A BASELINE STUDY OF EXTUBATION EVENTS OCCURRING AT THE INTENSIVE CARE UNIT OF THE KENYATTA NATIONAL HOSPITAL

A DISSERTATION PRESENTED IN PART FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE MASTERS DEGREE IN ANAESTHESIA, UNIVERSITY OF NAIROBI

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A BASELINE STUDY OF EXTUBATION EVENTS OCCURRING AT THE INTENSIVE CARE UNIT OF THE KENYATTA NATIONAL HOSPITAL

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DECLARATION.

I declare that this proposal is my original work and has not been submitted for a degree award in any university.

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This proposal has been submitted for the degree of Masters of Medicine in Anaesthesiology with my approval as a university supervisor.

SUPERVISOR: SIGNATURE DATE

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DEDICATION:

I dedicate this thesis to my mother, Salome, my biggest supporter and the greatest influence on my life, and to my siblings Angela and Paul for their unwavering and unconditional love and support.

ACKNOWLEDGEMENTS:

I would like to thank my supervisor, Dr. Mark Gacii, as well as my teachers Dr. Thomas Chokwe and Dr. David Misango who provided guidance and support during the development and writing of this thesis.

I owe my deepest gratitude to my sister Angela Mathangani for her priceless input in streamlining the rough draft.

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ABBREVIATIONS

AARC - American Association of Respiratory Clinicians

BIPAP - Bi-phasic intermittent positive airway pressure

CPAP - Continuous positive airway pressure

ETT – Endo tracheal tube

FiO_2 – Fraction of inspired oxygen

HDU – High Dependency Unit

ICU - Intensive Care Unit

IPPV - Intermittent positive pressure ventilation

KNH – Kenyatta National Hospital

PEEP – Positive end expiratory pressure

RSBI - Rapid Shallow Breathing Index

SBT – Spontaneous breathing trial

SIMV - Synchronized intermittent positive pressure ventilation

UE – Unplanned Extubation

UoN – University of Nairobi

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LIST OF ABBREVIATIONS

AARC	-	American Association of Respiratory Clinicians
BIPAP	-	Bi-phasic intermittent positive airway pressure
CPAP	-	Continuous positive airway pressure
ETT	-	Endotracheal tube
FiO_2	-	Fractional inspired oxygen concentration
HDU	-	High Dependency Unit
Hr	-	Hour
ICU	-	Intensive Care Unit
IPPV	-	Intermittent positive pressure ventilation
KNH	-	Kenyatta National Hospital
Min	-	Minutes
PEEP	-	Positive end expiratory pressure
RSBI	-	Rapid Shallow Breathing Index
SBT	-	Spontaneous breathing trial
SIMV	-	Synchronized intermittent positive pressure ventilation
UE	-	Unplanned Extubation
UoN	-	University of Nairobi

OPERATIONAL DEFINATIONS:

Intubation: - The placement of an endotracheal tube into the trachea.

Difficult intubation:- Tracheal intubation after more than 2 attempts at intubation.

Extubation: - The complete withdrawal of an endotracheal tube from the trachea.

Planned extubation: - The elective removal of the endotracheal tube.

Unplanned extubation: - The premature removal of the endotracheal tube.

Self extubation: - The premature removal of the endotracheal tube by action of the patient.

Accidental extubation: - The premature removal of the endotracheal tube during care and manipulation of the patient.

Extubation failure:- The need for reintubation within 72 hours of an extubation.

Extubation success:- No need for reintubation within 72 hours of an extubation.

Reintubation:- Reinsertion of the endotracheal tube into the trachea after an extubation incident.

IPPV: - Intermittent positive pressure ventilation: A ventilation mode best used in heavily sedated, paralyzed or unconscious patients with depressed respiratory drive. The patient is ventilated at a rate set by the operator.

SIMV: - Synchronized intermittent positive pressure ventilation: A ventilation mode where the ventilator synchronizes machine breaths with the patient's attempts at spontaneous breathing. Each machine breath occurs during the patient's expiratory pause or self initiated inspiration.

BIPAP:- Bi-phasic intermittent positive airway pressure ventilation: A ventilation mode that provides two phases of positive pressure during the patient's

spontaneously generated respiratory cycle. A high pressure level supports inspiration and a lower level of pressure keeps the alveoli open during expiration.

CPAP: - Continuous positive airway pressure: A spontaneous breathing mode of ventilation. It provides positive airway pressure during all phases of the patient's respiratory cycle increasing the patient's Functional Residual Capacity and opening up previously collapsed alveoli;

T- piece: - A T- shaped breathing circuit used to supply a spontaneously breathing patient with oxygen enriched air. The inhaled oxygen passes down one limb of the T- piece device and the exhaled gases exit through the second limb during expiration.

Pressure support: - A spontaneous mode of ventilation whereby the patient initiates every breath and the ventilator supports each patient generated breath with a preset pressure value.

NIPPV:- Non invasive positive pressure ventilation. This refers to the administration of ventilatory support by nasal, face or helmet masks without the use of invasive endotracheal or tracheostomy tube.

Desaturation:- Fall in arterial oxygen saturation (SaO_2) from > 90% to < 90%

Hypotension:- A Fall in systolic blood pressure to less than 90mmHg for longer than 10 min.

Bradycardia:- A fall in heart rate to below 60 beats/min

Hypoxia:- Partial pressure of oxygen in arterial blood (PaO2) < 8kPa or 60mmHg

Hypercapnia:- Partial pressure of carbon dioxide in arterial blood (PaCO2) > 6.0 kPa or 45mmHg

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SUMMARY:

Background: Extubation, or the removal of an endotracheal tube from the airway, is ideally planned and executed once an intubated patient is able to maintain adequate respiratory effort and a patent airway. However unplanned extubations do occur in intensive care units either accidentally, during manipulation of the patient, or as self extubation by the intubated patient and put the patient at increase risk of respiratory failure and reintubation. Planned extubations may also result in extubation failure and reintubation.

Objective: To study extubation events occurring in a population of intubated patients in KNH ICU. The primary end points of the study were:

1. The establishment of the incidence of planned and unplanned extubations occurring in orally intubated ICU patients in KNH and the resultant success and failure rates experienced with these modes of extubation.
2. The establishment of the complications experienced after extubation.

Methods: A prospective cross-sectional study was proposed. It was carried out in the KNH ICU. The study population consisted of orally intubated patients who consented to be included in the study. These patients were prospectively observed for an extubation event and followed up for a period of up to 72 hrs after the extubation event occurred.

Data collection was done using a survey tool and performed by recruited research assistants. Data collected will included patient demographic data, details describing the extubation event in terms of time, place and mode of occurrence, as well as associated adverse events. The occurrence of extubation failure within the 72 hour follow- up period was also documented in the same tool.

Data analysis: Resulting demographic and clinical data was collated, sorted, entered into the computer, analysed and interpreted with a view to fulfilling the aforementioned objectives.

INTRODUCTION

"God .... breathed into man's nostrils the breath of life, and man became a living soul." Genesis 2:7

It has been long acknowledged that breathing is essential to life. Breathing is the means through which atmospheric oxygen used in cellular respiration to create energy enters the body and expired carbon dioxide, a by-product of energy production, leaves the body. Failure to maintain an adequate level of this basic process of gas exchange is known as respiratory failure and results in permanent cellular damage and eventually death.

Mechanical ventilation, defined as the use of a mechanical device to repeatedly inflate and deflate the lungs, is initiated as a life saving intervention in critically ill patients whose ability to maintain a patent airway, adequate ventilation and alveolar gas exchange is already diminished or lost or in those at risk of impending respiratory failure. Patients on ventilatory support constitute a majority of the patient population in KNH ICU.

Mechanical ventilation is commonly used in conjunction with endotracheal cannulation. There are two main through which the trachea may be cannulated. Namely,

i. Translaryngeally with an endotracheal tube (ETT) inserted via either a nasal or an oral route.

ii. Via a tracheotomy on the anterior surface of the neck.

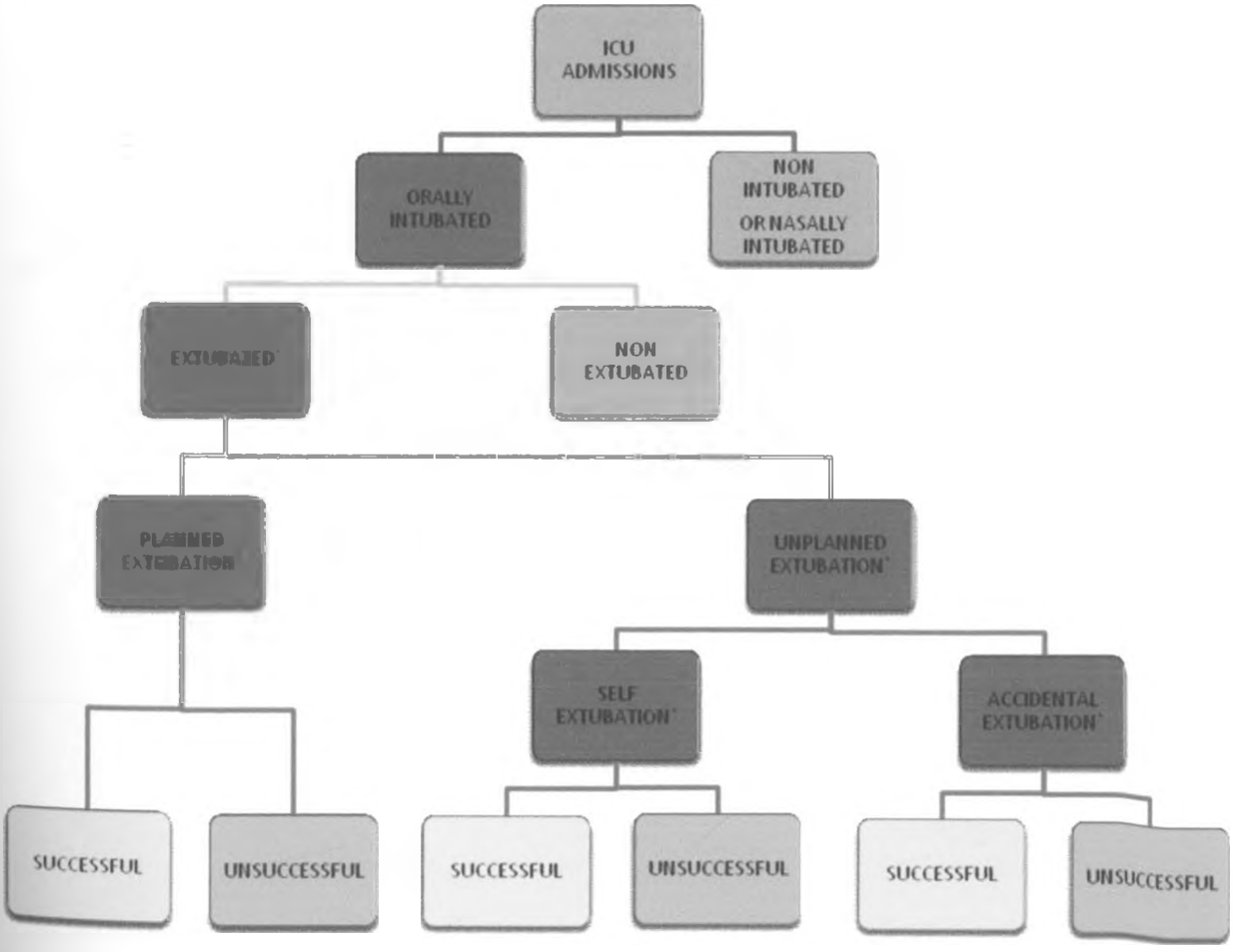
This research is concerned with the former approach.

Extubation refers to the process of removing a tube from a hollow organ or passageway, often from the airway. Ideally, it is a well planned and carefully executed event that takes into account the clinical condition of each intubated patient and their ability to maintain a patent airway. However, unplanned extubations are a common occurrence in intensive care units and they are considered an indicator of quality of care for critically ill patients in ICUs [1]. They may occur accidentally (e.g. during nursing care procedures or manipulation and transport of the patient), or as spontaneous self-extubations executed by the intubated patient. [45]

In some instances, an unplanned extubation could end up being a successful extubation, whereby the patient does not require reintubation. [35] However, unplanned extubations are generally considered undesirable and should be avoided as they can result in a number of serious complications such as difficulty in re-establishing an airway, upper airway trauma, respiratory insufficiency and respiratory failure. [7-9] These complications, in turn, may lead to cardiac arrest and even death.

Similarly, planned extubations may sometimes end up in failure, whereby the electively extubated patient experiences a similar set of complications faced by patients who undergo unplanned extubation. The following diagram illustrates the above facts:

Fig 1. Schematic of the proposed investigation into the extubation events occurring among KNH ICU patients.



Extubation failure, variably defined by different studies [37-40] as the requirement for reintubation within 24 – 72 hrs of extubation, is an outcome to be avoided. Reasons for its occurrence, whether resulting from inappropriate weaning technique during planned extubation or from improper patient care practices that lead to unplanned extubation, should be identified in order to institute methods that curb it.

STATEMENT OF THE PROBLEM:

ICU patient records obtained from the KNH Medical Records Department show that approximately 1000 patients are admitted per year into the ICU. The exact number of intubated patients is unknown as current records do not capture this data. However, an estimate by the Senior Nursing Officer in-charge of KNH ICU puts the figure at a significant 98% of total admissions. Similarly, there is no data documenting when or how the endotracheal tubes are removed from these patients. This implies that the KNH ICU staff manages extubations on a regular basis. However, the nature and frequency of various challenges presented by the process of extubation is unknown.

Essential data such as incidence of planned extubation, accidental extubation, self extubation and extubation failure is not adequately captured although these events are known to occur and impact significantly on patient outcome and overall cost of care.

LITERATURE REVIEW

INTUBATION:

In medicine, intubation refers to the placement of a tube into an external or internal orifice of the body. Although the term can refer to endoscopic procedures, it is most often used to denote endotracheal intubation. Endotracheal intubation is the placement of a flexible plastic or rubber tube, into the trachea to protect the patient's airway and provide a means of mechanical ventilation.

EXTUBATION:

Extubation refers to the complete withdrawal of an endotracheal tube from the trachea. It is accepted practice that after a patient is intubated and an appropriate level of ventilator support initiated, it should be maintained until the underlying cause of acute respiratory failure and other complicating issues have shown some sign of reversal.[2] The clinician may then, in a stepwise manner, reduce ventilator support from the initial maintenance level to lower support modes. The progressive transfer of the work of breathing from the ventilator to the patient is referred to as weaning. Once weaning is complete and mechanical ventilation is no longer required, the attending clinician must address the separate question of whether or not a patient can tolerate extubation.

The process of extubation is sometimes erroneously viewed as a routine automatic step that follows discontinuation from mechanical ventilation. This view is incorrect as the need for ventilatory support is distinct from the need for an artificial airway.[3] (e.g clinical syndromes such as acute epiglottitis and other airway diseases indicate the need for an artificial airway but ventilator support may not be required.)

Studies reveal that clinicians experience problems during extubation three times more commonly than they do during intubation: (4.6% versus 12.6%).[4] A closed claims analysis of the American Society of Anaesthesiologists' database revealed that death or brain damage with induction of anaesthesia decreased from 62% of perioperative claims in 1985 – 1992 to 35% in 1993 - 1999.[5] This decrease has been attributed to the widespread adoption of difficult airway guidelines which predominantly address induction of anaesthesia. In contrast, the claims for death or brain damage

associated with extubation remained almost the same. This implies that methods geared at making the process of extubation safer have not been as effectively employed.

CLASSIFICATION OF EXTUBATION:

The Manual of Emergency Airway Management[5] classifies extubation as:

1. Routine.
2. Intermediate risk
3. High risk.

The difference between them is described as follows: "*The extubation of patients who were easily intubated and in whom no intervening event has occurred to jeopardize their airways is routine. Those who were easily intubated but at greater risk of requiring reintubation due to hypoxemia, hypercapnea, inadequate clearance of secretions, inability to protect their airway or airway obstruction are intermediate risk extubations. Those in whom airway management is likely to be challenging or complex if reintubation is to be required represent high risk extubations.*"

The latter group is further considered to include:

1. "*Difficult intubations.*
2. *Those with interval complications (airway oedema, extrinsic compression, glottic injuries).*
3. *Those with conditions associated with difficult ventilation or intubation (eg. Morbid obesity, obstructive sleep apnoea, airway surgery, maxillofacial surgery deep neck infections and prolonged intubation.)*

According to this classification, the majority of intubated ICU patients fall into the intermediate and high risk extubation categories.

Extubations may also be classified as planned or unplanned.[11]

Ideally, an extubation is a planned and carefully executed event performed by healthcare workers after assessments of the patient's clinical condition and ability to maintain a patent airway are established as being adequate for extubation.

Unplanned extubations (UE) are unwelcome extubations. UE are classified as accidental extubations (e.g. occurring during nursing care procedures or manipulation and transport of the patient), or as self-extubations (when executed by the intubated patient.) [7-9, 10]

Postoperatively, most patients are extubated soon after the return of consciousness and resumption of spontaneous respiration. The resolution of neuromuscular block (paralysis) is easily demonstrated clinically by sustained head lift, good grip strength and ability to protrude the tongue out of the oral cavity. [11] The return of consciousness is demonstrated by the ability to follow simple commands.

The timing of the withdrawal of an artificial airway from critically ill patients recovering from respiratory failure is harder to establish and remains one of the more important and challenging aspects of critical care management. Some critically ill patients may be excellent candidates for extubation despite an inability to follow the same simple commands [12] and therefore different criteria should be employed to assess their readiness for extubation.

The decision to extubate involves weighing the risks of prolonged mechanical ventilation and intubation against the possibility of extubation failure. On the one hand, an overly cautious approach to extubation will minimize premature discontinuations, but could also unnecessarily prolong ventilatory support in some patients. On the other hand, over-aggressiveness in removing ventilator support and the artificial airway predisposes patients to the risk of extubation failure, with subsequent need for re-intubation and re-institution of ventilatory support.

Prolonged intubation increases a patient's risk of getting sinusitis[13, 14], laryngeal stenosis[15], laryngeal and tracheal injuries[15, 16], pulmonary infections[16] among others. This lays bare the fact that a patient should not remain with an endotracheal tube longer than is absolutely necessary.

Recognition of the time-dependent nature of these complications has led clinicians and investigators to concentrate their efforts on liberating patients from respiratory support and the ETT as expeditiously as is safely possible.

PLANNED EXTUBATION: ASSESSMENT OF EXTUBATION READINESS.

Readiness for extubation implies that weaning from mechanical ventilation is completed and that the patient:

1. Is sufficiently awake with intact airway reflexes
2. Is haemodynamically stable
3. Has manageable secretions.

Clinical judgement:

An early study in extubation observed the process to often be an arbitrary clinical decision based on a clinician's judgment and experience.[17] Another study showed that 50% of self extubated patients did not require reintubation.[18] This evidence suggests that when using clinical judgment alone, physicians do not extubate their intubated patients expeditiously.

Protocol-driven extubation:

Critical care teams worldwide have conducted numerous studies in the search for ways to assist physicians to correctly identify patients on mechanical ventilation who are capable of breathing spontaneously and ready for extubation.

A randomized controlled trial that compared protocol-directed weaning and physician-directed weaning found that protocol-directed weaning performed by nurses and respiratory therapists led to extubation more rapidly than physician-directed weaning.[19]

A separate study found that when physicians were notified that their patients had successfully completed a spontaneous breathing trial, they were more likely to extubate their patients early.[20] These two studies show that physicians and their patients benefit when guidelines that aid in the selection of patients suitable for extubation are implemented.

Quantitative assessments of respiratory function:

Further research performed in the last decade has yielded vital information that is being used to make the process of assessment of extubation readiness more of a science and less of an art. These methods of identification of patients suitable for extubation involve the quantitative determination of clinical weaning parameters that suggest adequate reversal of respiratory failure and that could reliably support the decision to extubate a patient.

Weaning parameters have been and continue to be investigated as possible predictors of successful extubation outcome. They range from simple readily available parameters such as respiratory rate, spontaneous minute ventilation, heart rate and blood pressure level to more sophisticated measurements such as the determination of oesophageal pressure using an oesophageal balloon. However, no single parameter has been proven to accurately predict extubation success.[21] Consequently, investigators developed a variety of integrated indexes from combinations of individual parameters. Examples of these include the Rapid Shallow Breathing Index (RSBI), a ratio of respiratory rate and tidal volume (f / Vt) and the CROP index that integrates chest wall compliance, respiratory rate, oxygenation, and pressure. As yet, none of the currently developed indexes are sufficiently sensitive and specific to be useful in predicting the success of extubation in an individual patient.[21] Because of these limitations, the routine use of these parameters and indexes are not recommended.

Spontaneous Breathing Trials

A multidisciplinary task force set up to produce evidence-based clinical practice guidelines for managing the ventilator-dependent patient during the discontinuation process concluded that a spontaneous breathing trial (SBT) provides the most useful information to guide clinical decision-making regarding weaning and extubation.[22] An SBT tests the ability of a patient to sustain adequate ventilation on minimal respiratory support. It may be performed in one of three ways:

1) with low levels of CPAP (1-5cmH_2O)

2) with low level of pressure support (5-7cmH_2O)

3) or simply as T- piece breathing.

Multiple studies have found that patients tolerant of SBTs that are 30 to 120 min in length were found to have successful ventilator discontinuations at least 77% of the time. [22]

The KNH ICU/HDU protocols booklet[23] outlines two weaning protocols that are similar to the guidelines put forward by the evidence based task force. According to this booklet, extubation in spontaneously breathing patients may be considered after one of two protocols is followed and successfully completed. The "sprint" or "CPAP" protocol uses continuous positive airway pressure (CPAP) mode of weaning. If a patient tolerates a 2-hour SBT on a CPAP level of 0 cmH_2O, extubation is considered. The second protocol known as "The Gentle Work Protocol" proposes the gradual reduction of pressure support by 2-5 cmH_2O per day till a pressure support level of 3-4 cmH_2O is achieved. If this low level of pressure support can sustain satisfactory ventilation for 14 hours, the patient is considered to have adequate capacity for spontaneous ventilation and may be considered for extubation.

PLANNED EXTUBATION: THE PROCEDURE

According to the American Association of Respiratory Clinicians (AARC) 2007 guidelines, the endotracheal tube should be removed in an environment in which the patient can be physiologically monitored and in which emergency equipment and appropriately trained health care providers with airway management skills are immediately available. [24]

Many centres have developed or adopted extubation procedure protocols to standardize the performance of the extubation procedure. For example an extubation protocol followed by the St George Hospital, New South Wales, Australia, details the sequence of steps to be followed by nurses while performing a planned extubation procedure and lists all the necessary equipment that should be close at hand during the process.[25]

Notably absent in the KNH ICU/HDU protocol booklet is a description of how elective extubation procedures in the ICU should be carried out.

UNPLANNED EXTUBATION

Generally, unplanned extubations (UE) are considered undesirable and have been reported as a problem for many institutions worldwide. [7-9].

A significant interest in UE has developed since Coppolo and May first focused attention on the topic in 1990. [26] That study found that 69% percent of UE were self extubations and that the majority of these occurred despite use of sedation and restraints. They concluded that self-extubation is a common occurrence which, despite obvious hazards, is often tolerated well by adults. Multivariate analyses carried out after 1990, however, have since attributed self extubation with increased morbidity and mortality. [22]

Unplanned removal of an endotracheal airway represents a potentially life-threatening incident as a displaced ETT may not be quickly or easily detected by attending staff members of an ICU. Equipment for emergent re-intubation or assisted ventilation, should it be required, may also not always be close at hand. A number of serious complications ranging from upper airway trauma, respiratory insufficiency and respiratory failure may result and in turn lead to cardiac arrest and even death. Unplanned extubations are thus increasingly being considered an indicator of health care quality in ICU. [1]

A review of available literature shows that UE occurs with a very varied incidence rate ranging from 0.87% [24] to 25%.[27-30] Research of the available literature did not reveal an internationally accepted standard for UE. Rather, each institution carried out an in-house study to determine the baseline rate of and reasons for UE and then formulated preventive measures and guidelines to reduce their respective incidence rates to an "acceptable level". Several methods geared at decreasing the rate of UE have been used. These methods range from improving the techniques employed in securing the endotracheal tube (ETT) to physical and/or chemical restraining of the intubated patient.

A quality control committee at a tertiary care hospital in Wisconsin, U.S.A, evaluated the techniques used for securing ETTs at their facility and attributed their high rate of UE (2.14% – 2.32% in their medical and surgical ICUs respectively) to the variable techniques employed in

securing the ETTs. A policy implemented to standardize the ETT securing technique resulted in the reduction of incidence of unplanned extubation in their medical and surgical ICUs to 0.87% and 1% respectively. [31]

Intubated patients may be chemically and/or physically restrained to prevent them from performing self-extubating manoeuvers. Stauffer and co-workers who noted high incidence of self-extubation among their patients, observed that some patients extubated themselves repeatedly despite arm restraints and careful nursing staff. [33] However, another study by Medina and co workers showed that it was possible to reduce the incidence of UE by employing not only arm restraints but also chest restraints. [34]

In some instances, a UE could end up being a successful extubation, whereby the patient does not require reintubation[35]. This ultimately suggests that some patients remain intubated for longer periods than necessary and that planned extubation should have been considered earlier. [36]

EXTUBATION FAILURE AND REINTUBATION

Extubation failure has been variably defined as the need for re-intubation occurring within 24 – 72 hours of an extubation. [37, 38, 39, 40,] Re-intubation refers to the re-insertion of an endotracheal tube into the trachea.

Extubation failure may occur after a planned or unplanned extubation. A review of available literature reveals that the incidence of extubation failure varies from 2% – 25% depending on the population studied and the time frame of study with higher incidences reported among paediatric populations.[32, 40] Extubation failure can occur for various reasons other than inappropriate discontinuation from ventilatory support. These include upper airway obstruction, inability to protect the airway and clear secretions. [41]

Extubation failure is associated with adverse outcomes, including increased hospital mortality, prolonged hospital stay, higher costs, and greater need for tracheotomy and transfer to postacute care. [39-40, 42] Delayed reintubation and reinstitution of ventilatory support may allow for deterioration and new organ failure, ultimately contributing to increased mortality and increased

costs. [37] Rapid reintubation or reinstitution of an artificial airway and ventilator support may help minimize the morbidity and mortality associated with failed extubation.

However, an urgent reintubation is likely to be more challenging than the original procedure. Fifty-five studies, totaling approximately 33,000 patients, demonstrate that on average 12.5% (range: 2% -25%) of extubated adult patients require reintubation between 24-72 h of endotracheal tube removal. [43] They showed that significant clinical deterioration may take place between the moment of extubation and the re-establishment of ventilatory support, especially when reintubation is delayed.

Data from a subset of patients who underwent tracheal reintubation was collected for analysis. Of the reintubations, 93% took place within 2 h of extubation. Of these patients, 72% had hemodynamic alterations and/or airway-related complications, including hypotension (35%), tachycardia (30%), hypertension (14%), multiple laryngoscopic attempts (22%), difficult laryngoscopy (16%), difficult intubations (14%), hypoxemia (14%), and esophageal intubation (14%). [44] In addition, one surgical airway and one case of "cannot ventilate, cannot intubate" leading to cardiac arrest and death were recorded. These findings suggest that patients requiring reintubation will likely do so soon after extubation and that reintubation can be fraught with significant hemodynamic and airway complications

Noninvasive positive pressure ventilation (NIPPV) has been considered a promising therapy to avoid reintubation after extubation failure, [46] and is currently gaining increased popularity among critical care practitioners in developed countries. Several randomized control trials [47 - 49] have shown that NIPPV can be successfully used as a "rescue therapy" to avert extubation failure in select groups of patients such as obese patients, hypercapnic patients with chronic respiratory disorders and patients with cardiogenic pulmonary oedema.

However, NIPPV involves the utilization of specialized equipment such as tightly fitting interfaces (nasal masks, face masks or helmet masks) as well as volume or pressure specialty ventilators devoted to noninvasive ventilation. This equipment is currently unavailable for use in our setting thus rendering clinicians in KNH ICU unable to utilize NIPPV to avoid extubation failure.

OBJECTIVE OF THE STUDY

Broad objective:

To study both planned and unplanned extubation events occurring in a population of orally intubated patients admitted into the KNH ICU.

Specific objectives:.

1. To determine the incidence of unplanned extubation in KNH ICU.
2. To determine the success rate of unplanned extubation in KNH ICU.
3. To determine the incidence of extubation failure after planned extubation in KNH ICU.
4. To document any adverse events experienced during extubation of patients in KNH ICU

JUSTIFICATION OF THE STUDY.

Kenyatta National Hospital is a 2000-bed tertiary care and teaching hospital with an ICU bed capacity of 21. (1%) Majority of the patients admitted to the intensive care unit require a period of respiratory support involving endotracheal intubation with or without mechanical ventilation. Extubation in a patient who has been intubated for a prolonged period of time carries significant risk and a strategy to manage this risk is mandatory.

The bulk of airway management literature is skewed toward developments in the field of tracheal intubation and the institution of an artificial airway while the period of extubation and reinstitution of a patient's own naturally functioning airway gets less attention. A casual review of chapters on airway management in anaesthesia textbooks revealed that emphasis is made on the anticipation and preparation for difficult intubations while much less instruction on how to prepare and perform an extubation is available in the same texts. It appears that extubation is very commonly assumed to be a 'routine' 'benign' reversal of the intubation process.

The period of extubation, however, is fraught with complications and may indeed be far more treacherous than that of intubation. Studies of the circumstances surrounding extubation events as well as the contribution of such extubation events to KNH ICU morbidity and mortality rates are warranted.

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METHODOLOGY

5.1 Study Site: The KNH ICU; A 21-bed ICU in a tertiary care hospital in Nairobi, Kenya that treats a mixed population consisting of general medical, surgical, paediatric and cardiac patients. The KNH also serves as a major teaching affiliate of the University of Nairobi Medical School

5.2 Study population: All orally intubated patients who obtained admission into KNH ICU during the study period were eligible for enrollment.

5.3 Study design: A descriptive cross-sectional study of extubation events occurring in KNH-ICU. Cross-sectional study design was appropriate because this study focused on describing the modes of extubation that patients admitted in the KNH ICU underwent and the types of adverse events they experienced after extubation.

5.4 Sample size:

In this study the sample size was calculated using the formula[50]

$$n = \frac{z^2 pq}{d^2}$$

where:

n is sample size (if the target population is more than 10,000)

z is the standard normal deviation at the required confidence level, in this case its 1.96

p is the proportion in the target population estimated to have characteristics being measured. Since there is no estimate available of the proportion in the target population assumed to have the characteristics of interest, 50% (0.5) should be used as recommended by Fisher et al.[50]

q is 1-p = 0.5

d is the level of statistical significance set = 0.05.

Therefore: $n = \frac{(1.96)^2 \times (0.5) \times (0.5)}{(0.05)^2} = 384$

Since the study population in this study was less than 10,000, the sample size will be calculated as follows:

$nf = \frac{n}{1 + n/N}$

Where:

nf = the desired sample size (when the population is less than 10,000);

n = the desired sample size (when the population is more than 10,000) which is 384 (from above calculation);

N = the estimate of the population size (number of intubated patients in KNH ICU over a 3 month period i.e. $1000 \div 4 = 250$)

Therefore:

$nf = \frac{384}{1+(384/250)} = 151$

Therefore the desired sample size for this study was 151.

5.4 Sampling method:

A convenient sampling method was employed in the study. Newly admitted patients were identified from the admission register and among these, the orally intubated patients were identified at the bedside by observation. Once ascertained by the investigator or attending clinician to be orally intubated, they were eligible for enrollment into the study.

5.5 Data collection procedure:

Data collection commenced after approval from KNH / UoN Ethics and Research Committee was obtained. The attending clinicians of the KNH ICU were recruited and trained as research assistants in this study to aid in the data collection procedure. Informed consent was obtained from conscious orally intubated patients or from the respective guardians of orally intubated children and patients with altered sensorium. A single copy of the data collection tool was assigned to every orally intubated patient recruited into the study and inserted into the patients file. A yellow sticker was used to tag the file of a recruited patient on follow-up. This strategy worked to minimize double participant recruitment. Data relevant to the study such as the patient demographic data as well as the place, date and time of intubation was obtained from the patient charts and files by the investigator or the attending clinician on admission and entered into section A of the data collection tool.

Patients thus recruited were then prospectively followed up and observed for an episode of extubation. The first extubation event that occured in these patients was documented in section B of the data collection tool by the investigator or the attending clinician. This section detailed the manner in which the extubation occurred (i.e. planned, accidental or self- extubation), the time it occurred as well as the mode of respiratory support the patient received prior to extubation. The patient was then followed up for a period of 72 hrs. If reintubation in the same patient was required within seventy two (72) hours of extubation, section C of the survey tool, concerning information surrounding the re-intubation, was to be filled out. A green sticker was used to identify files of patients who had experienced an extubation event or had completed the 72 hour follow-up period. This strategy strived to minimize double participant recruitment.

If an extubated patient required reintubation within seventy two (72) hours of an extubation event, the incident was classified as failed extubation. Conversely, if an extubated patient did not require reintubation within seventy two (72) hours of an extubation event, the incident was classified as a successful extubation. An extubation performed for the purpose of changing blocked or kinked endotracheal tubes was not considered as an extubation event. This was because it did not fall into

either of the planned or unplanned extubation categories described above nor could reintubation occurring electively after such an extubation be quantified as extubation failure.

5.6 Data quality control and management:

The principal investigator made at least two daily follow-up visits to the ICU at 8 am and 5pm, during the change of shift period, to ensure that the in-coming attending clinicians understood and were using the data collection tool correctly, to verify and collect completed survey tools. Patient charts and files were reviewed by the researcher at any time in order to verify information and correct mistakes or include omissions. Once the data had been verified, it was entered and stored into the computer as a Microsoft Excel 2007 database.

5.7 Data analysis and presentation: The resulting data was analysed using SPSS version 17.

Demographic characteristics such as age and sex were summarized using mean and proportions respectively. The modes of extubation, and complications experienced 30 minutes after extubation were summarized using proportions. Complications experienced during re-intubation were presented using proportions. The processed data was presented in the form of charts, tables and graphs.

5.8 Inclusion/Exclusion Criteria

- **Inclusion criteria:**
  - i. All orally intubated patients admitted to KNH ICU and whose consent had been obtained.
- **Exclusion criteria:**
  - i. Non intubated patients.
  - ii. Nasally intubated patients.
  - iii. Patients admitted with tracheostomies.
  - iv. Intubated patients whose next of kin decline to grant consent to the study.s

5.9 Ethical considerations

1. The nature of the study was explained to the personnel of the KNH ICU
2. Informed consent was sought from the patient (in the event that he or she was fully awake) or the guardians or next of kin (of children and patients with altered sensorium) before a patient was included in this study. In the absence of a guardian, the consultant in-charge was informed of the recruitment of the patient into the study.
3. No names of the participants were written in forms/documents involved in the study. Study subjects were coded with serial numbers to ensure confidentiality.
4. The study had no harmful effects on the participants. It did not entail any invasive procedures, drug administration or omission nor present any hazard whatsoever to the participants.
5. Permission to conduct the study was sought from Kenyatta National Hospital Ethics and Research Committee prior to commencement.
6. Study findings were availed to the Ethics and Research Committee of the Kenyatta National Hospital as well as the personnel of the KNH ICU and were used to make recommendations geared at improving the management of intubated patients in KNH ICU.

5.10 Study limitations:

1. Attending health care workers might have been concerned that occurrence of accidental and self-extubations may be seen as ineptitude or carelessness on their part and this might have lead to decreased documentation of these occurrences. In order to allay this fear, I reassured them that confidentiality will be maintained and that this was not a fault finding study.

2. This study relied heavily on the cooperation of on-duty clinicians in the ICU to accurately document any extubation incidents occurring during the period of time they are on duty. Participation on their part is completely voluntary. In order to gain their cooperation I endeavored to explain the significance of my study to each one individually as well as make the questionnaire as brief and as comprehensive as possible. I also made twice daily follow-up

visits to the ICU at 8.00am and 5pm before each shift begins to personally address any questions that may have arisen concerning use of the data collection tool during the data collection period.

3. Loss to follow-up limitation was a possibility in the event that after a successful extubation, the patient was discharged from the ICU before the 72 hour observation period elapsed. However, this limitation was minimised as the study did not involve a long- lag period. In addition, the principle investigator continued the follow up of these patients in the general or private wards to which they were routinely transferred for continued management.

RESULTS:

A total of 219 patients were admitted into the KNH ICU during the study period. 151 patients were orally intubated, 5 were nasally intubated and 63 were not intubated.

6.1 End point of intubation.

Removal of the ETT tube occurred in either of 3 instances:

- During planned or unplanned extubation events
- After placement of a tracheostomy tube
- After the death of an intubated patient.

An extubation event occurred in 66 patients (43.71%), 67 patients (44.37%) died while intubated and 18 patients (12%) progressed from endotracheal intubation to tracheostomy.

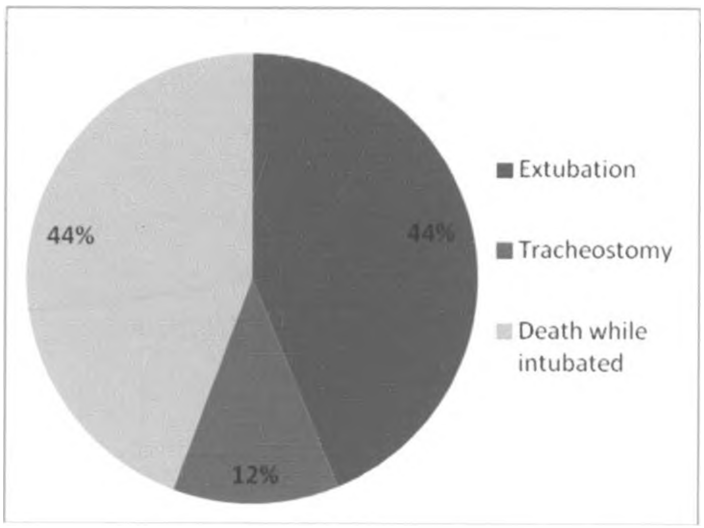

Fig 1. End point of intubation

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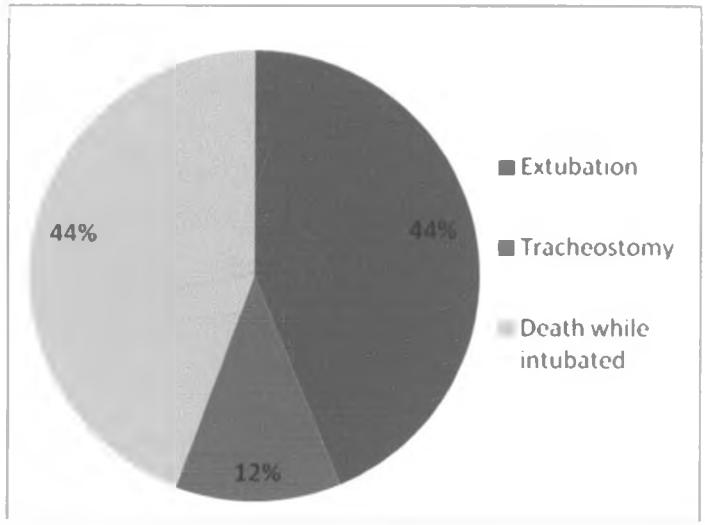

Fig 1. End point of intubation

6.2 Extubation modes.

Of the 66 patients who experienced an extubation event, 38 (58%) had a planned extubation while 28 had an unplanned extubation. Of the unplanned extubations, 14 (21%) were self-extubations and 14 (21%) were accidental extubations.

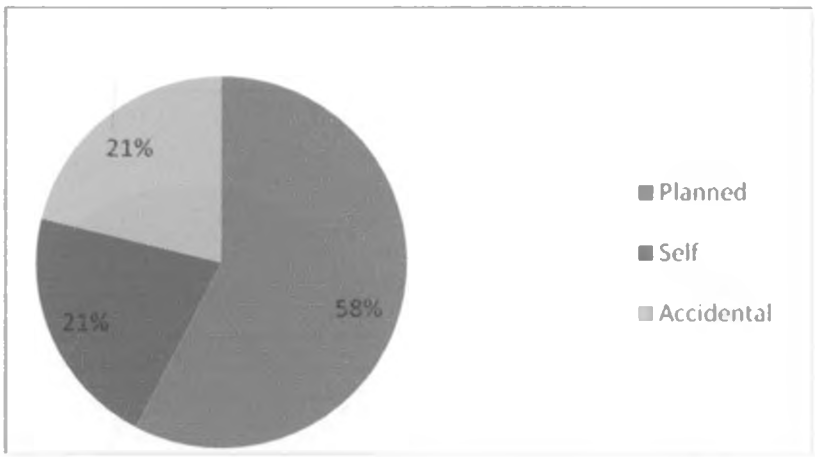

Fig 2. Modes of extubation

6.3 General outcome of extubation events.

66 orally intubated patients experienced an extubation event. Extubation failure was defined in this study as reintubation within 72 hours of extubation.

Successful extubations occurred in 40 patients (61%) while 26 patients (39%) required reintubation.

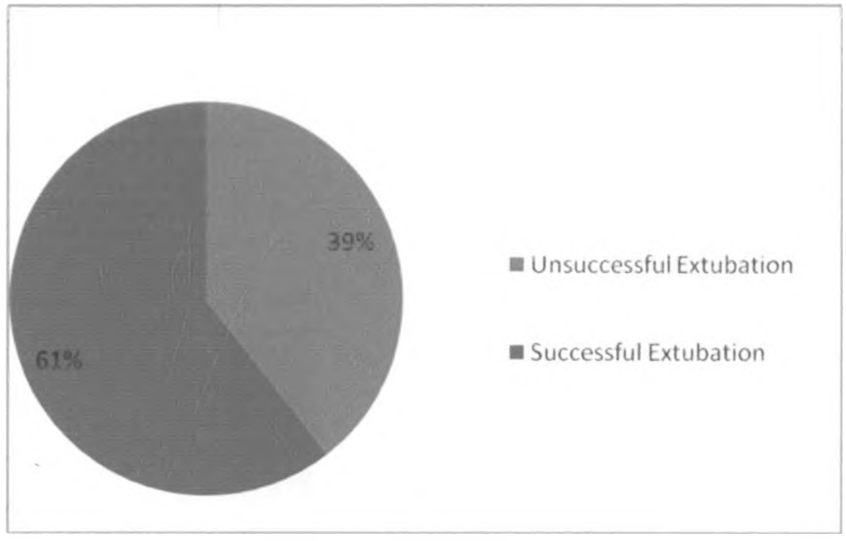

Fig. 3 Extubation outcome

24 extubated patients (92% of reintubations) were reintubated within 24 hrs of extubation. 2 patients required reintubation between 24 and 48 hours of extubation. None of the patients who had successfully completed 48 hours of extubation required reintubation.

6.4 Outcomes of extubation events after various modes of extubation.

Of the 38 planned extubations, 30 patients (78.95%) were extubated successfully while 8 patients (21.05%) experienced extubation failure and subsequent reintubation.

Of the 14 accidental extubations, 13 (92.86%) of the 13 resulted in extubation failure and reintubation while only 1 (7.14%) of the accidental extubations resulted in extubation success.

Of the 14 self-extubations, 9 (64.29%) resulted in extubation success while 5 (35.7%) resulted in extubation failure and reintubation.

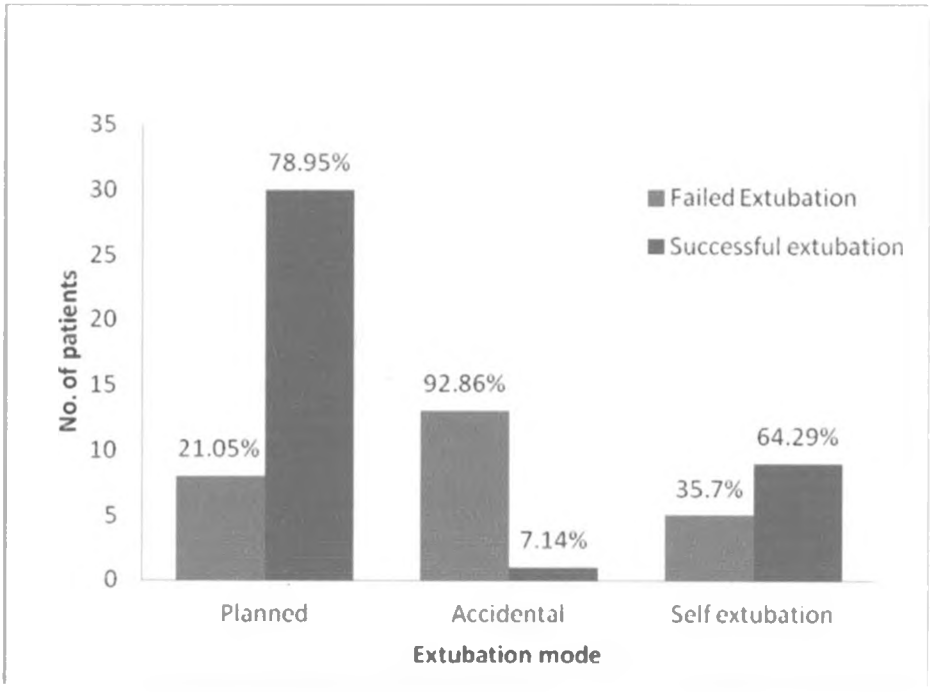

Fig 4. Outcomes experienced after various modes of extubation.

6.5 Timing of extubation events.

Most planned extubations occurred between 9.01 am – 6.00 pm while most self extubations occurred between 9.01 pm – 3.00 am. All accidental extubations occurred between 9.01 am – 12.00 am.

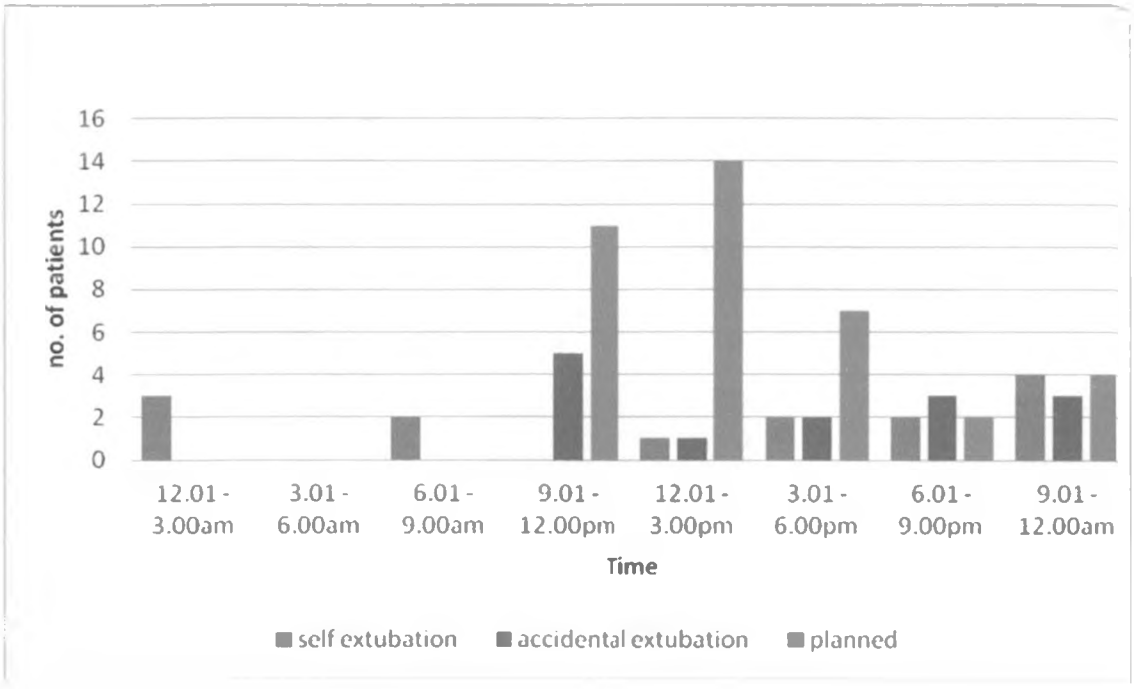

Fig 5. Timing of extubation events

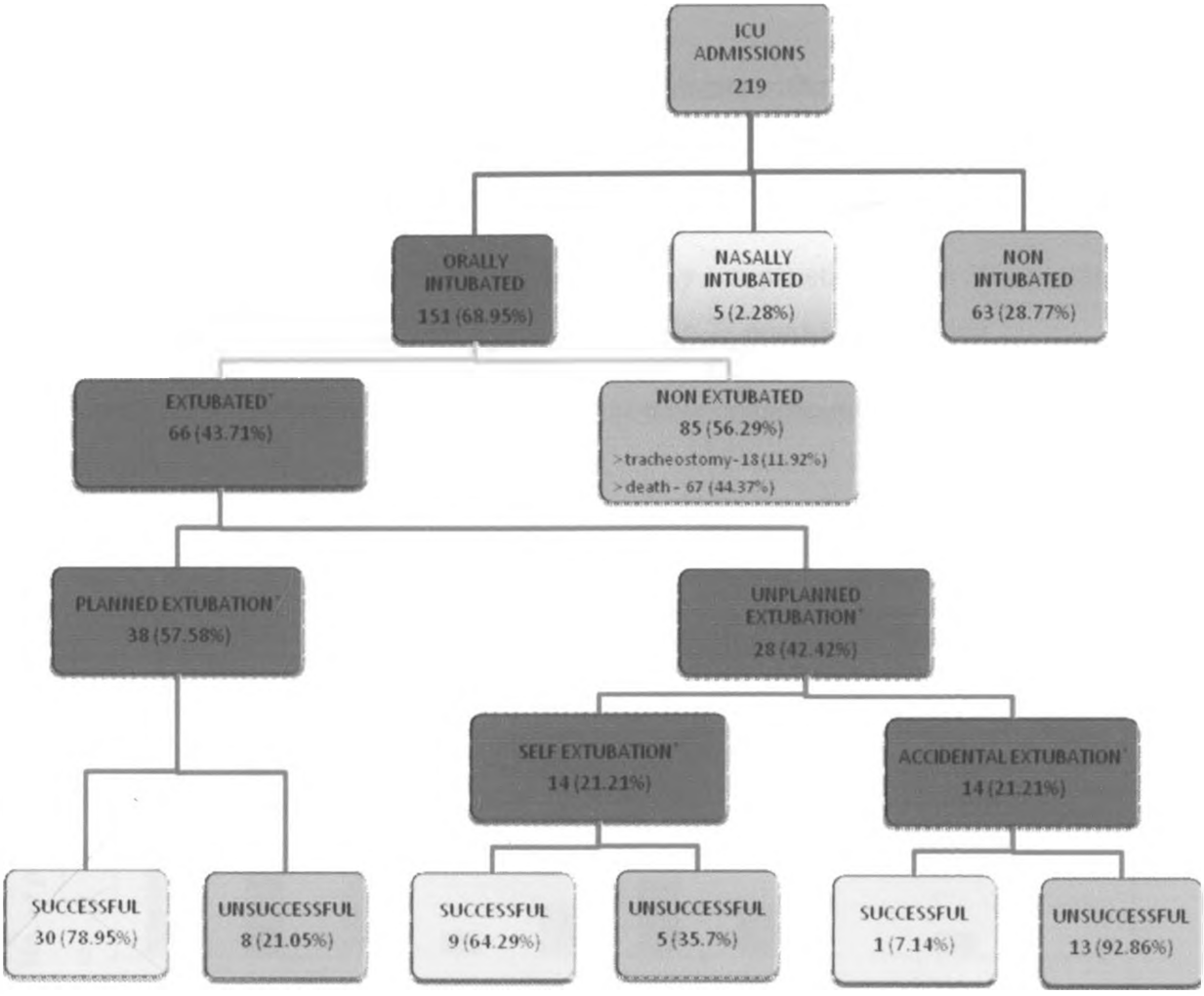

Fig 6. Schematic of extubation events in KNH ICU

The incidence of unplanned extubation in KNH ICU was 28/151 = 18.5%

The success rate of unplanned extubation in KNH ICU was 10/28 = 35.7%

The incidence of extubation failure after planned extubation in KNH ICU was 8/38 = 21%

6.6 Adverse events experienced during extubation.

The following adverse effects were experienced by patients within 30 minutes of extubation: Desaturation, laboured breathing, stridor, hypotension, aspiration, bradycardia, hypoxia, cardiac arrest. No patient experienced hypercapnia and no mortality occurred.

45 out of 66 extubated patients did not experienced any complication within 30 minutes of extubation. However 8 of them were reintubated within 72 hours of extubation.

21 out of 66 extubated patients experienced one of more complications within 30 minutes of extubation. 18 were reintubated within 72 hours.

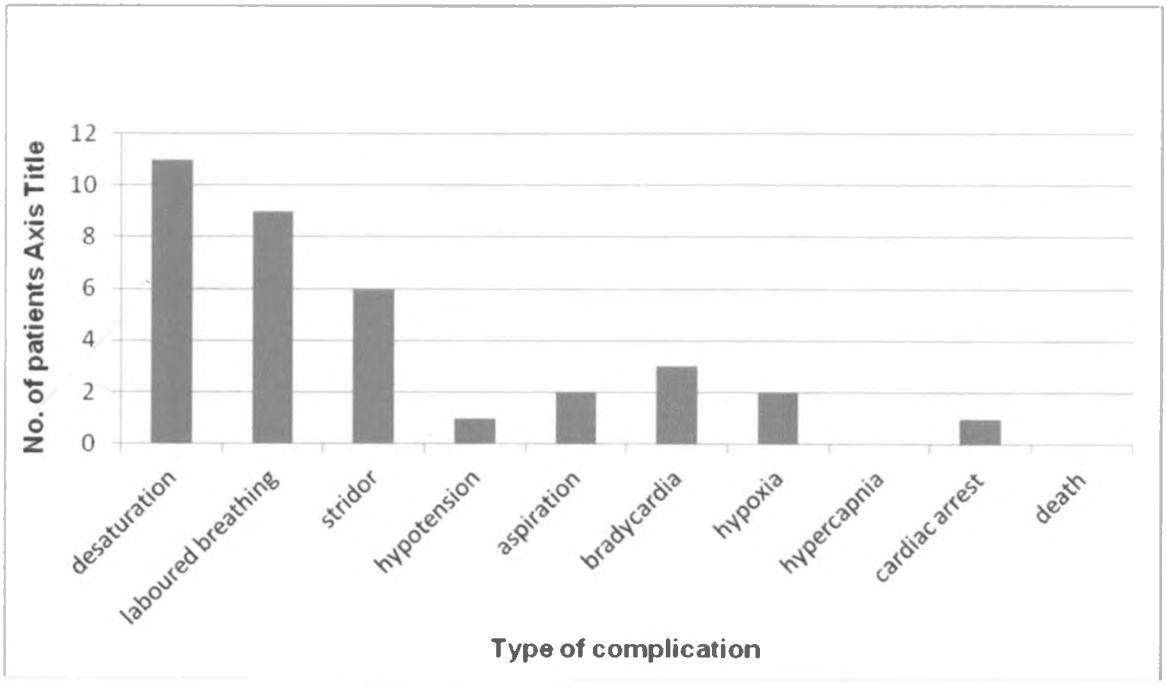

Fig 7. Complications within 30 min of extubation

6.7 Gender distribution and outcome of extubation events.

94 of the orally intubated patients admitted into the KNH ICU were male and comprised 62.3% of study participants. 57 of the patients were female and comprised 37.7% of study participants.

36 of the extubated patients were male while 30 of the extubated patients were female. As many females as males underwent self extubation and as many females as males underwent accidental extubation.

18 males (50%) were extubated successfully while 22 females (73.3 %) were extubated successfully.

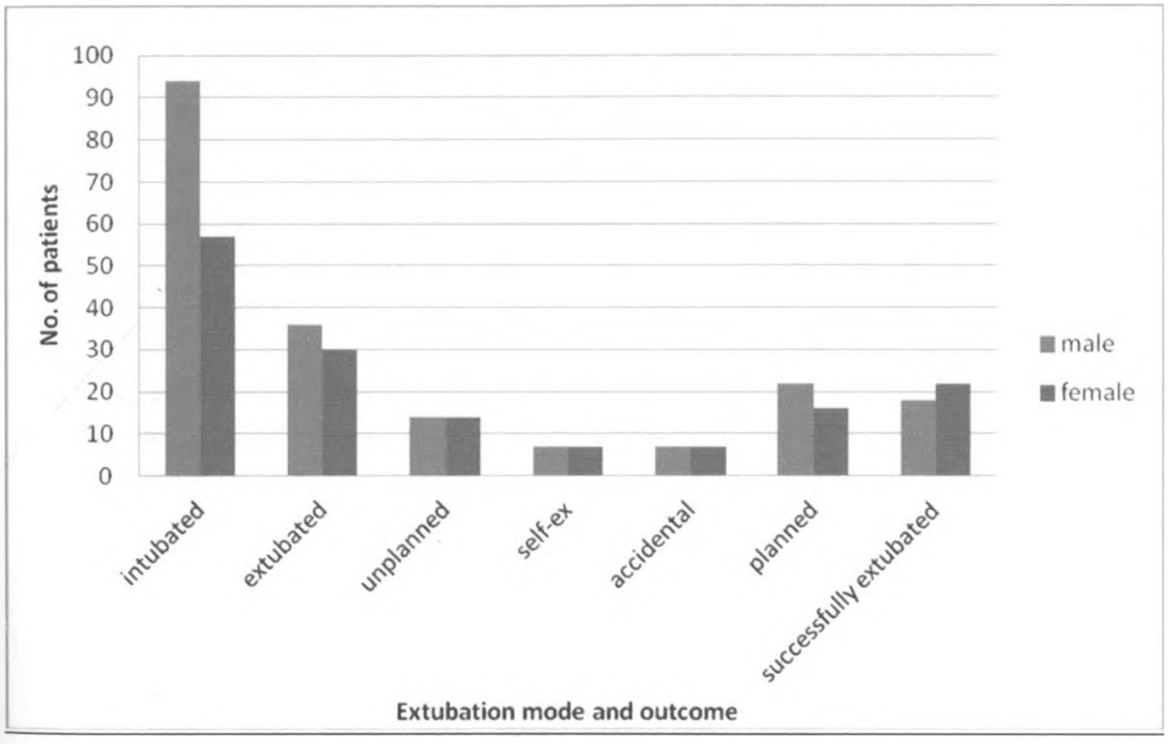

Fig 8. Gender outcome of orally intubated patients

6.8 Age distribution and outcome of extubation events.

35 patients (23.18%) were aged between 0-10 yrs. 5 of these had a successful extubation while 11 experienced an unsuccessful extubation. 9 patients (5.9%) were aged between 10- 20 yrs. 4 of them experienced successful extubation while none of them had an unplanned extubation. 23 patients (15.23%) were aged between 21 – 30 yrs. 8 of them experienced a successful extubation while 3 experienced an un successful extubation. 27 patients (17.88%) were aged between 31 – 40 yrs. 11 of them had a successful extubation while 5 experienced an unsuccessful extubation. 16 patients (10.59%) were aged between 41 – 50 yrs. 4 of these were successful extubations while 6 had unsuccessful extubations. 7 patients (4.63%) were aged between 51 – 60 yrs. None of them experienced an extubation event. 8 patients (5.3%) were aged between 61 – 70 yrs. 4 of these experienced a successful extubation while one of them had an unsuccessful extubation. 9 patients (5.9%) were aged between 71 – 80 yrs. 3 of these had a successful extubation while none had an unsuccessful extubation. 2 patients (1.32%) were aged above 81 yrs. One of these experienced a successful extubation. The ages of 15 unextubated adult patients could not be determined.

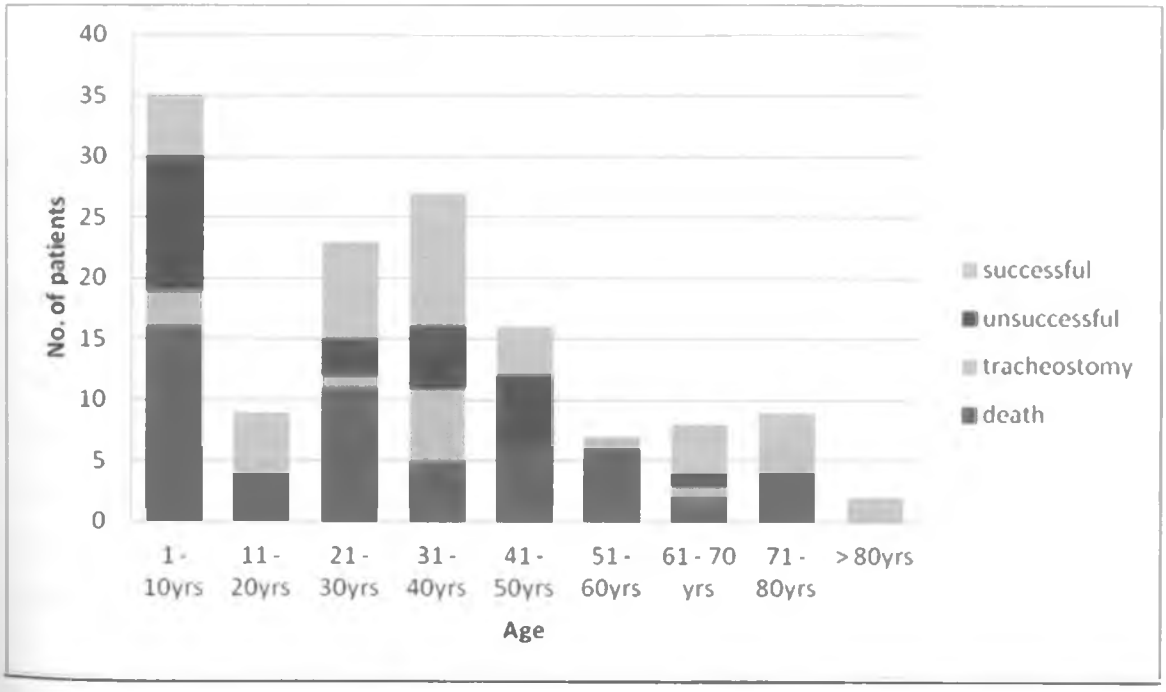

Fig 9. Age distribution and outcome of orally intubated patients

6.9 Sub-specialty category and outcome of extubation events.

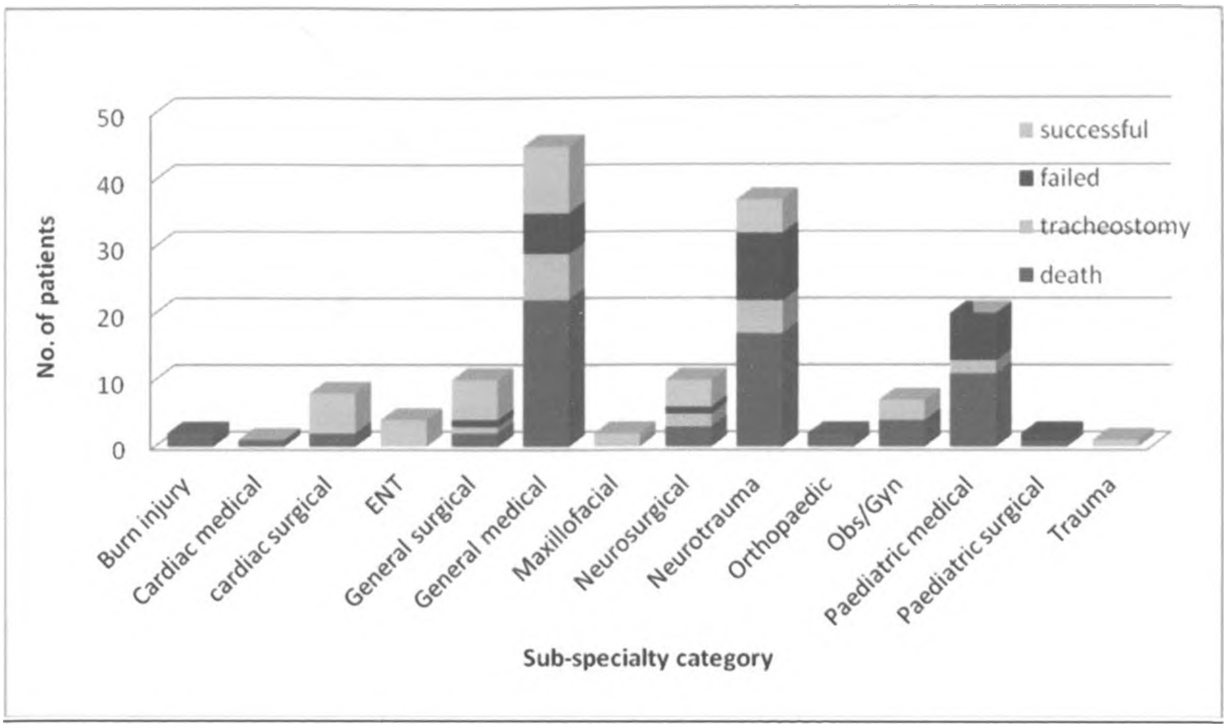

Fig 10. Sub-specialty category and outcome

None of the intubated burn injury, cardiac medical, or orthopaedic surgery patients experienced an extubation event.

All extubated cardiac surgical, ENT, maxillofacial, Obstetrics and gynecology and trauma patients experienced successful extubations.

The rest of the sub-specialty categories experienced varying outcomes of extubation as follows: General surgical had 1 failed and 6 successful extubations; General medical had 6 failed and 10 successful extubations; Neurosurgical had 1 failed and 4 successful extubations; Neurotrauma had 10 failed and 5 successful extubations; Paediatric medical had 7 failed and no successful extubations; Paediatric surgical had 1 failed extubation.

6.10 ETT securing methods and extubation mode.

Cloth ties, adhesive tape as well as a combination of these two methods were used to secure ETTs in the KNH ICU. Cloth ties were used in 92 cases, adhesive tape was used in 51 cases while a combination of adhesive tape and cloth ties were used in 8 cases. Of the patients whose ETTs were secured by cloth ties, 16 experienced planned extubation, 9 patients experienced accidental extubation and 10 patients experienced self extubation. Of the patients whose ETTs were secured by adhesive tape, 21 experienced planned extubation, 4 patients experienced accidental extubation and 4 patients experienced self extubation. Of the patients whose ETTs were secured by both adhesive tape and cloth ties, 1 experienced planned extubation, 1 experienced accidental extubation and none experienced self extubation. Progress

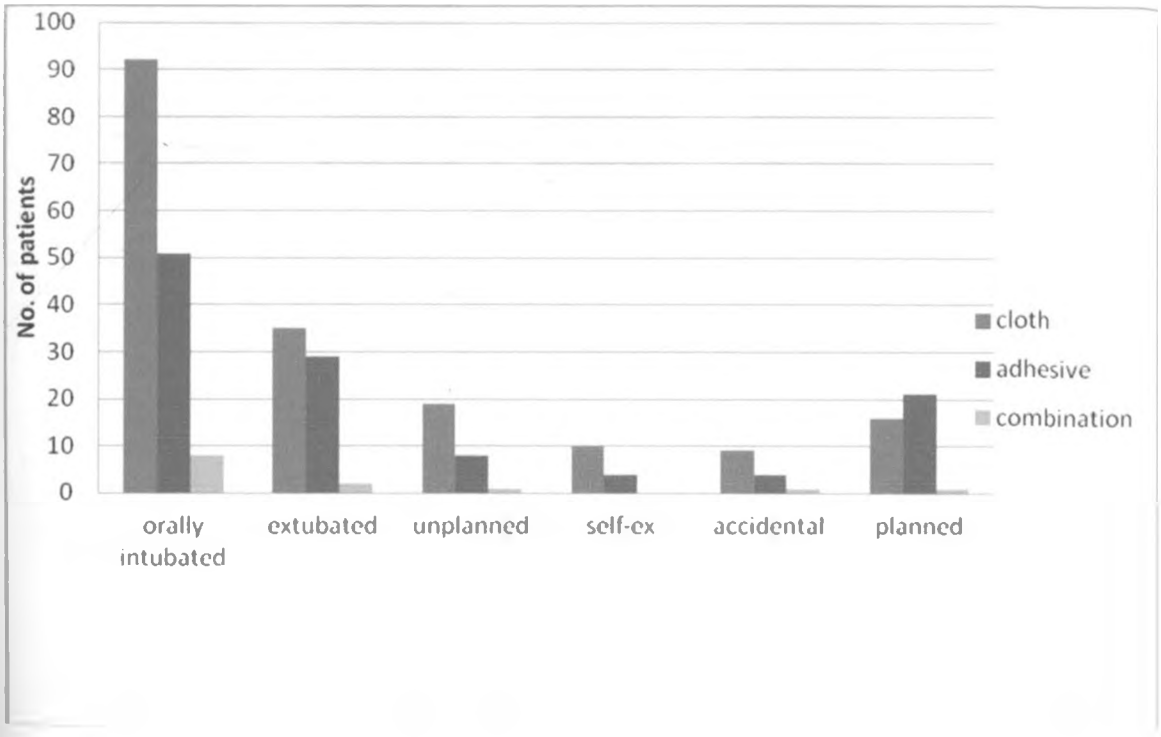

Fig 11. ETT securing method and outcome

6.11 ETT securing methods in various clinical categories.

Cloth ties were used predominantly in neurotrauma (15) and medical (14) patients while adhesive tape was used predominantly in surgical (22) and paediatric (5) patients. A combination of these two methods was used in one general surgical patient and one paediatric patient.

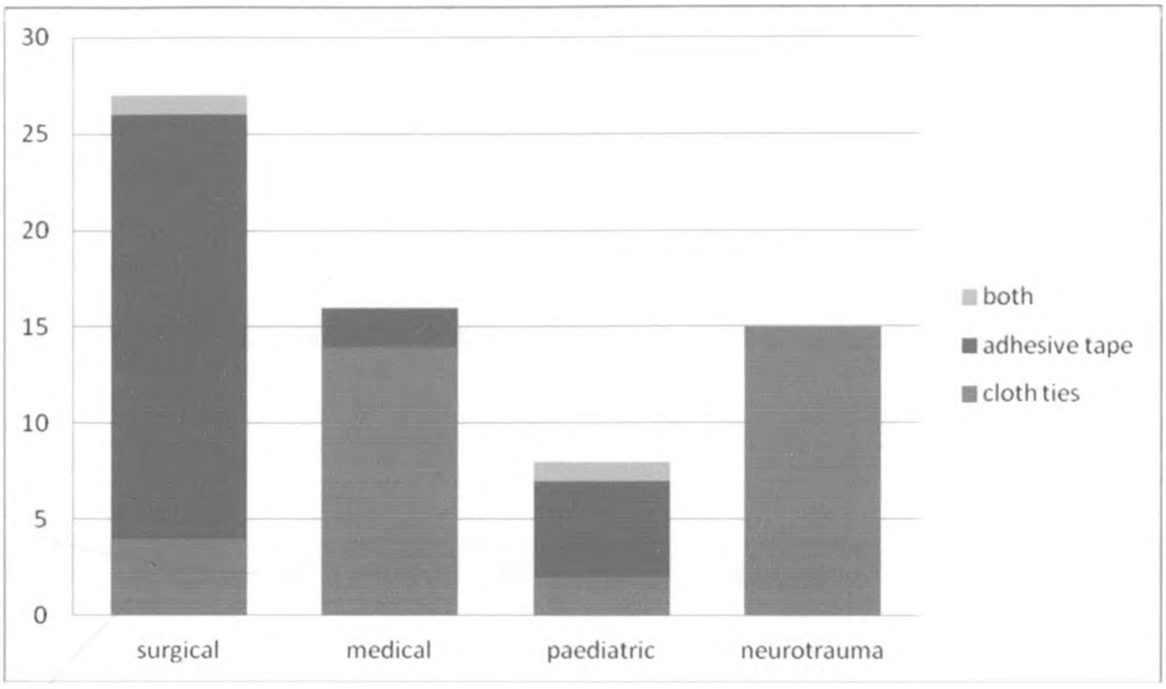

Fig 12. ETT securing method and patient clinical category

6.12 Use of pharmacological and physical restraints.

33 out of the 66 extubated patients were pharmacologically and or physically restrained at least an hour prior to extubation. The most widely used form of restraint were wrist restraints which were used in 27 patients (78.8%). Sedation alone was used in 4 patients (12%) while wrist and leg restraints, sedation and paralysis as well as sedation, wrist and leg restraints were used in 1 patient each (3%).

Table 1 Use of restraints in patients prior to extubation

EXTUBATION MODE	PLANNED		ACCIDENTAL		SELF		TOTAL
OUTCOME	successful	unsuccessful	successful	unsuccessful	successful	unsuccessful	
Physical restraints:							
Wrist restraints only	14	4	0	3	5	0	26
Wrist & leg restraints	0	0	0	1	0	0	1
Pharmacological restraints:							
Sedation only	3	0	0	0	1	0	4
Sedation & paralysis	1	0	0	0	0	0	1
Physical and pharmacological restraints:							
Sedation with wrist & leg restraints	0	0	0	0	1	0	1
No restraints							
	12	4	1	9	2	5	33
Total	30	8	1	13	9	5	66

7 self extubations (50%) occurred in restrained patients and 7 self extubations (50%) occurred in unrestrained patients. 4 accidental extubations (71%) occurred in restrained patients while 10 accidental extubations (29%) occurred in unrestrained patients. 22 planned extubations (58%) occurred in restrained patients while 16 planned extubations (42%) occurred in unrestrained patients.

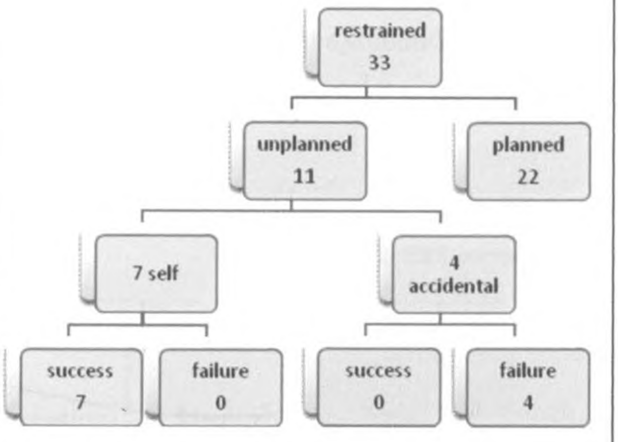

Fig. 13. Extubation outcome in restrained patients

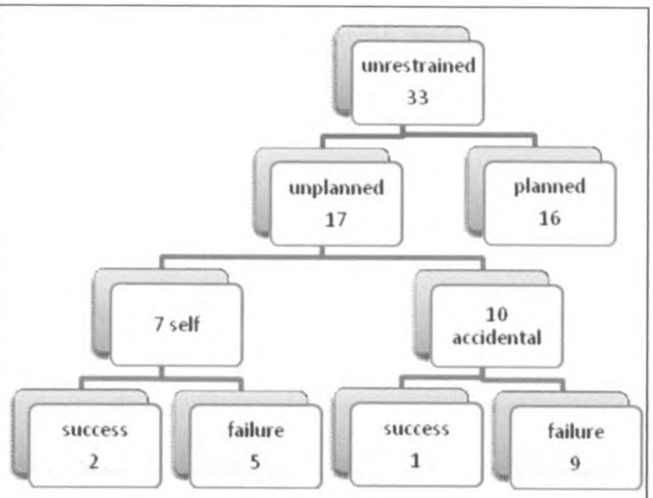

Fig. 14 Extubation outcome in unrestrained patients

6.13 SBT performance in predicting extubation outcome:

26 of the 30 successful planned extubations had successfully completed an SBT according to the AARC 2007 clinical practice guidelines before extubation while 4 had not.

5 out of 8 unsuccessful planned extubations had had successfully completed an SBT before extubation while 3 had not. 4 out of 9 successful self extubations had successfully completed an SBT before extubation while 5 had not. None of the unsuccessful self extubations had successfully completed an SBT before extubation. The only successful accidental extubation had successfully completed an SBT before extubation. 3 of the 13 unsuccessful accidental extubations had successfully completed an SBT before extubation while 10 had not.

Table 2: SBT performance in predicting extubation outcome.

Extubation mode & outcome	Planned successful		Planned unsuccessful		Successful self extubation		Unsuccessful self extubation		Successful accidental		Unsuccessful accidental	
Successful completion of SBT	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	26	**4**	**5**	**3**	**4**	**5**	**0**	**5**	**1**	**0**	**3**	**1**

DISCUSSION :

The main aim of this research was to study the occurrence of both planned and unplanned extubation events occurring at the KNH ICU and to determine important aspects associated with each mode in the hope that a better understanding of extubation events will lead to changes geared at improving the management of intubated patients.

Although the study participant's ages ranged between 2 months and 93 years, the patient population was largely a "youthful" population with a mean age of 31.6 yrs. (SD 23.6 years). 69% of patients were aged 40yrs and below. These results are in stark contrast to findings in western countries whereby older citizens have been found to consume a disproportionate share of critical care resources.

This could mean that in our setting, patients younger than 40 years were preferentially admitted to the ICU or that people aged 40 and below in the greater community were more exposed to factors that result in greater severity of illness and the need for ICU admission.

THE INCIDENCE OF UNPLANNED EXTUBATION IN KNH ICU

The 18.5% incidence of unplanned extubation is within but on the higher end of the 0.87% - 25% range reported in other studies.

The use of restraints and the ETT securing methods were examined in this study to determine their influence on the high rate of unplanned extubation events experienced by patients in our ICU.

Use of restraints.

The study findings revealed that the KNH ICU staff did not routinely physically or pharmacologically restrain intubated patients. Only 50% of extubated patients had been sedated or physically restrained while in other studies majority of the patients had been restrained.

The results mirrored the findings first noted by Coppolo and May, in that, self extubations occurred despite patients being restrained. 33% of restrained patients underwent unplanned extubation while 51% of unrestrained patients underwent unplanned extubation.

All seven self extubations that occurred in restrained patients were successful while most instances of self extubation among unrestrained patients were much less successful.

The frequency of accidental extubations was noted in this study to be almost 3 times higher in unrestrained patients than in restrained patients. The reason for this is unclear.

ETT securing methods:

This study revealed that variable techniques (cloth ties, adhesive tape as well as a combination of cloth ties and adhesive tape) are being employed to secure ETTs in the KNH ICU. Other studies have shown that the used of variable techniques are a cause of high UE rate. The high UE rate in the KNH ICU may therefore be attributed to this factor.

Fewer patients who had their ETTs secured with adhesive tape underwent unplanned extubation (53%) while the majority of patients who had their ETTs secured with cloth ties underwent unplanned extubation (68%)

However, paediatric and surgical patients usually had their ETTs secured with adhesive tape while medical and neurotrauma patients often had their ETTs secured by cloth ties. Earlier studies have shown that surgical patients have significantly fewer UE than medical patients, [50] and therefore selection bias is a possible reason why why fewer unplanned extubations were noted in patients with who's ETTs were secured with adhesive tape.

THE SUCCESS RATE OF UNPLANNED EXTUBATION IN KNH ICU

As was the case in earlier studies[35,45,52], not all UE experienced by patients in this study were unsuccessful extubations. 10 out of 28 UEs resulted in success indicating that extubation in these 10 patients should have been considered earlier by the ICU clinician.

Other studies have reported unplanned extubation success rates of between 44- 56%. The KNH ICU experienced a lower rate of successful unplanned extubation.

9 out of 10 successful unplanned extubations were self-extubations while 1 was accidental. The extremely low success rate (92%) of accidental extubations indicates that they should be avoided at all costs.

THE INCIDENCE OF EXTUBATION FAILURE AFTER PLANNED EXTUBATION IN KNH ICU

The overall incidence of extubation failure in the KNH ICU was 39%.

Specific patient groups were found to be especially high risk for extubation failure. These included male gender (50% failure rate), paediatric medical (100% failure rate), neurotrauma (67% failure rate), as well as patients who experienced an accidental extubation (93% failure rate).

The incidence of self and accidental extubations did not differ according to gender and thus did not count as a reason for the apparent successful extubations in women. The singlemost important factor that predisposed the male gender to higher risk of extubation failure was that male patients comprised 93% of the extubated neurotrauma patients; a sub-specialty category who were noted to be especially high risk for extubation failure in this study.

The incidence of failure after planned extubation in this study was 21%

This value in other studies varies from 2 – 25% depending on the population studied and time period used to determine extubation failure.[51]

This researcher did not come across a published ICU study into extubation events that managed as wide a variety of patients as the KNH ICU did. It appears that in keeping with the wide spectrum of patients requiring critical care, ICUs have become specialized centers which cater for specific patient groups. Most ICUs dealt exclusively in adult or paediatric populations. Many were specialized even further to cater to surgical or medical patients only. A few catered to an even more exclusive group of patients eg. coronary, neurovascular or burn injury ICUs.

Because of this inter-ICU variability, comparisons of extubation failure are difficult to apply considering the population studied heavily influences extubation outcomes; e.g. the exclusion of paediatric patients in our study in order to reflect the results of an adult population would decrease the planned extubation failure rate from 21% to 19% and the overall extubation failure rate from 39% to 30%. Considering adult surgical patients only would give a planned extubation failure rate of 7% and an overall failure rate of 5% etc.

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In addition, not only were other ICUs specialized, they were also manned by critical care physicians from a wide variety of specialty backgrounds including surgery, paediatrics and internal medicine. This possibly renders them better equipped to handle target patient populations.

All critical care physicians currently managing the KNH ICU during the study period were casually observed to have a background in anaesthesia. The degree of involvement of other specialist physicians in the management of their respective ICU patients was not investigated in this study but is possibly reflected in the extubation outcomes experienced by patients in the various sub-specialty categories. The low extubation success rates experienced by paediatric, general medical and neurotrauma patient populations leads to the conclusion that a change in their management is essential and should be geared towards development and delivery of a more specialized health care system. A greater degree of involvement of non-anaesthetist specialist physicians in the KNH ICU should also be sought.

The relatively longer 72 hour period used in this study to define extubation failure could have been a reason for a higher extubation failure rate. However, most extubation failures occurred within the first 24 hours of extubation. Only 2 patients who had successfully completed 24 hours of extubation were reintubated and none of the patients who had successfully completed 48hours of extubation required reintubation. The study is therefore comparable to studies that used the 24 and 48 hour time frames.

ADVERSE EVENTS EXPERIENCED DURING EXTUBATION IN KNH ICU

The following adverse effects were experienced by patients within 30 minutes of extubation: Desaturation, laboured breathing, stridor, hypotension, aspiration, bradycardia, hypoxia, cardiac arrest. No patient was reported to have experienced hypercapnia and no mortality occurred.

21 extubated patients (32%) experienced one or more complications within 30 min of extubation. 18 of them (86%) were reintubated within 72hours of extubation.

45 extubated patients (32%) had no complications within 30 min of extubation. However 8 of them (18%) were reintubated within 72hours of extubation.

THE ROLE OF SBT IN PREDICTING EXTUBATION SUCCESS IN KNH ICU

From section B item 12 of the survey tool it was possible to discern whether patients had completed a spontaneous breathing trial (SBT) prior to extubation.

SBT completion correctly predicted successful extubation in 31 out of 40 incidences of successful extubation. In all 9 instances when the absence of an SBT wrongly predicted extubation failure, that failure can be attributed to iatrogenic error whereby the patient was unnecessarily receiving substantial ventilatory support at the time of extubation.

The lack of successfully completed SBT correctly predicted extubation failure in 18 out of 26 cases of failed extubation. However successful SBT completion erroneously predicted extubation success in 8 out of 26 cases. A further review of these 8 cases revealed that 5 of the patients had been diagnosed as having suffered a severe head injury, while the remaining 3 patients had respectively been diagnosed as having hypertensive stroke, upper airway obstruction and herbal intoxication.

It thus appears that despite successful completion of an SBT, caution should be exercised while assessing extubation readiness in patients with depressed neurological function as well as patients with suspected upper airway obstruction as inability to maintain airway patency and not ventilatory failure can also be a reason for failed extubation.

CONCLUSIONS:

The incidence of unplanned extubation in KNH ICU was 18.5%. This is within but on the higher end of the range reported in other studies.

The success rate of unplanned extubations is 35.7%. Self extubations are more successful than accidental extubations, but the general success rate of UE is lower than that of planned extubations.

Specific patient groups are especially high risk for extubation failure.

High surveillance of extubated patients should be implemented during the first 30 minutes after an extubation event.

An SBT is a tool used frequently but not routinely by KNH ICU clinicians.

RECOMMENDATIONS:

1. All intubated patients in the KNH ICU should be routinely pharmacologically or physically restrained.
2. The ETT securing methods used in the KNH ICU should be standardised.
3. All intubated patients should have a routine SBT assessment prior to extubation in KNH ICU.
4. All patients who have completed a successful SBT should be extubated if airway patency and the ability to protect the airway are not in doubt.
5. A greater degree of involvement of non-anaesthetist specialist physicians in the KNH ICU should be pursued in order to provide specialized health care to patient groups at increased risk of extubation failure.

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APPENDIX Ia: **GUARDIAN EXPLANATION FORM**

Dear Sir/Madam,

I am a Senior House Officer undertaking a Masters of Medicine (M.Med.) degree in Anaesthesiology at the University of Nairobi. I am currently conducting a study titled, **"A BASELINE STUDY OF EXTUBATION EVENTS OCCURRING AT THE INTENSIVE CARE UNIT OF THE KENYATTA NATIONAL HOSPITAL."**

I hereby undertake to explain the nature of my study to you, the guardian(s) of an intubated patient admitted in the Intensive Care Unit of the Kenyatta National Hospital, in the hope that you will grant consent for your patient to be included in the study. I understand that this is a difficult time and I take this opportunity to wish your patient a rapid recovery.

This study intends to observe and document:

1. When and how the endotracheal tube currently inserted into your patient's airway will be removed.
2. Whether or not he/she will need to have the endotracheal tube re-inserted after its removal.
3. Whether or not the patient or attending doctor or the patient experiences any problems during removal or re-insertion of the endotracheal tube.

The study findings will be used to make recommendations geared at improving the management of intubated patients in KNH ICU. This study does not involve any risks to your patient neither does it entail the imposition, withholding or withdrawal of any treatment from him/her. Decisions concerning the management of your patient will be left to the KNH ICU team, in consultation with you. Your patient will not be denied treatment if, on his behalf, you decline to participate. Participation in this study is purely voluntary and no financial benefit will be gained. Participation will be terminated at any time you so wish. Strict confidentiality will be maintained. Feel free to seek any clarification on matters pertaining to this survey. Thank you for your co-operation.

Dr. Winnie Wakiuru Mathangani (Tel: 0721 624 304)

APPENDIX I b: **PATIENT EXPLANATION FORM**

Dear Sir/Madam,

I am a Senior House Officer undertaking a Masters of Medicine (M.Med.) degree in Anaesthesiology at the University of Nairobi. I am currently conducting a study titled, **"A BASELINE STUDY OF EXTUBATION EVENTS OCCURRING AT THE INTENSIVE CARE UNIT OF THE KENYATTA NATIONAL HOSPITAL."**

I hereby undertake to explain the nature of my study to you, a conscious intubated patient admitted in the Intensive Care Unit of the Kenyatta National Hospital, in the hope that you will grant consent to be included in the study. I understand that this is a difficult time and I take this opportunity to wish you a rapid recovery.

This study intends to observe and document:

1. When and how the endotracheal tube currently inserted into your airway will be removed.
2. Whether or not you will need to have the endotracheal tube re-inserted after its removal.
3. Whether or not you or the attending doctor experiences any problems during removal or re-insertion of the endotracheal tube.

The study findings will be used to make recommendations geared at improving the management of intubated patients in KNH ICU. This study does not involve any risks to you neither does it entail the imposition, withholding or withdrawal of any treatment from you. Decisions concerning your management will be left to the KNH ICU team, in consultation with you. You will not be denied treatment if you decline to participate. Participation in this study is purely voluntary and no financial benefit will be gained. Participation will be terminated at any time you so wish. Strict confidentiality will be maintained. Feel free to seek any clarification on matters pertaining to this survey. Thank you for your co-operation.

Dr. Winnie Wakiuru Mathangani (Tel: 0721 624 304)

APPENDIX II: **CONSENT FORM.**

I _____[initials], hereby consent to be included/ for my patient to be included in the survey on extubation events at the Kenyatta National Hospital's Intensive Care Unit.

I confirm that I have been fully informed about the procedure, the confidentiality, and the voluntary nature of participation in the study. I fully understand the right of withdrawal from the study at anytime.

I hereby give my informed consent under no duress or coercion whatsoever.

Signature _____ Date _____

Principal investigator's telephone number: 0721 624 304.

FOMU YA KIBALI CHA KUHUSISHWA

Mimi _____[herufi za majina] nakubali/nakubalia mgonjwa wangu kuhusishwa katika utafiti huu katika hospitali kuu ya Kenyatta.

Nadhibitisha ya kwamba nimeelezwa kuhusu utafiti huo na ninaelewa haki yangu ya kujiondoa wakati wowote kutoko kwa utafiti. Ninatia sahihi hii bila ya kusulutishwa.

Sahihi _____ Tarehe _____

Nambari ya simu ya mtafiti mkuu: 0721 624 304

A BASELINE STUDY OF EXTUBATION EVENTS OCCURRING AT KNH ICU.

APPENDIX III: **SURVEY TOOL**

TOOL NO: _____

SECTION A: To be filled in for **all** orally intubated patients.

1. NAME _____ (initials/number) 2. SEX: ☐ Male ☐ Female 3. AGE: _____

4. Place, Date and time of intubation: _____, _____, _____

5. ETT securing method: ☐ Adhesive tape ☐ Cloth ties ☐ None ☐ Other _____

6. ICU Admission date & time _____ / _____ 7. Admission diagnosis: _____

8. End point of intubation: ☐ Extubation ☐ Tracheostomy ☐ Death while intubated.

SECTION B : To be filled in **only** if the above patient experiences an extubation event.

9. Place, Date and time of extubation: _____/_____/_____

10. Type of extubation: ☐ Planned ☐ Accidental ☐ Self – extubation

11. Tick any complications experienced within 30 minutes of extubation:

☐ None ☐ Desaturation ☐ Laboured breathing ☐ Stridor ☐ Hypotension ☐ Aspiration
☐ Bradycardia ☐ Hypoxia ☐ Hypercapnea ☐ Cardiac arrest ☐ Death ☐ Other .....

12. Ventilatory mode **prior** to extubation:

☐ IPPV ☐ SIMV ☐ BIPAP ☐ CPAP ☐ T-PIECE

Level of: **A)** Pressure support _____ **B)** PEEP _____ **C)** FiO_2 _____ % or O_2 flow _____ lit/min

13. Was the above ventilatory mode maintained for > 30 min prior to extubation? ☐ Yes ☐ No

14. Use of physical restraints: ☐ Wrist/Hand ☐ Leg ☐ Other ☐ None

15. Administration of sedative drugs 1 hr prior to extubation: ☐ Yes ☐ No

16. Administration of muscle paralysis 1 hr prior to extubation: ☐ Yes ☐ No

SECTION C: To be filled in **only** in the event of a failed extubation. (i.e if the above extubated patient required reintubation within 72 hrs of extubation.)

17. Date, time and place of reintubation _____,_____,_____

18. Tick any complications experienced during emergent reintubation:

☐ Failed intubation ☐ Multiple intubation attempts ☐ Equipment malfunction/ unavailability

☐ Airway trauma ☐ Hypotension ☐ Aspiration ☐ Bradycardia ☐ Cardiac arrest ☐ Death

☐ Other ..... ☐ None

19. Ventilatory mode after reintubation:

☐ IPPV ☐ SIMV ☐ BIPAP ☐ CPAP ☐ T-PIECE

Level of : **A)** Pressure support _____ **B)** PEEP _____ **C)** FiO2 _____ % or O_2 flow _____ lit/min

For queries concerning the use of this data collection tool please contact the principal investigator Dr. Winnie Mathangani on (Tel: 0721 624 304)

APPENDIX IV: **BUDGET**

ITEM	UNIT COST KSh	NUMBER OF UNITS	TOTAL COST KSh
Computer	40000	1	40000
Printer/copier	5000	1	5000
Paper	400	4	1600
Internet hours	60	10	600
Statistician	5000	1	5000
Document binding	100	8	800
Sub total			**53000**
Contingency @ 5% of sub total			2650
Grand Total			**55650**

APPENDIX V: **WORK PLAN :**

ACTIVITY	2009 July	2009 Sept	2009 Oct	2009 Nov	2009 Dec	2010 Jan	2010 Feb	2010 Mar	2010 Apr	2010 May
Proposal Writing	√	√	√	√						
Presentation to Ethical Review Committee					√	√	√			
Data Collection							√	√		
Data Processing									√	
Report Writing									√	
Study Presentation										√

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11th March 2010

Dr. Winnie Wakiuru Mathangani
Dept. of Surgery/Anaesthesia
School of Medicine
University of Nairobi

Dear Dr. Mathangani

RESEARCH PROPOSAL: "A BASELINE STUDY OF EXTUBATION EVENTS OCCURING AT THE INTENSIVE CARE UNIT OF KENYATTA NATIONAL HOSPITAL" (P352/12/2009)

This is to inform you that the KNH/UON-Ethics & Research Committee has reviewed and **approved** your above revised research proposal for the period 11th March 2010 10th March 2011.

You will be required to request for a renewal of the approval if you intend to continue with the study beyond the deadline given. Clearance for export of biological specimens must also be obtained from KNH/UON-Ethics & Research Committee for each batch.

On behalf of the Committee, I wish you a fruitful research and look forward to receiving a summary of the research findings upon completion of the study.

This information will form part of the data base that will be consulted in future when processing related research study so as to minimize chances of study duplication.

Yours sincerely

DR. L. W. MUCHIRI
AG. SECRETARY, KNH/UON-ERC

c.c. Prof. K. M. Bhatt, Chairperson, KNH/UON-ERC
The Deputy Director CS, KNH
The Dean, School of Medicine, UON
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