# DRUG ADMINISTRATION PRACTICES OF ANAESTHESIA PRACTITIONERS AT KENYATTA NATIONAL HOSPITAL

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

**2014**

**DR WAIRIMU MWAURA WANGUHU**

**H58/68650/2011**

**PRINCIPAL INVESTIGATOR**

DR. WANGUHU WAIRIMU MWAURA, MBChB (Nbi)

POSTGRADUATE STUDENT IN ANAESTHESIA,

DEPARTMENT OF ANAESTHESIA,

UNIVERSITY OF NAIROBI.

**SUPERVISOR**

DR. MURIITHI MWITI, MBChB (Moi), MMed (UON),

LECTURER IN ANAESTHESIOLOGY,

DEPARTMENT OF ANAESTHESIA,

UNIVERSITY OF NAIROBI.

**DECLARATION**

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

Signature..... Date.....

This dissertation has been submitted for the degree of Masters of Medicine in Anaesthesia with my approval as university supervisor.

Signature..... Date.....

**ACKNOWLEDGEMENTS**

I wish to express my appreciation to my supervisor Dr. Muriithi Mwiti for his guidance, patience, support and invaluable input in writing this dissertation.

I would like to sincerely thank:

Dr. T. Chokwe for his input and my mentor Dr. C. Kabetu for his words of encouragement.

My parents and siblings for their constant support and encouragement.

**TABLE OF CONTENTS**

**LIST OF ABBREVIATIONS AND ACRONYMS**

AIMS- Australian Incident Monitoring Study

ANZCA- Australian and New Zealand College of Anaesthetists

APSF – Anaesthesia Patient Safety Foundation

ASA- American Society of Anaesthesiologists

IOM – Institute of Medicine

IS0- International Standards Organization

ISMP - Institute of Safe Medication Practices

JCAHO- Joint Commission on Accreditation of Health Care

NCCMERP- National Coordinating Council for Medication Error Reporting and Prevention

WHO- World Health Organization

**LIST OF OPERATIONAL DEFINITIONS**

1. **Drug error:** an error in the prescription, dispensing or administration of a drug with the result that the patient fails to receive the correct medication or proper dosage.
2. **Near miss:** a medication error that has the potential to harm a patient but does not produce patient injury because of chance, prevention or mitigation.
3. **Correct dose:** the recommended dose of a drug per kilogram body weight.
4. **Team leader:** the senior most anaesthesia practitioner in charge of the scheduled list of operations.

**LIST OF FIGURES AND TABLES**

**List of figures**



**List of tables**

**ABSTRACT**

**Background:** Patient safety is a serious global public health concern. The delivery of healthcare worldwide is challenged by a wide variety of safety problems. Iatrogenic harm through medication errors is one of these problems. Drug errors are of particular concern in anaesthesia as drug administration is a core clinical activity for anaesthesia practitioners. The study aimed to determine the drug administration practices of anaesthesia practitioners at KNH and the methods used to prevent drug errors.

**Methodology:** This was a prospective cross sectional study carried out in the Kenyatta National Hospital. Data was collected through observing the practice used by anaesthesia practitioners in the preparation, administration and storage of drugs in the anaesthesia workspace. Data analysis was analysed using SPSS version 20 as per the research objectives.

**Results:** A total of 260 anaesthetic procedures were observed. Syringe labelling at 94.6% was the most common method used by anaesthesia practitioners to prevent drug errors. The common drug errors were incorrect drug dose, wrong drug, lack of asepsis and inaccurate documentation of drugs administered. Drugs involved in drug errors included: neuromuscular blocking agents, antibiotics, lignocaine and epinephrine.

**Conclusion:** Anaesthesia practitioners at KNH are aware of the risk of drug errors during the administration of anaesthesia and use measures to prevent the drug errors. Standardisation of the practice of anaesthesia drug preparation, administration and storage of drugs in the KNH is required.

## 1.0 INTRODUCTION

Centuries ago Hippocrates the father of modern medicine recognized the potential for iatrogenic injury. The Hippocratic Oath drafted in 4th century B.C. is an oath taken by physicians pledging "to prescribe regimens for the good of my patients according to my ability and judgement and never do harm to anyone." Despite this oath, healthcare worldwide is not as safe as it should be or can be.

The Institute Of Medicine defines patient safety as freedom from accidental or preventable injuries produced by medical care[1]. Patient safety is a serious global public health concern with the delivery of healthcare challenged by a wide variety of safety problems. Iatrogenic harm is one of these problems. In 1999 the IOM released its report *To Err is Human: Building a Safer Health System*, the report focused on the issue of medical errors in the hospital setting[1]. Findings from the report showed that an estimated 44,000 to 98,000 people die each year in hospital as a result of medical errors, with drug errors accounting for an estimated 7000 deaths[2]. The release of this report resulted in a change in the way the public and health care systems thought about patient safety and quality of care. Status quo was deemed no longer acceptable and changes would have to be effected so that patients are not harmed by the same health care system that is supposed to offer healing.

Anaesthesiology is recognised as the leading medical speciality in addressing issues of patient safety[3]. Anaesthesia related mortality has decreased from 2 deaths per 10000 anaesthetics administered in the 1980s to about one death per 200000 to 300000 anaesthetics administered today[1] .The focus on patient safety in anaesthesia is due to the fact that anaesthesia is necessary for surgery but has no therapeutic benefit of its own and can be dangerous.

Drug error in anaesthesia has been recognised as an area in which improvements in patient safety can be made[4]. Anaesthesiology is unique as a medical speciality as the anaesthesia practitioner is responsible for the selection, preparation, dosing and administration of drugs themselves. Administration of one drug safely is not difficult. It has been estimated that an anaesthesiologist administers a quarter of a million drugs over a career lifetime[5]; to do this with a hundred percent accuracy is difficult.

All patients have a right to safe and effective healthcare. In this regard there have been calls to reduce drug errors as a source of iatrogenic harm. The IOM in 1999 set a target of 50% reduction in medical errors in five years; this has yet to be achieved[1]. To be able to meet this target we must accept the disturbing truth that medical errors do occur then begin to act to correct the problems that are contributing to unsafe healthcare.

## 2.0 LITERATURE REVIEW

### HISTORICAL BACKGROUND

One of the earliest studies done on medication errors in anaesthesia was in 1954 by Henry K. Beecher[6]. He did a review of 599,548 anaesthetics administered in ten hospitals between 1948 and 1952 and found that medication errors accounted for a significant proportion of adverse care events. A study by Barker and McConnell in 1966 on medication errors in hospitals demonstrated a rate of 16 errors per 100 doses of medication administered[7].

In 1975 the Institute of Safe Medication Practices was established with a mandate to advance medication safety in all health care settings. The mandate was to be achieved through identifying risks in medication use systems, recommending optimal system safeguards and advancing safe medical practice.

In 1984 the Anaesthesia Patient Safety Foundation a multidisciplinary organization was created expressly to help prevent adverse clinical outcomes in patients undergoing anaesthesia. Its vision is that any preventable harm to the patient during anaesthesia no matter how minor or infrequent is unacceptable. The foundation recognized the magnitude of preventable drug errors in anaesthesia and hosted a mediation safety conference in 2010 where a new paradigm shift was proposed to reduce medication errors causing harm to the patient. The paradigm is based on Standardization, Technology, Pharmacy/ Prefilled /Premixed and Culture (STPC) [4].

In 1991 the Harvard Medical Practice Study published its findings. It revealed that 3.7% of hospitalizations involved adverse events that prolonged hospital stay, caused disability or resulted in death[2]. In 1996 the Australian Incident Monitoring Study found that drug errors were the most commonly reported problem in the first 4000 incidents reported contributing to 30% of all reports[8].

In 1999 the institute of medicine in its report *TO ERR IS HUMAN* found that between 48000-98000 people die in hospitals in America each year as a result of preventable medical errors[1]. 7000 of these preventable errors were due to due to medication errors alone. The medication errors resulted in lost human lives, increase in healthcare costs, lost income and disability.

Recently, countries globally have recognised the importance of patient safety. The World Health Organization estimates that as many as one in ten patients receiving healthcare will suffer preventable harm. In 2002 WHO member states agreed on a world health assembly resolution on patient safety and the World Alliance for Patient Safety was formed**.** This has resulted in patient safety and quality in healthcare becoming a running theme in healthcare policies worldwide[9].

## CLASSIFICATION OF DRUG ERRORS

The best way to understand how drug errors occur and how to prevent them is to consider their classification which can be contextual, modal or psychological[16]. The contextual classification of drug errors deals with the specific time, place, medicines and people involved when the drug error occurred. Modal classification describes the ways in which the error occur e.g. omission, substitution while the psychological classification explains the events that caused the drug error rather than merely describing them[17].

Modal classification of drug errors describes drug errors as[18]:

1. Omission: drug not given.
2. Repetition: extra dose of an intended drug administered.
3. Substitution: incorrect drug instead of the desired drug, a swap
4. Insertion: a drug that was not intended to be given at any particular time or at any time.
5. Incorrect dose: wrong dose of an intended drug.
6. Incorrect route: wrong route of an intended drug

Psychological classification of drug errors is based on the work of psychologists which explains events rather than merely describing them[17]. Ferner and Aronson found that drug errors occur when actions are intended but not performed and are classified into mistakes or skill based errors.

Mistakes are defined as errors in planning an act, they can be knowledge based or rule based errors. Knowledge based errors result from ignorance related to knowledge and can be general (knowing that penicillin can cause allergic reactions) specific (knowing that an individual is allergic to penicillin) and expert (knowing which drugs contain penicillin).

Rule based errors result from the failure to apply a guiding principle and involves either the misapplication of a good rule or the application of a bad rule or failure to apply a good rule. Skill based errors are defined as errors in executing correctly planned actions. They can be action or memory based. Action based errors occur when the performance of an action was not that which was intended. Memory based errors are covert slips in which a step in the treatment process is omitted or duplicated.

**INCIDENCE OF MEDICATION ERROR**

Medication error is a leading cause of morbidity and mortality in hospitalized patients[1]. Drug errors alone, have been found to account found to account for 7000 deaths every year[3]. In addition to personal loss, adverse drug events impose a considerable financial burden to healthcare systems.

The reported incidence of medication error associated with anaesthetic practice varies widely. A prospective study carried out in New Zealand at two tertiary hospitals by Webster et al of nearly 8000 anaesthetics revealed that one drug administration error occurs for every 133 anaesthetics (0.75%) with a near miss rate of 0.37% for all medication errors[18]. In South Africa a prospective study carried out at three tertiary hospitals found a combined incidence of drug errors/near misses of 1 in every 274 anaesthetics admininistered[20]. Differences in study design, data collection, definition of drug error and inconsistency in reporting drug errors and near misses may account for the discrepancy in reported incidence.

A survey carried out on 687 Canadian anaesthetists revealed that 85% of the participants had experienced one drug error or near miss[21]. Most of the errors (98%) were of minor consequence, though four deaths were reported. A similar survey carried out in New Zealand found that 89% of the respondents admitted to having made a drug administration error at some stage during their career with 12.5% admitting to having harmed a patient through this way[22].

Two hundred and five drug error related claims were filled between 1980 and 2003 in the ASA closed claims database[23]. These claims represented 4% of the total compared to 11% of

841 National Health Service Litigation Authority claims collected from 1995-2007 alleging patient harm by drug administration error[24].

Medication errors in anaesthesia are not new and unfortunately they continue to occur despite being reported and studies being conducted since the early days of the speciality. In 1978 Cooper et al used critical incident reporting to study perioperative safety[25]. They discovered that twenty percent of all events reported in the study were related to medication errors with drug administration errors being the second most common critical incident after breathing circuit disconnection to cause harm to patients. In 2005, a review of the critical incidents reported to the Australian Incident Monitoring Study revealed 896 incidents involving drug errors among the 8088 reports in the AIMS database[8]. The incidence of drug errors in the Thai incidence study was lower with 82 (4.1%) reports of drug errors out of a total of 1996 incident report forms[26].

The risk of serious drug errors in anaesthesia maybe higher than in other medical specialities[27]. Research from the aviation industry indicates that errors occur more frequently in demanding and fast paced environments such as the operating theatre[28].The discipline of anaesthesia involves the delivery of multiple potent drugs often given in rapid succession in high acuity situations. The anaesthesia practitioner is directly responsible for the preparation, dosing and delivery of medications to patients during these situations. Best practice methods used elsewhere in the hospital that involve important and time consuming checks and balances to prevent drug errors are not readily transferrable and applicable to the operating room setting.

## DRUGS INVOLVED IN DRUG ERRORS

In the ASA closed claims project a wide variety of drugs were involved in drug errors. Two drugs in particular were involved in errors. Succinylcholine was involved in 35 cases (17%) and epinephrine in 17 cases (8%) [23]. Other drugs involved were opioids 11.7%, local anaesthetics 9.3%, inhalational agents 13.2%, hypnotics 6.3%, antibiotics 3.9% and non depolarizing neuromuscular agents 3.4%. Twelve of the thirty five cases involving succinylcholine resulted in awake paralysis, five had prolonged neuromuscular blockade. Hyperkalaemic cardiac arrest occurred in two paraplegic patients and a patient with Gullian-Barre syndrome who received succinylcholine. Drug administration errors with epinephrine

were particularly dangerous with death or major morbidity resulting in eleven of the seventeen epinephrine related cases[23].

In the Thai incidents monitoring study the drugs most commonly involved were non depolarizing neuromuscular relaxants (23.1%), opioids (21.9%), antibiotics (17.1%) and succinylcholine (7.3%) [26].

In a self reporting survey carried out in a South African teaching hospital 93.5% of the respondents admitted to having administered a wrong drug or the right drug into the wrong site at some stage during their anaesthetic career[29]. The syringe swap of succinylcholine for fentanyl was the single commonest error occurring in 30% of incidents. Other drugs involved were induction agents 8%, local anaesthetics 7%, muscle relaxants instead of reversal 20% and adrenaline at 9.5%[29]. Two patients suffered harm after receiving adrenaline in error. One patient suffered a myocardial infarction and developed pulmonary oedema while a second developed ventricular fibrillation that required defibrillation.

In a survey carried out by PC Gordon et al on drug administration errors by South African anaesthetists a total of 303 specific wrong drug administrations were made[30].The syringe swap of succinylcholine for fentanyl was the commonest error at 23%. In forty three incidents (14%) the error involved the wrong administration of a potentially dangerous vasoactive drug. Other drugs involved were non depolarizing neuromuscular muscle relaxants 25%, induction agents 4%, opiates 6%, antibiotics 3%, atropine 3%, neostigmine 2% and others at 16%[22].

In the Australian Incident Monitoring Study there were 144 wrong drug problems in the first 2000 reports. Overall, the most commonly involved drugs were nondepolarizing relaxants 44 incidents, opioids 27 incidents, succinylcholine 26 incidents and local anaesthetics with 15 incidents[33].

## MECHANISM OF DRUG ERROR

Healthcare professionals are human beings and like all human beings are fallible. The most important component of every anaesthetic regimen is the human performance of the anaesthetist and its relationship to patient safety. More than 70% of incidents or accidents in anaesthesia are due to human factors. Clinical excellence is not achieved by the use of sound medical knowledge alone. Human factors and the interaction of team members as well as organizational conditions in the system of care also play a major role.

Traditionally, deviation from optimum outcomes in anaesthesia was understood to be due to imperfections in the art and science of anaesthesia. More rarely adverse outcomes were ascribed to negligence or incompetence on the part of the anaesthesiologist. Today, there is understanding that anaesthetists both as professionals and individuals have strengths and vulnerabilities pertaining to their work environment[31]. Anaesthesiologists operate in complex environments with differing specialities interacting to treat a patient whose condition and response may have unknown characteristics. Risk to patient safety comes from a variety of sources in the environment. Error results from physiological and psychological limits of humans. Error management is based on understanding the nature and extent of error, changing the conditions that induce error, determining behaviours that mitigate error and training personnel in their use.

Error is the failure of planned actions to achieve the goal. Human error can be classified according to consequences that result from the error or by psychological origins. Psychological classification focuses on the mental antecedents of the error[32]. The errors are classified into slips, lapses and mistakes. Slips and lapses occur when the plan is adequate but execution of the plan does not go as intended. Slips relate to observable actions and are associated with attention failures. Lapses are more internal events and relate to failures of memory. Slips and lapses occur during the largely automatic performance of some routine task. Mistakes occur when the actions go as planned but the plan is inadequate to achieve its intended outcome. Mistakes can be knowledge based or rule based.

The Swiss cheese model of organizational accidents by James Reason shows how human factors interact with system factors to cause accidents[32]. The Swiss cheese model hypothesizes that in any system there are many levels of defence e.g. checking of drugs

before administration, use of a preoperative checklist. Each of these levels of defence has little “holes” in it which are caused by lack of training, limited resources, poor design. These holes are known as latent conditions. Latent conditions are aspects of the system that predispose to threat or error. If latent conditions become aligned over successive levels of defence they create a window of opportunity for a patient safety incident to occur. Latent conditions also increase the likely hood that the healthcare professional will make an active error. An active error is error that occurs while delivering patient care. A combination of latent conditions and active error causes all levels of defence to be breached and a patient safety incident occurs.

**DRUG ADMINISTRATION IN ANAESTHESIA**

As a speciality the preparation and administration of drugs during anaesthesia is a core clinical activity. Administration of a drug to a patient under anaesthesia is a complex procedure often taking place under stressful and hurried conditions[33]. Anaesthetists both prescribe and administer the drugs they use. This removes the process of double checking medication prior to administration and places a special emphasis on the anaesthesiologist to develop safe medication practices. The aims of safe drug administration in anaesthesia are; to give the correct drug for the correct patient in the correct dose by the correct route at the correct time and to record this information correctly in the anaesthetic record[34].

The Australian and New Zealand College of Anaesthetists have developed guidelines for the safe administration of injectable drugs in anaesthesia so as to help prevent drug errors[35]. Principles for the safe administration of drugs include:

- Identification of every patient to whom any drug is administered by the person administering the drug.
- Formal organization of anaesthesia drug drawers and workspaces with attention to tidiness and the position of ampoules and syringes.
- Separation of dangerous drugs which are used less frequently from those that are used routinely.
- Look alike and sound alike ampoules of drugs of different pharmacological classes should be stored apart.

- Adequate, uncluttered surface space and appropriate trays clean for each patient should be provided for drawing up, arranging and holding the drugs used for each anaesthetic.
- Every anaesthetizing location should hold a complete set of self adhesive preprinted labels colour coded by class of drug to be used to identify the contents of syringes. In the absence of preprinted labels for the syringes hand written ones should be prepared or syringes labelled directly using permanent marker pens.
- Label on any drug ampoule or syringe must be carefully read before a drug is drawn up or injected. At the minimum the name and dose of the drug must be checked.
- Drugs should be drawn up one syringe and one ampoule at a time. The label on the ampoule should be checked and matched to that on the syringe.
- If practicable immediately before its administration each drug identity and dose should be checked with a second person or automated device. Drugs given intrathecally should always be checked with a second person.

In January 2010 the Anaesthesia Patient Safety Foundation (APSF) issued consensus recommendations on perioperative medication safety. The APSF proposed a new paradigm built upon the traditional requirements of medication labelling and careful reading of labels. The APSF recommended a new paradigm of standardization, technology, pharmacy and culture (STPC) [4].

Standardization involves having high alert drugs available in standardized concentrations or diluents prepared by the pharmacy in a ready to use form suitable for adult and paediatric patients. The use of standardized fully compliant machine readable labels on ready to use syringes and infusions. Lastly, infusions should be delivered by an electronically controlled smart device containing a drug library.

Technology: every anaesthetizing location should have a mechanism to identify medications before drawing them up or administering them and mechanisms to provide feedback, decision support and documentation.

Pharmacy: routine provider prepared medication should be discontinued whenever possible. Use of standardized pre prepared medication kits by case type should be used whenever possible. Clinical pharmacists should be part of the operating room team.

Culture: establish a just culture for reporting errors including near misses and discussion of lessons learned. Establish a culture of education, understanding and accountability in regards to medication safety.

Administration of a drug is associated with upto forty component steps[36]thus no matter how hard an individual attempts to perfect their drug administration skills human error persists. It is the duty of the anaesthesiologist to care for and protect the patient during surgery. Anaesthesiologists should embrace the above multifaceted approach to patient safety in the context of medication administration.

**CONSEQUENCES OF DRUG ERRORS**

Although a majority of drug errors do not result in harm to the patient a significant minority result in morbidity and death. Some of the consequences associated with drug errors in anaesthesia include: loss of life, increase in financial burden to health care systems, additional hospitalization time, loss of income, disability, awareness under anaesthesia and prolonged anaesthetic time.

The NCCMERP recommends that patient outcome following a drug administration error be classified as follows[34]:

Category A: circumstances or events that have the capacity to cause error.

Category B: an error occurred but it did not reach the patient.

Category C: an error occurred that reached the patient, but did not cause harm.

Category D: an error occurred that reached the patient and required monitoring to confirm that it resulted in no harm to the patient and or required intervention to preclude harm.

Category E: an error occurred that may have contributed to or resulted in temporary harm to the patient and required intervention.

Category F: an error occurred that may have contributed to or resulted in temporary harm to the patient and required initial or prolonged hospitalization.

Category G: an error occurred that may have contributed to or resulted in permanent patient harm.

Category H: an error occurred that required intervention necessary to save life.

Category I: an error occurred that may have contributed to or resulted in the patient's death.

**PATIENT SAFETY IN ANAESTHESIA**

The IOM defines patient safety as the prevention of harm to patients[1]. Prevention of harm to patients is defined by the patient safety network as freedom from accidental or preventable injuries produced by medical care[37]. The theory of organizational safety teaches us that safety is a never ending process[31]. Any patient harmed by an anaesthetic is one patient too many. This is in concert with the APSF vision statement that no patient shall be harmed by anaesthesia[38].

Anaesthesia facilitates surgery but does not have any therapeutic benefit therefore the risk of anaesthesia must be as low as possible. Anaesthesia is safer than ever owing to many different strategies employed to improve patient safety by preventing error[1].Causes of error in anaesthesia can be classified into human factors, equipment factors and organisation/system issues. Strategies attributed to the reduction in anaesthetic mortality include: improved monitoring techniques, the development and widespread adoption of practice guidelines and addressing problems relating to human factors, equipment and system issues.

Several technological solutions have been used to improve patient safety while under anaesthesia. The use of pulse oximetry, capnography and the electrocardiograph has become standard in the industrialized world and is thought to have contributed significantly to patient safety. Engineered safety devices that physically prevent errors from being made e.g. the system of gas connectors that prevent a gas hose cylinder being installed at the wrong site have also contributed to increased patient safety. New technologies for management of the patients airway e.g. the fibre optic laryngoscope has revolutionised the management of patients with known difficult airways.

The second strategy adopted by anaesthesiologists was the development of practice parameters (standards and guidelines) to provide guidance for the diagnosis, management and treatment of specific clinical problems. The first set of standards for basic monitoring of

patients was developed by the Harvard hospitals and then later adopted by the American Society of Anaesthesiologists. The standards include the use of electrocardiographic monitoring, assessment of ventilation, use of pulse oximetry for patients during anaesthesia. The World Federation of Societies of Anaesthesiology has international standards for the safe practice of anaesthesia[39]. These standards are recommended for all anaesthesia professionals throughout the world. The standards incorporate and elaborate upon the core components of the safe anaesthesia part of the World Alliance for Patient Safety safe surgery saves lives campaign. The standards are intended to provide guidance and assistance to anaesthesia professionals for improving and maintaining the quality and safety of anaesthesia care.

Anaesthesiologists have also been leaders in applying lessons from human factors engineering and the systems approach. Human error is estimated to be involved in 70% of anaesthetic incidents and accidents[40]. Human factors encompass all those factors that can influence people and their behaviour. In a work context human factors are the environmental, organizational and job factors and individual characteristics which influence behaviour at work. The benefits of applying the study of human factors in healthcare include: understanding why healthcare staff make errors and identifying which system factors threaten patient safety. Improvements in the safety culture in healthcare organizations and identifying what went wrong and predicting what could go wrong.

The basic premise of the systems approach is that human beings are fallible and that errors are to be expected even in the best organizations. Errors are seen as consequences of system factors and can only be prevented by changing the conditions under which humans work as we cannot change the human condition.

**PREVENTION OF DRUG ERRORS**

The five rights of medication use are generally regarded as the standard for safe medication practices[41]. The five rights include the right patient, right drug, right route, right dose and right time and right documentation[41]. Drug related errors are a major factor associated with iatrogenic injury in hospitalised patients[1]. Evidence based medical practice is a principal that has received great emphasis in recent years. In keeping with this Webster et al came up with

evidence based recommendations for preventing drug errors during anaesthesia by a systematic review of literature on prevention of drug errors.

**SYRINGES SHOULD ALWAYS BE LABELLED**

The process by which medications are procured, stored, prescribed and administered to patients is complex; hence it is not surprising that medication errors contribute substantially to the overall problem of iatrogenic harm in healthcare. In anaesthesia unlike other fields of medicine anaesthetists prepare, administer and record medications on their own without the benefit of the safeguards provided by pharmacists and nurses of double checking medication prior to administration.

There is considerable evidence to support the view that user applied syringe labels are very important for medication safety and that poor labelling practices can lead to patient harm[42]. In the AIMS problems with syringe labelling were an important contributing factor to medication errors during anaesthesia[33]. A prospective survey carried out at three teaching hospitals in South Africa revealed that syringe identification errors contributed to 21.3% of the drug errors[20]. Syringe labelling errors at 28.4% was the most common contributing factor to drug errors reported in a self reporting survey carried out at a South African teaching hospital[30].

Medications are often selected based upon location and visual features of the container. The recognition and identification of an object depends on shape, colour, brightness and contrast. Identification of the medication is verified by reading the label. In an effort to promote safe administration of medications to patients and to standardize labelling practices the ASA has developed medication labelling standards[43]. The Joint Commission has also developed medication labelling requirements as part of its national patient safety goals promoting safe administration of medication[44]. The Joint Commission mandates that all medication labels both on and off the sterile field should include the following information: the medication name, preparation date, strength, quantity, diluents and volume, expiration date when not used within 24 hours and expiration time when expiration occurs in less than 24 hours[44]. A fundamental tenet of safe practice mandates considering as unsafe and therefore discarding any medicine or fluid that cannot be identified[45]. The labelling recommendations indicate that it maybe permissible not to label a syringe if it does not

leave the hands of the person preparing it and the person administers the medication immediately. This would be useful in anaesthesia where there maybe situations where there is time pressure to draw up a particular medication and administer it in response to a developing need e.g. atropine for sinus bradycardia.

To ensure the correct user applied label is applied the following steps are recommenced by the ANZCA[35]. The process of drawing up a medication and filling the label on the syringe should be done one medication at a time. The label on the medication ampoule must be read prior to drawing up the medication checking in part the name and the amount of the medication. The name on the ampoule should then be matched to the name on the user applied label.

Despite drug labelling being a key element of medication safety, it requires time and vigilance and is prone to human error[46]. Incomplete labelling and medication labelling errors is common among clinicians. Medication labelling errors have been found to approach 10%[47]. Less than 50% of syringe labelling meets the Joint Commissions standards on labelling[46] and 42% of clinicians were found to label inconsistently in a study done by the ISMP IN 2004[47].The incomplete and incorrect labels can lead to drug administration errors.

Label enhancements that can be used to reduce drug administration errors include: use of bar codes and peel off labels[43]. Peel off labels are attached to ampoules or vials without obscuring the information provided by the manufacturer. They allow the anaesthesiologist to transfer both the contents of the ampoule and peel of the label at the same time. In this way, syringe labelling errors are minimised. To enhance patient safety further, barcodes can be incorporated into pre-printed ISO standard labels. The barcode should be at a location on the syringe that will not interfere with label legibility. Prior to administration of a drug the anaesthesiologist is expected to read the label then scan it with the barcode reader. A computer attached to the anaesthetic machine then announces the name of the drug and displays the drug name on the computer screen with its colour code. It also identifies a default dose which maybe accepted or altered.

Syringe labelling does not provide full guarantee of patient safety. In the AIMS 63% of the wrong drug incidents with syringes occurred with correctly labelled syringes[33]. These incidents were attributed to the phenomenon of “brain failure” where the anaesthesiologist

knows what drug he /she wants to administer but in reading a correctly labelled syringe containing another drug takes this syringe and administers the wrong drug[33]. This does not mean that syringe labelling is of no value but rather that it should be used in conjunction with other prevention strategies to solve the drug error problem in anaesthesia.

**STANDARDIZED CONCENTRATIONS OF HIGH ALERT DRUGS**

In an effort to address the issue of drug errors and improve on patient safety the ISMP conducted a study to determine the drugs and situations most likely to cause patient harm to patients[48]. The results of the study showed that a majority of the medication errors resulting in death or serious injury involved a small number of high alert drugs. The ISMP termed these medications that have the highest risk of causing injury when misused as high alert medications[48].The top 5 high alert medications identified by the ISMP include insulin, opiates, injectable potassium chloride concentrate, intravenous anticoagulants(heparin) and sodium chloride solutions above 0.9%[49].In an effort to make healthcare systems safer, in 2003 the Joint Commission on Accreditation of Healthcare Organization (JCAHO) revealed a list of seven national patient safety goals. One of the goals stated that organizations should limit the number of different concentrations available for high risk medication[50].

Standardised drug concentrations have been shown to afford the following safety factors: fewer calculation errors, simplified communication between all disciplines of health workers and it encourages the standardization of other steps in the medication use process. Challenges encountered with the introduction of standardized concentrations of drugs include: the need for more than one standardized concentration due to extremes of age of patients in the same hospital. The need for an institution wide training program for those involved in drug administration is essential for the successful implementation of standardized concentrations. This can be time consuming and cumbersome.

**MACHINE READABLE LABELS**

One way in which patient safety can be improved is through the use of machine readable bar labels such as bar codes used in a standardized format on all mediation packages and containers. A scannable bar code will help guarantee that the right drug and the right dose are being administered to the right patient. Bar coded medication administration systems

consist of a handheld device for scanning machine readable barcodes on patients and medications. The medication barcodes must have specific information for drug identification. This information includes the national drug code number, the name of the medication, drug dosage and the drug company that produced the medication. The expiry date and lot number of the medication is additional information that may also be included.

One advantage of the bar code administration systems is that it improves patient safety by reducing drug administration errors. It is a user friendly and effective way of confirming drugs prior to administration[51]. A study conducted to determine the effect of barcode technology on the safety of medication administration found that barcode usage prevented about 90000 medical errors each year and reduced the mortality rate by 20%[52]. Second advantage is that the system interfaces with medicine administration records. Barcode readers are connected to an automated electronic record that records all medication administered. In a study conducted on the feasibility of confirming drugs administered during anaesthesia the electronic recording system was found to give the anaesthesiologist more time to concentrate on the patient a feature that improves on patient safety. The electronic recording system also produced a detailed and accurate anaesthetic record which was seen as a great incentive to use the system and as an important safety feature[51].

Limitations and concerns associated with the use of bar codes is that the bar code technology may interfere with the workflow process and disrupt delivery of care to patients[53.]Another limitation is that shortcomings in the bar code medication administration system design and work flow integration may result in non standard procedures being used by healthcare workers[54]. This deviation from protocol of use increases the likely hood that a drug error will occur.

It is important to remember that technology alone does not ensure a safe medicine use system and the process changes that accompany any technology can introduce new sources of error.

## STANDARDIZED ORGANIZATION OF DRUG DRAWERS AND ANAESTHETIC TRAYS

Substitution of muscle relaxants for reversal agents was one of the drug errors frequently reported in a survey of medication errors in anaesthetic practice[21]. The survey identified incorrectly stocked medication as one of the contributing factors for the errors[21]. In their review of 2000 incident reports from the AIMS database Currie et al found a similar pattern of results[33]. Currie noted that one of the cues used to select the correct ampoule was its location. Once selected the likelihood of detecting the incorrect medication before it was administered was relatively low. Wrong location of an ampoule was a contributing factor in 8 % of all the drug errors reported[33].

In a review of evidence based strategies to reduce medication errors one of the five specific strong recommendations was that formal organization of medication drawers and workspace should be used with attention to tidiness and positioning of ampoules and syringes[55]. Standardization means that all anaesthetic carts in all anaesthetizing locations where anaesthetists or individuals who stock the carts may work should have the same content in layout[21]. Currie et al recommended the use of a physical template to standardize the storage of medication[33].

Drugs should be consistently located in the same place so as to facilitate familiarity and recognition this would then reduce on errors made while selecting drugs. Standardization also reduces inefficiency as time is not wasted looking for medications in various locations.

Merry and Webster recommend for the layout of medication drawers a minimum of two drawers should be used. This reduces congestion and provides for separation of commonly used drugs in the first top drawer from those that are potentially more dangerous or are needed only occasionally in the second drawer[56]. Grouping of medication according to function/ drug class, frequency of use and isolating more hazardous medication should be done to reduce drug errors.

Anaesthetic trays facilitate orderly arrangement of syringes and ampoules to provide a physical means by which drugs used during an anaesthetic maybe tracked. One or two trays maybe used depending on the complexity of the anaesthetic and the number of drugs used. Webster et al used plastic trays designed to facilitate order in the layout of syringes and

ampoules[56]. They recommended dividing the tray into three areas an active area, prompt area and used area. The used area is for used ampoules or syringes retained in an orderly fashion. An active area for syringes in current use and a prompt area set aside for drugs that maybe needed later in the anaesthetic[56].

**READ BACK FOR HIGH ALERT DRUGS**

Extensive literature exists demonstrating that humans frequently use pattern recognition to identify words rather than reading the full text. Words are not read one letter at a time but instead are recognized by their shape. This is especially likely to happen when the particular word begins and ends with the same letter[57]. In order to prevent drug administration error caused by this slip anaesthesiologists and trainees therefore need to be taught to make a conscious effort to read the ampoule label prior to drawing up any drug[20].

An analysis of the first 2000 incident reports made to the Australian Incident Monitoring Study identified 144 incidents in which a drug error was made; of these 44 were ampoule substitution errors. To reduce the incidence of these errors Currie et al suggested that when a drug is selected it is vital the ampoule label be read and re-read as once the drug is in the syringe the risk of detecting the error is decreased [33].In a study conducted by Fasting et al 63 drug errors out of 55426 anaesthetic procedures were identified over a 36 month period[58]. Fourteen percent of these errors were ampoule swaps with the most common being substitution of glycopyrrolate and neostigmine. One of the preventative strategies strongly recommended at the end of the study was the practice of double checking of ampoules as the drug is drawn up into the syringe and checking the label on the syringe before administration. This recommendation is based on the aviation industry model of safety which has extensive standard operating procedures for double checking.

**COLOUR CODING**

Colour coding is the systematic standard application of a colour system to aid in the classification and identification of drug products[59]. A colour coding system allows people to memorize a colour and match a drug it to its function[59] .The colour coding system was designed to reduce medication errors in anaesthesiology. In anaesthesia drugs are often prepared and drawn up in syringes sometime before they are to be used. This gives rise to

the possibility of choosing the wrong ampoule or wrong syringe "syringe swap". The addition of colour to a label is thought to be an additional visual and psychological cue to choose the right ampoule or syringe hence reducing drug errors[58]. The colour coding system was developed by the American Society for Testing and Materials (ASTM) as a standard for user applied syringe drug labels in anaesthesia[60]. The ASTM assigns a specific colour to each class of anaesthetic drug e.g. opioids are assigned the colour blue 297[60]. The standardized colour coding system has been adopted by anaesthetists in America, New Zealand, Australia, Canada and the United Kingdom.

The use of colour coding of pharmaceutical products for the purpose of reducing medication errors is controversial among experts. Jensen et al in their article on evidence based strategies for preventing drug administration errors recommended that colour coding by class of drug according to an agreed national or international standard should be used as one of the ways to prevent drug errors[61].Currie et al after analysing the first 2000 incident suggested the use of colour coding according to the ASTM standard by the manufacturer or the hospital pharmacy as one of the strategies that can be used to reduce drug error[33.]

Fasting and Gisvold conducted a prospective study to determine the incidence of adverse drug errors in anaesthesia and the impact of colour coded syringes[58]. They found that the reduction in drug errors after the introduction of colour coded labels was not statistically significant. The authors concluded colour coding does not eliminate syringe swaps and suggested that colour alone may not suffice as a visual cue to eliminate errors. Other problems associated with the use of colour coding include a limit to the variety of discernible colours available for commercial use with research conducted in other industries showing that subtle distinctions in colour are poorly discernible unless products are adjacent to each other[59]. Clinicians might also be colour blind resulting in misidentification of colour coded products. Lastly, the label colour identifies a drug category but it does not necessarily identify a specific drug or the drug concentration contained in a drug syringe. The ISMP also has concerns about the widespread adoption of colour coding and believes it should be used with caution[59].Colour coding can be used to good effect but it should only be a supplement to reading the drug text. The primary mode of checking should always be careful reading of every label.

**DRUGS SHOULD BE DRAWN UP AND LABELLED BY THE ANAESTHETIST WHO WILL ADMINISTER THEM**

Repetitive tasks e.g. drawing up induction drugs can eventually lead to automatic pilot performance of the task. Slips are caused by failure to monitor a highly routine action[33]. They are more common when limited cognitive resources are compromised by haste, inattention, distraction and fatigue[33]. The task of drawing up drugs requires the most attention and should be delegated to a highly trained person whose sole task is to draw up and label the drugs. During this period of drug preparation the anaesthesiologist should draw up one drug at a time, label the syringe after drawing up the drug, minimise interruptions and double check the label on the ampoule and syringe prior to administering the drug[35].

The anaesthesiologist is responsible for whatever drugs he administers to the patient. Orser and Oxorn in their case report on anaesthetic drug error minimizing the risk advocate that all anaesthetic personnel should use extreme caution when administering medications which they did not prepare themselves[18]. All anaesthesiologists should be aware that drug errors can occur when two people are involved in the selection and preparation and administration of a drug.

**REPORTING DRUG ERRORS**

Reporting both errors and near misses has been key for many industries to improve on patient safety[1]. The IOM emphasizes on the importance of reporting errors as it holds providers of healthcare accountable for performance and provides information that leads to improved patient safety[1]. Healthcare organizations and the patients they serve can benefit from enabling reporting this is because it sets up a process where errors and near misses can be communicated to key stakeholders. Once the data is compiled and evaluated to determine causes of errors processes can be created to reduce the risk of errors occurring in future.

In the past verbal reports and paper based incident reports were used to detect and document clinically significant medical errors. Currently web based nationally representative

reporting programs are used to report errors and near misses. The reporting system can be mandatory, voluntary, confidential and non confidential.

The main advantage with voluntary reporting is that it may encourage practitioners to report near misses and errors thus producing important information that might reduce errors. Voluntary reporting may result in underreporting with the true error frequency being many times greater than what is actually reported. Mandatory reporting systems are usually enacted by the law. They require the reporting of specific errors, sentinel events and adverse events causing patient harm or unanticipated outcomes.

Many errors go unreported by health workers. In a survey carried out in Canada 60.1% of the anaesthesiologists did not report the drug errors they made, 10.4% reported them to colleagues and 7.5% in departmental meetings[21]. The main reason for underreporting drug errors is fear that it will result in repercussions e.g. malpractice litigation or career threatening disciplinary action. Second barrier to reporting errors is that there is significant variation in definition of how errors are defined, what is reported and who should be involved in mitigating and reporting the effects of drug errors. Lastly error reports are difficult to fill and feedback about needed system changes to improve patient safety are rarely given.

A just culture for reporting errors and near misses should be established as this forms a platform on which discussions on reducing error can be held and lessons learned. Clinicians working in a culture of blame and punishment do not report all errors as they fear punishment. The name, blame and shame mantra has been a long held tradition in healthcare. In a just culture the focus is moved from blaming an individual when an error occurs and instead focuses on finding the contributing factors and addressing them. Healthcare organizations are being challenged to provide an environment inn which it is safe to admit errors and understand why the errors occurred. When individuals and organizations are able to move from individual blame to a culture of safety, where the blame and shame of errors is eliminated and reporting is rewarded organizations are enabled to increase reporting of all errors. Patients and the public support error reporting, they not only want to be informed, they want to know that quality improvements supported by shared learning will prevent similar future errors.

## 3.0 JUSTIFICATION

Patient safety is a serious global public health concern with the delivery of healthcare challenged by a wide variety of safety problems. Iatrogenic harm is one of these safety problems. Drug errors feature prominently in studies conducted on iatrogenic harm. This is because a large number of drugs used in healthcare are administered by traditional error prone means, thus drug errors remain a significant hazard to the health of patients everywhere.

All patients have a right to effective and safe healthcare thus; drug errors are of particular concern in anaesthesia as administration of drugs is a core clinical activity for anaesthesia practitioners. Anaesthesiologists administer a large number of potent drugs, often in rapid sequence. Many of our patients are sedated or under anaesthesia thus they cannot detect or correct drug errors themselves. They depend on us the anaesthesiologists to prevent the drug errors, a responsibility we should not take lightly.

At the Kenyatta National Hospital there are multiple levels of anaesthesia practitioners with no standardized practice of drug administration for anaesthesia. There has been no study conducted at Kenyatta National Hospital to determine the drug administration practices of anaesthesia practitioners. This study will evaluate the process of drug administration during anaesthesia, drug errors that occur and the measures used to prevent drug errors. The information obtained can then be used to create guidelines for the safe administration of drugs in anaesthesia resulting in increased patient safety.

## 4.0 OBJECTIVES

### RESEARCH QUESTION

Are the drug administration practices used by anaesthesia practitioners effective in preventing drug errors during the administration of anaesthesia?

### MAIN OBJECTIVE

To evaluate the drug administration practices during the provision of anaesthesia at Kenyatta National Hospital.

### SPECIFIC OBJECTIVES

1. To evaluate the process of drug administration to patients undergoing any type of anaesthesia at KNH.
2. To determine the measures used by anaesthesia practitioners to prevent the occurrence of drug errors.
3. To determine the drug errors that occur during the administration of anaesthesia at Kenyatta National Hospital.
4. To determine the drugs commonly involved in drug errors.

## 5.0 METHODOLOGY

### 5.1 STUDY DESIGN

A prospective cross sectional cross sectional study design was chosen as it enabled data collection on all variables to be done at once.

### 5.2 STUDY SITE

Kenyatta National Hospital is a national referral and teaching hospital in Kenya and the largest hospital in East and Central Africa. The study area was the main operating theatre suite which comprises of 12 theatres, eleven elective and one emergency theatre.

### 5.3 STUDY POPULATION

Participants were recruited from patients undergoing any type of anaesthesia for any procedure at the Kenyatta National Hospital who fulfilled the inclusion criteria and consented to participate in the study.

### 5.4 SAMPLE SIZE

The sample size for the study was calculated using the formula:

$n = \frac{z^2 \times p (1-p)}{}$

Where

n is the sample size

z is the standard normal deviation at the required confidence level of 1.96

p is the proportion of the target population estimated to have characteristics being measured.

d is the level of statistical significance set =0.05

Therefore; $n = \frac{(1.96)^2 \times (0.5) \times (0.50)}{(0.05)^2}$

$= 384$

With a study population of less than 10,000 the sample size was 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 the above calculation

N= the estimate of the population size, which in this case is the number of elective and emergency cases in the main operating theatre.

$$nf = \frac{384}{1 + (384/1080)}$$

=260

The desired sample size for the study was 260.

### 5.5.1 INCLUSION CRITERIA

1. All consenting patients who underwent anaesthesia for any procedure at Kenyatta National Hospital.

### 5.5.2 EXCLUSION CRITERIA

1. Patients who did not give consent to participate in the study.
2. Non consenting anaesthesia practitioners.

### 5.6 SAMPLING PROCEDURE

Participants in the study were selected using a stratified sampling procedure. The different strata were based on the time of the day and whether they underwent elective or emergency surgery. The emergency surgery stratum was divided into day and night emergency. This helped to determine whether lack of sleep or fatigue played a role in the drug administration practices of anaesthesia practitioners. No elective surgery procedures were performed at night. The sample size was divided in the ratio of 2:1 between elective and emergency surgeries. The ratio was based on the number of elective to emergency cases performed each month in the operating theatres at KNH.

Theatre lists for any particular day were submitted and displayed in the patient receiving area and main theatre reception the evening prior to surgery. In each stratum, convenient sampling was used and participants selected based on their availability in the theatres.

Availability referred to the principal investigator being present at the start of the administration of the anaesthetic. Enrolment was done consecutively until the desired sample size for each stratum was achieved.

## 5.7 DATA COLLECTION PROCEDURE

Eligible patients were recruited from theatre lists displayed in the patient receiving area and main theatre reception the evening prior to surgery. Informed consent was obtained from the patients through explaining the purpose and procedure of the study, as well as confidentiality of the information obtained from the patient. Once the patient had understood the study, they were requested to consent and confirm their participation in the study by writing their identification number and signing the informed consent form provided by the principal investigator.

I observed the practice used in the prescription, preparation and administration of drugs by the anaesthesia practitioners and filled in the appropriate section in the questionnaire. Any potential drug errors observed during the collection of data were pointed out to the anaesthesia practitioner prior to administration of the drug so as to maintain patient safety.

Prior to the commencement of collection of data, the research assistant underwent training by the principal investigator to ensure that the data was collected in a standard manner and thus minimizing person to person variability.

## 5.8 DATA COLLECTION PROCESS

Informed consent was obtained from the participants prior to being included in the study. Observation of the practice involved in the prescription, preparation and administration of drugs by the anaesthesia practitioners was then done.

### 5.8.1 DRUG PRESCRIPTION AND PREPARATION

1. Observing whether the ordering and prescription of drugs was done by the anaesthesia practitioner who administered them.
2. Number of people involved in drug preparation.
3. Whether drugs were drawn up and labelled by the anaesthesia practitioner who would administer them.

4. The labelling method used to identify the contents of a syringe after a drug was drawn up.
5. Whether the label on the drug ampoule was read before the drug was drawn up.
6. Whether the label on the syringe was checked by a second person or matched to the label on the ampoule.
7. Sterile anaesthetic tray was used for each patient.

**5.8.2 DRUG ADMINISTRATION**

1. Observing whether the patient was identified prior to drug administration and the identification method used.
2. Observing which member of the anaesthetic team administered the drugs.
3. Number of people involved in drug administration.
4. Whether the patient's weight was checked prior to administration of the drug.
5. Whether asepsis was observed during drug administration.
6. Whether drugs were counterchecked prior to administration.
7. Observing whether the correct dose of a drug was administered, via the correct route at the right time with the accepted practice for that drug.
8. Observing whether drugs administered were recorded accurately in the anaesthetic chart including drug name, dose, time and route.

**5.8.3 STORAGE OF DRUGS IN THE ANAESTHESIA WORKSPACE**

Observation was made of how the anaesthesia practitioners store their drugs after preparing them:

1. Whether drugs were drawn up and stored in a logical fashion in receptacles reserved for this purpose.
2. Whether drugs for administration via different routes were stored separately.
3. How drugs used for emergency purposes were stored.
4. Whether empty ampoules and syringes containing drugs were stored till the end of the anaesthetic procedure.

**5.9 DATA MANAGEMENT AND ANALYSIS**

The data was collected using a questionnaire administered by the researcher and the patient's anaesthetic record after which completeness and missing entries were keenly cross checked and rectified. At the end of the data collection period, the data was coded and entered into Microsoft Access Database. The safety of the data was ensured by using a password protected database and backup files were stored on an external hard drive.

Quantitative data collected was coded, processed and cleaned of any inconsistencies and outliers. Qualitative data was analysed through the selection of concepts, categories and themes. This involved reading through the data and developing codes that drew similar connections between categories and themes. Data was analysed using Statistical Package for Social Sciences (SPSS) version 20 as per the specific research objectives. Relationship between variables was established using Chi-square tests of association. Logistic linear regression of logit models was established and the relationship between the dependent and independent variables since responses were categorical. All tests were considered significant at a p value <0.05. The findings of the study were organized and presented in tables, graphs and pie charts.

The results obtained from this study will be made available to the Ethics and Research Committee KNH/UON and the Department of Anaesthesia. The results will be made available as part requirement of ethical approval and so as to strengthen protocols on drug administration and patient safety while undergoing any anaesthetic.

## 5.10 ETHICAL CONSIDERATIONS

The study protocol was reviewed by the Kenyatta National Hospital/ University of Nairobi Ethics and Research Committee and undertaken once approval was given. Participants in the study were enrolled after the nature of the study was explained to them and informed consent obtained. Confidentiality of information obtained from the participants was strictly adhered to at all times. There were no additional costs to the patient for participating in the study and no treatment was withheld from non consenting patients.

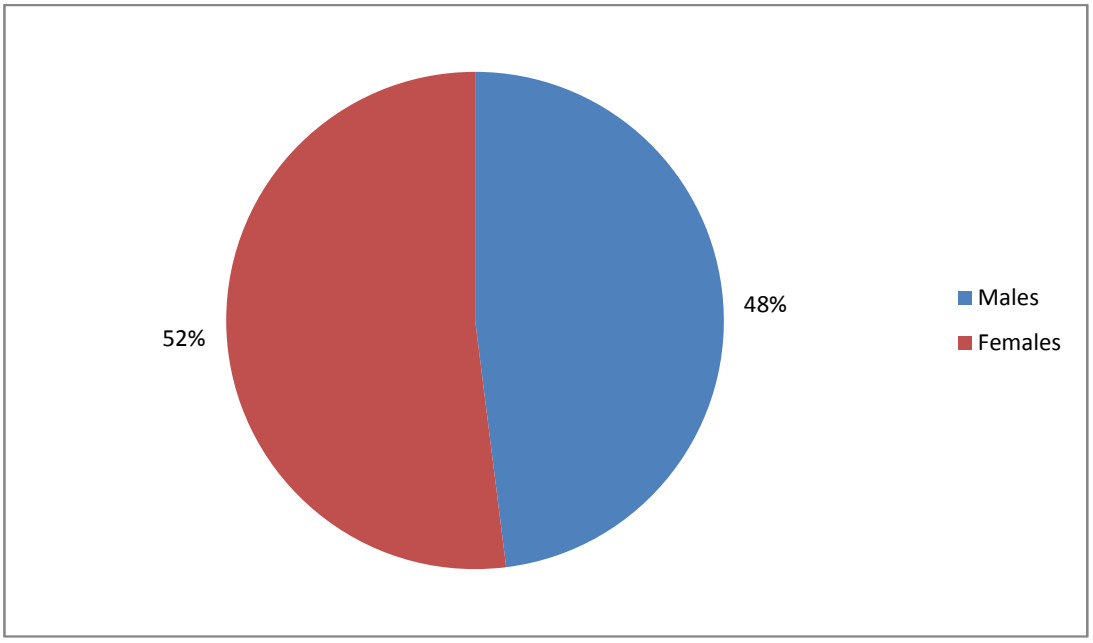
The study was observational and did not include invasive procedures. In the collection of data, the principal investigator was assisted by a research assistant who was trained in the administration of the questionnaire and obtaining any other relevant data from the anaesthetic record. The research assistant was a Registered Clinical officer student pursuing a Higher National Diploma in Anaesthesia. Any potential drug errors observed were pointed out to the anaesthesia practitioner prior to administration of the drug so as to maintain patient safety. Study findings were availed to the Ethics Committee of Kenyatta National Hospital and the University of Nairobi.

## 6.0 RESULTS

### A. DEMOGRAPHIC DATA

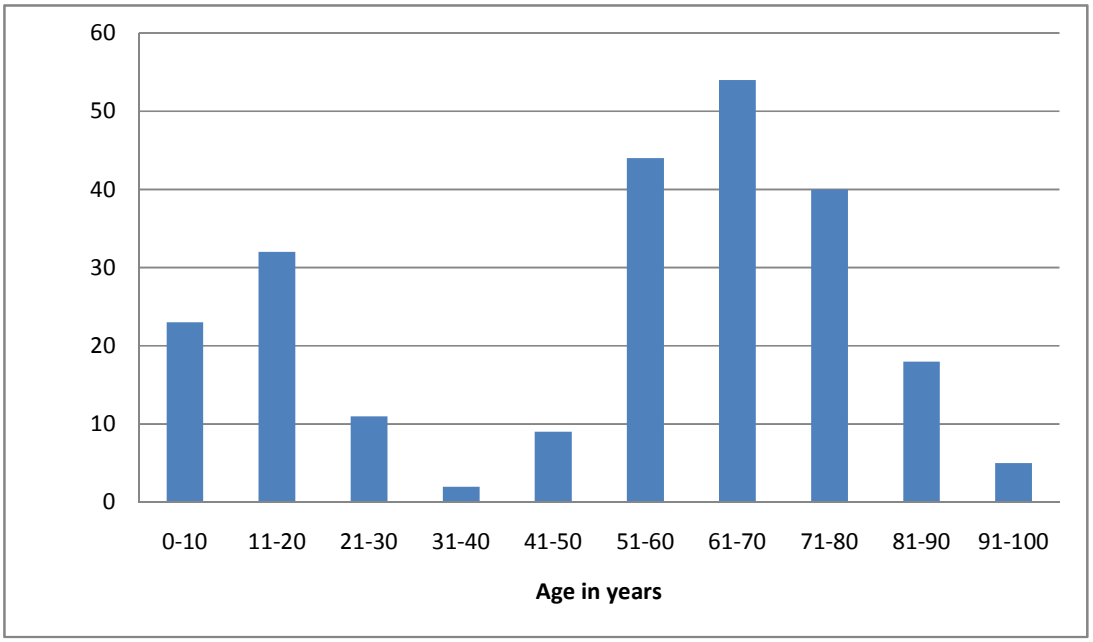
A total of 260 patients were enrolled in the study, of these 124 (48%) were males and136 (52%) were females as shown below:

**Figure 1: Pie chart showing the sex distribution of patients included in the study.**



Age of the patients included in the study ranged from a few days old to a maximum age of 86 years.

**Figure 2: Graph showing the age distribution of patients**

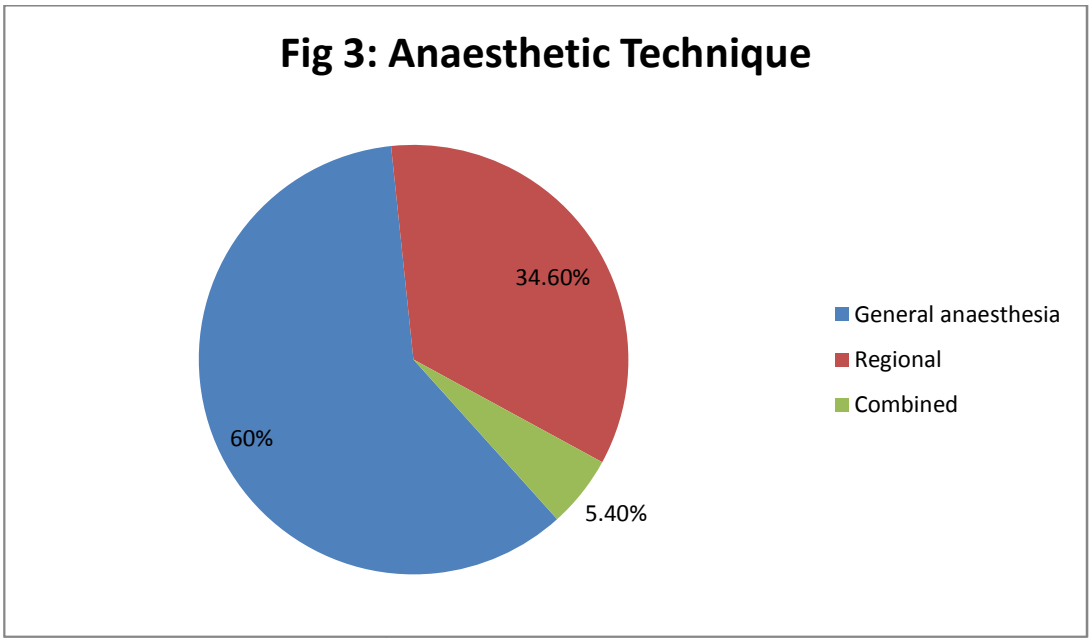



The number of patients according to the different surgical specialities was also analysed. Most of the patients underwent general surgical procedures (49 patients) while maxillofacial had the least number of patients (3 patients). The table below shows the number of patients per surgical speciality.

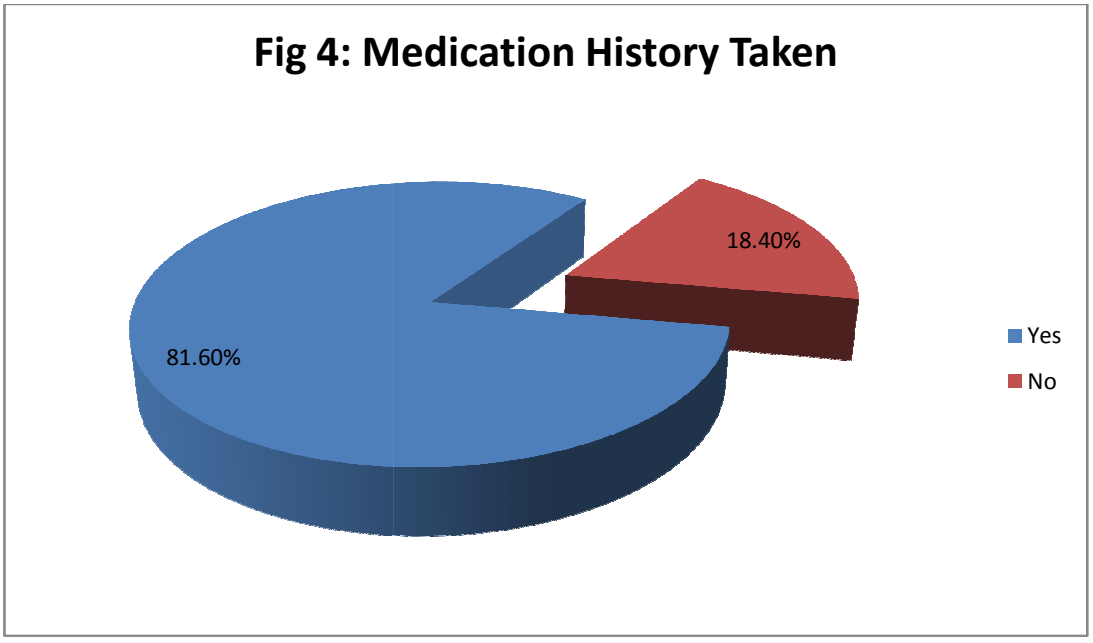
**Table 1: Table showing number of patients per surgical speciality n=260**

| SURGICAL SPECIALITY | FREQUENCY (%) |
|---|---|
| General surgery | 49 (18.8%) |
| Orthopaedics | 45 (17.2%) |
| Paediatrics | 19 (7.3%) |
| E.N.T. | 23(8.8%) |
| Plastic surgery | 15(5.7%) |
| Cardiothoracic surgery | 23 (8.8%) |
| Ophthalmology | 15(5.7%) |
| Neurosurgery | 15 (5.7%) |
| Obstetrics | 38 (14.6%) |
| Gynaecology | 16 (6.1%) |
| Maxillofacial | 2 (0.7%) |

General anaesthesia was the most common anaesthetic technique used in 156 patients while a combined technique was used in 14 patients.

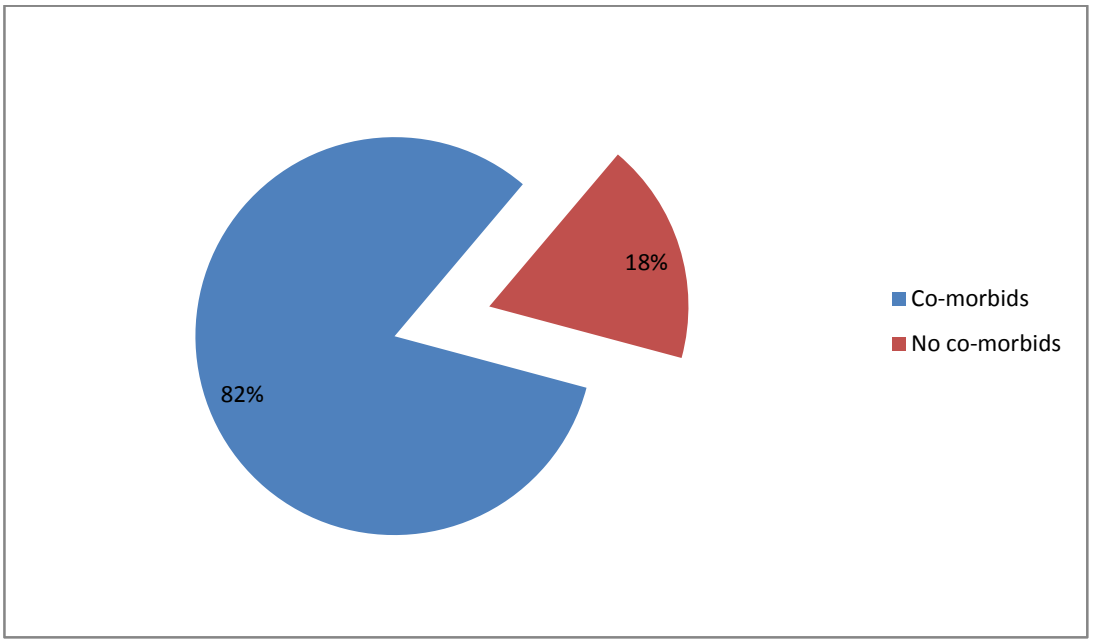



Medication history was taken in 213 patients, which compromised 81.6% of the patients sampled.



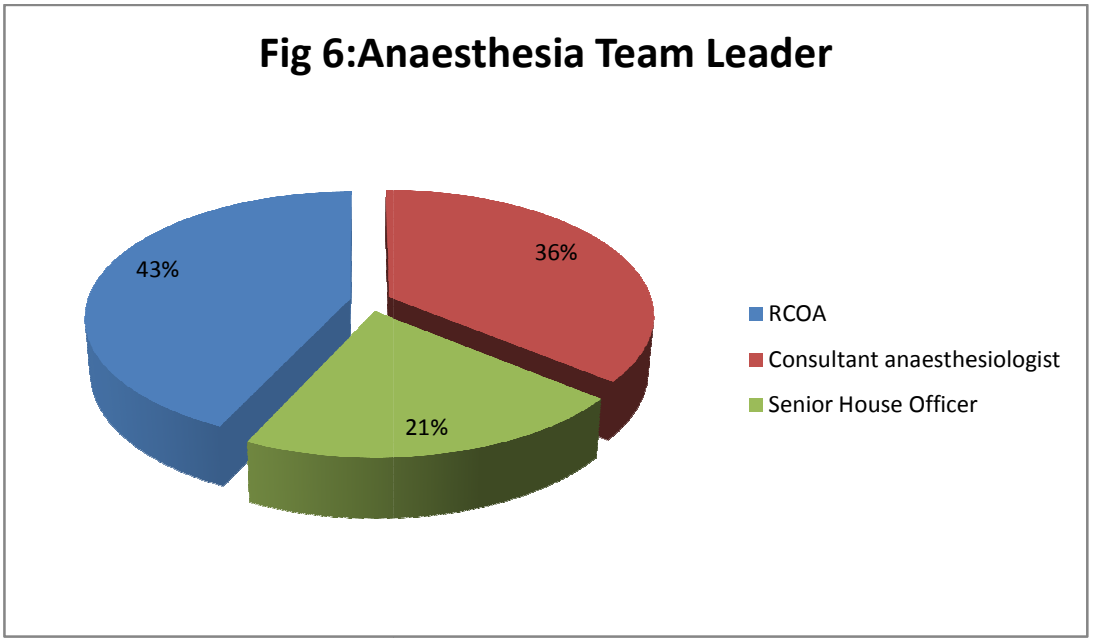
214 of the 260 patients sampled did not have any co morbidities. The remaining patients had the following co-morbidities: diabetes, hypertension, chronic kidney disease, coronary artery disease, asthma, sepsis, carcinoma of the cervix and HIV.

**Figure 5: Patients with co-morbid disease**



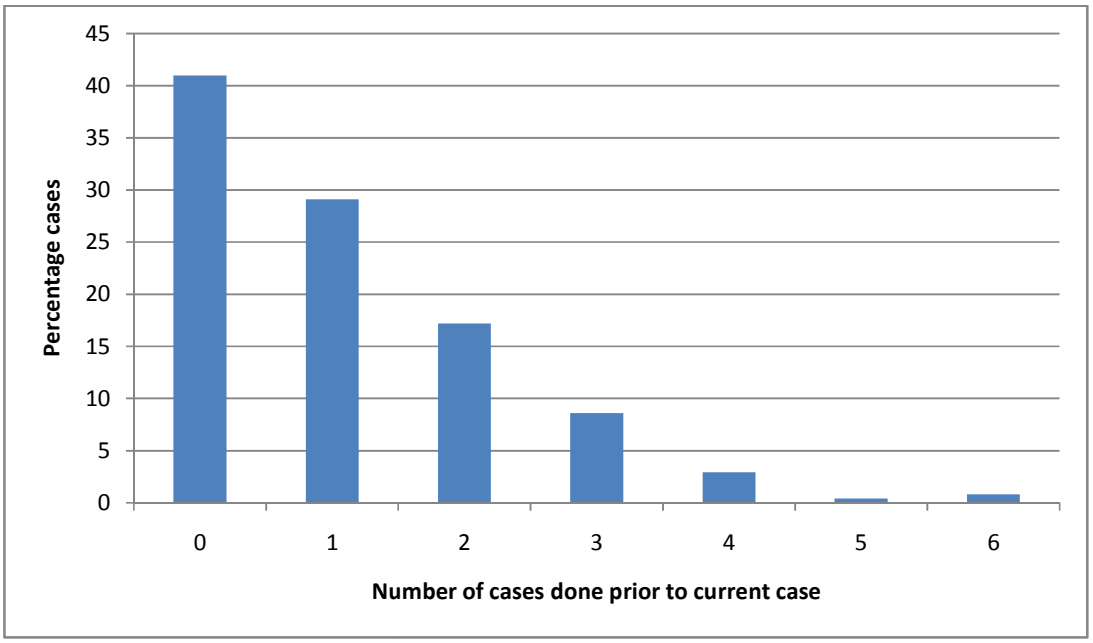
**B. ANAESTHESIA TEAM**

The team leader of the anaesthesia team was the registered clinical officer anaesthetist in 43% of the cases, followed by consultant anaesthesiologist at 36% and senior house officers at 21% of the cases. There was always a consultant available to cover the lists being run by the registered clinical officer anaesthetist and senior house officers.




Number of cases done prior to the current case under observation ranged from 0-6.

**Figure 7: Number of cases done prior to current case**



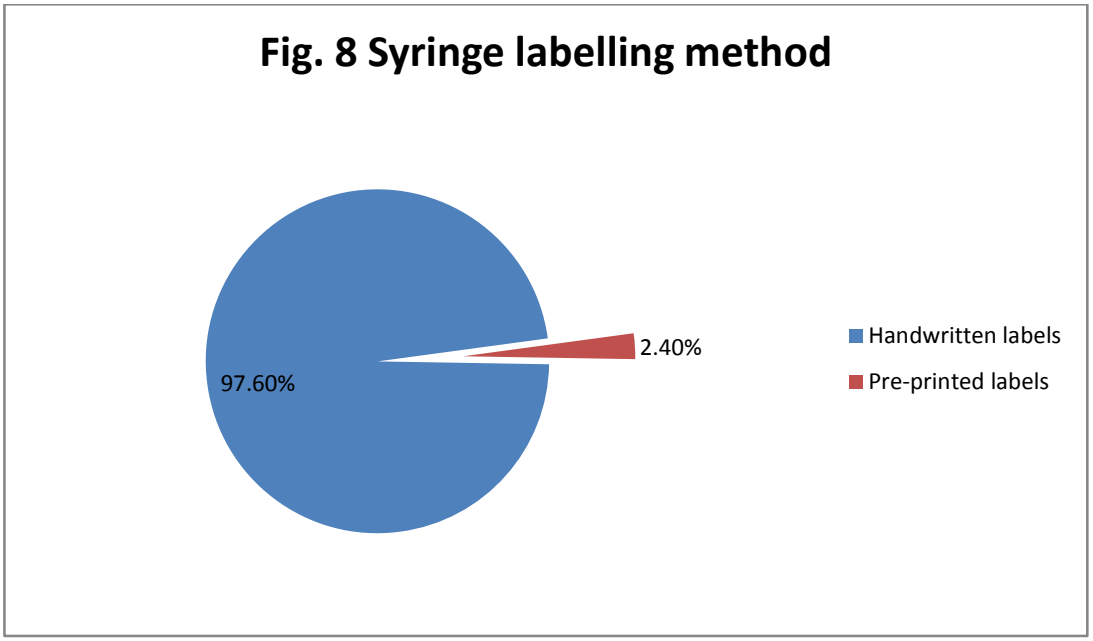
## C. DRUG PREPARATION

**Table 2: Drug preparation process n=260**

Ordering and prescription of drugs was done in seventy seven percent of the cases observed by the anaesthetist who administered them. Syringe labelling after drawing up the drug was done in 246 of the cases, with handwritten labels being the most common method used.

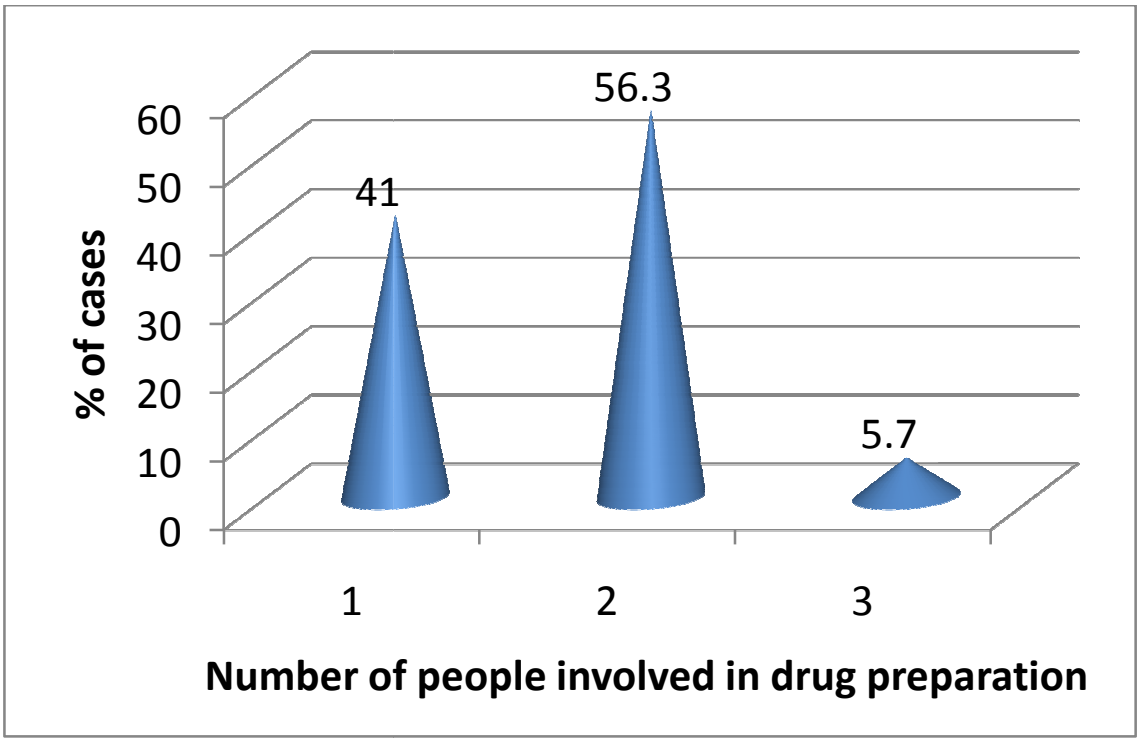
| | YES | NO |
|---|---|---|
| Ordering and prescription done by the anaesthetist who administered them | 77.4% | 22.6% |
| Drugs drawn up and labelled by the anaesthetist who prescribed them | 73.6% | 26.4% |
| Label on any drug ampoule read before the drug is drawn up | 86.6% | 13.4% |
| Syringe labelling done after drawing up the drug | 94.6% | 5.4% |
| Labels checked by a second person | 25.7% | 73.6% |
| Sterile anaesthetic tray provided for each patient | 52.1% | 47.9% |

**Figure 8: Pie chart illustrating the labelling method used on syringes**



The number of people involved in drug preparation ranged between one to three people.

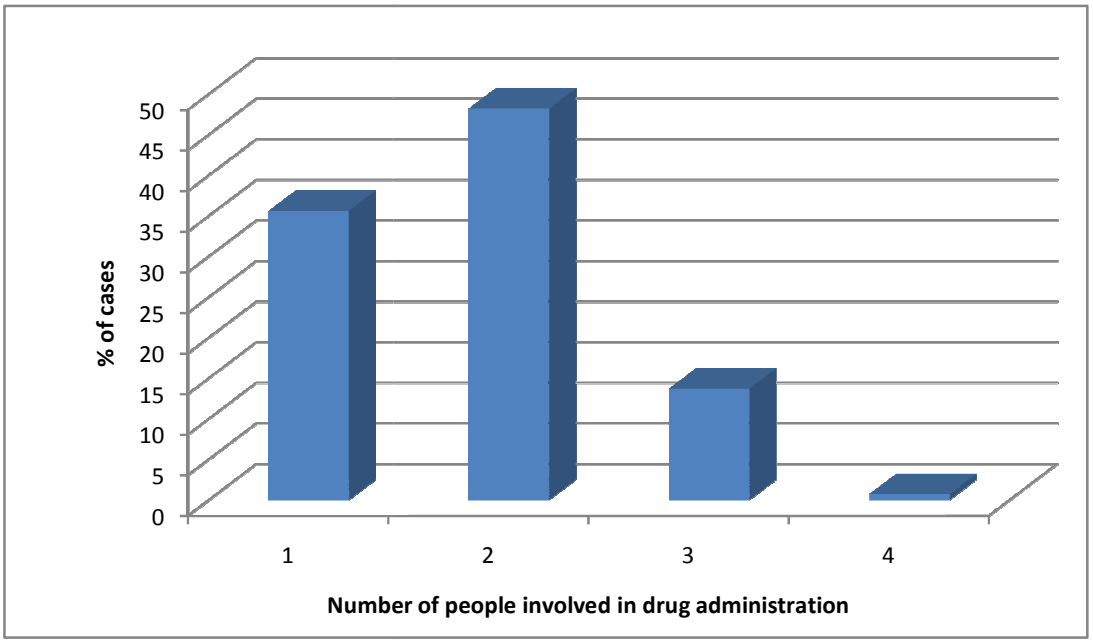
**Figure 9: graph illustrating the number of people involved in drug preparation**




**D. <u>DRUG ADMINISTRATION</u>**

The number of people involved in administration of drugs to patients undergoing anaesthesia ranged from one to four persons.

**Figure 10: Graph showing number of people involved in drug administration**

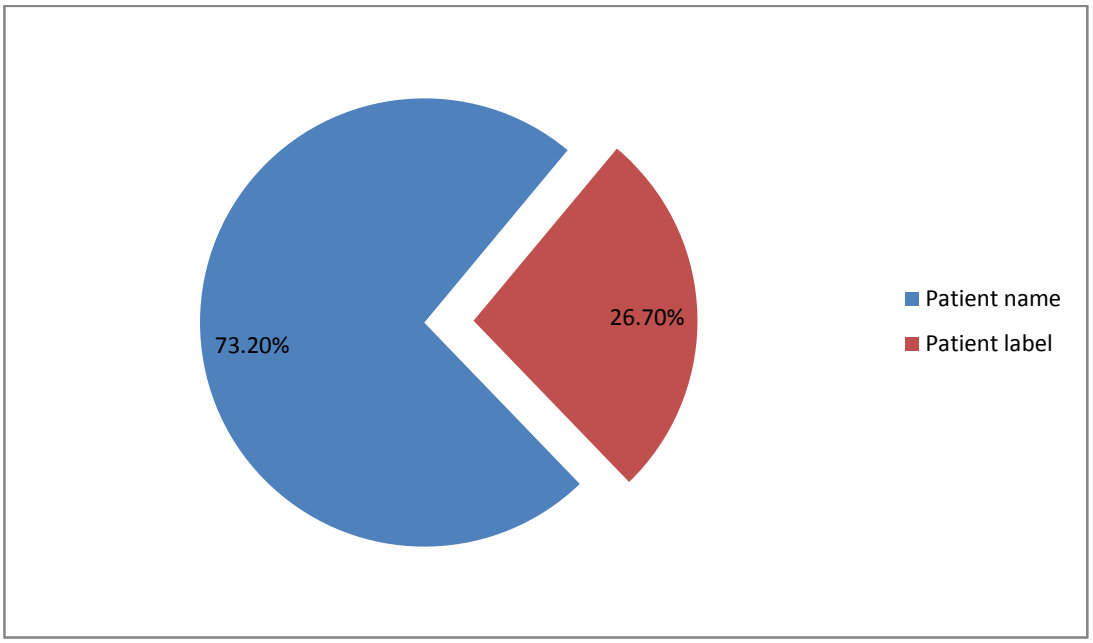


Majority of the patients (213) were identified prior to drug administration. Patients were identified by calling out their name in eighty two percent of the cases observed. Forty four percent of the patients sampled had their weight checked in the ward prior to drug administration in theatre. Asepsis was maintained during administration of drugs in 56% of the cases. Drugs were counter checked prior to administration in thirty five percent of the patients sampled.

**Table 3: Drug administration process n=260**

| | YES | NO |
|---|---|---|
| Patient identified prior to drug administration | 82% | 18% |
| Patient weight checked prior to drug administration | 44% | 56% |
| Asepsis observed during drug administration | 56.3% | 43.6% |
| Drugs counter checked prior to administration | 35.2% | 64.7% |

**Figure 11: Pie chart showing identification method used**




## E. STORAGE OF DRUGS DURING ANAESTHESIA

In eighty one percent of the cases observed, the drugs drawn up were stored in receptacles reserved for this purpose. Emergency drugs were stored in a separate receptacle in sixty percent of cases while empty ampoules and syringes were stored until the end of the anaesthetic in fifty two percent of cases observed.

**Table 4: Storage of drugs during anaesthesia n=260**

| | YES | NO |
|---|---|---|
| Drawn up drugs are stored in receptacles reserved for this purpose | 81% | 19% |
| Drugs drawn up for administration via different routes are not stored in the same receptacle | 24% | 76% |
| Emergency drugs are stored in a separate receptacle | 59.4% | 40.6% |
| Empty ampoules and syringes containing drugs are stored until the end of the anaesthetic | 52% | 48% |

**F. <u>DRUG ERRORS OR NEAR MISSES OBSERVED</u>**

1. Administration of the wrong dose of atropine, local anaesthetics, antibiotics, non depolarising muscle relaxants, succinylcholine, induction agents and adrenaline. The correct dose of a drug is the recommended dose of the drug per kilogram body weight. Patients weight was checked prior to administration of the anaesthetic in 115 of the cases observed. Weight approximation was used in the remaining cases.

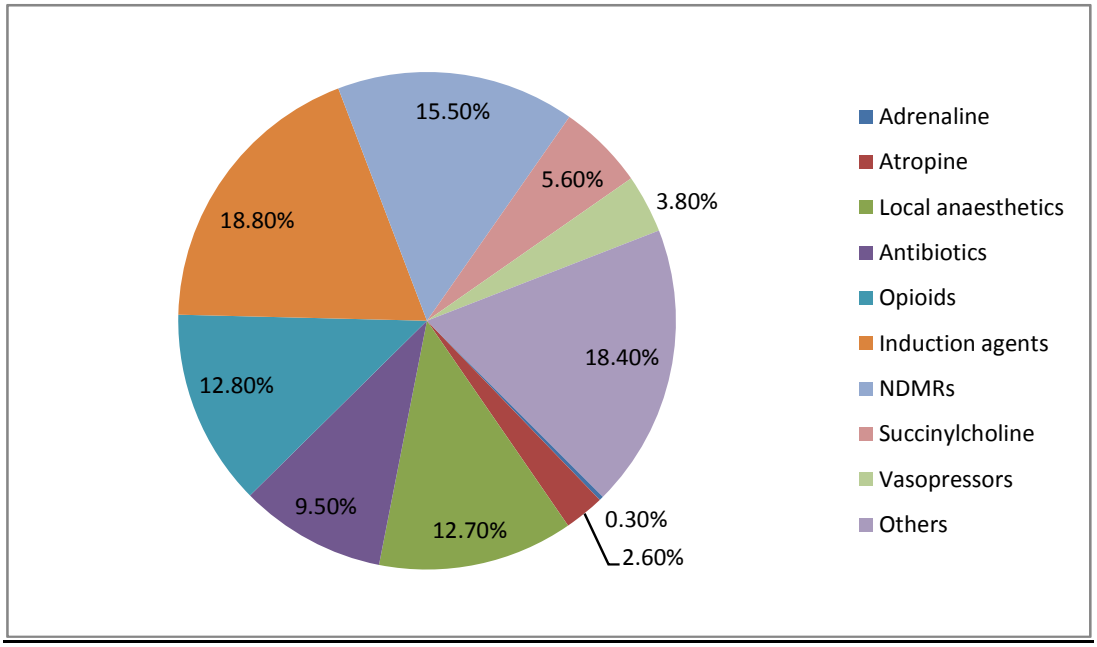
2. Asepsis was not observed during administration of drugs in one hundred and fourteen of the cases observed.

3. Wrong drug: potential administration of an antibiotic to a patient with a known drug allergy.

4. Incomplete documentation of the drugs administered during the anaesthetic in eighty two percent of the cases observed.

## G.DRUGS COMMONLY INVOLVED IN DRUG ERROR

**Figure 12: pie chart showing the drugs commonly involved in drug errors**




## COMPLICATIONS OF DRUG ERRORS

The complications of drug errors observed included tachycardia, prolonged muscle paralysis in one patient each and hypotension in three patients.

## 7.0 DISCUSSION

The main objective of the study was to determine the drug administration practices of anaesthesia practitioners at Kenyatta National Hospital. Several aspects of the administration practices were assessed including: prescription and preparation of drugs, administration of drugs and storage of drugs in the anaesthesia work space.

A total number of 260 anaesthetic procedures were observed. Of these, fifty two percent of the patients were female and general anaesthesia was used in sixty percent of the cases. This tallies with the KNH post anaesthesia care unit records which show that more female patients undergo surgical procedures and that general anaesthesia is the most common anaesthetic technique used.

In eighteen percent of the cases observed medication history was not obtained prior to undergoing the anaesthetic procedure. These patients were found to be twice as likely to experience a drug error as those patients from whom medication history was obtained. Guidelines on the safe administration of drugs in anaesthesia state that a complete drug history should be obtained from the patient or the patient's clinical record before any drugs are administered[35]. Obtaining a drug history prior to any anaesthetic procedure should be part of standard practice for all patients as this will reduce the likely hood of drug errors occurring.

Preparation of drugs was done by more than one person in sixty two percent of the anaesthetic procedures observed. This practice differs from the guidelines set for the safe administration of drugs in anaesthesia[35] which state that the task of drawing up drugs and labelling syringes should be delegated to one person so as to minimise distraction and the likely hood of syringe mislabelling. Studies done on prevention of drug errors show that the incidence of drug errors is reduced when drugs are prepared and labelled by the anaesthesia practitioner who will administer them[55].

Asepsis was observed during drug administration in fifty six percent of the anaesthetics observed. Lack of asepsis was through using one anaesthetic tray on more than one patient, withdrawing drugs from previously opened ampoules and lack of sterility during provision of regional anaesthesia. This practice differs from current guidelines. ANZCA recommends that appropriate trays clean for each patient should be provided for drawing up, arranging and holding the drugs used in each anaesthetic[35]. Drug contamination must also be avoided[35]. To minimise the risk of cross

infection between patients the contents of any one ampoule should be administered to only one patient.

Eighty two percent of the patients were identified prior to administration of anaesthesia. Improvement is required in this area as current guidelines state that every patient to whom any drug is administered should be identified clearly and explicitly by the person administering the drug[55].Patient identification prior to surgery is part of the recommendations in the WHO guidelines for safe surgery[9].

The label on the drug ampoule was read before the drug was drawn up in eighty seven percent of the anaesthetic procedures observed. This is comparable to findings from a survey of Canadian anaesthesia practitioners which found that the drug ampoule was read prior to drawing up the drug in 94% of the anaesthetics[21]. Reading the label on any drug ampoule before it is drawn up is one of the ways of minimising drug errors in intravenous drug administration in anaesthesia[55].

Syringe labelling was one of the methods used by anaesthesia practitioners in KNH to prevent drug errors with 94% of the syringes being labelled after drawing up the drug. Syringe labelling is more frequently used as a drug error prevention method in KNH. In a study carried out by the ISMP it was found that 42% of anaesthesia practitioners label inconsistently[47] while, a survey of Canadian anaesthesiologists found that only seventy two percent used self adhesive labels regularly as a way to prevent drug errors[21]. Current guidelines state that syringes should always be labelled and a standardised approach used in labelling medication within an institution. The labelling system used should be based on the international standard for labelling syringes used in anaesthesia[44].

Syringe labels were checked by a second person in sixty seven of the cases observed. Second person confirmation was not used as frequently due to the practical issue of having a second person continually available to confirm the drugs prior to their administration. Second person confirmation of drugs has been found to enhance patient safety and to increase awareness of drug errors and other safety issues[51].

Drawn up drugs were stored in receptacles reserved for this purpose in eighty one percent of the cases observed with emergency drugs being stored in a separate receptacle in only fifty nine percent of the cases. Attention needs to be given to the way drugs are stored in the theatre environment. At present there is no uniform system for drug storage in the anaesthetic workspace or drug drawers. This results in drugs with radically different

actions being stored next to each other increasing the likely hood of drug errors. Systematic and methodical storage of drugs in receptacles will ensure there is formal organisation of the anaesthesia workspace and tidiness which is one of the strategies identified for reducing drug errors[56].

The type of drug errors observed during the study included: incorrect drug dose, administration of the wrong drug, lack of asepsis and inaccurate documentation of drugs administered during the anaesthetic. This defers from the errors reported in a prospective survey on drug administration errors at three South African hospitals where substitution was the most common drug error followed by incorrect dose, repetition then omission[20]. Incorrect dose was the commonest drug error as patients weight was checked in only forty four percent of the cases observed. To prevent this drug error all patients should be weighed prior to any anaesthetic procedure.

The drugs commonly involved in drug errors included muscle relaxants, opioids, antibiotics, local anaesthetics, induction agents, atropine and adrenaline. Similar drugs were identified as the drugs involved in drug errors in a survey of drug administration errors in South Africa[30] and in the ASA closed claim project[23]. The drugs involved included opioids, non depolarising muscle relaxants, antibiotics, local anaesthetics, epinephrine and succinylcholine. Anaesthesia practitioners should be more vigilant in the preparation and administration of these drugs.

Complications of the drug errors observed included tachycardia and prolonged muscle paralysis. These complications would be classified under category D in the NCCMERP classification of consequences of drug errors[34]. This is similar to the AIMS where in 64% of the incidents in which the wrong drug was given some physiological change occurred but none was fatal[33]. Majority of drug errors do not result in harm to the patients, a significant minority can result in morbidity and death.

## CONCLUSION

1. Reading the drug label on the ampoule prior to drawing up the drug, syringe labelling and counter checking drugs prior to administration are some of the measures used by anaesthesia practitioners at KNH to prevent drug errors.
2. The drug errors that occur during the administration of anaesthesia are incorrect dose, wrong drug and lack of asepsis during drug administration.
3. Accurate documentation of drugs administered during the anaesthetic remains a challenge.
4. The drugs commonly involved in drug errors include atropine, muscle relaxants, opioids, local anaesthetics, antibiotics and adrenaline.

## RECOMMENDATIONS

1. A protocol on drug preparation, administration and storage of drugs in the anaesthesia work space should be developed so as to standardise the practise of drug administration in KNH.
2. A comprehensive history including co-morbidities and medication history should be obtained prior to administration of any anaesthetic. All patients should be weighed prior to coming to theatre.
3. Documentation of drugs administered needs to be improved upon with reference to indicating the drug administered, dose, time, route of administration used and any adverse reactions observed.
4. Incident reporting systems for reporting drug errors and near misses should be developed.

## LIMITATIONS

1. Ideal drug administration practises may have been used due to the presence of the principal investigator in the operating theatre.

**REFERENCES**


1. Kohn LT, Corrigan JM, Donaldson MS. (1999) To err is human: building a safer health system. Committee on the Quality of Health Care in America, Institute of Medicine. Washington, DC: National Academy Press.

2. Leape LL, Brennan TA, Laird N. (1991) The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. *New England Journal of Medicine* 324:377-84.

3. Lucian L. Leape (1994) Error in Medicine. *JAMA* 272(23):1851-1857

4. John H. Eichhorn, MD (2010) APSF Hosts Medication Safety Conference *APSF* 25(1): 1-20

5. Merry A, McCall Smith A. The Human Factor. In Merry A, McCall Smith A. Errors, Medicine and the Law. Cambridge: Cambridge University Press, 2001: 46.

6. Beecher HK, Todd DP. (1954) A study of deaths associated with anaesthesia and surgery. *Annals of Surgery* 140:2-34.

7. Barker KN, McConnell WE. (1962) The problems of detecting medication errors in hospitals. *Am J Hosp Pharm* 19:360-9

8. Abeysekera A, Bergman IJ, Kluger MT, Short TG.(2005) Drug error in anaesthetic practice: a review of 896 reports from the Australian Incident Monitoring Study database. *Anaesthesia* 60:220-227.

9. World Health Organization (2004) The Launch of the World Alliance For Patient Safety. (Online) Available from: http://www.who.int/patientsafety/worldalliance/en/

10. National Coordinating Council for Medication Error Reporting and Prevention (2014). What is a Medication Error? (Online) Available from: http://www.nccmerp.org/aboutMedErrors.html

11. Ferner RE, Aronson JK. (2006) Clarification of terminology in medication errors: definitions and classification. *Drug Saf.* 29:1011–22.

12. Wheeler SJ, Wheeler DW. (2005) Medication errors in Anaesthesia and critical care. *Anaesthesia* 60:57-73

13. Aspden, P.M. Patient Safety: achieving a new standard for care 2004. Washington, D.C. National Academies Press.

14. Bates D.W. (2003) Policy and the future of adverse events detected using information technology *J Am Med Inform Assoc* 10:226-8

15. Institute for Safe Medication Practices (2009) ISMP Survey Helps To Define Near Miss and Close Call. (Online) ISMP. Available from: https://www.ismp.org/newsletters/acutecare/articles/20090924.asp

16. Jeffrey K Aronson (2009) Medication Errors: definitions and classification *Br. J Clin. Pharmacol*. June 67:599-604.

17. Orser BA, Oxorn DC. (1994) An anaesthetic drug error: minimizing the risk *Can J Anaesth* 41:120-124.

18. Webster CS, Merry AF, Larsson L, McGrath KA, Weller J. (2001) The frequency and nature of drug administration errors during anaesthesia. *Anaesthesia Intensive Care* 29:494-500.

19. American Society of Health-System Pharmacists (1993) ASHP guidelines on preventing medication errors in hospitals *AM J Hosp Pharm* 50: 305-314.

20. Llewellyn RL, Gordon PC, Wheatcroft D. (2009) Drug administration errors: a prospective survey from three South African teaching hospitals. *Anaesth Intensive Care* 37(1):93-98.

21. Orser BA, Chen RJ, Yee DA. (2001) Medication errors in anaesthetic practice: a survey of 687 practitioners. *Can J Anaesth* 48:139-146.

22. Merry AF, Peck DJ. (1995) Anaesthetists, errors in drug administration and the law. *N Z Med J* 108:185-187.

*23.* Bowdle TA. (2003) Drug Administration Errors from the ASA Closed Claims Project. *ASA Newsletter* 67:11–3.

*24.* The National Health Service Litigation Authority (2007) NHSLA Annual Report and Accounts. (Online). Available from: *http://www.nhsla.com/NR/rdonlyres/83BCFCEF-81F7-4FB7-9A46-1499F03188DF/0/NHSLAAnnualReportandAccounts2007.pdf*

*25.* Cooper JB, Newbower RS, Long CD, McPeek B. (1978) Preventable anaesthesia mishaps: a study of human factors. *Anaesthesiology* 49:399-406.

26. Hintong T, Chau-In W, Thienthong S, Nakcharoenwaree S.(2006) An analysis of the drug error problem in the Thai Anaesthesia Incidents Study. *J Med Assoc Thai* 17:118-127.

27. Building a safer NHS for Patients: Improving Medication Safety. A Report by the Chief Pharmaceutical Officer. Smith J, ed. London: Department of Health, 2004.

28. Chou CD, Madhavian D, Funk K. (1996) Studies in cockpit task management errors. *Int J Aviat Psychol* 6:307-20.

29. PC Gordon. (2004) Wrong drug administration errors among anaesthetists in a South African teaching hospital. *SAJAA* 10:7-8.

30. Gordon PC, Llewellyn RL, James MFM. (2006) Drug administration errors by South African anaesthetists -a survey. *S Afr Med J* 96:630-632.

31. Marcus Rall. (2009) Human Performance and Patient Safety. In Ronald D. Miller (ed.) Miller's Anaesthesia. 7th ed. USA: Elsevier

32. Reason J. (2000) Human Error; models and management. *British Medical Journal* 320:768-70.

33. Currie M, Mackay P, Morgan C, Runciman WB, Russell WJ, Sellen A et al. (1993) The Australian Incident Monitoring Study. The "wrong drug" problem in anaesthesia: an analysis of 2000 incident reports. *Anaesth. Intensive Care* 21:596-601.

34. National Coordinating Council for Medication Error Reporting and Prevention (1998). NCC MERP Taxonomy of Medication Errors. (Online) NCC MERP. Available from: http://www.nccmerp.org/medErrorTaxonomy.html

35. Australian and New Zealand College of Anaesthetists (2012). Guidelines for the safe administration of injectable drugs in anaesthesia. (Online) ANZCA. Available from: http://www.anzca.edu.au/resources/professional-documents/pdfs/ps51-2009-guidelines-for-the-safe-administration-of-injectable-drugs-in-anaesthesia.pdf.

36. Fraind DB, Slagle JM, Tubbesing VA, Hughes SA, Weinger MB. (2002) Reengineering intravenous drug and fluid administration processes in the operating room: step one task analysis of existing processes. *Anaesthesiology* 97:139-147.

37. Agency for Healthcare Research and Quality (2014). Definition of Patient Safety. (Online) AHRQ Patient Safety Network. Available from: http://psnet.ahrq.gov/glossary.aspx?indexLetter=P

38. APSF (2014) Mission Statement (Online) APSF. Available from http://www.apsf.org/about.php (Accessed 04/1/2014).

39. WFSA (2010) International Standards for the Safe Practice of Anaesthesia.(Online) AAGBI. Available from http://www.aagbi.org/international/international-relations-committee/international-standards-anaesthesia .

40. Wilson M. (1993) Errors and accidents in anaesthetics. Oxford University Press 1993:61-79.

41. NHS (2013) Guidelines for the Administration of Medicines (Online) NHS. Available from: http://www.nhsprofessionals.nhs.uk/Download/comms/CG3%20-%20Administration%20of%20Medicine%20Guidelines%20V4%20March%202013.pdf.

42. Wheeler D, Degnan B, Sehmi J. (2008) Variability in the concentrations of intravenous drug infusions prepared in a critical care unit. *Intensive Care Medicine* 34:1441-1447.

43. American Society of Anaesthesiologists (2009) Statement on The Labelling of Pharmaceuticals For Use In Anaesthesiology. (Online) ASA www.asahq.org

44. Joint Commission On Accreditation of Healthcare Organizations (2011) National Patient Safety Goals. ( Online) JCAHO. Available from: http://www.jointcommission.org/assets/1/6/2011_NPSGs_HAP.pdf.

45. Australian Commission On Safety and Quality In Healthcare (2012). National Recommendations for User-applied Labelling of Injectable Medicines, Fluids and Lines. (Online) ACSQH. Available from: http://www.safetyandquality.gov.au/our-work/medication-safety/user-applied-labelling/

46. Joint Commission on Accreditation of Healthcare Organizations (2012) Top Standards Compliance Issues for 2012. (Online) JCAHO. Available from: http://www.jointcommission.org/assets/1/6/13_OBS_Top_Challenging_2012_Stds_.pdf

47. ISMP (2011) Institute for Safe Medication Practice medication safety self assessment. (Online) ISMP. Available from: http://www.ismp.org/selfassessments/Hospital/2011/full.pdf

48. Cohen MR, Kilo CM. (1999) High alert medication: safeguarding against errors. *American Pharmaceutical Association* 1999, 5:15-40.

49. ISMP (2014). ISMP's List of High-Alert Medication. (Online) Available from: http://www.ismp.org/tools/institutionalhighAlert.asp.

50. Joint Commission on Accreditation of Healthcare Organizations (2007) National Patient Safety Goals Hospital Program. Available from https://www.premierinc.com/safety/topics/patient_safety/downloads/03-2007-hap-npsg.pdf

51. R. Evley, J. Russel, D. Mathew et al. (2010) Confirming the drugs administered during anaesthesia: a feasibility study in the pilot National Health Service sites, UK. *British Journal of Anaesthesia* 105(3):289-296.

52. Poon, E.G. et al (2010) Effect of bar-code technology on the safety of medication administration. *New England Journal of Medicine* 362:1698-1707.

53. Poon, E.G. et al (2006) Impact of barcode medication administration technology on how nurses spend their time providing patient care. *Journal of Nursing Administration* 38:541-549.

54. Ross Koppel, Tosha Wetterneck, Ben-Tzion Karsh. (2008) Workarounds to Barcode Medication Administration Systems: Their Occurrences Causes and Threats to Patient Safety. *J Am Med Inform Assoc* 15(4):408-423.

55. L.S. Jensen, A.F. Merry, C.S. Webster, J. Weller and L. Larsson. (2004) Evidence based strategies for preventing drug administration errors in anaesthesia. *Anaesthesia* 59:495-504.

56. Alan F. Merry, Craig S. Webster and Daniel J Mathew. (2001) A New, Safety-Oriented Integrated Drug Administration and Automated Anaesthesia Record System. *Anaesthesia and Analgesia* 93:385-390.

57. Nott MR. (2001) Misidentification in filling and confirmation bias. *Anaesthesia* 56:917.

58. Fasting S, Gisvold SE. (2000) Adverse drug errors in anaesthesia, and the impact of coloured syringe labels. *Canadian Journal of Anaesthesia* 47:1060-1067.

59. Institute for Safe Medication Practices (2008). Colour Coded Syringes for Anaesthesia Drugs Use With Care. (Online) ISMP. Available from: https://www.ismp.org/newsletters/acutecare/articles/20081218.asp

60. American Society for Testing and Materials (2011). Statement On The Labelling of Pharmaceuticals For Use In Anaesthesiology. (Online) ASTM. Available from: http://www.astm.org/SNEWS/JA_2011/d1032_ja11.html.

**APPENDIX 1**

**INFORMED CONSENT FORM**

DRUG ADMINISTRATION PRACTICES OF ANAESTHESIA PRACTITIONERS AT THE KENYATTA NATIONAL HOSPITAL

I am Dr. Wairimu Mwaura Wanguhu, a post graduate student in Anaesthesia at the University of Nairobi. I am conducting a study on the drug administration practices of anaesthesia practitioners at Kenyatta National Hospital.

**PURPOSE OF THE STUDY**

The aim of the study is to determine the drug administration practices of anaesthesia practitioners at KNH. The results of the study will help to identify areas of weakness in the drug administration process which can be improved upon so as to increase patient safety at the hospital.

**STUDY PROCEDURE AND INTERVENTIONS**

The study procedure will involve the use of a questionnaire to collect data. There will be no invasive procedures performed.

**VOLUNTARY PARTICIPATION**

Your participation in this study is entirely voluntary. You reserve the right to withdraw from the study at any stage. No treatment will be withheld from non consenting patients.

**RISKS AND BENEFITS**

You are not exposed to any risks by participating in this study. Any potential drug errors observed will be pointed out to the anaesthesia practitioner prior to administration of the drug so as to maintain patient safety.

**CONFIDENTIALITY**

I will only use initials of your name for confidentiality purposes. This will guarantee that the data collected will remain confidential.

**CONTACTS**

For any questions and clarifications about the study you can contact the following people;

1. Dr Wairimu Mwaura Wanguhu
   0727340720, wairimu07@gmail.com
2. Dr Muriithi Mwiti
   0721366294, mtmwiti@gmail.com
   Department of Anaesthesia, University of Nairobi

3. The secretary, Ethics and Research committee, KNH/UON
   (+254-020) 2726300 Ext 44355, uonknh_erc@uonbi.ac.ke

Thank you.

**APPENDIX 2**

**CONSENT FORM**

I .....do hereby give consent to participate in the above study whose nature, benefits and risks have been fully explained to me by the researcher. I have not been coerced or enticed to participate and voluntarily gave permission. I have been assured of my confidentiality and that am free to withdraw from the study at any point and this will not influence the treatment I receive.

Identification number.....

Signature..... Date.....

**RESEARCHER'S SECTION**

I .....have explained the nature of the study to the participant detailing the benefits and risks of the study and have not withheld any information. I have assured the participants of their confidentiality and the right to withdraw from the study at any stage and this will in no way influence the patient's treatment.

Name (initials).....

Signature..... Date.....

**MAELEZO YA IDHIBATI**

Mimi ni Dr. Wairimu Mwaura Wanguhu mwanafunzi wa masters katika sehemu ya Anaesthesia kwenye chuo kikuu cha Nairobi. Ninafanya utafiti kuhusu binu zinazotumiwa na wataalamu wa anaesthesia kupatiana madawa katika thiata za Kenyatta National Hospital.

Maudhui wa utafiti huu ni kubaini binu sinazotumiwa na waatalumu wa anaesthesia kupatiana madawa katika thiata za Kenyatta National Hospital. Matokeo ya utafiti huu yatatumika kueneza usalama wa wagonjwa katika hospitali.

Fomu ya maswali itatumika kupata ujumbe inayohitajika kwa utafiti.

Kushiriki katika utafiti huu ni huru na kwa hiari kwa kila mtu. Iwapo ungependa kujiondoa wakati wowote upo uhuru kufanya hivyo. Kukataa kushiriki kwa utafiti huu, haitadhuru huduma utakayoipata katika hospitali hii.

Kujuimka kwako katika utafiti huu haitakuletea madhara yoyote.

Fomu zote za maswali hazitakuwa na majina na ujumbe wote utawekwa siri.

Ukiwa na maswali yoyote unaweza kujumuisha wafuatao:

1. Dr Wairimu Mwaura Wanguhu
   0727340720, wairimu07@gmail.com
2. Dr Muriithi Mwiti
   0721366294, mtmwiti@gmail.com
   Department of Anaesthesia, University of Nairobi
3. The secretary, Ethics and Research committee, KNH/UON
   (+254-020) 2726300 Ext 44355, uonknh_erc@uonbi.ac.ke

**FOMU YA IDHINI KUSHIRIKI**

**SEHEMU YA MGONJWA**

Mimi..... nimetoa kibali changu kushiriki katika utafiti huu. Nimeelezwa juu ya manufaa ya utafiti huu, vilevile kuhusu madhara yanayoweza kutokea na nimekubali kushiriki kwa hiari yangu.

Nimeahidiwa kuwa habari zozote nitakazotoa na ujumbe itakayopatikana itabakia siri. Ni na uhuru wa kujiondoa kwenye utafiti huu wakati wowote na kufanya hivyo hakutabadili kwa vyovyote vile, matibabu nitakayopokea.

Nambari ya kitambulisho.....

Sahihi..... Tarehe.....

**SEHEMU YA MTAFITI**

Mimi mtafiti nimemweleza mshiriki kwa kina kuhusu utafiti huu, manufaa na madhara yote bila kuficha habari zozote. Pia nimemweleza kuwa ujumbe itakayopatikana itabakia siri na kwamba ana uhuru wa kujiondoa kwenye utafiti huu wakati wowote bila dhuluma na kufanya hivi hakutabadili kwa namna yoyote matibabu atakayopokea.

Jina.....

Sahihi..... Tarehe.....

**APPENDIX 3**

**QUESTIONNAIRE**

**A. PATIENTS INFORMATION**

Age..... Sex..... Weight.....

Diagnosis:

Time of surgery:

Co-morbidities:

Type of surgery: Elective ☐
Emergency ☐

Type of anaesthetic technique General ☐ Regional ☐ Combined ☐

Medication history taken: YES ☐ NO ☐

**B. ANAESTHESIA TEAM**

1. Team leader

2. Members of the anaesthesia team: Consultant Anaesthesiologist ☐
Registered clinical officer anaesthetist ☐
Senior House Officer ☐
Clinical officer anaesthesia student ☐
Anaesthesia assistant ☐
Other.....

3. Number of cases done prior to current case.....

**C. DRUG PREPARATION**

1. Ordering and prescription done by the anaesthetist who will administer them
YES ☐
NO☐

2. Number of people involved in drug preparation.....

3. Drugs drawn and labelled by the anaesthetist who will administer them YES ☐
NO ☐

4. Syringe labelling done after drawing up the drug YES ☐
NO ☐

5. Label on any drug ampoule is read before drug is drawn up YES ☐
NO ☐

6. Labelling method used on syringes Preprinted labels ☐
Handwritten labels ☐

7. Labels checked by a second person YES ☐
NO ☐

8. Sterile anaesthetic trays provided for each patient YES ☐
NO ☐

**D. <u>DRUG ADMINISTRATION</u>**

1. Number of people involved in drug administration.....

2. Patient identified prior to drug administration YES ☐
NO ☐

3. Patient identified using Patient label ☐
Patient name ☐

4. Patient weight checked prior to administration YES ☐
NO ☐

5. Asepsis observed during drug administration YES ☐
NO ☐

6. Drugs counter checked prior to administration YES ☐
NO ☐

| DRUG | DOSE | TIME | ROUTE | ACCURATE DOCUMENTATION | CORRECT DOSE | CORRECT ROUTE | CORRECT TIMING |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |

**E. STORAGE OF DRUGS DURING ANAESTHESIA**

1. Drawn up drugs are stored in receptacles reserved for this purpose YES ☐
NO ☐

2. Drugs drawn up for administration via different routes are not stored in the same receptacle YES ☐
NO ☐

3. Emergency drugs are stored in a separate receptacle YES ☐
NO ☐

4. Empty ampoules and syringes containing drugs are stored until the end of the anaesthetic YES ☐
NO ☐

**F. DRUG ERRORS OR NEAR MISSES OBSERVED**

1.
2.
3.

**G. COMPLICATIONS OF DRUG ERRORS**

1.
2.
3.