental extubation. 44.7% were re-intubated within first eight hours; 86.4% of accidentally extubated patients and 41.2% of self-deliberate extubated patients. The mean nursing experience was 3.4 years and 97% of unplanned extubations occurred with nurses who had less than four years of experience. 25.3% of unplanned extubations occurred within or prior to one hour of shift change and in 79.1% the nurse was not at the bedside when the unplanned extubation occurred.
Mpe, Moloto and Mphahlele (2004:17) in South Africa	A six months prospective study of unplanned extubation	To describe incidence, risk factors and outcome of unplanned extubation	Total 233 patients were intubated	24 patients (10.3%) had a total 27 episodes of unplanned extubation, of which 25 were self-extubation and 2 accidental during nursing procedures. 33% of the patients were not sedated and 50% were restrained at the time of unplanned extubation. 25% of patients required reintubation.

Author/year and country	Type of study	Purpose/objective	Sample size	Major findings
				.
Phoa, Pek, Yap and Johan (2002:504) in Singapore	A twelve-month prospective study	Outcome of unplanned extubation in medical ICU	Conducted with 543 patients admitted and 312 mechanically ventilated	24 patients (8.7%) had unplanned extubations, of which 87% were self-extubations and 13% were accidental;. 58.3% of patients required re-intubation, of which 71.4% were conducted immediately after unplanned extubation. 50% of patients were sedated and 50% were restrained prior to unplanned extubation. The mean time between unplanned extubation was 3.1 days and mean length of stay in ICU was 10.1 days. The nurse-to-patient ratio was 1:2 daytime and 1:3 night time, although the time of shift when the unplanned extubation occurred was not a variable.
De Lassence, Alberti, Azoulay, Le Miere, Cheval, Vincent, Cohen, Garrouste-Orgeas, Adrie, Troche and Timsit (2002:148) in France,	Two-year prospective study in six ICU's.	Impact of unplanned extubation and reintubation on nosocomial pneumonia	Conducted with 750 mechanically ventilated patients and 7,953 ventilated days.	A total of 105 patients had 131 unplanned extubations with an overall rate of 14%, of which 67% were self-extubation and 22.1% were accidental extubation. The extubation rate was 16.4 per 1000 ventilated days. 1000 ventilated days were used to calculate the incidence density rate. 33.6% of patients required re-intubation. 34.7% of unplanned extubated patients developed nosocomial pneumonia.

Author/year and country	Type of study	Purpose/objective	Sample size	Major findings
Balon (2001:93) in theUSA	A 14 months prospective study in mixed ICU.	Common factors of spontaneous self-extubation	Conducted with 68 patients and 209.46 intubated days,	68 patients had episodes of 78 incidences of unplanned extubation, but only 75 episodes were included in the study The incidence of unplanned extubation was 35.8% per 100 intubated days (much higher than all the other studies in the literature review) 50% of patients presented with medical illnesses, 35% with trauma, 12% with cardiac disease, and 3% with surgical problems. In 65% of unplanned extubations, nurse-to-patient ratio was 1:2; in 16% ratio was 1:3, and in 4% the ratio was 1:4. 59% required re-intubation, 32% had been given sedation 4 hours prior to self-deliberate extubation. In the incidences of self-extubation, 64% pulled the tube out with their hands; 8% by "bucking"; 6.6% by tonguing the tube out; 5.3% by coughing out the tube, and 4% by moving their head from side to side.

Author/year and country	Type of study	Purpose/objective	Sample size	Major findings
Tung, Tadimati, Caruana-Montaldo, Atkins, Mion, Plamer, Slomka and Mendelson (2001:24) in the USA	Retrospective case-control study	To evaluate the relationship between sedation and deliberate self-extubation	A total of 150 patients were used in this study of which 50 patients had self-extubation and 100 patients were used as matched controls	Only 46 patients who had unplanned extubations had full data available and were included in the study. 56% of patients receiving midalozam in self-extubated patients were agitated compared to 33% in the control patients; 74% of patients who had unplanned extubations required re-intubation and 65% were on sedation and restraints. There was a positive correlation of benzodiazepine to unplanned extubation. Total numbers of intubated patients or the incidence rate of unplanned extubation during study period not mentioned. Benzodiazepines may be been used inappropriately to treat pain. The patients who had self-extubated had received higher doses of midalozam compared to the control patients; thus midazolam may be the risk for unplanned extubation. Findings concurred with Atkins, Mion, Mendelson, Palmer, Slomka and Franko (1997:1317). .

Chatterjee et al (2004:34) found that short-term intubations (less than 48 hours) were more likely to be blocked with secretions than long-term intubations. The unplanned extubation was attributed to nursing workload and increased nurse-to-patient ratios of I nurse to 2 patients or I nurse to 4 patients.

According to the AACN Synergy Model for Patient Care, the patients' needs, the nurses' competences and the healthcare environment are all integral parts that interact to form synergy (Kaplow & Reed 2008:20). To better understand why patients have unplanned extubation, it is necessary to identify how the patients' characteristics, nurses' competences and the healthcare system relate to the safety of patients in ICU. The patients' outcomes include functional changes, behavioural changes, trust, satisfaction, comfort and quality of life. Outcomes from nurses' competences include physiological changes, presence or absence of complications, and goals of treatment achieved. The healthcare system outcomes are readmission rates, length of stay and cost utilisation per patient. The AACN Synergy Model for Patient Care specifically describes relevant aspects of nurse-patient, nurse-nurse and nurse-systems relationships (Hardin & Kaplow 2005:8).

3.5.1 Patient's characteristics

The patient's characteristics in the AACN Synergy Model for Patient Care are in continuum and cannot be viewed separately. The eight patient's characteristics are resiliency, vulnerability, stability, complexity, resource availability, participation in care, participation in decision-making and predictability.

Regarding unplanned extubation, the patient's characteristics or the risk factors are agitation, sedation, and the use of physical restraints (Chang et al 2008:460; Curry et al 2008:45; Mion et al 2007:2714; Tung et al 2001:24). According to AACN Synergy Model for Patient Care, these are the biological, psychological, social and economic factors of the patient (Hardin & Kaplow 2005:8).

3.5.1.1 Agitation/delirium syndrome

According to Cohen, Gallanger, Pohlman, Dasta, Abraham and Papadokos (2002:97), agitation in a critically ill patient can be caused by many factors, including underlying disease, discomfort with the tubes attached to the patient, and unfamiliar surroundings. Agitation has complications such as self-extubation, removal of invasive lines, and the inability to participate in activities of daily living. Multiple pharmacologic agents, such as sedatives, antibiotics and muscle relaxants, are among the ethological factors contributing to agitation especially in elderly patients.

Hypoxia, electrolyte imbalance and hypotension are other causes of agitation. Patients who smoke and take alcohol are likely to develop agitation due to the withdrawal symptoms of nicotine and alcohol. Sedation scales like the RSS are used to measure agitation and sedation levels in ICU (Cohen et al 2002:97).

Lin, Huang, Liu, Lin, Wang, Huang, Fang, Shieh and Kuo (2008:373) point out that although recognising delirium in ventilated patients is difficult due to lack of verbal communication, the use of the confusion assessment method in ICU (CAM-ICU) and other non-verbal tools has made it is possible and has improved the detection rate. The CAM-ICU has four categories of assessment: acute onset of mental status changes fluctuating course; inattention; disorganised thinking, and altered level of consciousness.

In Taiwan, Lin et al (2008:373) found that patients admitted with sepsis and hypoalbuminemia were predisposed to develop delirium during their stay in ICU. Moreover, patients who developed delirium during the first five days in ICU had a prolonged stay on the ventilator and in ICU compared to patients who showed no signs of delirium.

Woods, Mion, Connor, Viray, Jahan, Huber, McHugh, Gonzales, Stoller, and Arroliga (2004:1067) point out that ventilated patients' agitation must be managed appropriately or they could be compromised physiologically and at greater risk of disrupting management.

In their study in the USA on the relationship of sedation to self-extubation, Tung et al (2001:24) that Midazolam use in ICU patients' increased agitation and led to self-extubation. In Canada, Krayem et al (2006:71) found that patients who were agitated and prescribed Midalozom as sedative had increased risks of unplanned extubation.

In a study of agitation in medical surgical ICU's, Jaber, Chanques, Altalrac, Sebbane, Vergne, Perrigault and Eldejam (2005:2749) found that 52% of the patients had at least one episode of agitation and of these 83% were medical patients and 42% were surgical patients. The mean duration of ventilation days was 4.4 in agitated patients and 3.2 in the non agitated group which was not significantly different. It was noted that 75% of the medical patients who were agitated had sepsis compared to 50% of the surgical patients. Furthermore, agitated patients stayed in ICU longer, and had a greater frequency of nosocomial infections as well as a higher rate of unplanned extubation.

Regarding the frequency of severe agitation among ventilated medical ICU patients, Woods et al (2004:168) found that 16.1% of ventilated patients admitted were severely agitated during the first 24 hours in ICU. In addition, 33.5% of patients experienced long-term agitation. The outcomes associated with these agitated patients were a longer stay in ICU, longer duration of ventilation, and greater frequency of self-extubation.

Pun and Ely (2007:625) describe delirium as "a disturbance of conscious with inattention accompanied by a change in cognition or perceptual disturbance that develops over a short period and fluctuates over time". There are two types of delirium, namely hyperactive and hypoactive delirium. Hyperactive delirium is characterised by agitation, restlessness, attempting to remove catheters and emotional lability, while hypoactive delirium is characterised by withdrawal, flat affect, apathy, lethargy and decreased responsiveness (Pun & Ely 2007:626).

According to Pisani, Murphy, Van Ness, Araujo and Inouye (2007:1633), a history of alcohol use, the use of benzodiazepines, and the severity of illness can lead to delirium. Reorientation, psychoactive medication and correction of electrolyte imbalances reduce delirium.

Confusion and agitation is a major factor justified by healthcare professionals when the physical restraints are used in critically ill patients (Maccioli, Dorman, Brown, Mazuski, Mclean, Kuszaj, Rosenbaum, Frankel, Devlin, Govert, Smith & Peruzzi 2003:2670). Furthermore, the majority of patients may experience some degree of agitation during their ICU stay.

According to Axell, Malmros, Bergbom and Lundberg (2002:726), ICU syndrome/delirium seems to be complex interaction between the patient's previous psychological problems, the psychological trauma of illness, the stress from the environment and ICU treatment and care. In addition, various physical factors related to abnormal blood biochemistry values and drugs affecting the brain are important when considering delirium in ICU patients.

In a study of 31 mechanically ventilated patients, Axell et al (2002:727) found that 19 patients had ICU syndrome; six had severe delirium, eight had moderate delirium and five had no delirium but only brief episodes of confusion. Patients who had severe delirium had significantly lower haemoglobin and arterial oxygenation levels compared to patients who experienced both moderate and no delirium episodes. There was no statistical significance in blood carbon dioxide tension or creatinine levels between these groups. Patients with severe delirium had received significantly larger doses of both fentanyl and midazolam. Patients with severe delirium had a longer duration on ventilator and longer stay in the ICU.

In the USA, patients who had unplanned extubation were restrained, were agitated, had a greater chance of getting hospital-acquired infections, and stayed longer in ICU. It was also noted that smokers were more prone to self-extubation than non-smokers (Atkins, Mion, Mendelson, Palmer, Slomka and Franko 1997:1317).

Regarding unplanned extubation, patients' characteristics or the risk factors identified were agitation, sedation, and the use of physical restraints (Chang et al 2008:460; Curry et al 2008:45; Mion et al 2007:2714; Tung et al 2001:24). According to the ACCN synergy model for patient care, these are the biological, psychological, social and economic factors of the patient (Hardin & Kaplow 2005:8).

In this study the patient characteristic of interest to the researcher was agitation and was measured by the RSS and delirium was not a variable.

3.5.1.2 Sedation

Sedation is required to allow patients to have undisturbed sleep, relieve anxiety and enhance tolerance to endotrachael tube and nursing care (Samuelson, Larsson, Lundberg & Fridlund 2003:351). Sedation is good for ICU patients as it depresses the cerebral metabolic rate and thus improves the cerebral oxygen supply:demand ratio. Critically ill patients who are endotracheally intubated often have pain, are anxious, have discomfort and sleep deprivation due to the ICU surroundings.

Sedation also depresses the patient's awareness of the environment and reduces responses to external stimulation. Sedation is monitored by scales such as the Ramsay Sedation Scale, which gives quantitative scores to clinical findings in a waking or sleeping state.

It is also necessary for ICU nurses to assess depth of sedation in patients and use sedation guidelines and protocols to achieve and maintain sedation on ventilated patients.

Rowe and Fletcher (2008:50) emphasise that daily sedation interruption, also known as sedation holiday, by stopping the sedation infusion and allowing the patient to wake up is necessary. The sedation can be restarted if deemed necessary or if the patient becomes agitated. With proper sedation assessment by the nurse, daily interruptions of sedation are the most ideal way of managing sedation on mechanically ventilated patients (Sessler & Varney 2008:552).

According to Walker and Gillen (2006:338), the management of sedation requires "multi professional involvement and an individualised approach to care". The doctor prescribes while the nurse increases and decreases the rate of infusion within the prescribed ranges. Walker and Gillen (2006:338) found that nurses used their own judgement as well as sedation scales. Nurses also responded to changes in patients' need for sedation, such as patient/ventilator asynchrony, anxiety, restlessness and risk of unplanned extubation.

In a study on sedation practice in mechanically ventilated patients in 87 ICUs in Sweden Samuelson et al (2003:350) found an average of one to eight patients requiring ventilation daily with a duration of two to seven days' ventilation. Of the ICUs, 91% sedated all mechanically ventilated patients and 76% used midazolam or propofol with a combination of opoid. Almost all ventilated patients in ICU were on continuous infusion of midalozom and propofol. Although many ICUs had sedation protocols, the nurses preferred to have their patients heavily sedated.

In a study in the USA on the relationship of sedation to self-extubation, Tung et al (2001:24) found that of the patients, 59% were on benzodiazepine; 46% were on midazolam only; 59% were on opioid, and 4% were prescribed anti-psychotic drugs; 65% had physical restraints and 74% were re-intubated. Of the patients who had self-extubated, 63% were agitated and restrained, and 56% of patients receiving midazolam were agitated. The study revealed that the use of midazolam may have induced a false security in the caregivers, thus decreasing vigilance and increasing the likelihood of self- extubation.

In Canada, Krayem et al (2006:71) 80% of unplanned extubation patients received midazolam and were agitated. However, the unplanned extubation had no significant impact on nursing workload. Finally, unplanned extubation was associated to a significantly higher incidence of agitation and cumulative dosage of benzodiapezepines.

According to McKenzie, McKinnon, Naughton, Teacher, Davies, Phillips and Hilton (2004:32), patients who have been on prolonged sedation are "slow to wake" and this causes neurological damage. In addition, precaution should be taken in sedating patients who have renal impairment with Midalozam, as patients become sedated faster and remain sedated for longer despite stoppage of the drug.

A study to explore staff perceptions to implement sedation protocol in Australia revealed that the staff found it very useful and were ready to implement it (Rose & Bucknail 2004:151). The sedation protocol was viewed as needs based per individual patient and not as a consistent method.

In the USA, the AACN developed a sedation assessment scale for the benefit of critically ill patients in ICU as the Ramsay Sedation Scale and other sedation scales were inadequate since they focus on only one domain, namely consciousness (De Jong, Burns, Campbell, Chulay, Jo Grap, Pierce & Simpson 2005:531). The new scale has five domains, namely consciousness, agitation, anxiety, sleep, and patient-ventilator synchrony.

Regarding the impact of alcohol on sedation, De Wit, Wan, Gill, Jenvey, Best, Tomlinson and Weaver (2007:73) found that patients who had a history of drinking alcohol needed more sedation than ones who didn't drink. Despite the increased need of sedation, both types of patients have a similar duration of mechanical ventilation.

3.5.1.3 *Physical restraints*

Physical restraints are mechanical devices, which restricts patients' movements. Nurses in ICU use physical restraints to promote patients' safety from self-harm such as self extubation.

In a study in Taiwan on the influence of physical restraints on unplanned extubation, Chang, Wang and Chao (2008:414) found that patients with physical restraints had 3.11 times more risk of unplanned extubation than those without restraints. Furthermore, patients who were restrained and had nosocomial infections had 12.44 times more risk of unplanned extubation.

In Hong Kong Lai (2007**:??**) found that nurses felt ambivalent about using physical restraints but nevertheless did so to prevent patients from falling. One of the reasons given for the use of restraints by the nurses was inadequate staffing. The study also revealed that the nurses had inaccurate and inadequate knowledge of restraints, and were also victims of the system (Lai 2007).

A bicultural study by Martin and Mathisen (2005:133) in the USA and Norway revealed the use of physical restraints common in adult critical care units in the USA, but limited among ICU patients in Norway. However, the nurse-to-patient ratio in Norway ICU at the time was 1:1 and nurses used other methods of distraction such as music therapy.

The British Association of Critical Care Nurses (BACCN) has a position statement in restraint use in adult critical care units (Bray, Hill, Robson, Leaver, Walker, O'Leary, Delaney, Walsh, Gager & Waterhouse 2004:199).

The BACCN recommends the use of alternate methods such as music therapy, nicotine patches for smokers, massage, communication, therapeutic touch, relatives' involvement in care, and acupuncture on agitated patients instead of physical restraints. Moreover, patients on sedation should have a scoring scale and bolus of drug then titrated by continuous infusion to manage sedation.

In South Africa Mpe et al (2004:17) found a 10.3% incidence of unplanned extubation in ICU, of which 50% had been physically restrained.

Choi and Song (2003:651) found that nurses in a Korean ICU used restraints on restless patients to prevent self-harm. The physical restraint use was nurse-driven and high in the ICU and they had no protocol on restraints. The restraints were removed on the request of either the patient or the relatives.

Maccioli, Dorman, Brown, Mazuski, Mclean, Kuszaj, Rosenbaum, Frankel, Devlin, Govert, Smith and Peruzzi (2003:2665) found that most medical professionals adhere to beneficence and respect for patients' autonomy. They advocate a multidisciplinary approach where assessment is done by the nurse and the team decides that best approach should be ordered by the physician.

Alternative therapy and staff education should also be enhanced. The patient who is restrained should be assessed hourly and a restraint order should be for 24 hours only, after which need assessment should be done. Finally, Maccioli et al (2003:2665) maintain that restraints should primarily be for patients' safety and not for behaviour.

3.5.2 Nurse's characteristics

According to the AACN Synergy Model for Patient care, the nursing characteristics are nursing competence and range from level 1: competent nurse, level 3: proficient nurse to level 5: expert nurse (Kaplow & Reed 2008:17). Nurses move from level 1 to level 3 by gaining knowledge, acquiring new skills, work experience and further training in ICU.

In regard to unplanned extubation, the nurse's characteristics are nursing ICU experience, competences and nursing workload.

3.5.2.1   Nurse's ICU experience, competences and workload

In accordance with the AACN Synergy Model for Patient Care, the ability to link the right patient, the right nurse and the right environment is essential to optimise patient outcome (Collins & Strother 2008:EI).

The increasing use of new technology in the treatment of critically ill patients means that there is an increased need of specialised nurses to care for these patients. Aari, Tarja and Helena (2008:78) emphasise that competence in ICU nursing differs from the overall competences in nursing. In ICU, nurses are expected to carry out nursing interventions independently and need to be both clinically as well as professionally competent. Better staffing correlates with higher quality of care (Unruh 2003:142).

In the USA, Aitken, Clarke, Cheung, Sloane and Silber (2003:1617) explored nurses' educational levels and surgical patients' mortality. The findings revealed a 10% increase in the proportion of nurses holding bachelor's degrees associated with a 5% decrease in mortality.

In a study in the USA on patients' perception of nurses' skills, Wysong and Driver (2009:36) found that the patients considered interpersonal skills, critical thinking and caring practices the most important skills in an ICU nurse.

In the USA, Curry et al (2008:45) explored the nursing characteristics associated with unplanned extubation. In 26% of incidents of unplanned extubation, the nursing experience in ICU ranged between 0 and 9 years. Finally, in 80% of unplanned extubation, the primary nurse was not present at the patient's bedside (Curry et al 2008:45).

Ream et al (2007:366) point out, however, that to quantify nursing workload is "time consuming, lacks an accepted definition and measurement standard, and often involves some measure of the volume and level of nursing work". Furthermore, work is usually

gauged by patients' acuity and/or amount of task-oriented activity performed, but work indexes are stronger predictors of adverse events than the nurse to patient ratio.

Ream et al (2007:366) found a 0.76% incidence of unplanned extubation in paediatric patients. In Spain, Bouza et al (2007:270) found that unplanned extubation was attributed to increased nursing workload. In India, Chartterjee et al (2004:36) revealed most of the unplanned extubations were accidental during nursing care. They also attribute the increased rate of unplanned extubation to the nurses' workload and increased nurse-to-patient ratios.

In Taiwan, Yeh et al (2004:255) found that nurses with less than 4 years' experience had more incidences of unplanned extubation compared to nurses with over 4 years experience. Moreover, most incidences occurred during nurses' shift change and on night shift.

In their study in India, Bhattacharya et al (2007:105) found unplanned extubation attributed to nursing workload, with a high nurse-to-patient ratio of 1 to 5. However, Krayem et al (2006:71) did not find unplanned extubation associated with the nursing workload.

Richmond et al (2004:32) stress that nurses' education and the use of commercial endotracheal tube holders reduce rates of unplanned extubation. Moons et al (2004:1348) maintain that more vigilant nursing care can reduce or prevent unplanned extubation.

In their study in Greece on patient severity as indicator of nursing workload, Kiekkas, Brokalaki, Manolis, Samios, Skartsani and Baltopoulos (2007:34) found that determining the clinical severity of ICU patients, using the Acute Physiology and Chronic Health Evaluation (APACHE) score II, is an important early indicator to measure nursing workload.

3.5.3   Healthcare system

In the AACN Synergy Model for Patient Care the healthcare system refers to the healthcare environment (Hardin & Kaplow 2005:4). The healthcare system outcomes

are readmission rates, length of stay, and cost utilisation per patient. Outcomes are considered patient conditions measured along a continuum. The six major quality outcome indicators are (Hardin & Kaplow 2005:4):

- Patient and family satisfaction
- Rate of adverse incidents
- Complication rate
- Adherence to the discharge plan
- Mortality rate
- The patient's length of stay

In this study, incident reporting and nurse-to-patient ratio in ICU were important, but the healthcare environment was not investigated.

3.5.3.1 Incident reporting

According to Reason (2000:768), human error can be viewed in two ways, namely the person approach and the systems approach. The person approach treats errors as moral issues, disciplinary measures, naming, blaming and shaming the individual. The systems approach views errors as consequences rather than causes, and considers countermeasures to change the system defences, how and why the defences failed. Error management is by limiting incidences of dangerous errors and creating systems to tolerate and contain their damaging effects.

Quality improvement in ICU can be through benchmarking quality indicators such as unplanned extubation. Adverse incidences are reported and analysed to improve the care of the patient, and should not be punitive. It is also important to maintain the patient's safety at all times.

The Joint Commission on Accreditation of Healthcare Organisations (JCAHO) upholds the principle of "do not harm" (Steiner 2006:96). Consequently, the JCAHO puts special emphasis on promoting patient safety through reporting and analysing the incidences that can lead to improvement in practice by policy making in healthcare (Steiner 2006:96).

In a study on incident reporting in Australia, Evans, Berry, Smith, Esterman, Selim, O'Shaughnessy and Dewit (2006:39) found that "near-miss incidences were rarely documented in medical records yet occurred more frequently than adverse events". According to Evans et al (2006:39), the barriers to incident reporting were a lack of feedback and the incidence form took too long to fill in.

The primary goal of quality improvement is voluntary reporting systems. In Australia, the healthcare system was behind the aviation safety system, which developed an error-reporting system that encourages pilots and other crew members to report all near-miss accidents. Wu, Pronovost and Marlock (2002:86) designed a web reporting system of incidents in ICU.

The Australian Incident Monitoring System (AIMS)-ICU was developed after a two-month pilot study in three ICUs yielded 129 incidents (Wu et al 2002:89). As this system was successful in Australia, Wu et al (2002:89) designed a web reporting system with the collaboration of the Society of Critical Care Medicine known as ICU safety reporting system (ICUSRS) in the USA. This web reporting system identifies the systems-based factors, staff factors, equipment factors, staff training, protocols, and human factors.

Hirose, Regenbogen, Liptiz, Imanaka, Ishizaki, Sekimoto, Oh and Gawande (2007:101) found under reporting common due to physicians reluctance to report adverse events for fear of retribution, censure or stigma, and staffing and workload.

Ursprung, Gray, Horbar, Nickerson, Plsek, Shiona, Suresh, and Goldman (2005:284) maintain that real-time audits performed during routine work can improve safety of patients, and fostering a blame free "culture of patients' safety" can improve reporting of adverse events.

Szekendi, Sullivan, Bobb, Feinglass, Rooney, Barnard and Noskin (2006:184) propose that through the use of electronic medical data, a computerised adverse detection tool can identify wide ranges of adverse events. Szekendi et al (2006:184) state further that "voluntary incidence reporting will only be improved when providers understand the

types of incidences that need to be reported and when they work in non-punitive culture and when reporting is quick and easy to accomplish".

Provonost, Thompson, Holzmuller, Lubomski. Dorman, Dickman, Fahey, Steinwachs, Engineer, Sexton, Wu and Morlock (2006:305) found that incidents of line/tube/drain accounted for 13% of adverse events, many of which incurred harm to patients. The incidents reported were attributed to excessive workload, insufficient staffing, longer work hours. According to Provonost et al (2006:305), the risk of error increased with nurses working longer shifts of 12 hours.

In an analysis of methodologies used in medical incidents to improve patient safety, Pronovost, Holzmueller, Young, Whitney, Wu, Thompson, Lubomski and Marlock (2007:27) developed a conceptual model for collecting, analysing, reporting and learning from adverse events and near misses in order to improve the safety of patients.

Capuzzo, Nawfal, Campi, Valpondi, Verri, and Alvisi (2005) question the reliability of staff reporting incidence versus observers. In their study, they concluded that staff reporting in comparison to observer reporting markedly underestimated the incidences of adverse events.

3.5.3.2 Nurse-to-patient ratio

The ideal nurse-to-patient ratio in ICU is one nurse to one patient. Curry et al (2008:45), Bhattacharya et al (2007:105) and Chartterjee et al (2004:36) assert that it is necessary to identify whether nursing staffing ratio has any association with patients' outcomes.

In a survey on adverse nurse outcomes and correlation with staffing and nurses' workload of five hospitals in Kuwait, Al-Kandari and Thomas (2006:139) found staff shortages a universal concern and nurses overworked due to low staffing and increased demands. Increased nurse-patient load and nursing activities were correlated to increased incidences of needle stick injury.

Needleman, Bauerhaus, Matike, Stewart and Zelevinsky (2002:1715) examined nurse-staffing levels and the association between registered nurse staffing and patients' outcomes. More registered nurse-hours per day were associated with shorter stay in

medical patients. Amongst the surgical patients, the more nurse-hours per day, the fewer complications such as urinary tract infections.

In a study on the effects of staffing on adverse events, mortality, morbidity and medical costs in 232 acute care hospitals in USA, Cho, Ketefian, Barkaukas and Smith (2003:71) found that 5.6% of patients with adverse events stayed longer in the hospital and adverse events such as pneumonia, wound infection and sepsis were positively related to increased mortality. With adequate registered nurse staffing, there was an inverse relationship with several adverse events (Cho et al 2003:71).

Toni and Popovich (2008:6) maintain that nurses' leadership and staff play a critical role in ongoing monitoring and auditing to measure compliance with safety and quality patient care. Moreover, having an action job card prepares staff and provides direction for efficient care.

In New York, Kinsley and Barone (2005:560) found that unplanned extubated patients had a longer stay in ICU; 56% of the unplanned extubated patients were ventilated patients, and 44% did not require reintubation.

In the USA, Balon (2001:93) explored common factors of spontaneous self-extubation and found incidences of 38.5 per 100 ventilated days, of which 80% were physically restrained, 59% required re-intubation, 32% had been given sedation 4 hours prior to self-deliberate extubation. Moreover, 89% of the patients responded to verbal commands.

Patients who had unplanned extubations were restrained, were agitated and had a greater chance of getting hospital-acquired infections (Atkins et al 1997:1317). Patients who had unplanned extubations stayed in ICU longer than the control subjects, and patients who smoked were more prone to self-deliberate extubation than non-smokers.

Regarding unplanned extubation, Bouza et al (2007:270) reported an incidence of 0.92 per 100 ventilated days, of which 71% were deliberate and 29% were accidental extubation; 41% of accidental extubations required re-intubation, and 59% of unplanned extubations occurred when the nurse was not at the bedside and most occurred on night shift.

3.6   RE-INTUBATION

Blamir, Vivar and Esteban (2003:226) describe re-intubation as when long-term mechanically ventilated patients have been weaned off and extubated and require intubation within 48 to 72 hours. Re-intubation is needed when the patient develops respiratory distress or complications such as laryngeal stidor or upper airway obstruction after planned/unplanned extubation. In addition, morbidity and pneumonia increase in patients who are re-intubated. Blamir et al (2003:226) found a higher incidence of ventilator-associated pneumonia with re-intubation.

Mort (2004:508) points out that emergency airway management "can be fraught with complications related to haemodynamic alterations and difficulty in oxygenation and ventilation". Mort (2004:508) adds that self-reporting of adverse events is "often limited by recognition of adverse events and fear of reporting one's own complications".

In this study, the researcher was interested in the re-intubation rates and any complications of unplanned extubation.

3.7   CONCLUSION

This chapter described the literature review. The literature reviewed indicated that patients' safety depends on identified risk factors associated with unplanned extubation; use of sedation, physical restraints, agitation and the outcome of the patients.

It also addresses the nurses' characteristics such as nursing workload, education, and experiences in ICU and how they are correlated to the unplanned extubation. Identifying and reporting incidence is very important. Furthermore, unless the culture of incidence reporting is changed from a punitive to a learning experience, the rates of adverse events will remain under-reported.

Chapter 4 describes the research design and methodology.

CHAPTER 4

Research design and methodology

4.1 INTRODUCTION

This chapter describes the research design and methodology used in the study, including the population, data collection, reliability and validity and ethical considerations. Burns and Grove (2007:31) point out that all these steps form part of the research process and are logically connected to each other as well as to the theoretical foundations of the study.

The purpose of the study was to identify the rates of deliberate and accidental unplanned extubation and the rates of re-intubation at the ICU of a selected hospital in Kenya. The research methods enabled the researcher to achieve the objectives, namely to:

- Identify the characteristics of patients associated who had unplanned extubation Identify the characteristics of the nurse responsible for the patient who had unplanned extubation.
- Identify the contributing factors leading to unplanned extubation.
- Make recommendations to enhance synergy in effort to prevent unplanned extubation.

4.2 RESEARCH DESIGN AND METHODS

The choice of appropriate research methods is essential (Bowling 2002:143). Therefore each study has its own research design and methodology depending on the nature of research.

4.2.1 Research design

To undertake a scientific study, all the components must comprise a meaningful whole (Polit & Beck 2008:765). To achieve this goal, the researcher needs to draw up a design and strategy for conducting the study or how to plan the study to answer the research

questions. Polit and Beck (2004:49) describe a research design as "the architectural backbone of the study". Bowling (2002:143) adds that the intended goal of the study provides the researcher with the basic strategies to adopt that are accurate and interpretable; for example, whether it is descriptive or experimental and with what population.

The research design guides the researcher in planning and implementing the study to achieve the research objectives and goals. McMillan and Schumacher (2001:166) state that the intended goal of a research design is to provide "credibility in answering the research question and to eliminate or minimize errors". According to Terre Blanche and Durrheim (2004:29), the research design is a "strategic framework for the execution or implementation of the research process". It guides the researcher to obtain the intended information (Burns & Grove 2001:223). The research design identifies the individuals to be studied, where, when and under what circumstances (McMillan & Schumacher 2001:166). Choosing a design depends on the problem and purpose of the study and the intent to generalize the findings (Burns & Grove 2007:38). The design includes the techniques that enable the researcher to collect and analyse data systematically.

In this study, the chosen design was quantitative with a non-experimental descriptive and retrospective approach. The study was conducted in the ambit of practice research.

4.2.1.1 Quantitative

Polit and Beck (2004:19) describe quantitative research as a formal, objective, systematic process in which numerical data are used to obtain information which is analysed statistically. The quantitative method also describes variables, examines relationships among the variables and determines the cause-effect interaction between the variables. This is currently the method of choice for scientific inquiry into nursing practice and requires rigorous control to identify and limit the effects of extraneous variables (Burns & Grove 2001:26). The extent of the control is to provide precise information on the topic or phenomenon under investigation and was suitable for this particular study as the researcher aimed at limiting extraneous factors not under study that might influence the results. Furthermore, control decreases the possibility of error and increases the probability that the study's findings are an accurate reflection of reality.

Polit and Beck (2004:15) emphasise that quantitative studies "are orderly, systematic and focused and follow a series of steps as a pre-specified plan". The quantitative method is used to describe variables, examine relationships among the variables and determine the cause-effect interaction between the variables.

4.2.1.2 Non-experimental

In non-experimental research there is no manipulation of the variables (Polit & Beck 2008:271). Non-experimental research is also called correlational or ex post facto research indicating that the research has been conducted after variation in the independent variable has occurred. According to LoBiondo-Wood and Haber (2006:239), non-experimental research is used by researchers who wish to explore events or the relationships/differences between variables.

The researcher chose a non-experimental design as it was best suited to the aims and objectives of the study in order to capture the phenomenon as it occurred without any manipulation. This was important as the study wished to capture all unplanned extubation that occurred in 2006/2007 without manipulation of any variables.

4.2.1.3 Descriptive

Descriptive research refers to a broad class of non-experimental studies. Descriptive research examines "interrelationship or association between two variables that has a tendency for variation in one variable to be related to the variation in another" (Polit & Beck 2008:272). The objectives of this type of research are to observe, describe and document aspects of a situation. It is used by researchers who are interested in describing relationships among variables without seeking causal correlations (Polit & Beck 2006:189). Burns and Grove (2007:25) describe descriptive research as the exploration and description of phenomena in real-life situations.

This study wished to describe and examine the relationship between the risk factors associated with unplanned extubation, how many patients were re-intubated and the outcome of patients after being re-intubated. It also examined the relationship of the nurses' nursing experience and ICU experience to that of unplanned extubation.

4.2.1.4   Retrospective

In a retrospective study, "the information about the phenomenon is collected as it occurs and focuses on the presently occurring outcome, and tries to ascertain the contributing factors that may have caused it" (Burns & Grove 2001:249). In this study, the researcher had no control over the independent variable as the presumed causative factor had already occurred. The independent variable was the unplanned extubation that had already occurred in the past.

The researcher links the phenomenon existing in the present to the phenomenon that occurred in the past and attempts to determine the antecedent factors that caused it (Polit & Beck 2006:190). LoBiondo-Wood and Haber (2006:247) state that "the additional benefit of ex-post facto design is that it offers a higher level of control".

This study was an attempt to find solutions to the occurring problem. The researcher took meticulous care while collecting data from the patients' medical records and the study was cost effective in terms of finance and time (Polit & Beck 2006:189).

4.2.2 Research methods

Research methods are techniques used to structure a study, and consist of a set of orderly disciplined procedures, steps and strategies to acquire and analyse information (Polit & Beck 2004:731). The data collection and analysis follows a systematic, well organized plan. Research methods may be quantitative or qualitative and include the outcomes and interventions in research (Burns & Grove 2001:26). The research method is a process and includes specific steps linked logically to investigate the phenomenon in the study (Burns & Grove 2007:28). Research methodology includes the population, sample, sampling criteria, eligibility criteria, setting, method of data collection, validity and reliability and ethical considerations.

4.2.2.1   Population

A population is "the entire aggregation of cases in which researcher is interested in" (Polit & Beck 2004:289). Burns and Grove (2007:40) describe a population as "all elements of individuals, objects, events, or substances that met the study criteria". The

population the researcher wishes to study is called the target population and should answer the research question (LoBiondo-Wood & Haber 2006:262).

Quantitative researchers specify the characteristics that delimit the study population through eligibility criteria or inclusive criteria to establish whether a person qualifies as a member of the population (Polit & Beck 2004:259). In this study, the target population comprised all patients admitted to the ICU during 1 January 2006 to 31 December 2007 and the nurses who took care of them during their admission.

4.2.2.2   Sample

A sample is a "subset of the population" (Polit & Beck 2008:765). The entities that make up a sample and population are called elements. An element is the basic unit and can be people, objects or an individual about which information is collected for research (LoBiondo-Wood & Haber 2006:263).

4.2.2.3   Sampling

Terre Blanche and Durrheim (2004:44) refer to sampling as decisions about "which people, events, behaviours or social processes are selected and/or observed". The aim of sampling is to select subjects that will be representative of the population about which the researcher aims to draw conclusions regarding what is being studied.

Sampling is "a process of selecting a portion or subset of the designated population to represent the entire population" (LoBiondo-Wood & Haber 2006:263).

There are two categories of sampling, namely non-probability and probability. In non-probability sampling, "elements are chosen in non-random methods" (LoBiondo-Wood & Haber 2006:264). There are three main types of non-probabilty sampling, namely convenience, quota and purposive sampling.

LoBiondo-Wood and Haber (2006:264) describe a convenience sample as "when the subjects are convenient and accessible to the researcher". Polit and Beck (2004:729) define quota sampling as "the non-random selection of participants in which the researcher   pre-specifies   characteristics   of   the   sample   to   increase   its

representativeness". Moreover, the researcher "selects participants based on personal judgment about which ones will be most representative or informative" (Polit & Beck 2004:729).

In this study, purposive sampling was most appropriate as the researcher consciously and deliberately included the patients admitted to ICU from 1 January 2006 to 31 December 2007 and the nurses who took care of these patients during the same period.

4.2.2.4   Sampling criteria

Polit and Beck (2008:765) refer to sampling criteria as "the characteristics essential for membership in a target population". According to Polit and Beck (2004:290), criteria are developed from the research problem, purpose of the study, conceptual and operational definitions of the study variables and design.

To be included in the study the patients had to have:

- Been admitted to ICU from 1 January 2006 to 31 December 2007
- Required endotracheal intubation
- Been intubated for than 6 hours
- Nurses who cared for patients when unplanned extubation occurred

The sample size was 357 patients who required intubation during the study period. The number of nurses in ICU during the study period was 30.

4.2.2.5   Eligibility criteria

Eligibility criteria refer to the entire aggregation of cases that meet specified criteria and are those characteristics that restrict the population to a homogenous group of subjects (Polit & Beck 2004:290; LoBiondo-Wood & Haber 2006:563).

The eligibility criteria for the patients were that they had been admitted to ICU between 1 January 2006 and 31 December 2007, required endotracheal intubation, and been intubated for more than six hours.

The researcher purposively selected a total of 357 patients from the admissions book which had full demographic and other relevant details of the patients admitted to the ICU. The nurse's duty rotation and allocation book was used to obtain information on the number of nurses and patients when unplanned extubation occurred.

4.2.3 Setting

Polit and Beck (2004:44) define the setting as "the place in which the research takes place".

The study was conducted at the ICU of a selected hospital in Nairobi, Kenya. This hospital is one of the leading institutions in the country where patients from neighbouring countries are referred. The hospital has a current 254-bed capacity, with plans to achieve 300-bed capacity in the near future.

The ICU is an open multidisclinary unit, which admits both adult and paediatric patients with medical, surgical, burn, trauma, gynaecology, obstetrics and neurological conditions. The unit has eight beds, which includes two isolation rooms. The nurse-to-patient ratio is 1 nurse to 1 patient following admission and the 1 nurse to 2 patients.

4.3   DATA COLLECTION

Burns and Grove (2001:49) define data collection as "the precise systematic gathering of information relevant to specific research objectives or questions". Data can be collected in several ways, depending on the study, and can include a variety of methods; however, the research objectives must be accomplished with the instrument used (Burns and Grove (2001:50) describe health-related documentary research as "the use of any records related to individuals or groups that have been generated in the course of their daily life. Such records may be created by a third party, such as a hospital or clinic or any records that relate to persons or families such as diaries, letters and personal notes."

The data for this study was gathered retrospectively by means of document analysis. The analysis for the records was done according to a check list developed to achieve the aim and objectives of this study. Nurses' data is kept by the nurse manager of ICU.

This data was used for obtaining the nurse information regarding type of qualification, years of nursing/ICU experience and formal training in critical care nursing.

The researcher requested and obtained permission to conduct the study from the Research and Ethics Committee of the hospital. The patient medical records for review are not permitted to leave the department so data was collected in the filing section of the medical records department. The researcher collected the data by reviewing all patients' medical records. The nurse allocated at the time of unplanned extubation was also obtained from the nurses' notes in the patients' medical files. After obtaining the name, the researcher approached the nurse manager of ICU to review the nurses' personal records and patient workload information obtained from the daily nurses' allocation records which are kept in ICU.

The data-collection process has five tasks, namely selecting subjects, collecting data, maintain research controls, protecting integrity and solving problems. All these tasks are interrelated and done simultaneously (Burns & Grove 2007:393).

In this study, the data collection process was done by the researcher. As this study involved looking at past medical records of the patients who were admitted between 1 January 2006 and 31 December 2007, a few difficulties were encountered at the beginning of data collection. For example, the past medical records of deceased patients were kept separately from the main medicals records. In addition, when patients had several files due to repeated admission, only one volume at a time could be removed by different medical record staff. This made it difficult for the researcher to follow the progress of the patient. The researcher had a meeting with the medical records manager who then allocated one member of staff to assist the researcher. This person was informed of the importance of removing all available records at the same time and the problem was resolved.

As all five tasks are interrelated, the researcher followed the following process:

- All 950 admission records of patients admitted in January 2006 to December 2007 were scrutinized in December 2008 to identify the patients who met the eligibility criterion of being intubated. A total of 357 patients who required intubation were selected.

- The medical records of these patients were requested in December 2008 and, using the check list, data was collected from 4 December 2008 to 5 January 2009.

- Further scrutiny of the 357 medical records revealed that 30 patients did not meet the criterion of being intubated for more than 6 hours and these were then excluded from the study. A further 10 medical records of patients were not in the medical records for various reasons and were also excluded. 10 patients medical records were used to collect data to pretest the clinical audit checklist; changes made in the clinical audit data checklist (see question 6 on the clinical audit checklist; Annexure C), this revised clinical audit checklist was used to collection of data.

- A total of 20 re-intubations were done during the study period on patients who were previously intubated and had either unplanned or planned extubation and were also included.

- Nurses were identified from the nurses' notes, data on their nursing education (both nursing and critical care), experience as nurse and ICU experience was obtained from the personal file kept in the team leader's office. Privacy and confidentiality of the nurse was maintained as only the researcher was aware of the nurse's identity and the nurse was given a specific code.

- Data coding was done by the researcher and data entry was done simultaneously as soon as data was collected.

- The coded data was given to the statistician for analysis on 8 January 2009 and results received gradually up to 11 September 2009.

During data collection, the researcher maintained consistency and protected the integrity of the study by reading and verifying all records, the nurses' and physicians' notes, to gain a clear picture of all intubated patients, especially when unplanned extubation occurred.

4.4   DATA-COLLECTION INSTRUMENT

Burns and Grove (2001:49) describe measurement as "the process of assigning numbers to objects or events to situations in accord with some rule". A component of measurement is instrumentation, which is the application of specific rules to the

development of a measurement device or instrument and the instrument is selected to examine a specific variable in the study. Selection of the instrument requires extensive examination of its reliability and validity (Burns & Grove 2001:49). The purpose is to produce trustworthy evidence that can be used in evaluating the outcomes of the research study.

For this study, the researcher conducted a literature review to identify critical points of unplanned extubation and then developed a set of specific questions for the check list based on studies by Moons et al (2004:1348-1355), Curry et al (2008:45-52), and Tung et al (2001:24). Input was also obtained for the check list from the ICU consultant, nurse manager and senior critical care nurses with ten years' experience.

4.4.1 Clinical audit check list

The researcher developed a structured check list to elicit the specific responses required and enable control over extraneous factors affecting the study. The clinical audit check list was evaluated by the Clinical Director of ICU and the Research and Ethics Committee of the hospital. The demographic details did not require the patients' identities, thereby maintaining confidentiality. After obtaining the details of the primary nurse from the patients' medical records, further information on duty rotation, highest nursing educational level achieved, nursing and ICU experience was acquired from the personnel records kept with the nurse manager.

The clinical audit check list was structured and guided by the study problem, purpose and objectives.

The questions were arranged in logical sequence to allow for meticulous documentation of events. The language of communication was English and the same tool was used for all subjects. The clinical audit check list was divided into three sections.

The following items appeared on the clinical audit check list:

Section A: Patient's profile
Demographic data of patient, age, gender
Medical history, intubation

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Section B: Patient's intubation and treatment history

Days intubated, ventilation and unplanned extubation

Use of sedation, neuromuscular, analgesics and physical restraints

Condition of the patient, outcome of patient

These two sections were based on the literature review and the conceptual framework used for this study, AACN Synergy Model of Patient Care in obtaining the characteristics of the patients.

Section C: Characteristics of the nurse

Nurse's workload, highest nursing education of primary nurse, critical care training, experience as nurse and in ICU.

According to the AACN Synergy Model of Patient Care, this section was based on obtaining the nurse's characteristics and workload.

4.4.2 Pre-testing of the clinical audit check list

A pre-test or pilot study demonstrates the effectiveness of the audit tool (Macnee 2004:248).

The clinical audit check list was used in a pre-test of the data of ten patients who were admitted to ICU in 2006 and were intubated. These patients were not included in the main study as changes were made to the clinical audit check list. Actual data was obtained during pre-testing and analysed carefully to ascertain whether they answered the research questions. The results of the pre-test were used to refine and amend the clinical audit check list to include whether the patient had unplanned extubation or not. The revised check list was used in the actual study.

4.5 DATA ANALYSIS

Data analysis refers to the "techniques used to reduce, organize and give meaning to data" (Burns & Grove 2007:536).

In this study the data was analysed using the Excel (Microsoft Office 2007) computer program for data coding and analysis. A statistician analysed the coded data by means of the Statistical Package for Social Sciences (SPSS) version 13. Frequency tables with accompanying percentages were used to gain insight into distributions of patients' and nurses' characteristics of patients who had unplanned extubation. Descriptive statistics such as mean and standard deviation were computed for the continuous variables. To assess the association between categorical variables and how unplanned extubation occurred, chi-square measure of association was used. If the p-valve was <0.05 this indicated there was a significant association.

4.6 VALIDITY OF THE STUDY

Polit and Beck (2001:308) define validity as "the degree to which an instrument measures what it is supposed to measure". According to Burns and Grove (2005:228), validity is "a measure of truth or accuracy of a claim". In this study, internal and external validity applied (Burns & Grove 2005:228).

4.6.1 Internal validity

Internal validity is the extent to which the effects in the study are a reflection of reality rather than the results of extraneous variables and whether the independent variable made any change to the dependent variables.

Polit and Beck (2008:307) describe temporal ambiguity, selection of study subjects, history, maturation, mortality, testing and instrumentation as threats to internal validity. LoBiondo-Wood and Haber (2006:209) state that any research can have threats that lead to false-positive or false-negative.

In this study, the design was retrospective and there was no manipulation of the variable. Also, the independent variable was a patient admitted to ICU who was intubated and had unplanned extubation. Moreover, the check list measured what it was meant to measure and there were no threats to internal validity.

4.6.2 External validity

Polit and Beck (2008:308) state that external validity concerns the extent to which the study results can be generalised. As this study was retrospective, the three aspects of validity were important, namely context, criterion-referenced and construct validity (Polit & Beck 2001:308).

Burns and Grove (2001:400) define content-related validity as "the extent to which the method of measurement includes all major elements of the concept being measured". They add that the researcher may cite sources from literature to seek feedback for understanding the phenomenon under study.

This study was retrospective and data was collected from the patients' medical records and the ICU hospital allocation book, using a clinical audit check list. Furthermore, three anaesthetists and three senior ICU critical trained nurses with five to ten years' ICU experience evaluated and validated the content validity of the clinical audit checklist.

4.7   RELIABILITY

Polit and Beck (2004: 730) describe reliability as "the consistency with which an instrument measures the attribute". An instrument is said to be reliable if its measures accurately reflect the true score of the attribute under investigation. To reinforce and assess the reliability of the instrument in this study, evaluating and test-retest reliability checked stability. The clinical audit check list was pre-tested prior to the main study and comparison scores measured thus further enhancing the stability of the instrument.

4.8   ETHICAL CONSIDERATIONS

Conducting research ethically begins with the identification of the topic and continues through to the publication of the study. Therefore, conducting a nursing study requires not only expertise and diligence but also honesty and integrity (Burns & Grove 2007:202; Polit & Beck 2004:142).

In this study, the researcher was committed to ensuring that the ethical consideration of confidentiality was strictly upheld. Permission to undertake the study was sought and

obtained from the Research and Ethics Committee of the selected hospital (see Annexure A) and the Department of Health Studies at the University of South Africa (UNISA) (see Annexure B).

This study was non-therapeutic research and was conducted "to generate knowledge for a discipline; the results of the study might benefit future patients but probably will not benefit those acting as research subjects" (Burns & Grove 2007:199). The three ethical principles which guide any study are respect of persons, beneficence and justice (Burns & Grove 2007:201).

- **Respect of persons**: Respect means that people should be treated as autonomous beings with the right to self-determination and freedom to participate or not in any research (Burns & Grove 2007:201).

  As this study was a retrospective audit of past medical records of patients, informed consent from both patients and nurses was not necessary. The researcher respected the subjects by protecting their privacy, not disclosing the information other than for its intended use for this study. Permission to conduct the study was requested and granted by the Research and Ethics Committee of the academic institution (see Addendum A) and the Ethics and Research Committee of the University of South Africa (UNISA) (see Addendum B). The rights of the institution were further respected and protected by not identifying the institution where the study was done.

- **Beneficence**: The principle of beneficence means to do good and above all do no harm (Burns & Grove 2007:201).

  The researcher upheld the principle of beneficence by ensuring confidentiality of both patients and nurses by not mentioning names but using serial numbers for identification. Confidentiality was maintained to protect the privacy of patients, nurses and the institution by not releasing their identity. Although informed consent was not necessary from the patients or nurses, the researcher maintained the subjects' anonymity throughout the study, to ensure that data was not linked to individuals.

The data collection was done by the researcher and completed data kept in a locked cupboard to which only the researcher had access. The researcher entered, coded and stored the data on a password protected computer to which only she had access.

- **Justice**: The principle of justice means that "all subjects should be treated fairly in terms of the benefits and risks of the research" (Burns & Grove 2007:201).

As this study was retrospective, data was obtained by accessing patients' medical records. The researcher respected the privacy and confidentiality of both patients and nurses and took the utmost care to protect their rights.

The patients' data was identified by serial number and no names were included in the analysis. The nurses were treated with privacy and confidentiality and their rights protected, as the researcher was only interested in their highest qualification, critical care training, years of experience in nursing and ICU and number of patients they were allocated to.

The study was related to patients' health care, therefore, care was taken to protect the patients' privacy and confidentiality. Moreover, only data directly relevant to the study was collected.

- **Scientific integrity**: Burns and Grove (2007:230) state that the "goal of research is to generate sound scientific knowledge, which is possible only through honest conduct, reporting, and publication of quality research".

The researcher took the utmost care to collect, code, analyse and interpret the data with honesty, without any fabrication of data during data collection, analysis or reporting. In addition, the results were reported as true findings of the analysis.

4.9   CONCLUSION

This chapter described the research design and methodology. The researcher developed a check list for data collection from the medical records in order to elicit responses relevant to the research problem. The researcher collected all the data personally and confidentiality was maintained throughout the study.

Chapter 5 discusses the data analysis and interpretation.

CHAPTER 5

Data analysis and interpretation

5.1   INTRODUCTION

The purpose of the study was to identify the patients' and nurses' characteristics associated with unplanned extubation. This chapter discusses the data analysis and interpretation and results.

The objectives of the study were to:

- Identify the characteristics of patients who had unplanned extubation in an ICU in a selected hospital in Nairobi.
- Identify the characteristics of the nurse caring for the patient at time of the unplanned extubation.
- Determine the number of patients the nurse had to cope with at once.

5.2   DATA MANAGEMENT AND ANALYSIS

The researcher selected a purposive sample of 357 patients who were endotracheally intubated between January 2006 and December 2007. A statistician analysed the data collected from the patients' medical records, using the Statistical Package of Social Sciences (SPSS) version 13 computer program. Frequency tables with accompanying percentages were used to gain insight into distributions of patients' and nurses characteristics. Descriptive statistics such as mean and standard deviation were computed for the continuous variables. To assess association between categorical variables and how unplanned extubation occurred, Chi-square measure of association was used. If the p-valve was <0.05 this indicated there was a significant association.

The check list for data collection consisted of three sections:

- Section A: Demographic profile, including patients' age, gender and diagnosis on admission to ICU.

- Section B: Information in regard to history of intubation, route and time of intubation, unplanned extubation, whether self-deliberate or accidental extubation, ventilator support, physical restraints usage, GSS, RSS, use of sedatives, neuro-muscular blockade, pain medication, re-intubabation and outcome of the patient.

- Section C: Nurses' workload, time of shift, highest nursing education of primary nurse, critical care training, experience as nurse and in ICU.

The three sections were analysed separately. Descriptive statistics were used to summarise the data, together with tables and figures. Data from open-ended questions were categorized and clustered according to frequency. The totals were indicated by frequency (n), followed by percentage (%), rounded to the first decimal point. Chi-square tests assessed the variables of sedation, restraints; Glasgow coma scale, nursing experience and nursing were used in relation to unplanned extubation. Pearson product moment (p test) correlation to determine the relationship among the variables was also used.

5.3 FINDINGS

Out of 950 patients admitted to the ICU of the selected hospital between 1 January 2006 and 31 December 2007, 357 patients required endotracheal intubation; 20 patients were re-intubated after successful weaning from the ventilator; 30 patients were excluded from this study as they were not intubated for more than 6 hours, and 10 patients' medical records were not traceable during the survey audit. The 10 patients' medical records used to pre-test the clinical audit tool were also excluded from the survey audit. A total of 57 patients had unplanned extubations (17.4% of total endotracheally intubated patients); 7 patients had more than one episode of unplanned extubation, and 1 patient had 5 unplanned extubations. All these episodes of unplanned extubation were included.

5.3.1 Results of the pre-test of the clinical audit check list

The clinical audit check list was pre-tested to check its reliability and if it answered the questions related to the study. Table 5.1 represents the results of the pre-test. The researcher added one question to the check list after the pre-test (see question 6 on the clinical audit check list).

Table 5.1   Pre-test results (n=10)

Section A: Patient profile	Frequency (n=10)	%
Age in years		
0-10 years	1	10.0
11-20years	0	0
21-30 years	1	10.0
31-40 years	1	10.0
41-50 years	0	0
51-60 years	3	30.0
61-70 years	1	10.0
71-80 years	1	10.0
81-90 years	2	20.0
Gender		
– Male	8	80.0
– Female	2	20.0
Diagnosis		
– Trauma	2	20.0
– General surgery	0	0
– Cardiac	0	0
– Medical	8	80.0
Method of intubation		
- Oral tracheal	10	100
- Nasal	0	0
Section B: Unplanned extubation	**Frequency (n=2)**	
Unplanned extubation	(n=10)	
Yes	2	20.0
No	8	80.0
Year of intubation	(n=10)	
2006	10	100
2007	0	0
Total days intubated	(n=10)	
– 0-5	5	50.0
– 6-10	4	40.0
– 11-15	1	10.0
Days intubated before the incident	(n=2)	
- 0-5	1	50.0
- 6-10	1	50.0
Was weaning process commenced?		
- Yes	0	0
- No	2	100
Ventilator mode	(n=2)	
- Pressure control	2	100
- Volume control	0	0
- SIMV	0	0
Incidence	(n=2)	
- Self-deliberate (patient)	1	50.0
- Accidental (nurse)	1	50.0
	(n=2)	
If self-deliberate please state how (e.g., coughed out)	1	50.0

	Frequency	%
If accidental please state how (e.g., during positioning patient)	1	50.0
Nurse location at time of unplanned extubation	(n=2)	
- At bedside	2	100.0
- Not at bedside	0	0
Physical restraints used	(n=2)	
- Yes	0	0
- No	2	100
Patient position		
- Supine	0	0
- Right side	1	50.0
- Left side	1	50.0
Glasgow Coma Scale		
- Yes Score___11/15	1	50.0
- No	1	50.0
Ramsay Sedation Scale		
- Anxious and restless	2	100
Chemical restraints		
Use of sedation	2	100
Use of analgesic infusion	1	50
Use of neuromuscular blockade	1	50
Did the patient require re-intubation?		
- Yes	2	100
- No	0	0
If yes, what time was the patient intubated		
- Immediately	2	100
- After 4 hours	0	0
Indicate any complication that occurred within 6 hours following extubation		
- No	2	100
- Yes	0	0
Final outcome of patient		
- Discharged from ICU	0	0
- Died in ICU	2	100
- Transferred out of hospital	0	0
Section C: Nursing staff	**Frequency (n=2)**	**%**
How many patients was the nurse responsible for during the shift?		
- One patient	1	50.0
- Two patient	1	50.0
Highest qualification of the nurse responsible for the patient		
- Registered nurse		
- BScN	1	50.0
- Enrolled nurse	1	50.0
- Community nurse	0	0
	0	0
Trained in critical care?		
- Yes	0	0
- No	2	100
How many years' experience does the nurse have in nursing?		
- Less than two years	1	50.0
- Three to four years	1	50.0
How many years of experience does the nurse have in the ICU?		
- Less than two years	2	100
- Three to four years	0	0

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Table 5.1 indicates that 5 patients (50%) were intubated for 0-5 days, 4 patients (40%) were intubated for 6 to 10 days and 1 patient (10%) was intubated for 10 to 15 days. 2 patients (20%) had unplanned extubation; 1 patient (50%) had self-deliberate and 1 patient (50%) had accidental unplanned extubation.

5.4 FINDINGS

A total of 950 patients were admitted to the ICU of the selected hospital between January 1, 2006 and December 31, 2007. Of these, 357 patients required endotracheal intubation; 20 patients were re-intubated after successful weaning from the ventilator; 10 patients were excluded from this study as they were used for the pretest; 30 patients were excluded from this study as they were not intubated for more than 6 hours, and 10 patients' medical records were not traceable in the medical records department during the data collection. A total of 57 patients had unplanned extubations (17.4% of total endotracheal intubated patients); 7 patients had more than one episode of unplanned extubation, and one patient had 5 unplanned extubations. All these episodes of unplanned extubation were included in the study as they met the criteria of being intubated for more than 6 hours and whether these patients required re-intubation, within the same admission.

Figure 5.1 shows the sample size of the study.
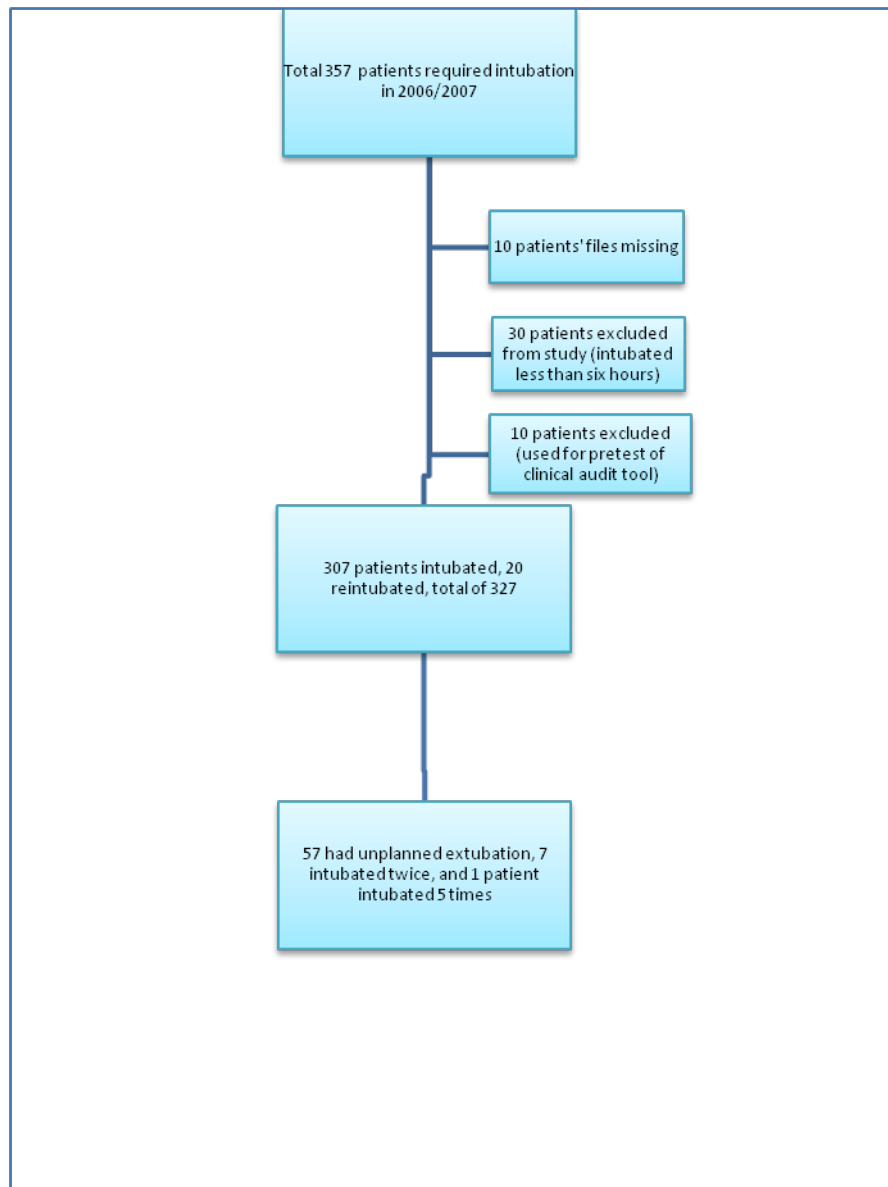
Figure 5.1   Sample size

5.4.1   Section A: Patient profile

The demographics of the patients who had required intubation from 1 January 2006 to 31 December 2007 included their age, gender, initial diagnosis on admission and method of intubation.

5.4.1.1 Age

Of the patients who were admitted and required intubation, 307 were endotracheally intubated for more than 6 hours and 20 required re-intubation. The patients' ages (in years) are shown in figure 5.2 and table 5.1.
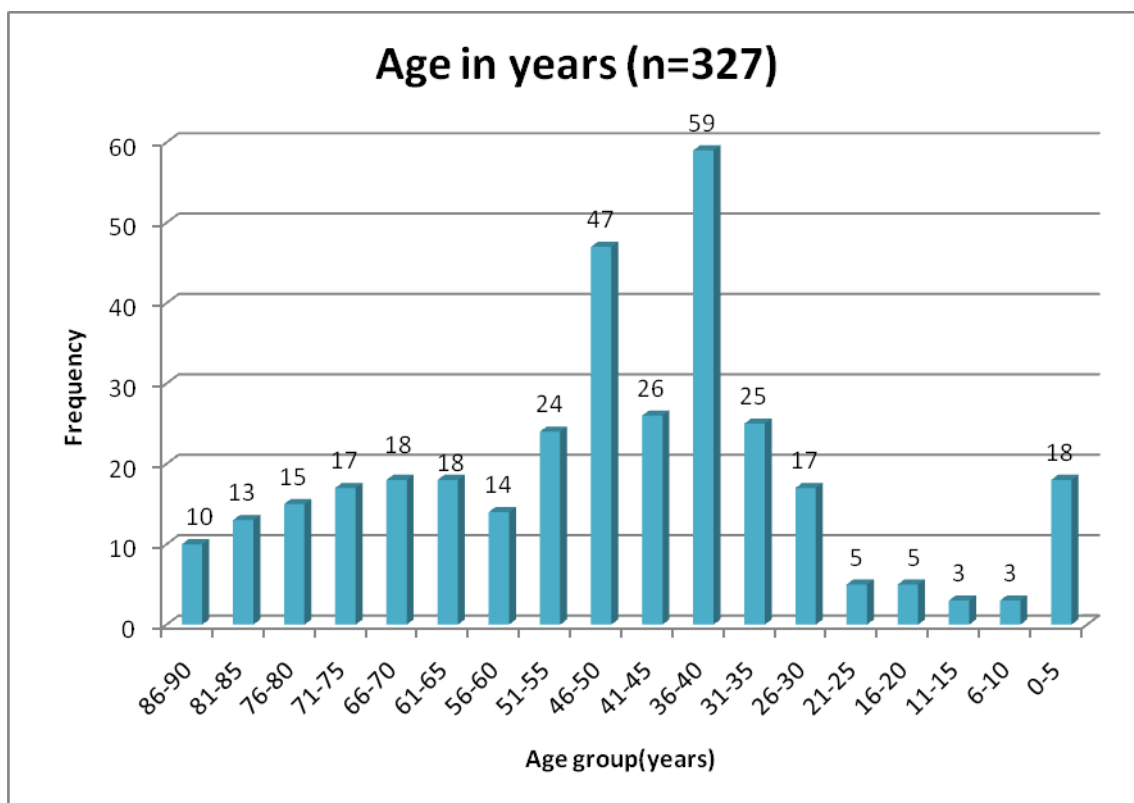
Figure 5.2   Age distribution of patients who required intubation (n=327)

Table 5.2   Frequency distribution of age of patients who required intubation (n=327)

Age	F	X^1	Fx^1	%
86-90	8	88	704	2.5
81-85	13	83	1079	3.9
76-80	15	78	1170	4.6
71-75	16	73	1168	4.9
66-70	18	68	1224	5.5
61-65	17	63	1071	5.2
56-60	13	58	754	4.0
51-55	21	53	1113	6.4
46-50	47	48	2256	14.4
41-45	26	43	1118	8.0
36-40	59	38	2242	18
31-35	25	33	825	7.7
26-30	17	28	476	5.2
21-25	4	92	115	1.2
16-20	5	18	90	1.5
11-15	3	13	39	0.9
6-10	3	8	24	0.9
0-5	17	3	51	5.2
	327		15519	100

$$Mean = \frac{\Sigma fx}{N} = \frac{15519}{327} = 47.5 \ years$$

According to table 5.2, 327 patients who required endotrachael intubation for more than 6 hours were admitted to the ICU from 1 January 2006 to 31 December 2007. Of these, 20 patients were re-intubated during the same admission after successful weaning and extubation. The patients' ages ranged as follows: 23 (7%) were 0-15 years; 26 (7.9%) were 16-30; 110 (33.6%) were 31-45; 98 (30%) were 46-65; 49 (15%) were 66-80, and 21 (6.4%) were 81-90. Further analysis revealed that 208 (63.6%) patients between the ages of 31 and 65 years required intubation. The mean age of the patients who required intubation was 47.5 years.

In Turkey, Eryuksei et al (2009:17) reported a mean age of 57 years for intubated patients. In Spain, Bouza et al (2007:272) found a mean age of 63 years. Bickett et al

(2005:65) found a mean age of 53.78 years, with a range of 18 to 87 years. In the USA, Lee, MacLennan, Naughton and O'Reilly (2003:576) found 13.9% of the patients were above 65 years old and 20.3% were children who required intubation.

The finding of this study of a mean age of 47.5 years with a range of 3 months to 88 years is much lower than that reported by Bouza et al (2007:274) and Eryuksel et al (2009:17) and is not comparable to any literature reviewed findings.

The reasons for the lower mean age were that the study was conducted in a general mixed ICU with both paediatric and adult as well as surgical and medical patients, and with different disease patterns. Bouza et al (2007:27) and Eryuksel et al (2009:17) conducted their studies in specific specialty ICUs.

5.4.1.2 Gender

Of the patients, 213 (65.1%) were males and 114 (34.9%) were females (see figure 5.3).
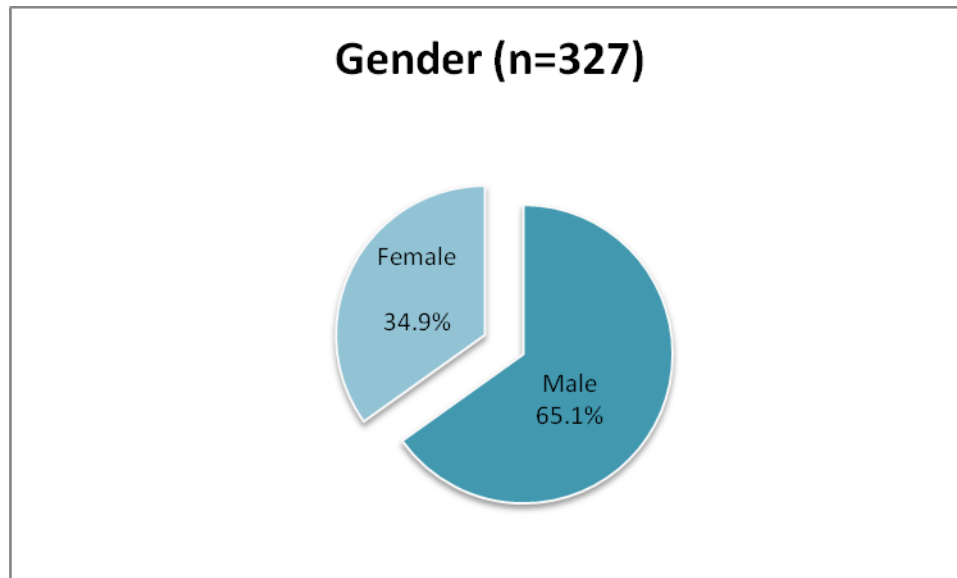
Figure 5.3   Patients' gender (n=327)

Bouza et al (2007:274) found 68.9% males and 31.1% females, and Tung et al (2001:26) found 73.3% males and 26.7% females.

5.4.1.3   Patients' initial diagnosis on admission

Regarding the patients' initial diagnosis, the results revealed that of the patients, 228 (69.7%) were admitted with medical illness; 32 (9.8%) were admitted for general surgery; 62 (19%) were admitted with trauma, and 5 (1.5%) had gynaecological/obstetric problems (see figure 5.4).
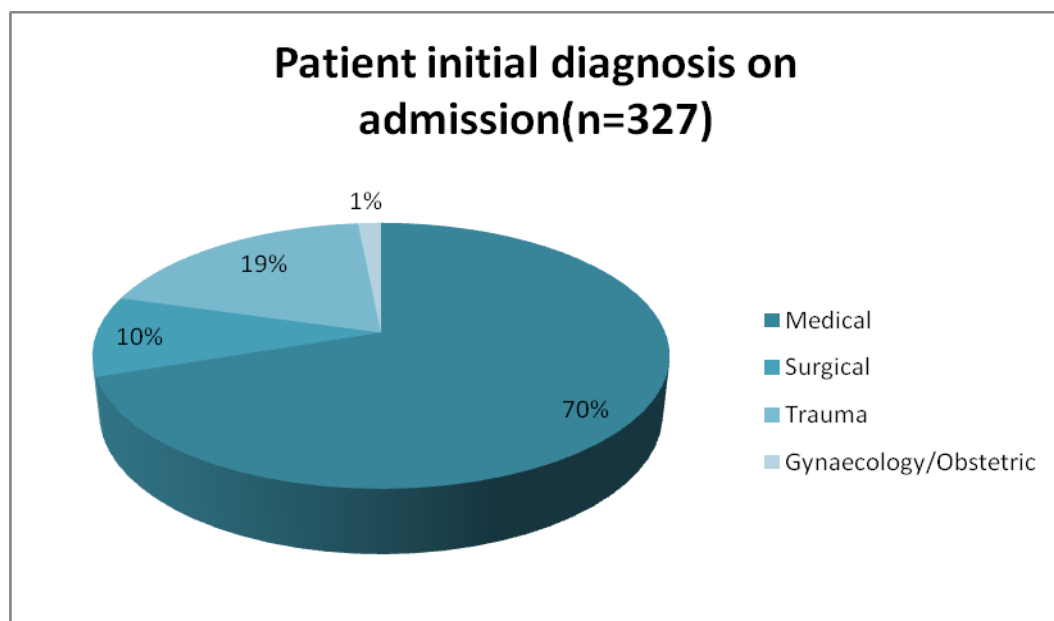
Figure 5.4   Patients' initial diagnosis on admission (n=327)

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Birkett et al (2005:65) found 50% of patients with medical illness and 50% with surgical illness. Kinsley and Barone (2005:561) reported 71% of patients with medical illness, 17% with surgical problems, and 12% with trauma.

Kinsley and Barone (2005:561) found 77% with medical illness and 20.7% with surgical illness. However, the patients (1.5%) with gynaecological/obstetric problems did not compare with any findings in the literature.

5.4.1.4 *Method of intubation*

Of the patients, 317 (97%) had oral tracheal intubation and 10 (3%) had nasotracheal intubation (see figure 5.5).
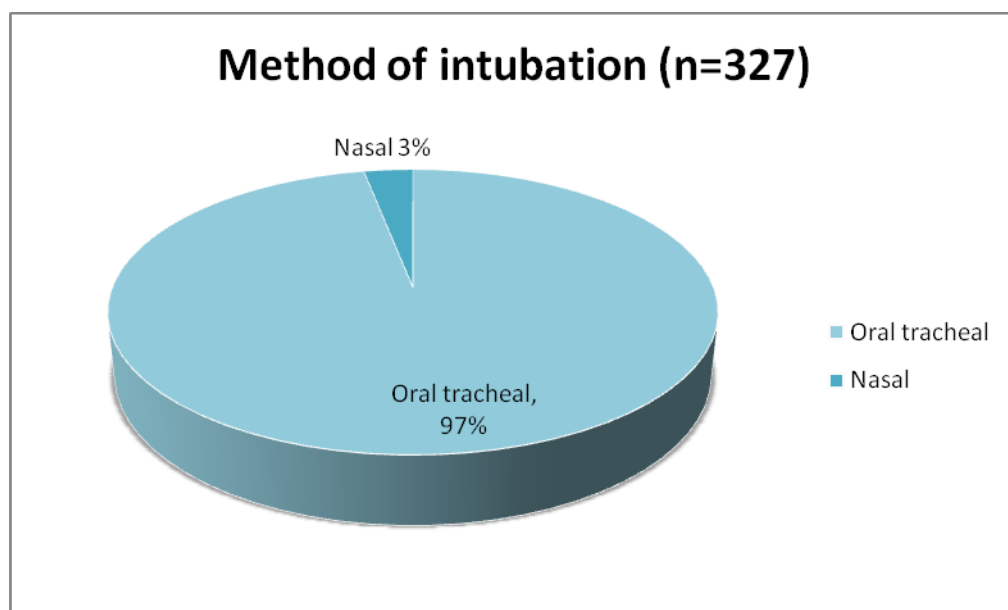
Figure 5.5   Method of intubation (N=327)

In the literature review, the reported preferred route was orotracheal intubation as it causes less nosocomial infections. Bouza et al (2007:270) found 97% orotracheal intubation; Moons et al (2004:1351) found 100% orotracheal intubation, and Kapadia et al (2000:661) reported 99% orotracheal intubation. The findings of this study are comparable with the studies of Bouza et al (2007:270) and Kapadia et al (2000:61).

The finding that 317 (97%) patients were orally tracheal intubated also confirms compliance with the intubation protocol, which was introduced in 2006.

5.4.2 Section B: Unplanned extubation

This section covered days intubated prior to unplanned extubation; type of unplanned extubation whether self-deliberate or accidental during nursing procedure or non-nursing procedure; location of the nurse at the time of incident; type of intubation; ventilator support; chemical restraints and physical restraints used; RSS, GCS, re-intubation, complications within 6 hours of unplanned extubation ,outcome of patient and total days intubated.

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5.4.2.1 Total days intubated

Table 5.3 shows the number of days patients required intubation during the study period.

Table 5.3   Total intubated days for all intubated patients (n=327)

Ventilated days	F	X^1	Fx^1	%
0-5	168	2.5	420	51.4
6-10	91	8	728	27.8
11-15	35	13	455	10.7
16-20	17	18	306	5.2
21-25	8	24	192	2.5
26-30	5	28	140	1.5
31-35	2	33	66	0.6
36-40	0	38	0	0
41-45	1	43	43	0.3
	327		2350	100

$$Mean = \frac{\Sigma fx}{N} = \frac{2350}{327} = 7.2 \; days$$

Further analysis revealed that the 327 patients were intubated for 2 350 ventilated days with a range of 1 to 43 days.

Of the patients, 168 (51.4%) were intubated for 0 to 5 days; 91 (27.8%) for 6 to 10 days; 35 (10.7%) for 11 to 15 days; 17 (5.2%) for 16 to 20 days, and 3 (0.9%) required intubation from 21 to 45 days. Further analysis revealed that the 327 patients were intubated for 2 350 ventilated days with a range of 1 to 43 days and a mean duration of 7.2 days.

Bouza et al (2007:270) found 344 intubated patients over a period of 3 710 ventilated days, with a mean of 10.7 ventilated days. Marcin et al (2005:254) reported 1 004 ventilated patients over 5,828 ventilated days; with a mean of 5.02 ventilated days, and Moons et al (2004:1349) found 627 ventilated patients over 3 829 ventilated days; with a mean of 6.1 ventilated days.

The finding of this study of 7.2 mean ventilated days is lower than that reported by Bouza et al (2007:270) but higher than both Marcin et al (2005:254) and Moons et al (2004:1349).

5.4.2.2 Unplanned extubation

Figure 5.6 shows the number of patients who had unplanned extubations.
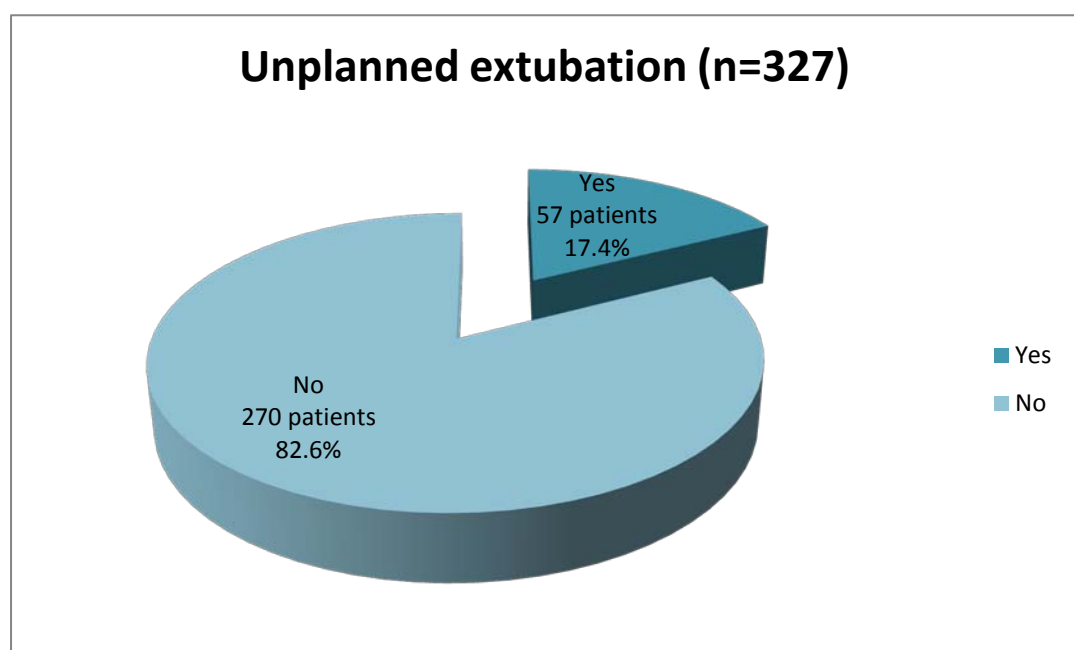
Figure 5.6   Unplanned extubation (n=327)

According to figure 5.6, of the patients who were endotracheally intubated, 270 (83%) had no adverse events of unplanned extubation while 57 (17.4%) had unplanned extubations. Furthermore, 7 (11.9%) patients had unplanned extubation twice and 1 (1.6%) had unplanned extubation 5 times.

Further analysis indicated the rate (57/327) of 17.4% unplanned extubations and incidence density (57/2350ventilated days) of 2.42 per 100 ventilated days.

Birkett et al (2005:63) reported a rate of 2.6% of unplanned extubation. Kinsley and Barone (2005:561) found a rate of 6.6% while Yeh et al (2004:257) found a rate of 22.5% of unplanned extubation. Mpe et al (2004:18) found that 10.3% of intubated patients had unplanned extubations.

Bhattacharya et al (2007:105) found a rate of 5.8% of unplanned extubation with an incidence density of 1.42 per 100 ventilated days. Bouza et al (2007:272) found a rate of 9.8% of unplanned extubation and an incidence density of 0.92 per 100 ventilated days. Chang et al (2008:411) found a rate of 8.7% unplanned extubation and an incidence density of 2.07% of unplanned extubation per 100 ventilated days. Ream et al (2007:366) revealed a rate of 5.4% of unplanned extubation and an incidence density of 0.76 per 100 ventilated days.

The finding of this study indicate that both the rate (17.4%) and incidence density (2.42 per 100 ventilated days) were much higher than Bhattacharya et al (2007:105): Bouza et al (2007:272); Chang et al (2008:411) and Ream et al (2007:366) who found rates of 5.4% to 9.8% of unplanned extubation and an incidence density of 0.7 per 100 ventilated days to 2.07 per 100 ventilated days. However, the rate (17.4%) is lower than Yeh et al's (2004:257) rate of 22.5%.

Although the incidence rate was higher than Mpe et al's (2004:18) 10.3%, this study was conducted over a period of two years compared to their six months.

5.4.2.3 *Age of patients who had unplanned extubation*

The findings revealed that a total of 57 patients had unplanned extubations in the ICU. Table 5.4 and figure 5.7 show the ages of patients who had unplanned extubation.

Table 5.4   Age frequency distribution of patients who had unplanned extubation (n=57)

Age	F	x^1	Fx^1	%
86-90	1	88	88	1.8
81-85	1	83	83	1.8
76-80	7	78	549	12.3
71-75	1	73	73	1.7
66-70	2	68	136	3.5
61-65	6	63	315	10.5
56-60	0	0	0	0
51-55	3	53	159	5.2
46-50	9	48	432	15.8
41-45	5	43	215	8.8
36-40	7	38	266	12.3
31-35	3	33	99	5.2
26-30	1	28	28	1.8
21-25	0	0	0	0
16-20	0	0	0	0
11-15	1	13	13	1.8
6-10	0	0	0	0
0-5	10	2.5	25	17.5
Total	F=57		2481	100

$$\text{Mean} = \frac{\Sigma fx^1}{N} = \frac{2481}{57} = 43.5 \text{ years}$$

The patients' ages were in calculated in years. Of the patients who had unplanned intubation, 11 (19.3%) were aged 0-20 years; 11 (19.33%) were 21-40; 17 (29.8%) were 41-60, and 18 (31.6%) were 61-90 years. The mean age was 43.5 years.

Birkett et al (2005:69) found a median age of 51.07 to 55.45 years between the seven surveys done. However, Bouza et al (2007:272), Krinsley et al (2005:561), Mpe et al (2004:18) and Tung et al (2001:25) found that unplanned extubation was common between 35 and 70 years of age with a mean age of 45 years.

The rate of unplanned extubation in adult patients in this study is comparable to Kinsley and Barone's (2005:561) finding.

Figure 5.7 shows the ages of patients who had unplanned extubation.

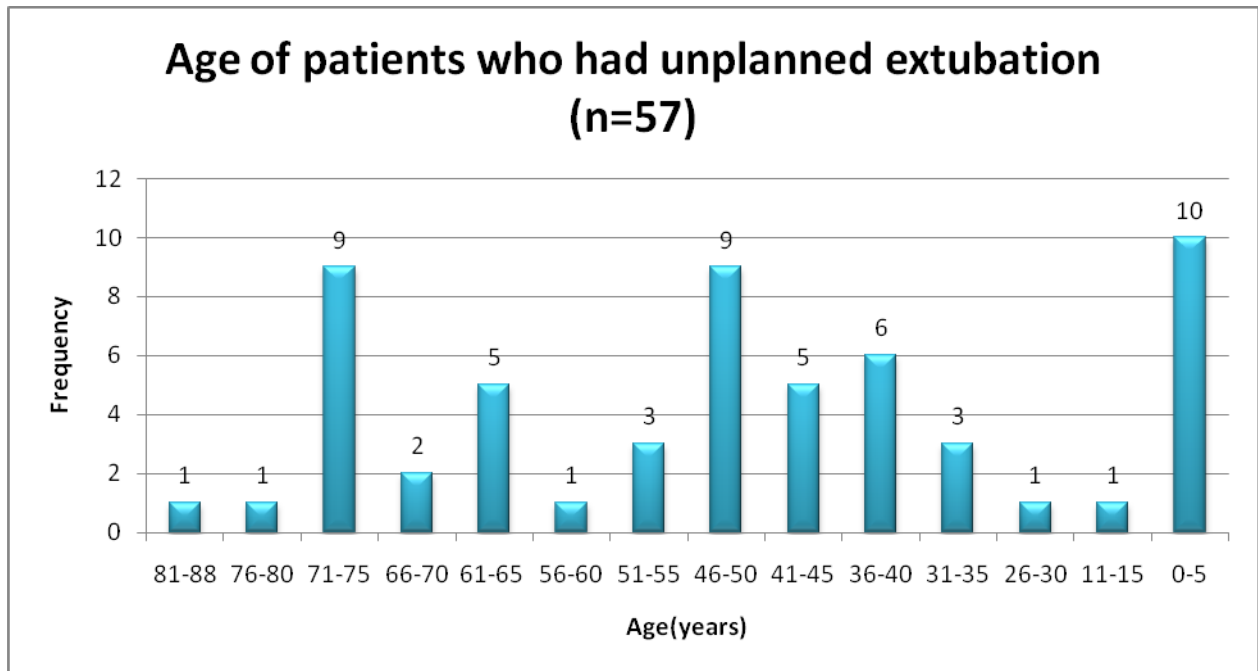**Figure 5.7   Age of patients who had unplanned extubation (n=57)**

According to the findings, the rate of unplanned extubation in the paediatric patients was 11 (19.3%) of the total unplanned extubations with a mean age of 3.37 years.

Regarding paediatric patients, Ream et al (2007:366) found that the ages ranged between newborn and 2.6 years with a median age of 4.2 years and an incidence rate of 5.4% unplanned extubation with a mean age of 2 years, while Popernack, Thomas and Luckling (2004:61) found a mean age of 34 months (2 years 10 months).

The finding of a 3.56% rate of unplanned extubation in paediatric patients was lower than Ream et al's (2007:366) but higher than Popernack et al's (2004:61).

5.4.2.4 Unplanned extubation: adult versus paediatric

Figure 5.8 shows the number of adult patients versus paediatric patients who had unplanned extubations.
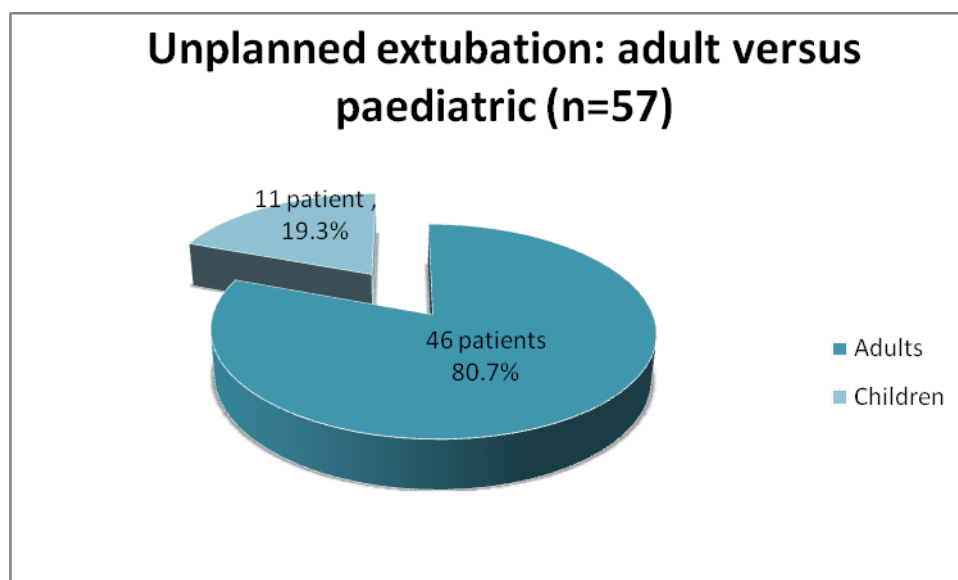
Figure 5.8   Unplanned extubation: adult versus paediatrics (n=57)

The study revealed that 11 (19.3%) paediatric patients from 0-15 years and 47 (80.7%) adults from 16-89 had unplanned extubations. A total of 24 (100%) children were endotracheally intubated over the two-year period of which 11 (45.8%) had unplanned extubations. A total of 313 (95.7%) adults required endotracheal intubation, of which 46 (14.7%) had unplanned intubations.

Marcin et al (2005:256) found a mean age of 39.4 months among paediatric patients who had unplanned extubations while De Silva, De Aguiar, Neto, and De Carvalho (2008:1211) found 18.7% of paediatric patients with a mean age of 7.5 months had unplanned extubations.

In this study, the 19.3% of paediatric patients with unplanned extubations is comparable to De Silva et al's (2008:1211) finding of 18.7%.

5.4.2.5   Gender distribution of patients who had unplanned extubation

Figure 5.9 indicates that of the patients (100%; n=57) who had unplanned extubation, 40 (70.1%) were males and 17 (28.8%) were females. In other words, more males (70.1%) than females (29.9%) had unplanned extubation.
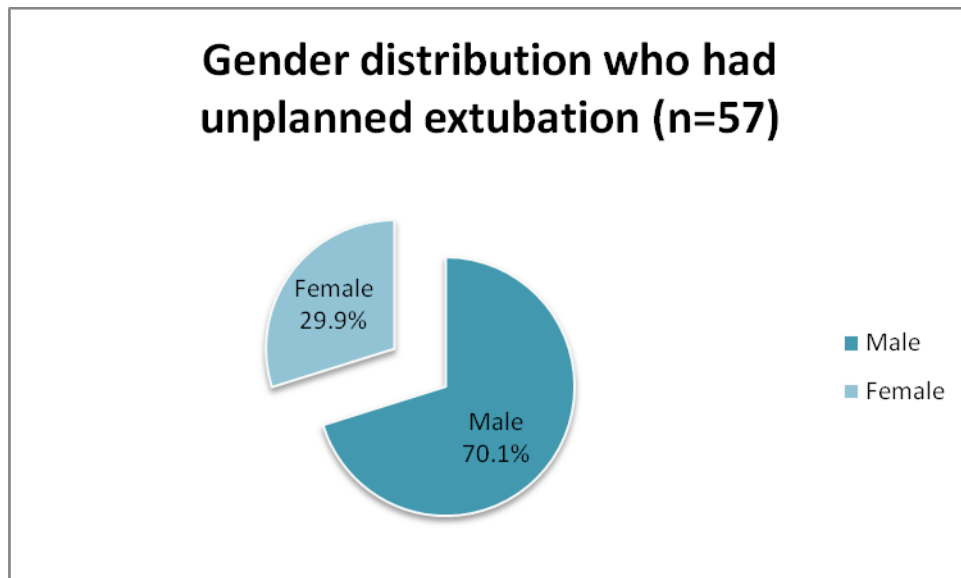
Figure 5.9   Gender distribution in patients who had unplanned extubation (n=57)

In the literature reviewed some studies used gender as a variable and reported more incidences of unplanned extubation in male patients. Curry et al (2008:47) found 84% of males; Krinsley and Barone (2005:561) found 57% of males; Mpe et al (2004:18) found 62.5% of males, and Yeh et al (2004:258) found 65.4% males had unplanned extubations. However, no reasons were given for the gender differences in these studies.

The findings revealed that more male (65.1%) than female patients (34.9%) required endotracheal intubation therefore more male patients (70.1%) had unplanned extubations.

These findings were comparable to those of Curry et al (2008:47) 84%, Krinsley and Barone (2005:561) 57%, Mpe et al (2004:16) 62.5%, and Yeh et al (2004:258) 65.4%.

5.4.2.6 Diagnosis of patients who had unplanned extubation

Of the patients who had unplanned extubation, 39 (68.4%) were diagnosed with medical illness, 10 (17.5%) with surgical illness, 7 (12.3%) with trauma, and 1 (1.8%) with gynaecological illness (see figure 5.10).
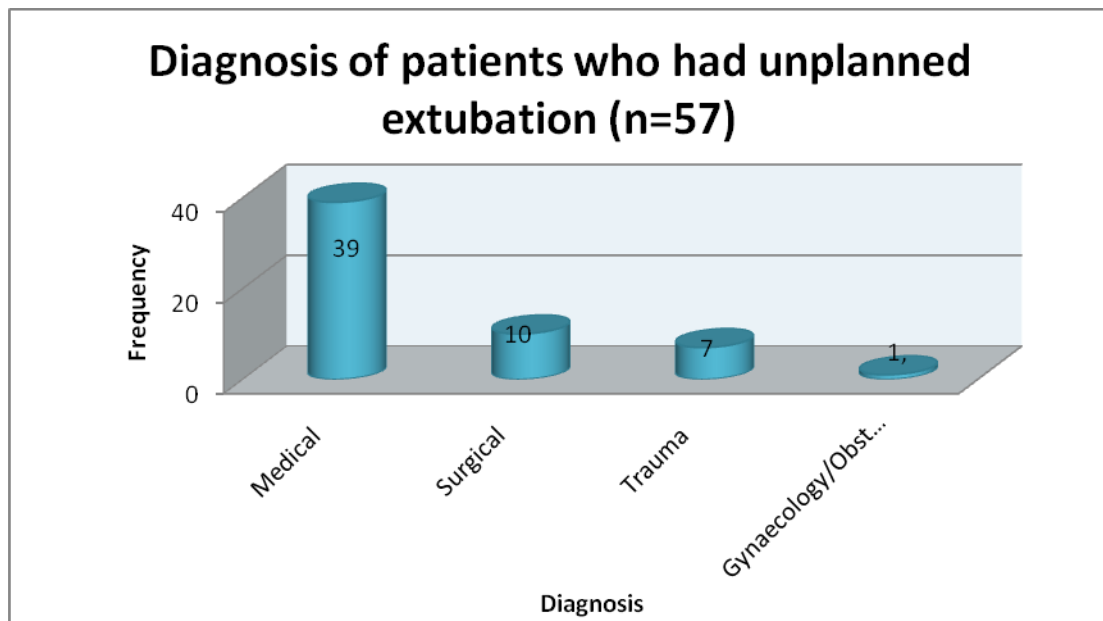
Figure 5.10 Diagnosis of patients who had unplanned extubation (n= 57)

Yeh et al (2004:256) found an incidence rate of 22.5% in medical patients. Moons et al (2004:1348) reported a higher rate of 9.5% in medical ICU in 100 ventilated days compared to a rate of 2.6% per 100 ventilated days in surgical ICU. Birkett et al (2004:69) found between 72% and 90% of medical patients in general ICU compared to 10% to 28% in surgical ICU. However, Razek et al (2000:466) found 4.9% of patients in surgical ICU had unplanned extubation.

The study finding that 68.4% of patients with medical illness had unplanned extubations compared to 17.5% of patients with surgical problems was comparable to Birkett et al's (2004:69) finding.

However, in the literature reviewed no study identified gynaecological or obstetric patients with unplanned extubation.

5.4.2.7 Method of intubation

Of the patients who had unplanned intubation, 52 (91.2%) were orotracheally intubated and 5 (8.8%) were nasotracheally intubated. No patient who had a tracheostomy had unplanned extubation (see figure 5.11).
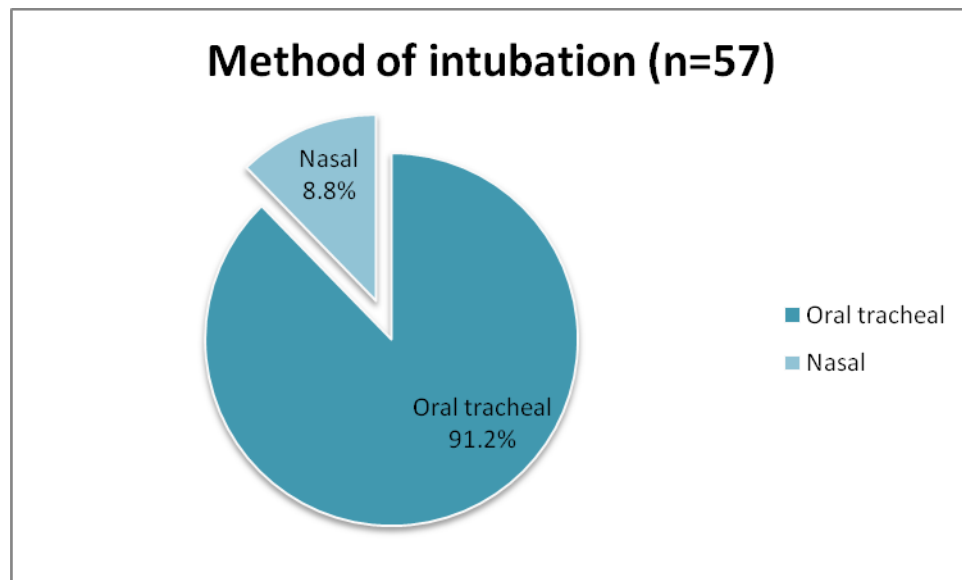
Figure 5.11   Method of intubation (n=57)

Mpe et al (2004:17) found that all patients who had unplanned extubations were orally intubated. De Silva et al (2008:1209) found that all paediatric patients who had unplanned extubation were orally intubated.

In this study, 97% of the patients had orotracheal intubation, which also explains why more patients with oral tracheal intubation than nasal intubation had unplanned extubation.

5.4.2.8 Time of incident

The findings indicate that of the patients, 25 (43.9%) had unplanned extubation during the day shift and 32 (56.1%) had unplanned extubation during the night shift. Figure 5.12 shows when the unplanned extubation occurred.
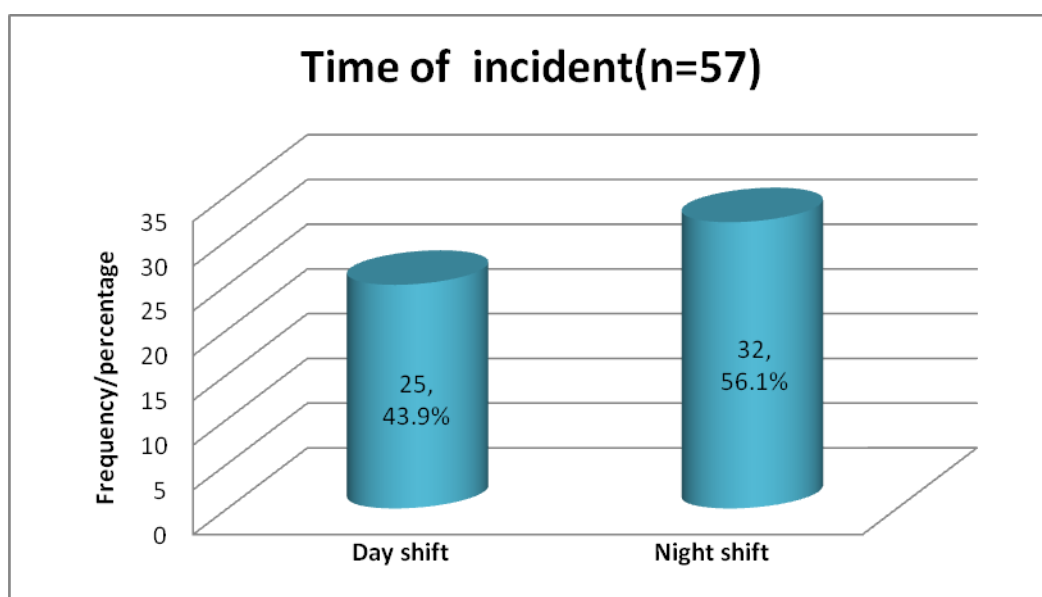
Figure 5.12 Time of incidence (N=57)

Yeh et al (2004:259) found that of the patients who had unplanned extubations, 43% occurred during the night shift; 27.2% occurred during the day shift, and 29.7% occurred during the evening shift. Curry et al (2008:48) found no significant difference in the number of unplanned extubations during the day and night shift.

Balon (2001:97) found that 40% of spontaneous self-extubation occurred during the 11 pm to 7 am shift, 25% occurred during the 7 am to 3 pm shift, and 33% occurred during the 3 pm to 11 pm shift.

Beckman et al (2001:540) found that 59% of unplanned extubations occurred during day shifts, 33% occurred during week night shifts, and 8% occurred on weekends and public holidays.

This study had two shifts compared to three 8-hour shifts consequently the findings cannot be compared to any reported findings (Balon et al 2001:97; Beckman et al 2001:540; Birkett et al 2005:69; Yeh et al 2004:259).

5.4.2.9   *Days' intubated before the incident*

The study examined how long the patients were intubated before unplanned extubation took place. Of the patients, 36 (63.1%) were intubated from 1-5 days; 14 (24.6%) were

intubated for 6-10 days; 3 (5.3%) were intubated from 11-15 days, and 4 (7%) were intubated for 16-20 days with a mean of 5.8 days and a maximum of 20 days of intubation. Table 5.5 shows the number of days the patient was intubated prior to unplanned extubation.

Table 5.5   Days intubated before the incident (n=57)

DAYS	F	X^1	FX^1	%
1-5	36	3	108	63.1
6-10	14	8	112	24.6
11-15	3	13	39	5.3
16-20	4	18	72	7.0
Total	57		331	100

$$Mean = \frac{\Sigma fx}{N} = \frac{331}{57} = 5.8 \; days$$

Curry et al (2008:48) found that 39% of unplanned extubations occurred within the first 2 days of intubation. Krinsley and Barone (2005:562) found that unplanned extubations took place from 2 to 9 days, with a mean of 5 days. Yeh et al (2004:260) found that 66% of unplanned extubations occurred in the first 2 days.

In this study, 63.1% patients had unplanned extubations within the first 5 days of intubation with a mean of 5.10 days. These findings were comparable to Curry et al (2008:48), Krinsley and Barone (2004:260) and Yeh et al (2004:260). The finding that 5.1% patients were intubated for 16 to 20 days is also comparable to Yeh et al's (2004:260) 10% who were intubated for more than 14 days.

5.4.2.10 Weaning process commenced

The findings indicated that the weaning process had been commenced on 6 patients (10.5%) and had not been commenced on 51 (89.5%) (see figure 5.13).
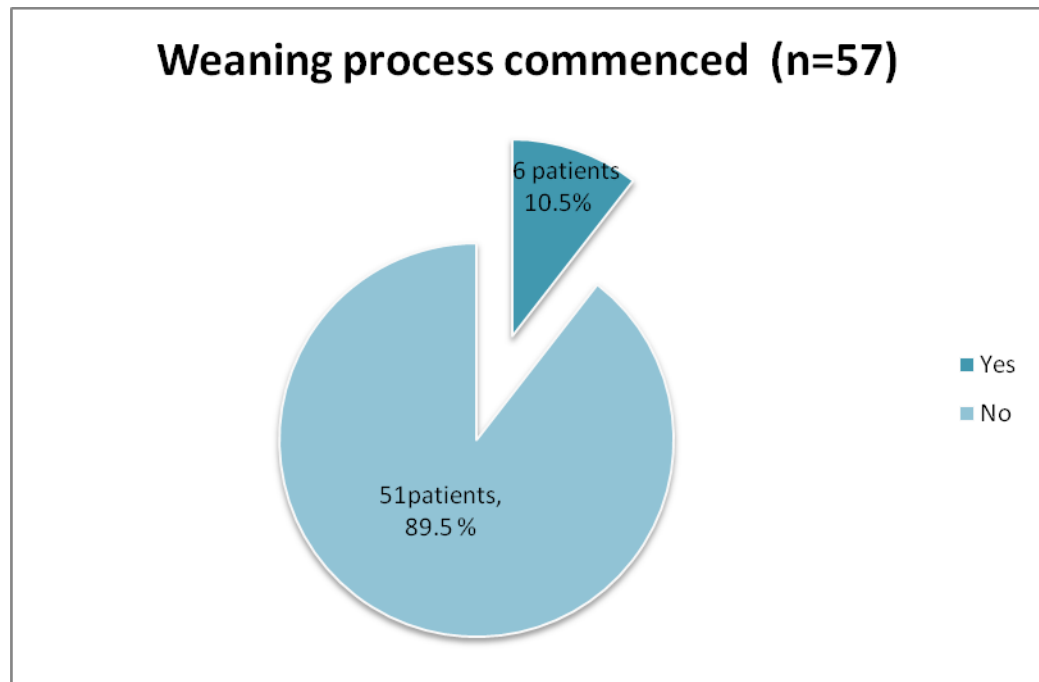
Figure 5:13 Weaning process commenced (n=57)

Curry et al (2008:48) found that 16% of the patients were being weaned off the ventilator when unplanned extubation occurred. Moons et al (2004:1350) found that 65.4% had unplanned extubation and of these 42.9% were proposed for planned extubation on the day of extubation. Sadowski et al (2004:630) found that 46% of unplanned extubations occurred during the weaning process.

Ream et al (2007:369), Chatterjee et al (2004:38) and Yeh et al 2004:256 did not include the weaning process as a variable.

5.4.2.11   Ventilator mode

Regarding the patients' ventilator mode when unplanned extubation occurred, 1 (1.8%) was on SIMV; 13 (22.8%) were on volume control; 39 (68.4%) were on pressure control, and 4 (7%) were on T-piece. Figure 5.14 shows the type of ventilator mode of the patients who had unplanned extubations.

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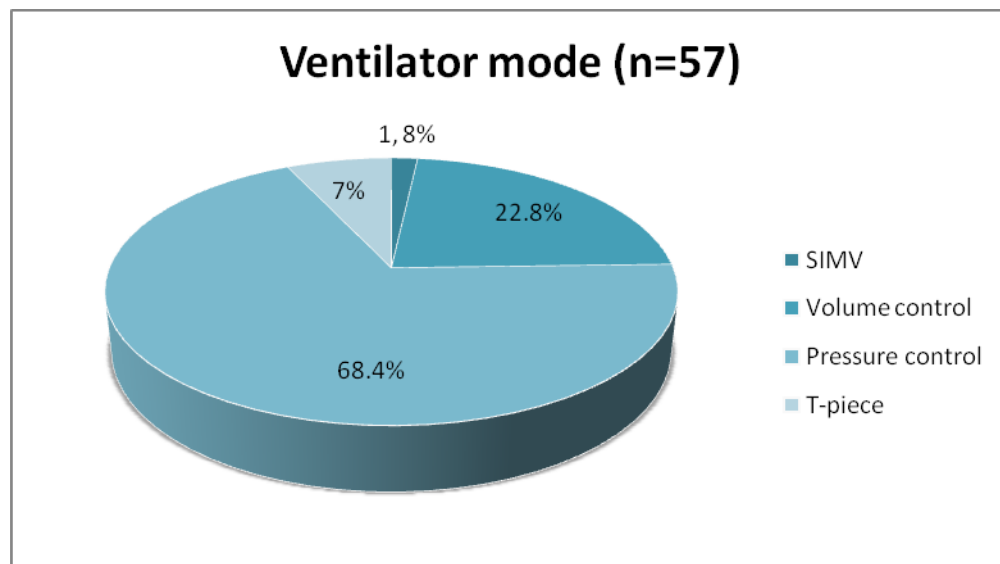
Figure 5.14   Ventilator mode (n=57)

Eryuksel et al (2009:17) found that 100% of patients who had unplanned extubation were on ventilation, but did not elaborate on type of support; whether mandatory or intermittent pressure support. Ream et al (2007:366) found that 5.4% of ventilated patients had unplanned extubations. Moon et al (2004:1351) found that of the patients, 15.4% were on full support (mandatory) ventilation and 84.6% were on partial ventilator support.

In this study, 93% of the patients were on ventilator support when they had unplanned extubation and 7% were on T-piece, breathing trial and actively being weaned off the mechanical ventilator. These findings are comparable to Eryuskel et al (2009:17) and Moon et al (2004:1351).

5.3.2.12 *Incidence*

The study found that of the patients, 23 (40.4%) had self-deliberate extubation and 34 (59.4%) had accidental extubation (see figure 5.15).
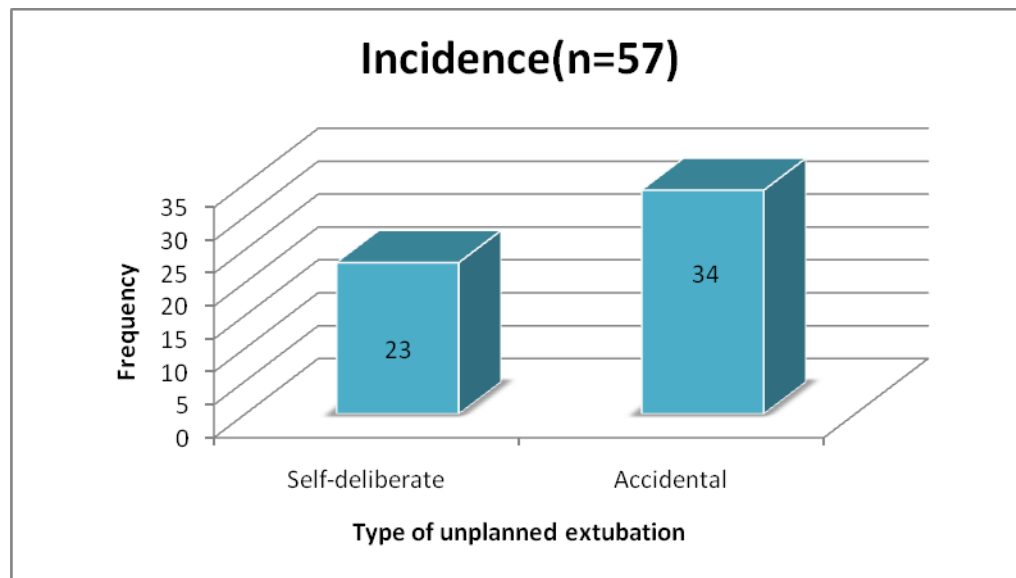
Figure 5.15 Incidence (n=57)

Curry et al (2008:46) found 100% deliberate self-extubation. Yeh et al (2004:257) found 91.7% deliberate self-extubation and 8.3% accidental extubation. Mpe et al (2004:18) found 92.5% were deliberate self-extubation and only 7.04% accidental extubation. In their 7-year survey, Birkett, Sutherland and Leslie (2004:69) found that of the patients, 75% to 100% had deliberate self-extubation compared to 0% to 25% who had accidental extubation. In a study of seven ICUs in Belgium, Moons et al (2004:1350) found that 76.9% were deliberate self-extubation while 23.1% were accidental extubation.

The findings of this study were unique as more patients had accidental unplanned extubation than self-deliberate extubation compared to the literature review (Curry et al 2008:47, Yeh et al 2004:257, Moons et al 2004:1350, Mpe et al 2004:18, Birkett et al 2004:69).

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5.4.2.13 Self-deliberate extubation: how the tube came out

In this study, the patients had self-deliberate extubation either by pulling the endotracheal tube out or by coughing the endotracheal tube out: 12 (52.2%) pulled out the tube and 11 (47.8%) coughed out the tube. Figure 5.16 shows how the self-deliberate extubation occurred.
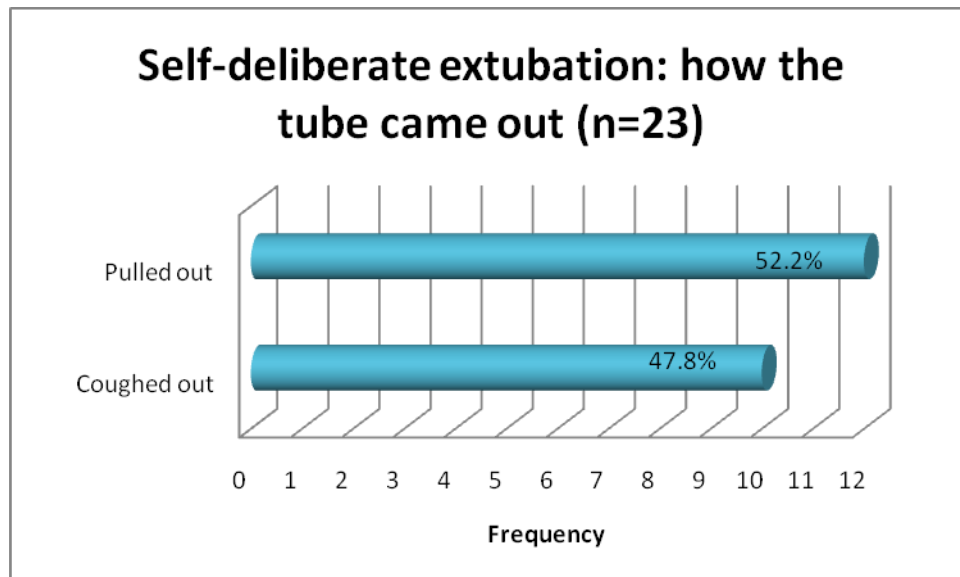
Figure 5.16 Self-deliberate extubation: how the tube came out (n=23)

Balon (2001:93) found that out of 75% of self-deliberate extubated patients, 64% pulled out the tube with their hands, 8% bucked the tube out, 6.6% tongued out the tube, and 5.3% coughed out the tube.

Although Bhattacharya et al (2007:106) compared self-deliberate and accidental extubation, they did not describe on how the incidence occurred.

Chatterjee et al (2004:36) grouped the patients as short-term endotracheal intubation in which leaking cuffs, blocked tubes, and endobronchial intubation were the variables. At the same time, however, self-deliberate and accidental extubation were not variables, but simply short-term and long-term intubation.

The findings of this study are comparable to Balon's (2001:93) 64% who pulled out the tubes, although the rate of coughing out the tube is higher than Balon's (2001:93) 5.3%.

5.4.2.14 Accidental extubation during nursing procedure

The findings of the study revealed that out of the 34 accidental extubations, 30 (88.2%) occurred during nursing procedures (see table 5.6).

Table 5.6   Accidental extubation during nursing procedure (n=30)

Nursing procedure	Frequency	%
Changing patients' position	9	30
Changing tapes	3	10
Wheeling patient to x-ray department	1	3.3
Blocked tube	9	30
Cuff leaking	8	26.7

Table 5.6 indicates that of the accidental extubations, 9 (30%) occurred while changing the patient's position; 3 (10%) occurred while changing the endotracheal tube tape; 1 (3.3%) occurred while wheeling the patient to the x-ray department; 9 (30%) had blocked tubes, and 8 (26.7%) had cuff leaking. The patients who had blocked tubes were identified by constant ventilator high pressure alarms and the nurses finding resistance on insertion of the suction catheter during suctioning. These patients required immediate extubation and re-intubation. On examining the tube, they were blocked with crusty/thick secretions. The 8 (26.7%) with leaking cuffs were also identified with continuous low pressure alarms on the ventilator.

Yeh et al (2004:256) found that 10 (45.5%) accidental extubations occurred during nursing duties such as mouth and tube care, changing patients' position and during patients' transport. Richmond et al (2004:36) found that the unplanned extubation rate decreased from 2.14% to 0.87% in medical ICU and from 2.32% to 1.0% in surgical ICU after education on different methods of securing the endotracheal tube.

Carrion et al (2000:66) found that between 0.5% and 2.1% of unplanned extubations were care-giver related, but do not elaborate on which health care worker, how and which procedures were being done when the patients had accidental extubations. Bouza et al (2007:270) found that 23% of unplanned extubations were linked to tube fixation and nursing procedures without describing what nursing procedures.

Chatterjee et al (2004:38) found that 3.97% patients, mostly short-term intubated patients, had blocked tubes, and 34.5% of unplanned extubations were either patient- or caregiver-related extubations. Chatterjee et al (2004:38) do not explain how the unplanned extubations happened.

Lee, Maclennan, Naughton and O'Reilly (2003:580) found that seven cuffs ruptured causing air leak and patients required re-intubation immediately. Upon examination, the removed endotracheal tubes were found to be faulty.

The findings of this study also indicated a higher rate of accidental extubations compared to Bhattacharya et al (2007:106) and Yeh et al (2004:256).

5.4.2.15 Accidental extubation during non-nursing procedures

The findings indicated that of the patients, 4 (11.8%) had unplanned extubations during non-nursing procedures (see table 5.7).

Table 5.7   Accidental extubation during non-nursing procedure (n=4)

Reason for accidental extubation	Frequency	%
Dislodged during central line insertion	1	25
Tube dislodged during portable chest x-ray	2	50
Air leak (small tube)	1	25

Table 5.7 shows that of the 4 (11.8%) patients who had accidental extubations due to non-nursing procedures, 2 (50%) had dislodgement of the endotracheal tube during positioning for portable chest x-rays; 1 (25%) had an air leak in a non-cuffed tube, and 1 (25%) had accidental extubation during central line insertion.
.
One paediatric patient had an air leak which was noticed after 8 hours of intubation due to a small diameter endotracheal tube and was re-intubated immediately. The patient was initially intubated for airway clearance (suctioning) and required to be ventilated after 8 hours, when the air leak was noticed and was immediately re-intubated with a larger diameter tube.

All the patients who had accidental extubations during non-nursing procedures were on ventilator support and required re-intubation immediately.

5.4.2.16 Nurse location at time of unplanned extubation

Of the patients, 21 (36.8%) had the nurse at their bedside at the time of unplanned extubation; for 11 (19.3%) the nurses were not at their bedside, and for 25 (43.9%) the patients' records do not indicate where the nurse was when the unplanned extubations occurred. Figure 5.17 shows the location of the primary nurse at the time of unplanned extubation.
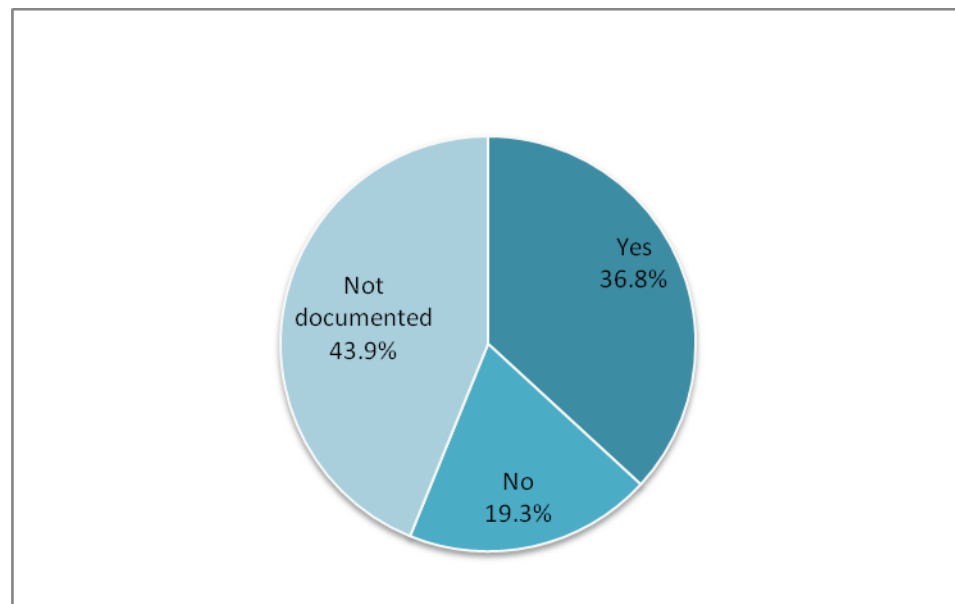
Figure 5.17 Nurse location at time of unplanned extubation (n=57)

Curry et al (2008:45) found that only 11.1% patients' nurses were present with them when unplanned extubation occurred; 40.7% patients' nurses were at the nurses' station; 40.7% patients' nurses were elsewhere in the unit, and in 14.8% cases the nurses' location was not known. Bouza et al (2007:270) found that of the patients, 41% had nurses at their bedside and 59% had no care giver at their bedside. Bhattacharya et al (2007:106) found that 75% of unplanned extubation, both self-deliberate and

accidental, were detected by resident doctors although it is not clear whether these doctors were at the patient's bedside during the incident.

The finding that the nurses' location was not known in 42% of the cases was higher than reported studies, although the 39% of nurses present at the patients' bedside is higher than Curry et al's (2008:45) 11.1% and is comparable to Bouza et al's (2007:270) finding.

5.4.2.17   Use of physical restraints

Of the patients, 17 (29.8%) were restrained, 26 (45.6%) were not restrained, and 14 (24.6%) had no data on restraints usage in their records. Figure 5.18 shows the use of physical restraints prior to unplanned extubation.
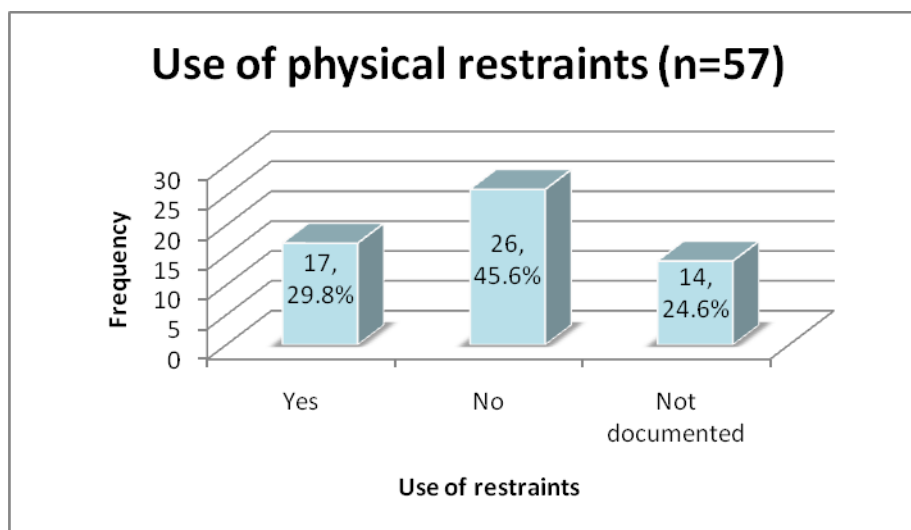
Figure 5.18   Use of physical restraints (n=57)

Curry et al (2008:47) found that 87% were restrained, and Yeh et al (2004:258) found that 61.9% were restrained.

In this study, of the patients who had unplanned extubations, 29.6% were physically restrained, which is lower than the reported studies, but the records of 24.6% did not indicate the use or not of restraints.

5.4.2.18 Patient's position

Regarding the position of the patients who had unplanned extubations, the findings indicated that 20 (35%) were in a supine position with the head of the bed elevated; 7 (12.3%) were lying on their right side; 8 (14%) were on their left side; 3 patients (5.3%) were in prone position, 5 patients (8.8%) were sitting out, and 14 patients(24.6%) position not indicated in the records of the patients (see figure 5.19).
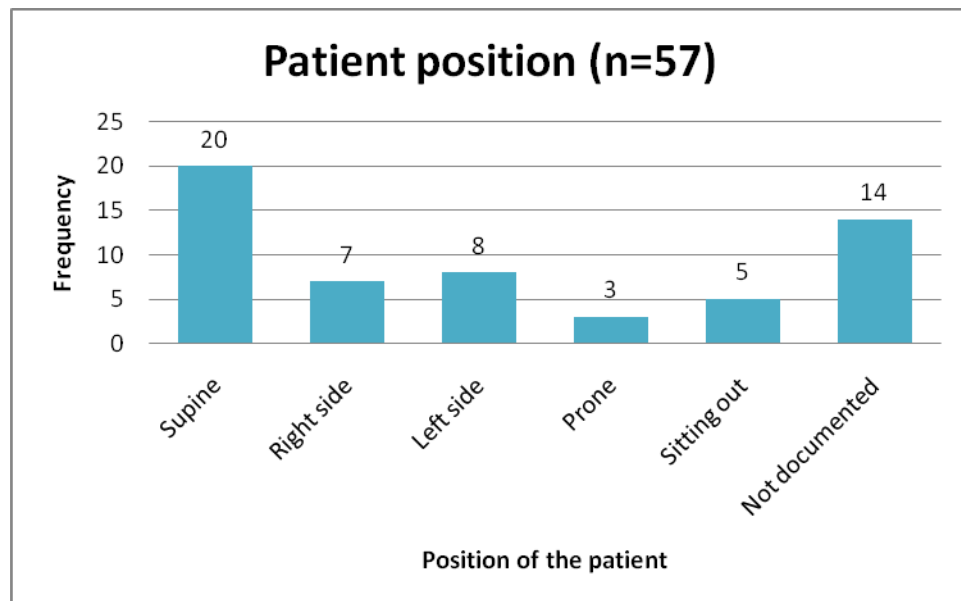
Figure 5.19 Patient's position (n=57)

Birkett et al (2005:69) found thatof the patients, 5.5% to 22.5% were sitting out on chairs in the first three surveys, but none in the later surveys; 4% to 61% were supine; 11.1% to 61.5% had the head of the bed elevated to 30°,and 17% to 50% on their side in all seven surveys.

The findings of this study are comparable to Birkett et al (2005:69,) but 24.6% data not recorded is high whereas Birkett et al (2005:69) found no records available only in the first survey but all records available in the later surveys.

5.4.2.19 Glascow Coma Scale (GCS)

Table 5.8 describes the GCS of patients who had unplanned extubation immediately after the incidence. The GCS is scored on the eye opening, best motor response and best verbal response.

Table 5.8   Glasgow Coma Scale prior to unplanned extubation (n=48)

Glascow Coma Scale	Frequency	%
Below 8	15	31.3
9-12	32	66.6
13-15	1	2.1

The data analysis revealed that 9 patients were younger than two or slightly above two years old as the GCS cannot score a paediatric patient under 2 on verbal response. Of the 57 patients who had unplanned extubation, only 48 were scored with the GCS.

The study found that of the patients, 15 (31.3%) scored below 8 on the GCS; 32 (66.6%) scored 9 to 12, and 1 (2.1%) scored 13 to 15 on the GCS.

On the GCS a score of 8 and below means that the patient is semiconscious; 9 to 12 means that the patient is both conscious and not well aware of the surroundings; 13 to 14 means that the patient is conscious but has one deficit: either confused, unable to respond to commands or cannot move limbs normally. A score of 15 means patient is conscious, oriented to time and space.

Of the patients in this study, 31.3% scored 8 meaning they were semiconscious; 66.6% scored 9 to 12 so were conscious and not well aware of their surroundings, and 2.1% were fully conscious, alert and oriented to time and space. The mean GCS was 9.64 and standard deviation 2.114.

Chiang et al (2008:408) found a mean GCS of 10.3. Moons et al (2004:1349) found a median GCS of 12.5 for patients who had self-deliberate extubations and a median of 7 for patients who had accidental extubations. Balon (2001:96) found that 33% were oriented and conversed well and 16% were disoriented. Tung et al (2001:26) found 22%

were alert and oriented while Yeh et al (2004:258) found 78.2% alert and 91.0% were communicating.

In this study, 66.6% were not well aware of their surroundings; 2.1% were oriented, and 31.3% were semiconscious. The mean GCS of 9.64 was lower than Chiang et al (2008:408) and Moon et al (2004:1349). In addition, the 31.3% who had GCS below 8 was higher than any reported study.

5.4.2.20   Ramsay Sedation Scale (RSS) prior to unplanned extubation

Of the patients, 48 had Ramsay Sedation Scale (RSS) scores and 9 were under the age of 2 years so were not scored (see figure 5.20).
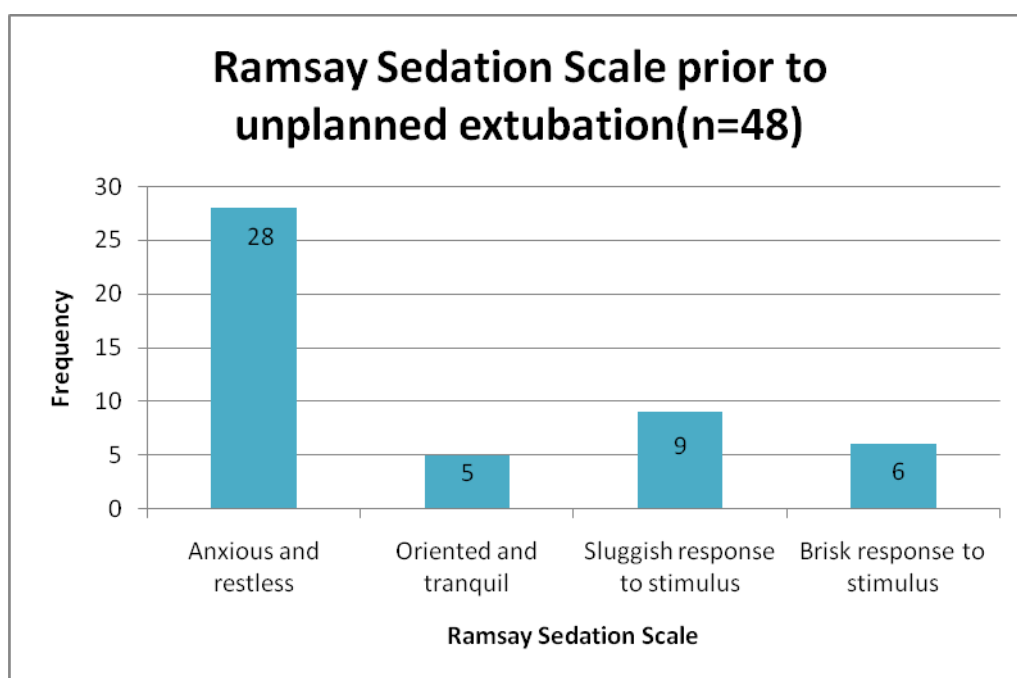
Figure 5.20   Patients' RSS scores (n=48)

According to the findings, 28 (49.1%) were anxious and restless; 5 (8.7%) were oriented and tranquil; 9 (15.8%) had a sluggish response to stimulus, and 6 (10.4%) had a brisk response to stimulus. Moreover, no patient scored 6 on the RSS, which indicates no response.

Curry et al (2008:47) found 19.2% anxious; 38.5% cooperative; 26.9% with a brisk response, and 3.8% with a sluggish response to glabellar tap. Yeh et al (2004:258)

found 65% were anxious; 78.2% were alert; 91% were communicating, and only 9% were not able to communicate. Balon (2001:9) found 40% were agitated and 75% were able to communicate prior to unplanned extubation.

Compared to the literature reviewed, this study found more patients anxious (56%). However, as this was a retrospective study, the data on patients' condition and alertness was subjective.

5.4.2.21 Chemical restraints

Chemical restraints are the use sedation, use of analgesic infusion and the use of neuro muscular blockade.

5.4.2.21.1   Use of sedation

Figure 5.21 describes the use of sedation prior to unplanned extubation. The sedation used in this study was Midalozam, which is a benzodiazepine.
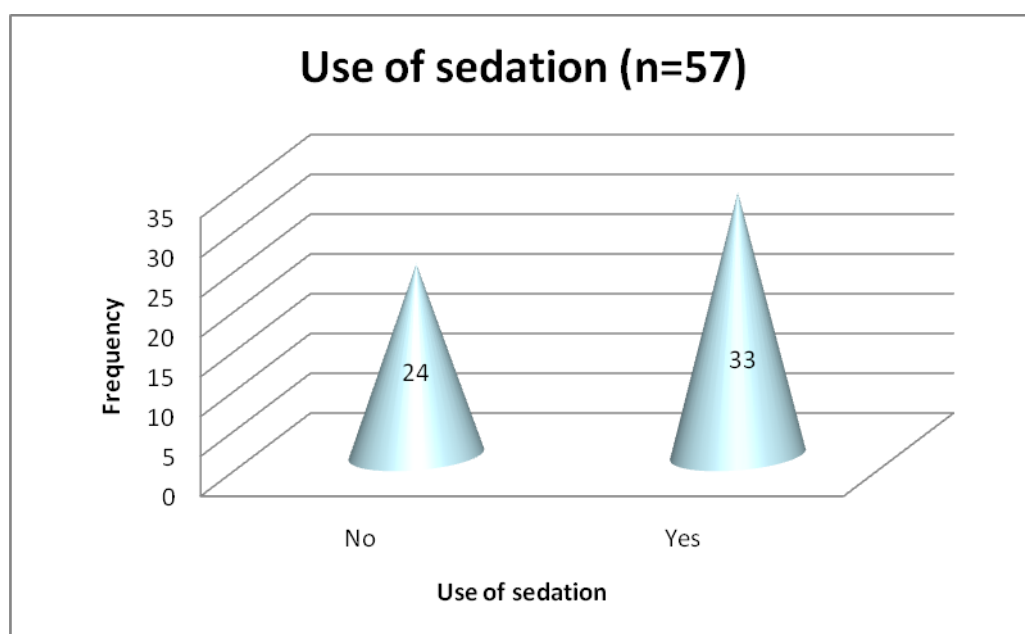
Figure 5.21   Use of sedation (n=59)

200

According to the findings, 24 (42.1%) were not sedated and 33 (57.9%) were on sedation when unplanned extubation occurred.

Curry et al (2008:49 found that 67.7% were sedated with fentanyl. Krayem et al (2006:71) found that 80% were sedated with midalozam prior to unplanned extubation.

Bouza et al (2007:272) found 29% were sedated. Yeh et al (2004:258) found only 6.25% were sedated. In their first five surveys, Birkett et al (2004:70) reported 43% to 55.5% were sedated with Midalozam whereas in the last two surveys only 14% to 17% were sedated with Midalozam. Sadowski et al (2004:630) revealed that 51% were on sedation prior to unplanned extubation. Tung et al (2001:26) found that 46% were sedated with Midalazom prior to unplanned extubation.

The findings of this study; 57.9% of patients were sedated with Midalozam is lower than Curry et al (2008:45) who reported 67.7% but is higher than of Birkett et al (2004:70) and Sadowski et al (2004:630) reported range of 17% to 55.5%.

5.4.2.21.2 Use of analgesia infusion

The study found that injection morphine was given via continuous infusion of 1 mg/min. Figure 5.22 shows the use of analgesics on patients who had unplanned extubation.
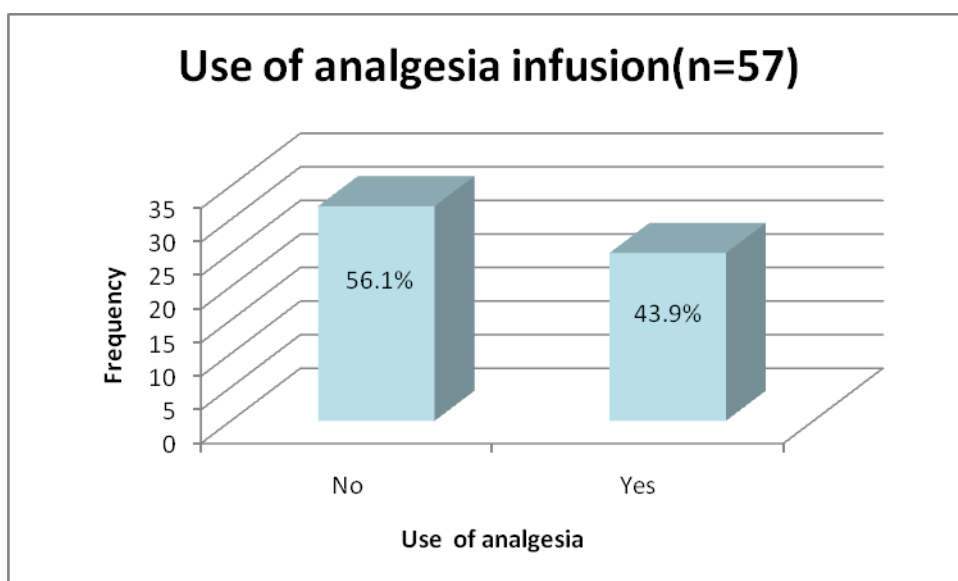
Figure 5.22 Use of analgesia infusion (n=57)

Figure 5.22 reveals that of the patients, 32 (56.1%) were not on analgesic infusion and 26 (43.9%) were receiving morphine 1mg/min via infusion pump.

Tung et al (2001:26) found 33% on morphine and 11% on meperidine. Balon et al (2001:97) found that 48% had morphine ranging from one- to four-hourly when necessary. Curry et al (2008:49) found 67.7% on fentanyl and 45.2% on propofol.

The finding that 43.9% received pain medication is comparable to Balon et al's (2001:97) as in both studies morphine was the drug used for pain management. In this study, however, morphine was used as continuous infusion while Balon et al (2001:97) found morphine usage only when necessary.

5.4.2.21.3   Use of neuromuscular blockade

Figure 5.23 shows the use of neuromuscular blockade pancuuronium, atracurium usage as paralytic agent prior to unplanned extubation.
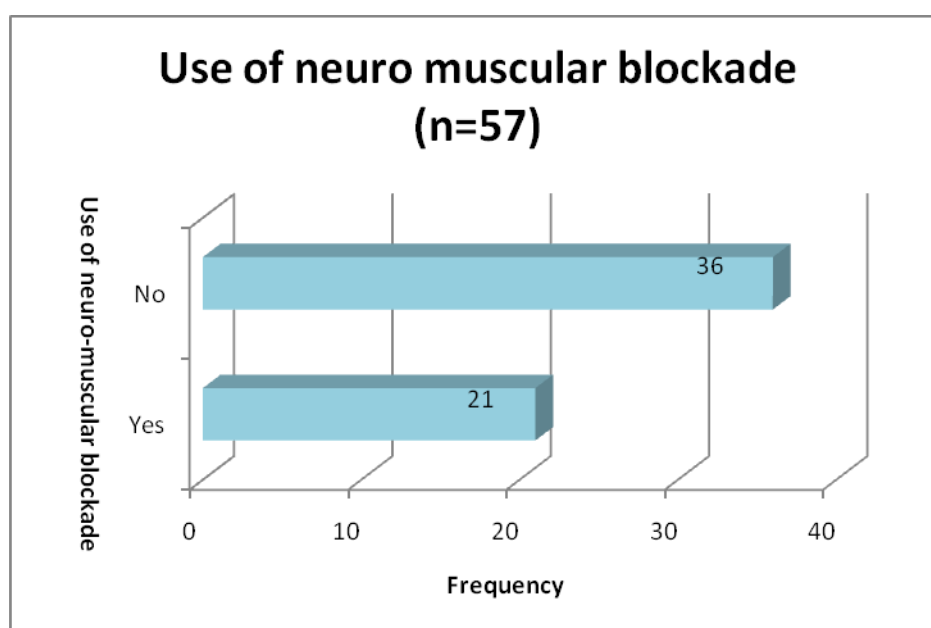
Figure 5.23   Use of neuromuscular blockade (n=57)

Of the patients, 21 (38.9%) were given neuromuscular blockade while 35 (63.1%) were not on any neuromuscular blockade at the time of unplanned extubation.

In the literature reviewed, Balon et al (2001:26) found that 9% who had self-extubation were on neuromuscular blockade. Tung et al (2001:26) indicated 46% on Fentanyl and 9% on neuromuscular blockade infusion.

The findings of this study of 38.9% of patients who were on neuromuscular blockade are comparable to Tung et al's (2001:26 finding).

5.4.2.22   Did patient require re-intubation?

Figure 5.24 shows the number of patients who required re-intubation after the unplanned extubation.
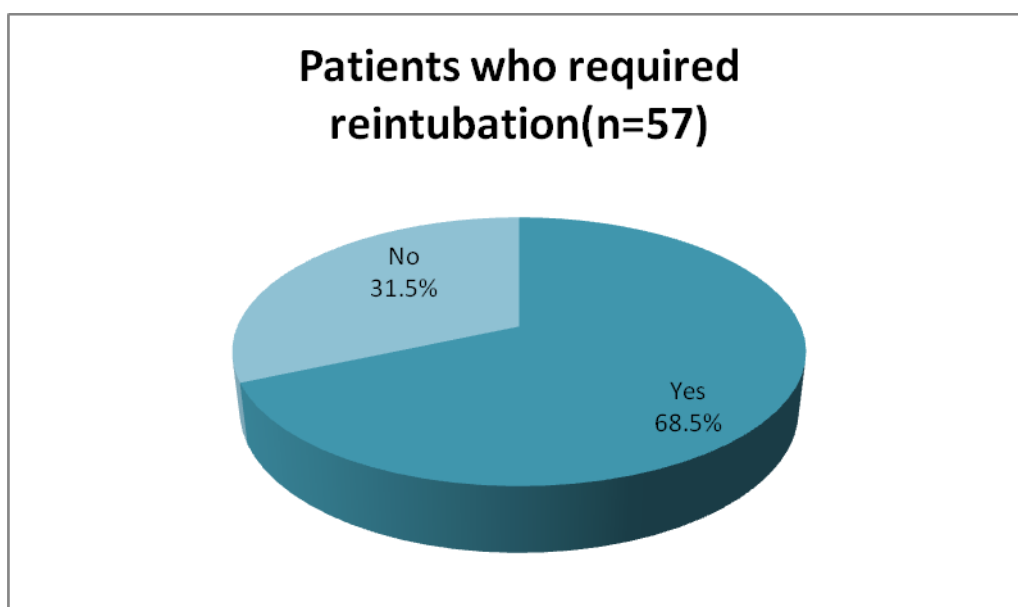
Figure 5.24   Patients who required re-intubation (n=57)

Of the patients, 39 (68.5%) required re-intubation and 18 (31.5%) did not require re-intubation after the unplanned extubation.

Further analysis of the results shown in table 5.9 revealed that 13 (56.5%) of self-deliberate unplanned extubations did not require re-intubation and 10 (43.5%) required re-intubation, versus 29 (85.3%) accidental extubations that required re-intubation compared to 5 (14.7%) who did not require re-intubation. Table 5.9 shows the comparison between self-deliberate and accidental extubations.

Table 5.9   Re-intubation: comparison between self-deliberate and accidental extubation (n=57)

	Self-deliberate (n=23)		Accidental(n=34)		Total unplanned extubation (n=57)	
Patient re-intubation	Frequency (n)	%	Frequency (n)	%	Frequency (n)	%
− Yes − No	10 13	43.5 56.5	29 5	85.3 14.7	39 18	68.5 31.5

In Curry et al's (2008:49) study, 48.38% of the self-deliberate unplanned extubation patients required to be re-intubated immediately. Bhattacharya et al (2007:107) found that 30.76% of self-deliberate extubations required re-intubation and 100% of accidental extubations required re-intubation.

Kinsley and Barone (2005:563) found that 44% required re-intubation within 48 hours of unplanned extubation. Moons et al (2004:1352) found that 57.7% required re-intubation within 48 hours of unplanned extubation.

Yeh et al (2004:260) found that 86.4% required re-intubation after accidental extubation and 41.2% of self-extubated patients required reintubation. According to Chatterjee et al (2004:39), 100% of patients who had accidental extubation required re-intubation.

Birkett et al (2004:714) found the re-intubation rate fluctuated between 15.5% and 52.6% over their seven-year survey of patients who had unplanned extubations and required re-intubation. Tung et al (2001:26) found that 74% of unplanned extubations required re-intubation.

The results of this study that 85.3% of accidental extubations and 43.5% of self-deliberate extubations required re-intubation is comparable with Yeh et al's (2004:260) finding that 86.4% of accidental extubations and 41.2% of self-deliberate extubations required re-intubation.

5.4.2.23 Time of re-intubation

The study examined the time of re-intubation (see figure 5.25).
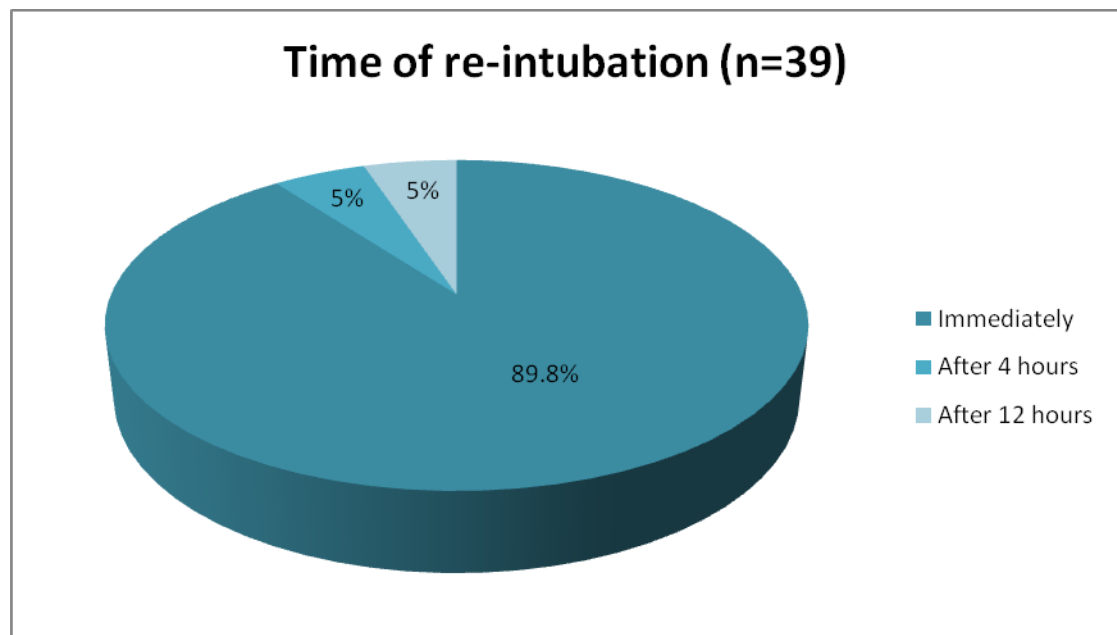
Figure 5.25 Time of re-intubation (n=39)

The study found that of the patients, 35 (89.8%) required re-intubation immediately; 2 (5.1%) required re-intubation after 4 hours, and 2 (5.1%) required re-intubation after 12 hours.

Further analysis indicated that of the patients, 29 (85.3%) were re-intubated immediately; of the 10 (25.6%) who had self-deliberate extubation, 6 (10.5%) required re-intubation immediately; 2 (5.1%) were re-intubated after 4 hours, and 2 (5.1%) after 12 hours.

Kinsley et al (2005:563) found that 44% required re-intubation within 48 hours of unplanned extubation. Moons et al (2004:1352) found that 57.7% required re-intubation within 48 hours of unplanned extubation.

Moreover, Curry et al (2008:45), Bhattacharya et al (2007:106) and Chatterjee et al 2004:37) did not use timing of re-intubation as a variable.

5.4.2.24 Complications within 6 hours of unplanned extubation

The complications occurring within six hours of extubation were examined and analysed (see figure 5.26 and table 5.10).
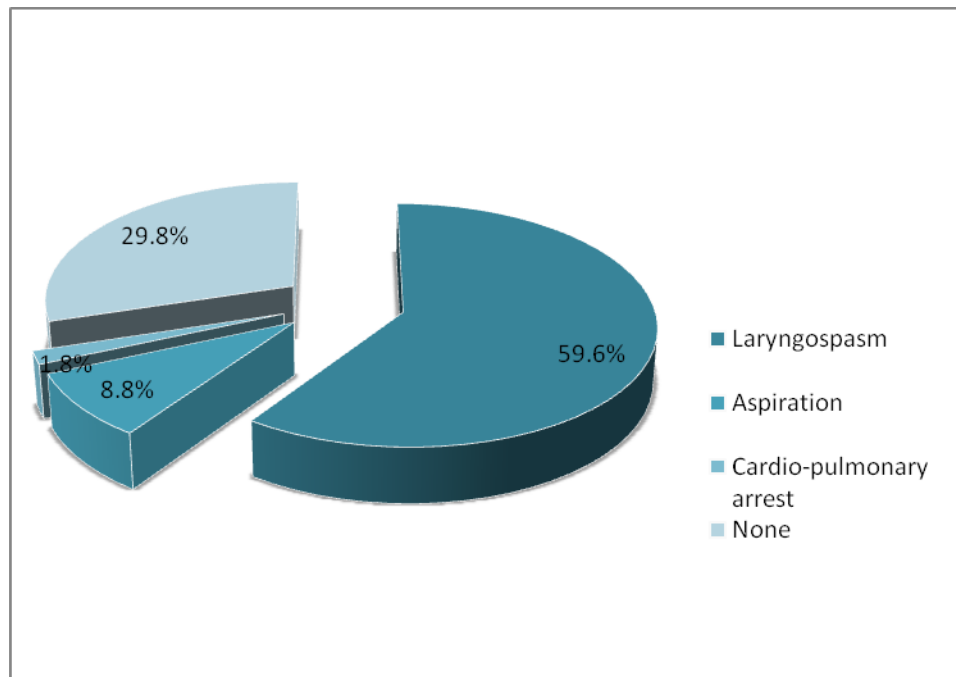
Figure 5.26 Complications within 6 hours of unplanned extubation (n=57)

The results indicated that of the patients, 34 (59.6%) had laryngospasm; 5 (8.8%) had aspiration; 1 (1.8%) had cardiopulmonary arrest during re-intubation, was successfully resuscitated but died after 24 hours, and 17 (29.8%) had no complications (see figure 5.26 and table 5.10).

Table 5.10   Complications within 6 hours after unplanned extubation (n=57)

Complications	Self-deliberate extubation (n=23)		Accidental extubation (n=34)		Total unplanned extubation (n=57)	
	Frequency (n)	%	Frequency (n)	%	Frequency (n)	%
Laryngospasm	10	43.5	24	70.6	34	59.6
Aspiration	0	0	5	14.7	5	8.8
Laryngeal oedema	0	0	0	0	0	0
Cardio-pulmonary arrest	0	0	1	2.9	1	1.8
Death	0	0	0	0	0	0
None	13	56.5	4	11.8	17	29.8
Total	23	100	34	100	57	100

Table 5.10 shows the complication frequency in self-deliberate and accidental extubation.

Further analysis revealed that of the patients, 10 (43.5%) with self-deliberate extubation had laryngospasm and 24 (70. 5%) of accidental extubation had laryngospasm; 5 (14.7%) who had accidental extubation had aspiration within 6 hours of unplanned extubation, 1 (2.9%) suffered cardiopulmonary arrest during re-intubation, was successfully resuscitated but died 24 hours later, and 17 (29.8%) had no complications.

Bhattacharya et al (2007:106) found that 69.2% who self-extubated had transient desaturation, 30.7% were hypoventilating, and 7.6% had bradycardia. Furthermore, that patients who had accidental extubation had multiple complications: 50% had hypoventilation, respiratory arrest and bradycardia, 16.6% had cardiac arrest, and 16.6% had aspiration.

Moons et al (2004:1349) reports that 7.7% of patients had laryngeal oedema and 3.8% had aspiration pneumonia. Chatterjee et al (2004:37) found complications in three

categories: 87.2% were minor, 10.9% were moderate, and 1.8% suffered cardiac arrest due to hypoxia. De Lassence et al (2002:148) found that 34.7% of unplanned extubation patients developed nosocomial pneumonia.

All the above studies reviewed were prospective whereas this study was retrospective. The finding that 68.4% of total unplanned extubated patients had complications within 6 hours of unplanned extubation was lower than Bhattacharya et al (2007:106) and Chatterjee et al (2004:37), but higher than Moons et al (2004:1349).The finding that 1.8% had cardiopulmonary arrest was comparable to Bhattacharya et al (2007:106) and Chatterjee et al (2004:37).

5.4.2.25 Patients' outcomes

Regarding the patient outcomes after unplanned extubation, the study found that of the patients, 33 (57.9%) were discharged from the ICU; 21 (36.8%) died in the ICU, and 3 (5.3%) were transferred to other hospitals in Nairobi. One patient who had accidental extubation suffered cardiac arrest during re-intubation and died 24 hours later (see figure 5.27).
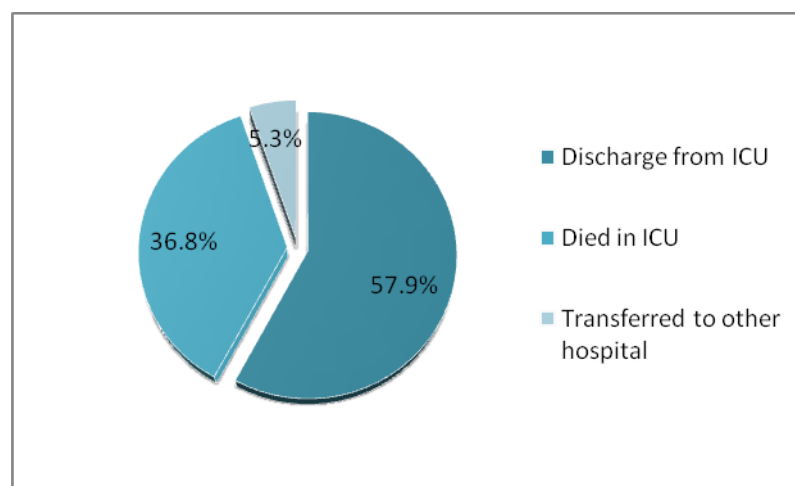
Figure 5.27 Patients' final outcomes

Chatterjee et al (2004:36) found one patient who had self-deliberate extubation suffered cardiac arrest due to hypoxia. Kapadia et al (2000:673) found that one patient had the tracheostomy tube partially displaced and suffered cardiac arrest, resuscitation was not successful and the patient died.

No other study reviewed had final outcome as one of their variables.

5.4.2.26   Total days' intubated: patients who had unplanned extubation

Table 5.11 shows the total days patients who had unplanned extubation were intubated for.

Table 5.11   Total days intubated: patients who had unplanned extubation (n=57)

Age	F	x^1	Fx^1	%
1.5	15	3	45	26.3
6-10	20	8	160	35.1
11-15	10	13	130	17.5
16-20	8	18	144	14
21-25	3	23	69	5.3
26-30	1	28	28	1.8
Total	57		576	100

$$\text{Mean} = \frac{\Sigma fx^1}{N} = \frac{576}{57} = 10.1 \text{ days}$$

The findings indicate that of the patients, 15 (26.3%) required total intubation for 1-5 days, 20 (35.1%) for 6-10 days, 10 (17.5%) for 11-15 days, 8 (14%) for 16-20 days, 3 (5.3%) for 21-25 days, and 1 (1.8%) was intubated for 28 days; the mean days of intubation was 10.1 days.

These findings indicate that the patients who had unplanned extubation required a longer period on intubation and ventilation (10.1days) compared to the mean days of all the patients who required intubation (7.2 days) (see table 5.3).

Epstein et al (2000:1916) found that unplanned extubation patients required an additional 14.3 to 15.2 days of ventilator support. Chang et al (2008:412) found that patients who had restraints and unplanned extubation required a mean of 16.8 days of intubation compared to 14.9 mean days for patients who had no physical restraints and had unplanned extubation.

This study finding reports lower total days of intubation required by the patients who had unplanned extubation than both Epstein et al (2000:1916)14.3-15.2 days and Chang et al (2008:418) 14.9-16.8 days.

5.4.3 Section C: Nursing staff

This section discusses the data analysis and interpretation of number of patients the nurse was responsible for, the nurse's qualification and years of experience both as nurse and in the ICU.

5.4.3.1 Nurse-patient ratio: how many patients was the nurse responsible for during the shift?

The study found that in the case of 29 (50.9%) patients, the nurse-patient ratio was 1:1 and with 28 (49.1%) patients, the ratio was 1:2. Figure 5.28 shows the number of patients the primary nurse was responsible for at the time of unplanned extubation.
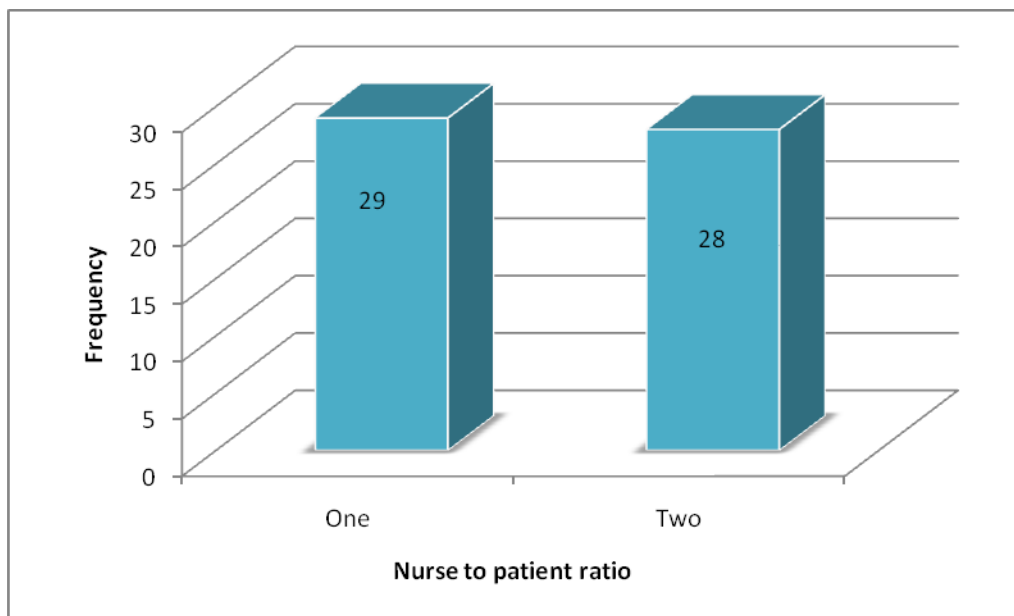
Figure 5.28 Nurse-patient ratio (n=57)

From figure 5.28 it is clear that of the nurses, 50.9% had one patient and 49.1% had 2 patients at the time unplanned extubation occurred.

Table 5.12 shows the comparisons of the nurse-to-patient ratio between self-deliberate and accidental extubation.

Table 5.12 Number of patients nurse responsible for when patient had unplanned extubation (n=57)

No of patients	Self-deliberate extubation (n=23)		Accidental extubation (n=34)		Total unplanned extubation (n=57)	
	Frequency (n)	%	Frequency (n)	%	Frequency (n)	%
1	10	43.5	19	55.9	29	50.9
2	13	56.5	15	44.1	28	49.1
Total	23	100	34	100	57	100

Table 5.12 indicates that for 29 (50.9%) patients the nurse was responsible for one patient, and for 28 (49.1%) patients, the nurse had two patients allocated when unplanned extubation occurred.

In their study, Bhattarcharya et al (2007:107) found the patient-to-nurse ratio varied between 1:2 patients and 1:5 patients, with the least usually nurses being on the night shift. Chatterjee et al (2004:39) also found that, depending on the time of shift, the nurse-to-patient ratio varied between I:2 and 1:4. Moons et al (2004:1351) found a nurse-to-patient ratio of I:2 during unplanned extubation.

The findings of this study of a 50.9% nurse-to-patient ratio of 1:1 and a 49.1% ratio of 1:2 cannot be compared to other studies as the ratios were different and an equal number of unplanned extubations occurred regardless of the nurse-to-patient ratio.

5.4.3.2 *Qualifications of nurse responsible for patient who had unplanned extubation*

Figure 5.29 shows the highest nursing qualifications of the nurse responsible for the patient who had unplanned extubation.
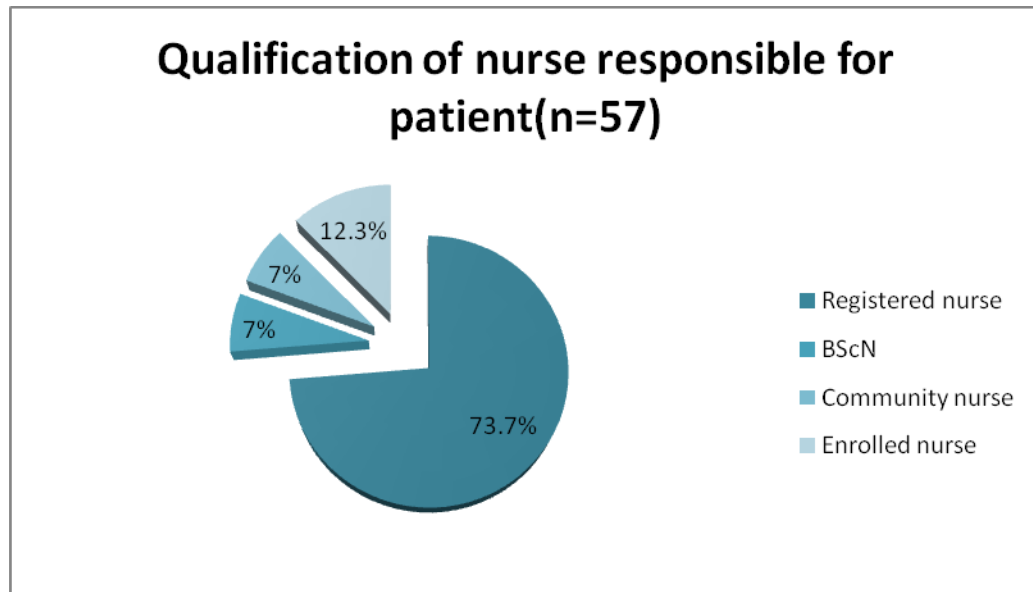
Figure 5.29 Qualification of nurse responsible for patient   (n=57)

Regarding the highest qualifications of the nurses responsible, the study found that of the nurses 42 (73.7%) were registered nurses with diploma; 4 (7%) held Baccalaureate of Science in Nursing (BScN) degrees; 4 (7%) were registered community nurses, and 7 (12.3%) were enrolled community nurses.

In literature reviewed, only Curry et al (2008:48) included the nurses' qualifications as a variable and found that 6.9% had a diploma in nursing; 52% held a BScN, and 41.6% had associated degrees.

The findings of this study are unique and cannot be compared to any other studies as the nurses' qualifications differed and it was not a variable in the literature reviewed.

5.4.3.3 Nurse responsible formal training in critical care

Figure 5.30 shows the number of nurses who had formal training in critical care nursing when the unplanned extubation occurred.
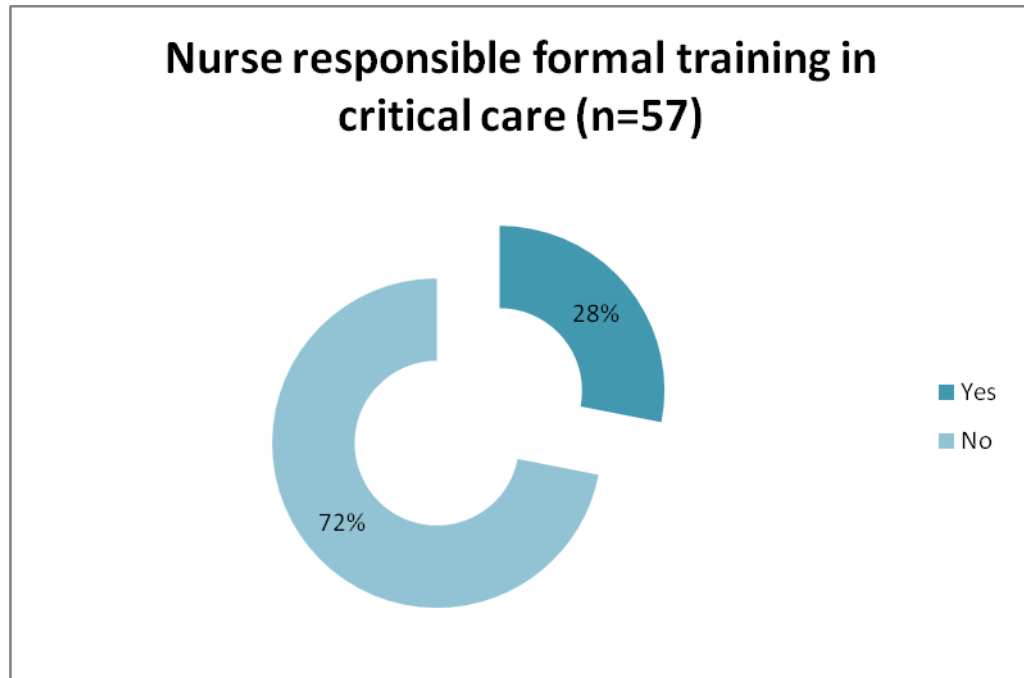
Figure 5.30   Responsible nurse's formal training in critical care (n=57)

The study found that of the nurses, 41 (72%) had no formal training in critical care nursing and 16 (28%) had formal training in critical care nursing when the unplanned extubation occurred.

The researcher found no literature that measured formal training in critical care as one of the variables. Therefore the findings of this study are unique.

5.4.3.4 How many years' experience does the nurse have in nursing?

Figure 5.31 shows the nursing experience of the nurse responsible for the patient who had unplanned extubation.
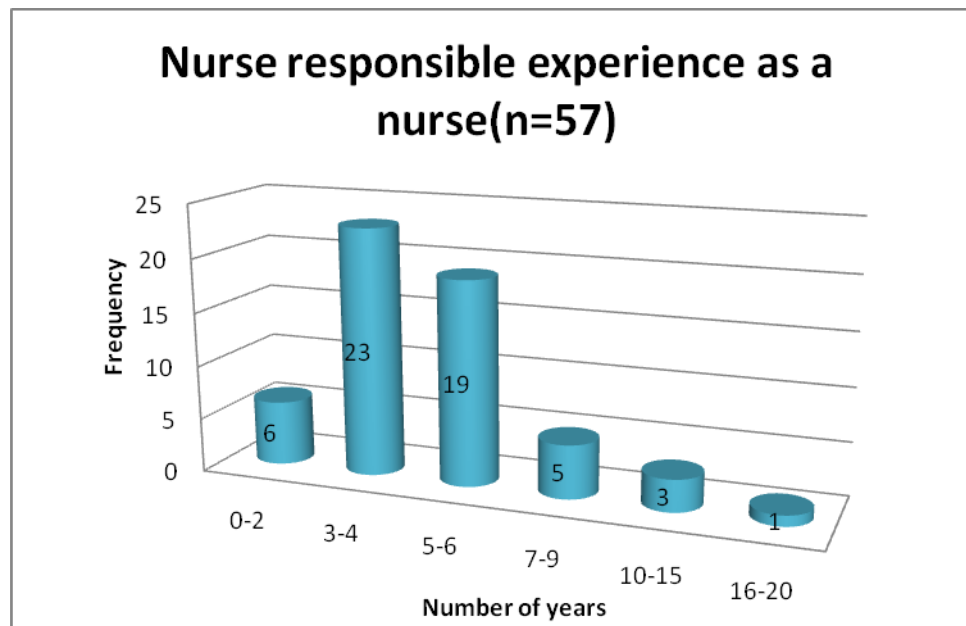
Figure 5.31   Nursing experience of nurse responsible (n=57).

The study found that of the nurses, 6 (10.5%) had less than 2 years' experience; 23 (40.3%) had 3-4 years' experience; 19 (33.3%) had 5-6 years' experience; 5 (8.8%) had 7-9 years' experience; 3 (5.3%) had 10-15 years' experience and 1 (1.8%) had 16-20 years' experience. The mean years of experience was 2.69 years with a standard deviation of 1.052.

Further analysis using the Benner model of nursing to group the nurses revealed that 10.5% were novices, 40.3% were advanced beginners, 33.3% were competent, 5.3% were proficient, and 1.8% were expert (Benner et al 2004:188).

Regarding their experience, Curry et al (2008:45) found that 32.3% had 0-4 years' experience; 29% had 5-9 years' experience, and 38.8% had more than 10 years' experience. Yeh et al (2004:257) found that 24.8% had less than 2 years' experience; 72.9% had 2-4 years' experience, and 2.3% had more than 4 years' experience.

Marcin et al (2005:254) found that the nurses responsible for the patients who had unplanned extubation had 7.8 years' experience and those responsible for the control patients had 7 years' experience.

The study found that of the nurses, 48 (84.2%) had 0-6 years' experience and 9 (15.8%) had over 7 years' experience. In this study nurses who had less than 10 years' experience had more incidents of unplanned extubation (93%) compared to Curry et al's (2008:45) finding of 61.3% incidents with nurses who had less than 10 years' experience.

However in this study the nurses who had more than 10 years' experience (6.7%) had lower incidents of unplanned extubation than Curry et al (2008:45) who reported 38.3% incidents with nurses with more than 10 years' experience.

5.4.3.5 *Nurse responsible experience as a nurse in ICU*

Figure 5.32 shows the ICU experience of the nurse responsible.
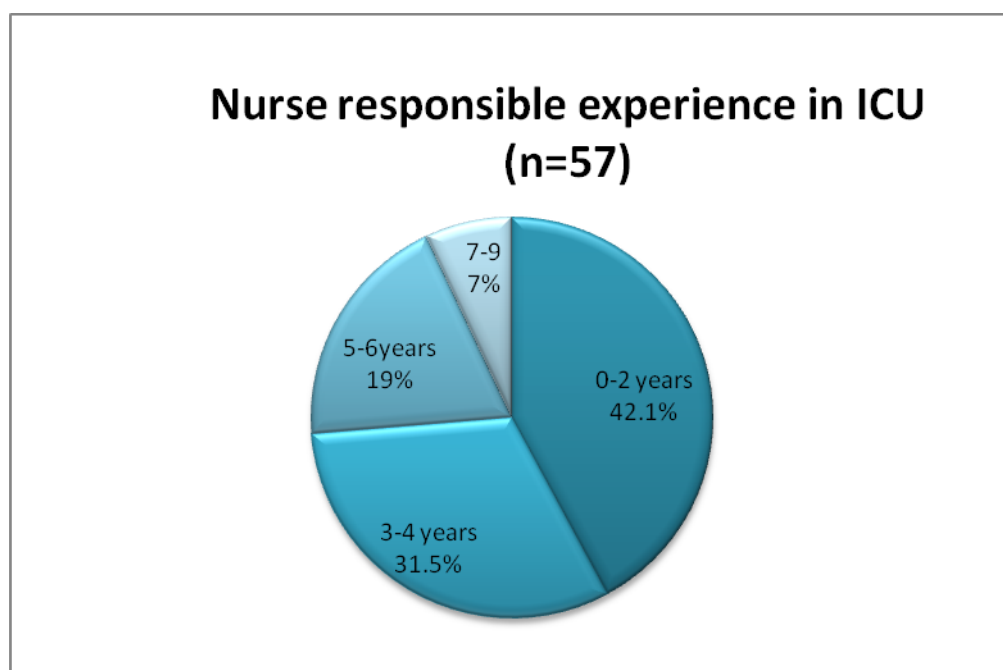
Figure 5.32 ICU experience of nurse responsible (n=57)

Of the nurses in this study, 24 (42.1%) had less than 2 years' experience in ICU; 18 (31.5%) had 3-4 years' experience in ICU, and 15 (26.3%) had more than 5 years' experience in ICU, caring for patients who had unplanned extubation. The mean years of ICU experience was 1.96 years and a standard deviation of 1.105.

Chang et al (2008:408) found that nurses in ICU had more than 2 years' experience and a mean of 4.85 years' experience. Curry et al (2008:48) found that 51.6% of nurses had less than 5 years of ICU experience.

In this study the nurses (74%) responsible for patients who had unplanned extubation who had less than 5 years' experience was more than Curry et al (2008:48) who found 51.6%.

According to AACN Synergy Model for Patient Care this section is the characteristics or competence of nurse which should match with the needs of the patients for safe patient outcomes. The competencies required by the nurse are clinical judgment, advocacy and moral agent, caring practices, clinical inquiry, system thinking, collaboration, response to diversity and facilitator of learning. The nurse acquires more skills, competences and knowledge with clinical experiences.

5.5 OVERVIEW OF RESEARCH FINDINGS

The findings of this study that the highest education received by nurse responsible for patient who had unplanned extubation; 42 nurses (73.7%) were registered nurse with diploma, 4 nurses (7%) with Baccalaureate of Science in nursing (BScN), 4 nurses (7%) were registered community nurse and 7 nurses (12.3%) were enrolled community(figure 5.29).

This study was conducted over a period of 327 ventilated patients and 2350 ventilated days (table 5.3), 57 unplanned extubation (figure 5.6), rate of 17.4% with incidence density of 2.42/100 ventilated days. Both the rate and the incidence density is higher than reported studies(Bouza et al 2007:270; Chang et al 2008:408; Krayem et al 2006:71; Krinsley & Barone et al 2005:65; Marcin et al 2005:254; Moons et al 2004:1349; Phoa et al 2002:504; Sadowski et al 2004:628).

The incidence rate of this study is lower than Yeh et al (2004:257) who reports rate of 22.5% and Balon et al (2001:93) who reports a rate of 35.8% per 100 ventilated days.

5.5.1 Prevalence of unplanned extubation

The prevalence of unplanned extubation was 0.175 (95% confidence interval 0.134-0.216). Among the patient with unplanned extubation the prevalence were as shown in table 5.13.

Table 5.13   Prevalence of unplanned extubation

How unplanned extubation occurred	Prevalence	95% confidence interval
How extubation occurred Self-deliberate extubation Accidental extubation	0.414 0.586	(0.283, 0.544) (0.456, 0.717)

5.5.2 Mean, median, mode standard deviation and variance of total days intubated

Table 5.14 shows the mean, mode, standard deviation and variance of total days intubated of patients who had unplanned extubation; for self-deliberate extubation and accidental extubation.

Table 5.14   Mean, median, mode, standard deviation and variance of total days intubated (n=57)

Days intubated	Self –deliberate extubation(n=23)	Accidental extubation (n=34)	Total (n=57)
Mean	8.2	10.7	10.1
Median	7.0	8.0	7
Mode	7.0	4.0	7
Standard deviation	5.9	6.6	6.4
Variance	34.8	42.9	40.6

As per the findings the patients who had self-deliberate extubation the mean days of total days intubated was 8.2 days which is lower than the means days of 10.7 days by a patient who had accidental extubation.

5.5.3 Pearson chi-square of total days intubated and days intubated prior to unplanned extubation

Table 5.15 shows the Pearson chi-square of total days intubated and days intubated prior to unplanned extubation.

Table 5.15   Pearson chi-square of total days intubated and days intubated before unplanned extubation (n=57)

Characteristics	How the tube came out						p-value
	Deliberate		Accidental		Total		
	Frequency (n=23)	%	Frequency (n=34)	%	Frequency (n=57)	%	
Total day intubated							
− 0-5	7	30.4	8	23.5	15	27.6	0.297
− 6-10	12	52.2	11	32.4	23	40.4	
− 11-15	2	8.7	5	14.7	7	12.3	
− >15	2	8.7	10	29.4	12	20.7	
Days intubated before unplanned extubation							
− 0-5	15	65.2	24	70.6	39	68.4	0.209
− 6-10	7	30.4	7	20.6	14	24.6	
− 11-15	1	4.3	2	5.9	3	5.2	
− >15	0	0.0	3	8.8	3	5.2	

Table 5.15 shows the p value of the total days intubated for patients who had self-deliberate unplanned extubation and the accidental extubation. p-value of less than <0.5 is statistically significant. The total days intubated p-value is <0.297 and is statistically not significant, the total days before unplanned extubation occurred p-value is < 0.209 is not statistically significant with both self-deliberate and accidental extubation.

5.5.4 Pearson chi-square of GCS and RSS

Table 5.16 shows the GCS of the patients who had unplanned extubation.

Table 5.16   Pearson chi-square of Glasgow Coma Scale and Ramsay Sedation Scale

Characteristics Type of restraint	How the tube came out				Total		p-value
	Deliberate		Accidental				
Glasgow Coma Scale(GCS)	Frequency (n=20)	%	Frequency (n=28)	%	Frequency (n=48)	%	
<8 9-12 13-15	0 19 1	0 95 5	15 13 0	53.6 46.4 0	15 32 1	31.3 66.6 2.1	0.022
Ramsay Sedation Scale (RSS)	Frequency (n=10)	%	Frequency (n=23)	%	Frequency (n=33)	%	
Anxious and restless cooperative, oriented and tranquil Responding to commands only Sluggish response to stimulus Brisk response to stimulus	9 1 0 0 0	90 10 0 0 0	7 0 5 7 4	30.4 0 21.7 25 17.4	16 1 5 7 4	48.5 3 15.2 21.2 12.1	0.049

In this study, the GCS; p-value of < 0.022 and RSS p-value of <0.049 are both statistically significant.

5.5.5 Pearson's chi-square of use of physical/chemical restraints

Table 5.17 shows the use of physical/chemical restraints on patients who had self-deliberate and accidental extubation.

Table 5.17   Pearson's chi-square of use of physical and chemical restraints

Characteristics Type of restraint	How the tube came out				Total		p-value
	Deliberate		Accidental				
Use of physical restraints	Frequency (n=23)	%	Frequency (n=34)	%	Frequency (n=57)	%	
− No − Yes − Not documented	9 7 7	39.1 30.4 30.4	17 10 7	50.0 29.4 20.6	26 17 14	45.6 29.8 24.6	0.000
Use of sedation Use of analgesic infusion Use of neuromuscular blockade	10 9 3	43.5 39.1 13.0	23 16 18	67.4 47.0 52.9	33 25 21	57.9 43.9 36.8	0.080 0.041 0.002

The study found a p-value of 0.080 for use of sedation and p-value of <0.041for use of analgesic infusion, both statistically not significant. However, use of physical restraints had a p-value of <0.000 and neuromuscular blockade had a p-value of <0.002, which was less than <0.05, and were statistically significant.

5.5.6 Patient's characteristics

According to the ACCN Synergy Model for Patient Care used as conceptual framework for this study the patients' characteristics need to match the competences/ characteristics of nurse and those of the health care system in order to synergise and have safe outcomes.

The patient's characteristics identified in this study were the underlying illness, type of intubation, mode of ventilator support, position of patient, type of incidence: self-deliberate and accidental extubation, how the tube came out, presence of nurse, RSS, GCS, use of physical and chemical restraints; use of sedation, analgesia, and neuro-muscular blockade. Rate of re-intubation, complications and outcome of patient will also be discussed.

A total of 950 patients were admitted during the study period: from 1 January 2006 to 31 December 2007. Of these patients, 357 were intubated; 10 were used for pre-testing the clinical audit tool; 30 were excluded as they did not meet the inclusive criteria of being intubated for more than 6 hours, and 10 patients' files missing from the medical records department (see figure 5.1). The age of intubated patients ranged from 3 months to 90 years with a mean age of 47.5 years (see figure 5.2, table 5.2). Of the patients, 65.1% were males and 34.9% were females (see figure 5.3); 69.7% were admitted with medical illness; 9.8% after surgery; 19% after trauma, and 1.5% with gynaecological/obstetric illness (see figure 5.4). Of the patients, 97% were intubated orally and 3% were intubated nasally (see figure 5.5), with a total of 2 350 days of intubation and a mean of 7.2 days (see table 5.3).

A total of 57 patients had unplanned extubation (see figure 5.6); the mean age of the patients was 43.5 years (see table 5.4) with a range of 3 months to 88 years (see figure 5.7). Of these, 80.7% were adult and 19.3% were paediatric patients (see figure 5.8); 70.1% were males and 29.9% were females (see figure 5.9). Of the patients, 68.4%

were admitted with medical illness; 17.5% with surgical illness; 12.3% with trauma, and 1.8% with gynaecological/obstetric illness (see figure 5.10); 91.2% had orotracheal intubation and 8.8% had nasal intubation (see figure 5.11), 43.9% had unplanned extubation on day shift and 56.1% had unplanned extubation on night shift (see figure 5.12).

Days intubated prior to unplanned extubation ranged from 1 to 20 days with a mean of 5.8 days; 87.7% had unplanned extubation during the first ten days of intubation (see table 5.5). In this study, no patients with tracheostomy had unplanned extubation. Weaning process commenced on 10.5% of the patients on the day of unplanned extubation (see figure 5.13); 1.8% were on SIMV mode of ventilation; 22.8% were on volume control; 68.4% were on pressure control mode of ventilation, and 7% were on t-piece at the time of unplanned extubation (figure 5.14)

Of the patients, 23 (40.4%) had self-deliberate unplanned extubation and 34 (59.7%) had accidental extubation (see figure 5.15). Of those who self-deliberate extubated, 47.8% coughed the tube out and 52.2% pulled the tube out (see figure 5.16). Accidental extubation during nursing procedure occurred as follows: 30% while changing patients' position; 10% while changing tapes securing the tube; 3.3% while wheeling patient to x-ray department; 30% due to blocked tubes, and 26.7% due to tube cuffs leaking (see table 5.6). Balon et al (2001:93) found that 64% pulled the tube out with their hands and 5.3% coughed the tube out (see table 5.7).

Of the patients, 4 (7%) had unplanned extubation during non-nursing related procedures such as portable chest x-ray, central line insertion, and small diameter endotracheal tube (see table 5.8). The finding of 57.6% accidental extubation is higher than reported in the literature reviewed. Curry et al (2008:45), Yeh et al (2004:257), Moon et al (2004:1349) and Mpe et al (2004:16) reported more self-deliberate extubation than accidental extubation.

It was of concern that 15.8% of the accidental extubations during changing position and 5.3% during change of endotracheal tapes and needs further investigation (see table 5.9). Further analysis of unplanned extubation revealed that 15.8% was due to blocked tubes and 14% due to leaking cuffs. Heat-moisture exchange filters were used in this

ICU and the finding of blocked tubes requires further investigation as does the incidental finding of leaking cuffs (see table 5.9).

The study found that of the patients, 21 (36.8%) had a nurse at the bedside; 11 (19.3%) did not have nurses with the, and 25 (43.9%) had no documented nurses' location (see figure 5.17). The finding that 36.8% had a nurse present at the bedside was lower than Sadowski et al's (2004:630) finding; comparable to Bouza et al's (2007:270) finding, and higher than Curry et al's (2008:45) finding of 11.1%. There is a need to investigate the nurses' documentation process.

Of the patients, 17 (29.8%) were restrained; 26 (45.6%) were not restrained, and 14 (24.6%) had no record of restraints usage (see figure 5.18). There is a need to investigate why 43.9% of patients' notes did not reflect the physical restraints usage.

Unplanned extubation occurred when 20 (35%) were in a supine position with the head of the bed elevated; 7 (12.3%) were lying on their right side; 8 (14%) were on their left side; 3 (5.3%) were in a prone position; 5 (8.8%) were sitting out, and the records of 14 (24.6%) did not indicate the position (see figure 5.19). The findings of the patients' position were comparable to Birkett et al (2005:69). The 24.6% of incomplete documentation needs further investigation.

Of the patients, 31.3% had a score below 8 on the GCS; 66.6% were conscious and not well aware of the surroundings, and 2.1% were oriented to time and space (see table 5.10). This finding indicates that 68% were conscious and could communicate. The RSS indicated that 48.5% were anxious and restless; 15.2% responded to commands; 21.2% had a sluggish response, and 12.1% had a brisk response (see figure 5.20). Yeh et al (2004:258) found that 56% were anxious, 78.2% were alert, and 91% could communicate. The findings of this study were comparable to those of Curry et al (2008:45), Balon et al (2001:93), and Yeh et al (2004:258).

Chemical restraints were used in this study. The use of sedation indicated that 42.1% patients were not sedated and 57.9% were on sedation when unplanned extubation occurred (see figure 5.21). Of the patients, 43.9% were on analgesic infusion (see figure 5.22) and 38.9% were on neuromuscular blockade (see figure 5.23). The findings indicated further that of the patients, 43% to 60% were not on any sedation, analgesic

infusion and neuromuscular blockade when they had unplanned extubation. The findings of use of chemical restraints is comparable to literature reviewed(Balon et al 2001:97; Curry et al 2008:48; Sadowski et al 2004:630; Tung et al 2001:26).

Of the patients, 68.5% required re-intubation and 31.5% did not require re-intubation after unplanned extubation (see figure 5.24). Various studies reviewed found that 30.6% to 67% required re-intubation (Bhattacharya et al 2007:107; Curry et al 2008:48; Kinsley & Barone 2005:563; Moon et al 2004:1352). The finding that 89.8% patients required re-intubation immediately (see figure 5.25) was unique since only Kinsley and Barone (2005:563) and Moons et al (2004:1352) used re-intubation (within 48 hours) as a variable.

The study found that of the patients, 70.1% had immediate complications; 58% had laryngospasm; 8% had aspiration; 1.8% had cardiopulmonary arrest during re-intubation, was successfully resuscitated but died after 24 hours, and 29.8% had no complications (see figure 5.26). A comparison revealed that 87.1% of the accidentally extubated patients had complications compared to 43.7% of the self-deliberate extubated patients (see table 5.11). The finding that 68.4% of unplanned extubated patients had complications within 6 hours of unplanned extubation was lower than that reported by Bhattacharya et al (2007:106) and Chatterjee et al (2004:37), but higher than Moons et al (2004:1349). Bhattacharya et al (2007:106), Chatterjee et al (2004:37) and Kapadia et al (2000:673) found that one patient suffered cardiac arrest after unplanned extubation.

Regarding the patient outcome following unplanned extubation, the study found that of the patients, 57.9% were discharged from ICU; 36.8% died in the ICU, and 5.3% were transferred to another hospital for further management (see figure 5.27). In the literature review, only Krinsley and Barone (2005:564) reported that 50% who had unplanned extubation were discharged home; 25% were sent to skilled nursing homes; 13.8% to rehabilitation or psychiatric units, and 11.3% were transferred to another hospital. The mean of intubation was 10.1 days (see table 5.11).

5.5.7 Nurse's characteristics

According to the AACN Synergy Model for Patient Care, the nurse's characteristics or competences are most important to meet the needs of the patient and in the right health care environment can synergise and have positive patient outcomes.

This study identified the characteristics of nurse-to-patient ratio, nursing education both in nursing and critical care, and years of experience as a nurse and in the ICU. The ICU in the selected hospital in Nairobi groups the nurses according to the clinical experience, therefore it was important to identify the nurse's characteristics associated with unplanned extubation.

The study found that of the nurses, 49.1% had I patient allocated to them and 50.9% had two patients allocated to them at the time of unplanned extubation (see figure 5.28). Of the patients who had accidental extubation, 55.9% had a 1:1 nurse ratio while 44.1% had a 1:2 nurse ratio. Of the patients who had self-deliberate extubation, 43.5% had a 1:1 nurse ratio and 56.5% had a 1:2 nurse ratio (see table 5.12).

Bhattarcharya et al (2007:107) found that the nurse-to-patient ratio varied between 1:2 and 1:5, the least usually being on night shift. According to Chatterjee et al (2004:39), depending on the time of shift, the nurse-to-patient ratio varied between 1:2 and 1:4. Moons et al (2004:1351) reported a nurse-to-patient ratio of I:2 during unplanned extubation. The findings of this study cannot be compared to other studies as the shift times are different and this study was done in a general ICU, while the reported studies were in specialised surgical, medical or paediatric ICUs (Bhattarcharya et al 2007:107; Curry et al 2008:45; Bouza et al 2007:270; Phoa et al 2002:54; Balon et al 2001:93).

Of the nurses in this study, 73.7% were Registered Nurse with diploma; 7% held BScN degrees; 7% were registered community nurses, and 7% were enrolled community nurses (see figure 5.29). In addition, 72% had no formal training in critical care nursing and 28% had formal training in critical care (see figure 5.30).

Regarding the nurses' experience in nursing, the study found that 10.5% had less than 2 years' experience; 40.3% had 3-4 years' experience; 33.3% had 5-6 years' experience; 8.8% had 7-9 years' experience, and 7% had over 10 years' experience

(see figure 5.31). The findings on their experience in ICU revealed that 42.1% of the nurses responsible for patients who had unplanned extubation had less than 2 years' experience; 31.5% had 3-4 years' experience, and 26.3% had more than 5 years' ICU experience (see figure 5.32).

Chang et al (2008:408) and Marcin et al (2007:254) examined nursing experience and only Curry et al (2008:45) reported that 51.6% of unplanned extubations occurred with nurses who had less than 5 years of ICU experience. The studies reviewed also did not indicate the nurses' formal training nor was it used as a measurable variable.

Therefore the findings of this study that of the nurses, 92.9% had less than 10 years' nursing experience and 73.6% had less than 4 years of ICU experience were higher than those of Chang et al (2008:408), Marcin et al (2007:254), Curry et al (2008:45) and Yeh et al (2004:257).

The findings indicate that of the patients who had unplanned extubation, 50.7% were cared for by nurses with less than 4 years' experience in nursing and 73.6% by nurses who had less than 4 years' experience in ICU nursing.

5.5.8 Health care environment

According to the AACN Synergy Model for Patient Care, the health care environment is also important to synergise the needs of patients with the competencies of the nurse. However, in this study the characteristics of the health care environment were not under investigation.

It should nevertheless be noted that during the study period 23 unplanned extubations were reported to the Risk Manager and ICU team (Hospital Records Book 2006/2007), and the study found a total of 57 unplanned extubations, which was more than 150% of the reported incidences. There is a need to investigate the reasons for the discrepancy in reporting incidents of unplanned extubation.

5.6 CONCLUSION

This chapter presented the data analysis and interpretation. The findings were discussed and compared to the literature reviewed.

Chapter 6 concludes the study and makes recommendations for practice and further research.

CHAPTER 6

Conclusions, limitations and recommendations

6.1 INTRODUCTION

The aim of this study was to identify the patients' and nurses' characteristics associated with unplanned extubation of patients in an ICU of a selected hospital in Kenya. This chapter discusses the findings, briefly describes the limitations of the study and makes recommendations for practice and future research.

The AACN Synergy Model for Patient Care formed the conceptual framework for the study. The study wished to identify the risk factors associated with unplanned extubation. Factors identified with unplanned extubation include the actual number of unplanned extubations, both self-deliberate and accidental, the factors leading to unplanned extubation, and the re-intubation rates at the ICU of the hospital. The research methods enabled the researcher to achieve the objectives, namely to

- Identify the characteristics of patients who had unplanned extubation.
- Identify the characteristics of the nurse responsible for the patient who had unplanned extubation.
- Identify the contributing factors leading to unplanned extubation.
- Make recommendations to enhance synergy in an effort to prevent unplanned extubation.

6.2 RESEARCH DESIGN AND METHODOLOGY

The researcher chose a quantitative design with a non-experimental descriptive, correlational and retrospective approach. The study was conducted in the ambit of practice research. The quantitative method was used to describe variables and determine the relationships between the variables in order to identify the characteristics associated with unplanned extubation.

The actual number of unplanned extubations, whether self-deliberate or accidental, and the patients' and nurses' characteristics in this ICU of the selected hospital in Nairobi, Kenya were not known. The study sought to use the knowledge of contributing factors to identify the patients' and nurses' characteristics associated with unplanned extubation, using the AACN Synergy Model for Patient Care as the conceptual framework. Out of a total of 950 patients admitted to the ICU, 327 required intubation and 57 had unplanned extubation during the study period.

The data was collected using a clinical audit check list developed for the study.

6.3   FINDINGS

Based on the data analysis of 59 patients who had unplanned extubation, the researcher reached conclusions based on the objectives of the study.

6.3.1 Characteristics of patients who had unplanned extubation in an ICU in a selected hospital in Kenya

The data collected in Section A and B of the clinical audit check list covered this objective.

6.3.1.1   Section A: Patient profile

The data from the patient profile section of the check list yielded results consistent with the literature reviewed and contributed to the knowledge of patients' characteristics who had unplanned extubation in the ICU of the selected hospital in Nairobi, Kenya. The study revealed that 70.1% of male patients had unplanned extubation and 68.4% who had unplanned extubation had medical problems compared to 17.5% who were admitted with surgical problems, 12.3% with trauma, and 1.8% with gynaecological/obstetric problems. In addition, the mean age of the patients who had unplanned extubation was 43.5 years. Of the patients, 97% were orotracheally intubated, which assured that the intubation protocol introduced in 2006 had been implemented.

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The researcher concluded that one of the reasons for the higher rates of patients with medical problems was that the disease profile of patients admitted to the ICU differed from other ICUs and this study was conducted in a general ICU. The literature studies were conducted in medical, surgical, cardiac or paediatric ICUs. Another reason for the discrepancy was the disease pattern. According to the 2002 Kenyan Disease Statistics Survey, HIV/AIDS and lower respiratory illness were the top two causes of death. In the AACN Synergy Model for Patient Care classification of patients' characteristics, the ICU patient who has been intubated is vulnerable and the patient's needs should be matched with the nurse's competences and health care system for safe positive outcomes.

6.3.1.2 Section B: Unplanned extubation

Section B focused on the patients' characteristics associated with unplanned extubation, guided by the AACN Synergy Model for Patient Care.

6.3.1.2.1 Time of incident

The data revealed that of the patients, 43.9% had unplanned extubation during the day shift and 56.1% during the night shift.

As incidences of unplanned extubation can occur at any time, nurses need to be vigilant on both day and night shift, and provide quality care to patients in order to have safe outcomes.

6.3.1.2.2 Total days intubated

The data on total intubated prior to unplanned extubation indicated that 61.7% occurred in the first five days of intubation and 93.2% occurred between day 1 and day 10, with a mean of 5.10 days. Of the patients, 6.8% were ventilated for 11 to 20 days prior to the unplanned extubation.

The researcher concluded that both physicians and nurses need to be aware that unplanned extubation can occur regardless of days of intubation

6.3.1.2.3 Weaning process commenced

The weaning process had been commenced on 10.5% of the patients and 89.5% still required ventilator support.

The researcher concluded that both nurses and doctors need to be aware that patients who are being weaning off should be provided with constant vigilant care, reassurance and teaching to ensure their safety.

6.3.1.2.4 *Ventilator mode*

The data on the type of ventilator mode the patients were on when unplanned extubation occurred indicated that 97% were on various modes of ventilator support and 7% were on T-piece.

The researcher concluded that nurses should be knowledgeable and competent, and provide support to patients who are intubated and on ventilator support. Patients who are intubated should have constant emotional and physical support provide by both nurse and family.

6.3.1.2.5 Incidence

The data indicated that 17.4% of unplanned extubations occurred during the study period with a mean rate of 2.42/100 ventilated days. Further analysis revealed that 40.4% were self-deliberate extubation while 59.6% were accidental extubation. Of the self-extubated patients, 52% pulled the tube out and 48% coughed the tube out.

Regarding accidental extubation, the study found that 88.2% occurred during nursing-related procedures and 11.8.% during non-nursing-related procedures.

6.3.1.2.6 If accidental during nursing-related procedure

The data from accidental extubation during nursing procedures revealed that 30% of the total unplanned extubations were due to accidental extubation during position change 30% were due to blocked tubes and 26.7% were due to leaking cuffs.

6.3.1.2.7 If accidental intubtion during a non-nursing procedure

The study found that 11.8% of accidental extubations occurred during non-nursing-related procedures. Of these, 5.1% occurred during positioning for portable chest x-ray and 2.9% during transport to x-ray department.

The researcher concluded that the finding of more accidental extubations was unique and not consistent with the literature studies which indicated more self-deliberate extubation compared to accidental extubation.

6.3.1.2.8 Nurse location at time of unplanned extubation

The study found that of the nurses, 36.8% were with the patient when unplanned extubation took place, and 43.9% did not indicate their location in patients' records when unplanned extubation occurred.

6.3.1.2.9 Physical restraints

The results of this study indicated that 29.8% of the patients had physical restraints when they had unplanned extubation. However, in 24.6% of patients' records there was no documentation of physical restraints used or not used.

Nurses in ICU should be aware that physical restraints do not prevent unplanned extubation. There is a need to educate nurses on the importance of proper and correct documentation. In addition, there is a need to identify therapies other than physical restraints for patients who are intubated, such as music therapy.

6.3.1.2.10 Patient position

The findings indicate 35% of the patients were in a supine position; 5.3% were in a prone position; 8.8% were sitting out, and 24.6% patients` records did not indicate position.
The researcher concluded that unplanned extubation can occur regardless of the position of the patient, although this study indicated that 24.6% the patients documentation was incomplete.

6.3.1.2.11   Glasgow Coma Scale

Regarding the GCS, the findings of this study indicate that 31.3% of the patients had below 8, which was much higher than the reported studies; 68% were alert, of whom 66% were alert but not aware of their surroundings. Self-deliberate extubation occurred on patients who were either completely alert or alert but unaware of their surroundings, and accidental extubated patients were semiconscious.

The researcher concluded that nurses need to take precautions to safeguard the patient who is semiconscious by ensuring that safe quality care is given at all times. As this study found more incidents of accidental extubation both during nursing-related and non-nursing-related procedures, there is a need to educate nurses on competences based on the safety of ventilated patients to ensure the patients' safety throughout their stay in the ICU.

6.3.1.2.12 RSS prior to unplanned extubation

Regarding the RSS, the findings indicate that 68% of the patients were anxious and 19.2% had a sluggish or brisk response.

The researcher concluded that this indicated that sedation was not maintained properly as 68% of patients were anxious or not sedated adequately, and this anxiety could also be due to pain. Moreover, that only 57.9% patients who had unplanned extubation were receiving sedation also supports this conclusion. This also has implications for nurses because despite having a sedation protocol, there is a need to identify the nurses' need to acquire more knowledge on the use of sedation protocol.

6.3.1.2.13   Chemical restraints

The findings indicate that of the patients, 57.9% were sedated with Midalozom; 43.9% were on analgesia infusion, and 38.9% were receiving neuromuscular blockade.

The researcher concluded that nurses in the ICU need to acquire more knowledge on the chemical restraints and their effects. Nurses should also ensure that patients are accessed adequately for pain assessment as 42.1% to 56.1% of the patients were not on any sedation or analgesics. Furthermore, doctors need to be educated on the importance of a sedation-free holiday (period) in order to access the patient.

6.3.1.2.14   Did the patient require re-intubation?

The findings indicate that 68.5% of the patients required re-intubation. Of these, 85.3% were accidental extubated patients who required immediate re-intubation compared to 43.5% of self-deliberate extubated patients. This finding is consistent with the literature reviewed although the accidental extubation rate was higher in this study.

The researcher concluded that nurses in the ICU should be aware of this finding, be competent to access patients more vigilantly for need of re-intubation. Nurses should also ensure that all intubation equipment needed is kept within reach as the patient who has unplanned extubation might need immediate re-intubation.

6.3.1.2.15   Time of re-intubation

The findings indicated that 89.8% of the patients required immediate re-intubation and 10.2% within 4 to 8 hours. That 31.5% did not require re-intubation signified that these patients were ready to be weaned off the ventilator.

Further analysis indicated that 85.3% of the patients who had accidental extubation required immediate re-intubation compared to 15.3% of self-deliberate extubation. Other findings indicated that only 10.5% were being weaned off (see section 6.3.2.5).

The researcher concluded that this has implications for both nurses and doctors in ICU. and nurses should be aware that patients who have accidental extubation mostly require immediate re-intubation.

6.3.1.2.16   Complications within 6 hours of unplanned extubation

The study findings indicated that 59.6% of the patients had laryngospasm; 8.8% had aspiration after unplanned extubation, and 1.8% had cardiopulmonary arrest during re-intubation, was successfully resuscitated but died after 24 hours.

The researcher concluded that patients who have unplanned extubation are prone to complications. Nurses in the ICU should be aware that patients who have unplanned extubation are prone to complications. Nurses should be able to assess patients more frequently, and be more vigilant and competent to recognise the complications in patients who have unplanned extubation.

6.3.1.2.17 Outcome of patient

The study findings indicated that 57.9% were discharged from the ICU, 36.8% died in the ICU, and 5.3% were transferred to other hospitals for various reasons.

6.3.1.2.18   Total days' intubated: patients who had unplanned extubation

The findings indicated that the total mean days of patients who had unplanned extubation was 10.1 days compared to a mean of 7.2 days for patients who did not have the adverse event of unplanned extubation.

6.4   OBJECTIVE NO 2

Identify the characteristics of the nurse responsible for the patient who had unplanned extubation.

According to the AACN Synergy Model for Patient Care, this data was for identifying the nursing characteristics or competencies.

6.4.1 Section C: Nursing staff

Data on the nurse-patient ratio, formal nursing education, and nursing as well as ICU experience were obtained and analysed.

6.4.1.1 Nurse-patient ratio

The study found a nurse-to-patient ratio of 1:1 for 49% of the patients and 1:2 for 50.8%.

This led to the conclusion that nurses should be educated, knowledgeable and competent to care for intubated patients in the ICU. Nursing managers should ensure that proficient and expert nurses are readily available on all shifts to guide and support the novice and advanced beginner clinical nurse at all times.

6.4.1.2 Highest qualification of the nurse responsible for the patient who had unplanned extubation

The study found that of the nurses caring for intubated patients, 74% were registered nurses with a diploma in nursing and 30.5% had formal training in critical care.

The researcher concluded that the team leader and nurse manager of ICU should be made aware of this finding and should ensure that the nurses increase their knowledge and skills in caring for critically ill patients either by formal critical care education or informal in-service training. The clinical nurse instructor should work with the nursing manager to ensure that the nurses in ICU gain the necessary knowledge, competency and skills to care for the critically ill patient in the ICU. This will further enhance the safety of patients in the ICU.

The results of this study indicate that 73.7% of the nurses were registered nurses with diploma in nursing, 7% were BScN and community nurses, and 12.3% were enrolled nurses. This finding was not consistent with the literature reviewed as only a few studies reported on the nurse's training as a measured variable.

6.4.1.3 Nursing experience and ICU experience

The findings indicated that of the nurses, 92.8% had less than 10 years' nursing experience and 74.2% had less than 5 years' experience in the ICU.

The researcher concluded that ICU nurse managers and clinical practice educators should be made aware of this finding. Nurse managers should also ensure that proficient and expert nurses are available on all shifts for the guidance and support of nurses at all times.

6.5   HEALTH CARE ENVIRONMENT

According to the AACN synergy model of patient care, the health care environment is also important to synergise the patient's needs and the nurse's competencies for safe patient outcomes. Nevertheless, in this study the characteristics of the health care environment were not under investigation. The results of the incidence rate of unplanned extubation are discussed here.

6.5.1 Incidence rate of unplanned extubation

The findings indicated that 17.4% of unplanned extubation and an incidence rate of 2.42 per 100 ventilated days of unplanned extubation occurred during the study period. It should be noted that only 23 (40.4%) incidences of unplanned extubation were reported as incidents and forwarded as clinical indicators to the risk manager while 34 (59.6%) incidences were not reported.

The researcher concluded that ICU nurse managers and risk managers should be made aware of this finding. There is also a need to further investigate the reasons why the nurses did not report these incidences correctly. Nurses in the ICU need to be educated on the importance of proper and correct identification of incidences, and reporting of adverse events so that preventive methods can be identified.

6.6   RELATING THE FINDINGS TO THE ASSUMPTIONS

The study was based on characteristics associated with unplanned extubation in the ICU of a selected hospital in Nairobi. Five assumptions from the AACN Synergy model further guided this study (see chapter 1, section 1.7.1). Each of the assumptions will be discussed separately.

6.6.1   Assumption 1: *Patients can be described by number of characteristics that connect and contribute to each other. Characteristics cannot be looked at in isolation.*

From the finding of this study, the characteristics of an intubated ventilated patient can be described by a number of characteristics that connect and contribute to each other. This assumption was true. The study described the patients by age (with a range of 3 months to 88 years and a mean of 43.5 years of age); diagnosis (68.4% had medical illness); 91.2% were intubated orally; 10.5% extubated during the weaning process; 100% were on different modes of ventilator support; 40.4% had self-deliberate extubation and 59.6% had accidental extubation; 29.8% had been physically restrained; 35% were in a supine position; the GSC mean score was 9.76, standard deviation of 2.08; RSS of use of physical and chemical restraints; required re-intubation, complications and outcome of the patient.

6.6.2   Assumptions no 2 and no 3

No 2: Nurses can be described on a number of dimensions. The interrelated dimensions paint a profile of a nurse. The goal of nursing is to restore a patient to an optimal level of wellness as defined by the patient.

No 3: The   goal of nursing is to restore a patient to an optimal level of wellness as defined by the patient. Death can be a possible outcome, in which the goal of nursing care is to move patient and family towards a peaceful death.

From the finding of this study, assumptions 2 and 3 are the nurse characteristics. According to the study, the nurses' profile was the educational background, experience

as nursing and in ICU. Of the nurses, 73.7% were registered nurse with diploma, 7% BScN, 7% were registered community nurse, and 12.3% were enrolled community nurse; 10.5% had less than 2 years' experience, 40.3% had 3-4 years' experience, 33.3% had 5-6 years' experience, 8.8% had 7-9 years' experience, 5.3% had 10-15 years' experience, and 1.8% had 16-20 years' experience.

The study results indicate that this assumption was true: 85.3% of the patients who had accidental extubation required re-intubation compared to 40% of the patients who had self-deliberate extubation required re-intubation were cared by 73.6% nurses who had less than 5 years' nursing experience.

6.6.3 Assumptions no 4 and no 5

No 4: Nurses may work to optimize outcomes for patients, patients' families, healthcare providers, and healthcare systems/organizations.

No 5: Nurses bring their background to each situation, including various levels of education/knowledge and skills/experience.

The study results indicate that these assumptions were true: 72% of the patients who had unplanned extubation were being cared for by nurses who had no formal training in critical care nursing; 73.6% were cared by nurses who had less than 5 years' ICU experience. The study found that 36.8% of the patients who had unplanned extubation died in ICU.

Nurses in the ICU should ensure the safety of the patient at all times by providing quality care. The nurse also needs knowledge, skills and competency to care for patients in ICU who are vulnerable.

The AACN synergy model for patient care indicates that to maintain the continuum of care, the patients' characteristics have to synergize with the nurses' characteristics. For this, the health care system should be safe for the patients and regular monitoring of quality indicators to improve the care be conducted.

6.7   CONTRIBUTION OF THE STUDY

Unplanned extubation is recognised as a complication in ICU. Agitation, sedation with Midalozom, and the use of physical restraints are contributory factors. This study found that more accidental than self-deliberate extubations were reported. Moreover, more unplanned extubations occurred with nurses without ICU training and less than 5 years' ICU experience, and 28% of unplanned extubations was due to blocked tubes with secretions and leaking cuffs.

6.8   LIMITATIONS OF THE STUDY

This study was restricted to only one ICU in a selected hospital in Nairobi, Kenya. The study was retrospective, which means data was collected from patients' medical records, therefore the researcher relied on the accuracy of the written data by individuals and had no way of confirming it. It was also difficult to quantify the nurses' workload and other patients' activities at the time of the incidence. These factors could affect the nurses' and doctors' documentation and may have produced different results had the study been a prospective one.

Although the AACN Synergy Model for Patient Care that was used as a conceptual framework for this study is widely accepted in USA, the reliability and validity of this conceptual framework has not been tested in Kenya.

As the study was conducted in one ICU of a selected private hospital in Kenya, it cannot be generalised to other hospitals in Kenya both public and private.

6.9   RECOMMENDATIONS

Based on the findings, the researcher makes the following recommendations for practice and further research.

6.9.1 Practice

The nurses' characteristics should match the needs of critically ill patients who have been intubated. The nurse in ICU should be competent and have all eight characteristics according to the AACN Synergy Model for Patient Care.

Nurses, physicians and other allied health care workers in ICU should be informed of the findings of this study in order to be more vigilant and provide safe quality care and reduce the rate of unplanned extubation.

In order to provide quality care to patients to have safe outcomes, nurses need to be vigilant on both day and night shift, as unplanned extubation can occur on any shift.

The nursing manager should ensure adequate staffing on both shifts with different levels of competencies. Early identification of contributing factors will further enhance patients' safe outcomes in ICU.

All health care workers should be made aware that intubation can occur at any time, irrespective of days' intubated, so that precautions are taken to ensure the safety of patients.

Nurses need to be educated on the care of intubated patients and be more vigilant when rendering care to intubated patients to enhance safety and prevent unplanned extubation. Nurses should inform the patients of the importance of keeping the endotracheal tube until the physician decides they are ready to be weaned off the ventilator. The nurse should constantly reassure patients to allay fears of not being able to communicate verbally.

Nurses in ICU should ensure that adequate personnel are available to assist in changing patients' position and changing tapes. All ventilator tubing should be secured safely and nurses should be vigilant by ensuring that the tubes are not pulled out during position change.

There is a need to identify and study why so many endotracheal tubes were blocked despite regular chest physiotherapy, suctioning and use of heat-moisture exchange filters. The types of endotracheal tubes used in the ICU and which brands of tubes are prone to have leaking cuffs should be identified.

The ICU nurses should be aware that their presence at the bedside of the intubated patient provides security and assurance to the patient. The nurse manager should ensure adequate coverage during break period and assign teams to care for each patient.

Nurses should be educated on the importance of proper and correct documentation. In addition, there is a need to identify therapies other than physical restraints for patients who are intubated, such as music therapy.

Nurses in ICU need to acquire more knowledge on sedation protocol and should give psychological support and reassurance to allay anxiety and promote safety. Doctors should also assess patients for need of sedation or pain management effectively to promote patient safety in the ICU.

Formal education on critical care and on-going informal competency-based education should be introduced and provided for nurses working in ICU to equip them with the knowledge and skills to care for critically ill patients.

Nurse managers and clinical practice educators should ensure that nurses increase their skills and competency in caring for the ICU patient by formal education and informal training.

Nurses need continuous upgrading of skills and knowledge in order to advance from level 1: novice to level 5: expert nurse.

6.9.2 Further research

The researcher recommends that research be undertaken on the following topics:

- The educational and training needs of an ICU nurse

- Unplanned extubation in the ICU of selected hospitals in Nairobi, Kenya
- Nurses' perceptions and experience of care for ventilated patients in ICU
- An exploration of the efficacy of different types of endotracheal tubes
- Nurses' and doctors' perceptions of reporting patients' adverse events at selected hospitals
- An examination of chest physiotherapy and its implications for intubated patients' haemodynamics status

6.10   CONCLUSION

This chapter identified and discussed the patients' and nurses' characteristics associated with unplanned extubation. The findings indicate that for patients to have safe positive outcomes in the ICU there is a need to monitor adverse events, identify root causes and plan corrective actions accordingly. There is also a need to observe nursing practices such as chest physiotherapy and suctioning of the intubated patient. Finally, as Will Durant (1885-1981) said, "Education is a progressive discovery of our own ignorance."

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