Effect of Teaching Program on ICU Nurse’s knowledge and Practice of Endotracheal Suctioning procedure at Omdurman military hospital 2019

A Thesis submitted in fulfillment of requirement of Ph.D degree in medical surgical nursing

By: Raghda Elbokhary Alamin Ahmed

B.sc –MSc- university of medical sciences and technology

Supervised by: Prof. Yousif Mohammed yousif

MD-MBBS- Professor of otorhinolaryngology- Shendi University

Co-supervised: Dr. Higazi Mohammed Ahmed Abdallah Awad

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قال تعالى

وقرأ رأى علما

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First I’d like to thank my merciful god for helping and guiding me to achieve this humble PHD research.

This work is especially dedicated to all these Candles that glowed up to Lighten my way and supported me throughout this journey.

To my love at first sight, my partner for life, my beloved husband.

To my guardian angels, my beloved parents.

To my one-of-a-kind brothers & sisters.

To my dear friends.

To my amazing family.

Thank you all…
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My heart is full with gratitude to my supervisors:

Prof. Yousif Mohammed Yousif

For his precious time, unfathomable guidance and support that helped me greatly in understanding and writing this research, words are beyond expression for my thanks for you,

Dr. Higazi Mohammed Ahmed Abdallah Awad

For his encouragement that he gave me, his patience for my downfalls that blessed me with an unforgettable experience may allah bless you and award you jannatul firdaous

Head Nurse: Alaa Bakery Ali Ahmed

For her support and facilitating data collection and teaching program application
Abstract:

**Background:** critical care setting is one of the most complex environments in the healthcare facility. Critical care units manage the intersecting challenges of maintaining a high-tech environment and ensuring staff competency in operating the equipment, providing high-quality care to the facility’s sickest patients, and tending to the needs of staff members working in a very stressful environment.

**Aim:** assess the effect of the teaching program on nurse’s knowledge and practice regarding endotracheal suctioning procedure at Omdurman military hospital.

**Methodology:** a quasi-experimental, study design was carried out at Omdurman military hospital intensive care unit (ICU) to assess the effect of the teaching program on nurse’s knowledge and practice regarding endotracheal suctioning procedure which started from May to October 2016, total coverage sample of (50) nurses worked in ICU, the data was collected through well-constructed questionnaire, which consists of two parts, and the checklist consist of 3 sections of (35) items, validity of the study was determined through the pilot study, descriptive statistical analysis was used, data were analyzed using SPSS version 22.

**Results:** the findings of the study indicated that the implementation of an education program for ICU nurses was effective, the knowledge of nurses about endotracheal suction has improved in phase II. Percentage of nurses with good knowledge from (30%) in phase I (68%) in phase II with highly significant results (P-value =0.000). also, the percentage of nurses with good practice increased from (12%) in phase I (80%) in phase II with highly significant results (P-value =0.000).

**Conclusion:** the study revealed that knowledge about endotracheal suction was improved, the study subjects had an acceptable level of practice which improved in phase II. The study reported that sessions of continuous educational programs were effective in increasing knowledge and improving the practice of endotracheal suction and these programs can be applied all over the country. The study recommended that the developed education program regarding endotracheal suction procedure must be available in all hospital’s ICUs and must be revised and updated annually.
ملخص الدراسة:

الخلفية: وحّدات الرعاية الحرجة هي أكثر البنى تعددًا في مؤسسات الرعاية الصحية، فوجب أن يتحدى للتحديات الكامنة في الحفاظ على بنية عالية التقنية ووضع تشكيل المعدات بكفاءة من قبل الموظفين، وتوفير رعاية ذات جودة للمرضى في المنشأة. وتشجيع وتعليم الموظفين والعاملين في بنية العمل الشاق.

الهدف من الدراسة: تقييم البرنامج التعليمي وتأثيره على معرفة الممرضين وممارساتهم فيما يتعلق بالشفط داخل القصبة الهوائية التعليمية للعلوم الاجتماعية (22).

المنهجية: تم إجراء تصميم تجريبي للدراسة في بنية الرعاية المكافئة المستشفى المركزي العسكري بدأت في الفترة من مايو إلى أكتوبر 2016، وهي عينة تجريبية لمجال الرعاية (50) ممرضة ومرضى يعملون في بنية الرعاية المركزية، وقد تم جمع البيانات من خلال استبيان مبني بشكل جيد، والذي يتكون من جزءين، والائتمان التدريبي تتألف من ثمانية أجزاء من عنصر، تم تحديد صحة الدراسة التجريبية، تم استخدام التحليل الإحصائي الوصفي، تحليل البيانات باستخدام الرمز (p=0.000.0).

نتائج: أشارت نتائج الدراسة إلى أن تطبيق البرنامج التعليمي لممرضي بنية الرعاية المركزية كان فعالًا، وقد تحسنت معرفة الممرضات والممرضين عن الشفط داخل القصبة الهوائية في المرحلة الثانية. بالنسبة للمرتبة الثانية للممارسة في بنية الرعاية المركزية، فقد تم قياس في هذه المرحلة (50%) في بنية الرعاية المركزية، ونسبةindice=0.12% في بنية الرعاية المركزية، ونسبةindice=0.000 في بنية الرعاية المركزية.

الخلاصة: كشفت الدراسة أن المعرفة حول الشفط داخل القصبة الهوائية قد تحسنت، وكان لدى سير الدراسة محتوى مقبول من الممارسة التي تحسن في المرحلة الثانية من الدراسة. ذكرت الدراسة أن جلسات البرنامج التعليمي كانت فعالة في زيادة المعرفة وتحسين ممارسة الشفط داخل القصبة الهوائية ويمكن تطبيق هذا البرنامج في جميع أنحاء البلاد. ووصفت الدراسة أن يكون البرنامج التعليمي الذي تم تطويره بشأن الشفط داخل القصبة الهوائية متاحًا في جميع وحدات الرعاية المركزية بالمستشفيات وجب مراجعته وتحديثه سنويا.
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<table>
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<tr>
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<tbody>
<tr>
<td>AARC</td>
<td>American Association Of Respiratory Care</td>
</tr>
<tr>
<td>ACI</td>
<td>Agency For Clinical Innovation</td>
</tr>
<tr>
<td>BP</td>
<td>Blood Pressure</td>
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<tr>
<td>CCU</td>
<td>Coronary Care Unit</td>
</tr>
<tr>
<td>CDC</td>
<td>Centers For Disease Control And Prevention</td>
</tr>
<tr>
<td>CES</td>
<td>Closed-Circuit Endotracheal Suction</td>
</tr>
<tr>
<td>CSS</td>
<td>Closed Suction System</td>
</tr>
<tr>
<td>CVS</td>
<td>Cardiovascular System</td>
</tr>
<tr>
<td>ECG</td>
<td>Electrocardiography</td>
</tr>
<tr>
<td>ENA</td>
<td>Emirates Nursing Association</td>
</tr>
<tr>
<td>ETS</td>
<td>Endotracheal Suctioning</td>
</tr>
<tr>
<td>ETT</td>
<td>Endotracheal Tube</td>
</tr>
<tr>
<td>FIO$_2$</td>
<td>Fraction Of Inspired Oxygen</td>
</tr>
<tr>
<td>ICCMU</td>
<td>Intensive Care Coordination And Monitoring Unit</td>
</tr>
<tr>
<td>ICP</td>
<td>Intracranial Pressure</td>
</tr>
<tr>
<td>ICU</td>
<td>Intensive Care Units</td>
</tr>
<tr>
<td>INR</td>
<td>International Normalized Ratio</td>
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<tr>
<td>MAP</td>
<td>Mean Arterial Pressure</td>
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<tr>
<td>Abbreviation</td>
<td>Description</td>
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<td>--------------</td>
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<tr>
<td>MHI</td>
<td>Manual Hyperinflation</td>
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<tr>
<td>MMHG</td>
<td>Millimeter Mercury</td>
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<tr>
<td>MVP</td>
<td>Mechanical Ventilator Patients</td>
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<tr>
<td>NHSN</td>
<td>National Health Care Safety Network</td>
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<tr>
<td>NICU</td>
<td>Neonatal Intensive Care Unit</td>
</tr>
<tr>
<td>NIV</td>
<td>Non-Invasive Ventilation</td>
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<tr>
<td>NSI</td>
<td>Normal Saline Instillation</td>
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<tr>
<td>NSW</td>
<td>New South Wales</td>
</tr>
<tr>
<td>OES</td>
<td>Open-Circuit Endotracheal Suction</td>
</tr>
<tr>
<td>OSS</td>
<td>Open Suction System</td>
</tr>
<tr>
<td>PEEP</td>
<td>Positive End Expiratory Pressure</td>
</tr>
<tr>
<td>PICU</td>
<td>Premature Intensive Care Unit</td>
</tr>
<tr>
<td>PPE</td>
<td>Personal Protective Equipment’s</td>
</tr>
<tr>
<td>RN</td>
<td>Registered Nurse</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package For Social Sciences</td>
</tr>
<tr>
<td>US</td>
<td>Unites States</td>
</tr>
<tr>
<td>VAP</td>
<td>Ventilator Associated Pneumonia</td>
</tr>
<tr>
<td>VHI</td>
<td>Ventilator Hyperinflation</td>
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Chapter one

introduction

problem statement

objectives
1.1. Introduction:

Critical care setting is one of the most complex environments in a healthcare facility. Critical care units must manage the intersecting challenges of maintaining a high-tech environment and ensuring staff competency in operating the equipment, providing high-quality care to the facility’s sickest patients, and tending to the needs of staff members working in a very stressful environment. While other hospital units may need to manage one or two challenges at a time, critical care settings must manage them all simultaneously while remaining focused on the delivery of safe patient care (1).

Patient in Critical care unit often requires mechanical assistance to maintain airway patency. Inserting a tube in to the trachea by passing the upper airway and laryngeal structures creates an artificial airway (2). All patients with an artificial airway require endotracheal suctioning (ETS) to remove secretions and prevent airway obstruction (3). The American association for respiratory care (AARC) defined endotracheal suctioning (ETS) as a component of bronchial hygiene therapy and mechanical ventilation that involves the mechanical aspiration of pulmonary secretions from a patient’s artificial airway to prevent its obstruction. It’s one of the most common procedures performed in patients with artificial airways. The procedure includes patient preparation, the suctioning event, and follow-up care (4).

The most significant discrepancies were observed on infection-control practices, which may constitute important risk factors for ventilator associated pneumonia (VAP) by increasing microbial colonization of the lower airway. The observed deficiencies may jeopardize patient safety and, thus the quality of nursing care (2). The findings raised concerns about all aspects of endotracheal suctioning. A considerable lack of knowledge about various aspects of the suctioning procedure accompanied by poor practice was highlighted (5). However, failure to meet the standards in the implementation of this procedure can have numerous detrimental effects. Possible complications of endotracheal tube suctioning include hypoxia, bronchospasm, atelectasis, tracheal tissue injury, and increase in intracranial pressure, cardiac dysrhythmia and ventilator-associate pneumonia (6).

Many studies showed that nurses don’t adhere to current practice guidelines for endotracheal suctioning and have low levels of knowledge and practice leading to drastic complications and thus increasing the risk for ventilator associated pneumonia (VAP) (7). Numerous studies exist regarding evidence-based measures for endotracheal suction (ETS),
however, only a few studies have been performed in recent years to assess the impact of an educational program on knowledge and its impact on practice in ETS \(^8\). There’s a deficiency in literature regarding nurses’ knowledge of ETS \(^9\).

Educational attainment is closely related to income, occupation, access to medical care and lifestyle habits. Education has been inversely associated with mortality, an overall measure of health. Several cohort analyses have examined the relationship between education and mortality in the Western countries and it showed that low educational level was associated with higher all-cause death rates \(^{10}\).

Given the deficiency in current literature regarding direct studies to examine effect of education on ICU nurses’ knowledge and practice of ETS, this study will provide an opportunity to examine groups of ICU nurses’ knowledge before and after an educational program on ETS. The study will also assess the impact of that educational intervention on nursing practice in ETS.
1.2. **Problem statement:**

Endotracheal suctioning is the necessary procedure carried out in the critical care units but has a number of potential risks and complications that ranges from hypoxemia to cardiac rhythm disturbances, trauma, and in extreme circumstances cardiac arrest and death. Patients may also experience moderate to severe pain. Ventilator associated pneumonia is the major complication. It is therefore imperative that healthcare professionals are aware of these risks and are able to practice according to current best evidence\(^9\).

Many studies showed that nurses don’t adhere to current practice guidelines for endotracheal suctioning and have low levels of knowledge and practice leading to drastic complications and thus increasing the risk for ventilator associated pneumonia (VAP)\(^7\). Researchers have identified that nurses are unaware of current suctioning recommendations and practice is often based on ritual and tradition as opposed to empirical. Nurse’s lack of adherence to aseptic technique may be a factor in transmitting infection or cross infection which in turn increases patient’s length of stay. When an infection can be prevented by ordinary and reasonable care, nurses must use such care. Adequate knowledge along with the correct procedure performance is required to follow the aseptic technique which in turn prevents infection.\(^11\)

Nurse understaffing is ranked by the public and physicians as one of the greatest threats to patient safety in United States hospitals. The widespread shortage of nurses, increased concern about recruiting an adequate supply of new nurses to replace those expected to retire over the next 15 years, and constrained hospital budgets. The finding also raise questions about whether characteristics of the hospital registered nurses workforce other than ratios of nurses to patients are important in achieving excellent patient outcomes.\(^12\)

In Sudan where shortage of nursing staff is evident, skilled and knowledgeable nurses are extremely important and needed to make appropriate decisions pertaining to patient care in order to minimize risks to their patients’ health and wellbeing. Evidence-based practices should empower intensive care nurses to prevent poor outcomes in the suction procedure of the tracheal tube. A study by Elbokhary R revealed that 85.7% of nurses have poor knowledge about endotracheal suction and 23.3% have poor practice level\(^13\).

Education plays the key role in the management of patients with endotracheal tube. Thus, when nurses are educated on proper ETS procedure, they can apply evidence-based practice, leading to reduced ventilator associated pneumonia (VAP) related morbidity and mortality\(^10\).
To ensure the highest standards of nursing care, nursing practice must be based on a strong body of scientific knowledge and evidenced based practice. This can be achieved through adherence to the evidence based guidelines for endotracheal suctioning, ultimately improving patient outcomes. Improved outcomes will shorten the length of patients’ ICU stay, and overall need for hospitalization, as well as benefit the patient financially due to decreased hospital costs. Hospitals also gain benefits, as they are continually faced with the challenge of providing cost effective services to patients and communities.
1.3. **Objectives:**

1.3.1. **General objectives:**
To assess the effect of the teaching program on ICU nurse’s knowledge and practice regarding endotracheal suctioning on Omdurman military hospital 2019.

1.3.2. **Specific objectives:**
1) To assess the existing knowledge regarding endotracheal suctioning among Intensive Care Unit nurses.
2) To assess the existing practice regarding endotracheal suctioning among Intensive Care Unit nurses in:
   a) Pre assessment and preparation
   b) Procedure performance.
   c) Post assessment and after care
3) To implement the educational programme regarding ETS on ICU nurses practice compliance.
4) Evaluate the effectiveness of the educational programme regarding ETS on nurses knowledge and practice.
5) To assess the coorelation between demographic background and nurses knowledge and practice of ETS.
1.4. Hypothesis:

1. $H_01$: there will be no difference between pretest and post-test knowledge scores regarding endotracheal suctioning procedure among ICU nurses at selected hospitals.

2. $H_{11}$: There will be improvement in knowledge scores of ICU nurses after implementation of the structured teaching program.

3. $H_02$: There will be no difference between pretest and post-test in assessment of practice regarding endotracheal suctioning procedure among ICU nurses at selected hospitals.

4. $H_{12}$: There will be improvement in practice compliance scores of ICU nurses after administration of the structured teaching program.
Chapter two

literature review
2. Literature review:

2.1 Nursing education:

Education has a prominent role in bringing about changes and obtaining anticipated results. Education is a basic means to get ends. Many useful changes and transformations had been possible by developing appropriate educational backgrounds. Nurses need to participate in decisions in order to create a better job environment and better care of their patients. But their participation is not adequately accountable. The history of nursing education is related to the history of nursing policy making. During years by developing educational and practical nursing standards through effective policies by nurses, this thought came to minds that nurses are able to self-regulation and self-direction (14).

Educational development describes actions, planned and undertaken by faculty members themselves or by others working with faculty, aimed at enhancing teaching. Previous research into higher education teachers’ participation in such educational development has shown the importance of both intrinsic factors and professional motives. Also, there have been efforts to investigate barriers to and opportunities for educational development at individual, group and institutional levels among medical educators (15).

Nurses are the frontline health personnel who provide the care aspects of cure to patients who need suction. Thus, a nurse has to undergo a specific training in endotracheal suction, thereby ensuring quality care which in turn will promote efficient utilization of hospital resources. This knowledge could aid the nurses to facilitate early recovery of the patients, hasten discharge and enhances cost effectiveness through reduction of hospital stays. (16)

A study by shubhasini to evaluate the effectiveness of learning package regarding care of patients on mechanical ventilator to the staff nurses of a selected hospital in Mangalore. An evaluator approach with one group pre-test post-test was used. The sample consisted of 30 staff nurse that was selected using a purposive sampling technique and the data was collected using a structured questionnaire and observation check list. The study found that the knowledge and skill score of staff nurses was low before the administration of learning package and demonstration of endotracheal suctioning procedure. The learning package facilitated them to gain more knowledge regarding care of patients on mechanical ventilator and skills in endotracheal suctioning practice. (17)
A study was designed to examine to what extent intensive care nurses' knowledge and practice of endotracheal suctioning is based on research evidence, to investigate the relationships between knowledge and practice, and to evaluate the effectiveness of a research-based teaching program. This quasi-experimental study was a randomized, controlled, single-blinded comparison of two research-based teaching programs, with 16 intensive care nurses, using non-participant observation and a self-report questionnaire. Initial baseline data revealed a low level of knowledge for many participants, which was also reflected in practice, as suctioning was performed against many of the research recommendations. Following teaching, significant improvements were seen in both knowledge and practice. Four weeks later these differences were generally sustained, and provide evidence of the effectiveness of the educational intervention. The study raised concern about all aspects of endotracheal suctioning and highlighted the need for changes in nursing practice, with clinical guidelines and focused practice-based education. \(^{(18)}\)

Another study done in by reed to evaluate the effectiveness of an educational intervention on healthcare professionals' adherence to the technical recommendations for tracheobronchial aspiration in intensive care unit patients. A quasi-experimental study was performed to evaluate intensive care unit professionals' adherence to the tracheobronchial aspiration technical recommendations in intensive care unit patients both before and after a theoretical and practical educational intervention. Comparisons were performed using the chi-square test, and the significance level was set to p<0.05. A total of 124 procedures, pre- and post-intervention, were observed. Increased adherence was observed in the following actions: the use of personal protective equipment (p=0.01); precaution when opening the catheter package (p<0.001); the use of a sterile glove on the dominant hand to remove the catheter (p=0.003); the contact of the sterile glove with the catheter only (p<0.001); the execution of circular movements during the catheter removal (p<0.001); wrapping the catheter in the sterile glove at the end of the procedure (p=0.003); the use of distilled water, opened at the start of the procedure, to wash the connection latex (p=0.002); the disposal of the leftover distilled water at the end of the procedure (p<0.001); and the performance of the aspiration technique procedures (p<0.001). There was a low adherence by health professionals to the preventive measures against hospital infection, indicating the need to implement educational strategies. The educational intervention used was
shown to be effective in increasing adherence to the technical recommendations for
traceobronchial aspiration.\textsuperscript{(19)}

Another study by Savita Sharma aimed to evaluate the effectiveness of endotracheal
suctioning protocol in terms of knowledge and practices of nursing personnel. The structured
knowledge questionnaire and an observation checklist regarding endotracheal suctioning was
developed and used for data collection and the endotracheal suctioning protocol was also
developed and nurses were educated as per protocol. An experimental approach was used with
quasi experimental design. Pre and post-implementation data from 30 purposively selected ICU
nursing personnel of Maharishi Markandeshwar Institute of Medical Science &Research
Hospital, Mullana was collected. Subsequent reinforcements were given until >80% practice
score was achieved. Findings of the study revealed that the mean post-implementation
knowledge score and practice score of nursing personnel regarding endotracheal suctioning was
significantly higher than the mean preimplementation knowledge and practice score (p<0.001).
Hence, the protocol was effective in enhancing the knowledge and improving the practices of
nursing personnel regarding the endotracheal suctioning.\textsuperscript{(20)}

A quasi-experimental study was performed by Lima to evaluate intensive care unit
professionals’ adherence to the tracheobronchial aspiration technical recommendations in
intensive care unit patients both before and after a theoretical and practical educational
intervention. Comparisons were performed using the chi-square test, and the significance level
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glove with the catheter only (p<0.001); the execution of circular movements during the catheter
removal (p<0.001); wrapping the catheter in the sterile glove at the end of the procedure
(p=0.003); the use of distilled water, opened at the start of the procedure, to wash the connection
latex (p=0.002); the disposal of the leftover distilled water at the end of the procedure (p<0.001);
and the performance of the aspiration technique procedures (p<0.001). There was a low
adherence by health professionals to the preventive measures against hospital infection,
indicating the need to implement educational strategies. The educational intervention used was
shown to be effective in increasing adherence to the technical recommendations for tracheobronchial aspiration.\(^{(21)}\)

Another study by Tina Day on Effect of performance feedback on tracheal suctioning knowledge and skills: randomized controlled trial. A Ninety-five qualified healthcare professionals (nurses and physiotherapists) in two acute hospitals were randomly allocated to receive either individualized performance feedback or no additional feedback after a standardized lecture and practical demonstration of tracheal suctioning. Randomization was stratified by profession, seniority and site. Data were collected in 2005 in a clinical setting involving patients and a simulation setting. The outcome measures were knowledge and practice of tracheal suctioning, assessed by self-completion questionnaire and structured observation. In both settings, intervention groups performed statistically significantly better in terms of knowledge \((P = 0.014)\) and practice \((P = 0.037)\) at final follow-up. Those who received performance feedback had statistically significantly higher knowledge \((P = 0.004)\) and practice \((P < 0.01)\) scores than the control group. For practice, there was also a relationship between professions \((P < 0.01)\), with physiotherapists performing better than nurses overall, and an interaction between group and setting \((P < 0.01)\), with performance feedback showing a stronger positive effect in the simulation setting. Retention of knowledge and tracheal suctioning practice is improved when training is followed up by tailored feedback on performance. Further research would shed light on how long such improvements are sustained, and whether the improvements seen in a simulated setting can be generalized to clinical settings.\(^{(22)}\)

This study was designed to investigate closed-system ETS practices of critical care nurses and to compare their practice with standard recommendations. A prospective observational study was conducted during August and December 2012 to establish how critical care nurses \((N = 40)\) perform different steps in a typical ETS practice and to compare it with the current best practice recommendations through a 23-item structured checklist. The results were categorized into three sections: Pre-suctioning, suctioning, and post-suctioning practices. Pre-suctioning, suctioning, and post-suctioning practices mean scores were 7.5, 11.75, and 8.5, respectively, out of 16, 16, and 12, respectively. The total suctioning practice score was 27.75 out of 44. Most discrepancies were observed in the patients’ assessment and preparation, infection control practices, and use of an appropriate catheter. Spearman correlation coefficient indicated a significant statistical positive correlation between suctioning education period and suctioning practice score \((P <
0.0001) and between working experience and suctioning practice score (P = 0.02). The findings revealed that critical care nurses do not fully adhere to the best practice recommendation in CSS. We recommend that standard guidelines on ETS practice be included in the current education of critical care nurses. \(^{(23)}\)

A quasi-experimental study was performed to evaluate the effect of education and quality control work group on prevention of VAP by 18 nurses in the women’s medical ward, Surat Thani Hospital, Thailand. Pre-intervention nursing practices were observed in March, 2002, followed by interventions in April 2002 and two post-tests on nursing practices in May 2002 and July 2002. Interventions included education and quality control work group focusing on nursing practices on prevention of VAP. Each observation period lasted for one month. Research instruments included a demographic data collection form, a quality control circle teaching plan, an evaluation manual and an observational recording form. After the intervention, significant improvement on nursing practices for prevention of VAP was observed in the first (60% vs. 85%; P<0.001) and the second month (60% vs. 91%; P<0.001) post-intervention. Compliance to nursing practice guidelines among the participants were also increased in all practice categories (87% vs. 98%; P<0.001). The present study suggests the positive roles of education and quality control work group to improve nursing practices for preventions of VAP. Additional studies are needed to examine the long-term effects of these interventions \(^{(24)}\).

An experimental interventional study done by kargar M to evaluate the training and educational needs in nurses working with NICUs affiliation to the Shiraz University of Medical Sciences to increase thrie potential with regards to ETT suctioning. Data collection was done by a test of 30 points to evaluate knowledge and checklist with 47 points to evaluate performance. After random allocation, the subjects’ knowledge was evaluated. Then the ETT suction education was given to the test group and NICU infection control education was given to the controls. Two days and two months after the intervention, the subjects were reevaluated. the results were compared. Man-Whitney test showed the level of knowledge between the two groups at the beginning of the study had no significant difference (p = 0.71), while the average score in the two groups 2 days and 2 months after the intervention (education had significant difference (p = 0.001). there was a significant difference 2days and 2 months after intervention (p = 0.001) in the performance \(^{(25)}\).
2.2 Definition of artificial airways:

Internally, the airway is made up of many structures and well-defined spaces. It originates at the nasal and oral cavities. The nasal cavity extends from the nostrils to the posterior nares or choana. The nasopharynx extends from the end of the nasal cavity to the level of the soft palate. The oral cavity is bounded by the teeth anteriorly, hard and soft palate superiorly and the tongue inferiorly. The oropharynx, which communicates with the oral cavity and nasopharynx, extends from the soft palate to the tip of the epiglottis. The oropharynx continues as the laryngopharynx (hypopharynx), which extends from the epiglottis to the upper border of the cricoid cartilage (level of the C6 vertebral body). The larynx lies between the laryngopharynx and trachea (26).

Tracheal suction through an artificial airway; endotracheal, tracheostomy, or nasotracheal tube bypasses the normal protective mechanisms such as the cough reflex that the upper airways provide. An artificial airway refers to the plastic tube inserted via the nose, mouth or trachea and located into the trachea of the patient (27). An artificial airway is any device inserted into the respiratory tract to facilitate breathing or secretion removal (28).

2.3 Types of artificial airways:

When a patient’s airway is at risk for obstruction or becomes obstructed, an artificial airway is inserted to maintain airway patency. Some common devices used for this purpose are oropharyngeal airways, nasopharyngeal airways, endotracheal tubes, and tracheostomy tubes. Oral airways are used to keep the upper airway patent when it is at risk for becoming obstructed by the tongue or by secretions. Because this type of airway stimulates the gag reflex, it should be used only for patients whose level of consciousness is altered. Nasopharyngeal airways, sometimes called nasal trumpets, are also used to keep the upper airway patent. They are inserted through the nares and extend into the oropharynx. Because this type of airway does not stimulate the gag reflex, it can be used for patients who are alert. Tracheostomy tubes are used for long-term airway support. They are inserted through a small opening in the neck into the trachea. This type of airway may be permanent or temporary depending on the patient’s condition and reason for the tracheostomy. Endotracheal tubes are used for patients undergoing a procedure that requires general anesthesia and/or mechanical ventilation. They are inserted either through the nose or the mouth past the epiglottis and vocal cords into the trachea and down to where the
trachea bifurcates into the bronchi. ET tubes are not usually left in place for more than 14 days as doing so places the patient at risk for infection and airway injury \(^{(29)}\).

### 2.4 Indications for artificial airways insertion:

The major indications for insertion of an artificial airway include: secure or maintain a patent airway, to assist in the delivery of mechanical ventilatory support, and where non-invasive ventilation (NIV) has failed, to facilitate the removal of tracheal secretions, to aid in the management of multi-organ failure/sepsis, to reduce the risk of aspiration where patients are unable to protect their own airway (neurological, unconscious), to deliver high concentrations of oxygen \(^{(30)}\).

### 2.5 Definition of endotracheal suctioning:

The American association of respiratory care (AARC) defined endotracheal suctioning (ETS) as a component of bronchial hygiene therapy and mechanical ventilation that involves the mechanical aspiration of pulmonary secretions from a patient’s artificial airway to prevent its obstruction. It’s one of the most common procedures performed in patients with artificial airways. The procedure includes patient preparation, the suctioning event, and follow-up care \(^{(4)}\).

ETS is the insertion of a catheter and the removal of secretions from an artificial airway, using a suction device attached to a negative pressure vacuum setup. The purpose is to clear secretions from the airway, to maintain a patent airway and to optimize ventilation and oxygenation. It’s also procedure used to remove substances from the tracheal artificial tubing; endotracheal tube, tracheostomy tube \(^{(16)}\).

The American Association of Respiratory Care (AARC) provided guidelines for suctioning mechanically ventilated patients in 2010. The electronic literature search for articles published between January 1990 and October 2009 was conducted by using MEDLINE, CINAHL, and Cochrane Library databases. The clinical practice guideline is the result of reviewing a total of 114 clinical trials, 62 reviews and 6 meta-analyses on endotracheal suctioning. The guidelines defined what is endotracheal suctioning and described the assessment and preparation, procedure performance and follow up care. It also discussed the indications, contraindications, complications, infection control, patient monitoring and outcome evaluation. It also recommended that; Endotracheal suctioning should be performed only when secretions are present, and not routinely. Pre-oxygenation is considered only if the patient has a clinically important reduction in oxygen saturation with suctioning. Routine use of normal saline
instillation prior to endotracheal suction should not be performed. Suction catheter is used that occludes less than 50% the lumen of the endotracheal tube in adults. (4)

The Australian NSW agency for clinical innovation has also provided a clinical practice guideline for suctioning an adult ICU patient with an artificial airway. The purpose of this guideline is to provide intensive care clinicians with evidence and best practice recommendations and guidance on suctioning critically ill adult patients with an artificial airway. Developed under the auspices of the Intensive Care Best Practice Manual Project, this guideline highlights the ability of the Agency for Clinical Innovation (ACI) to facilitate strong working relationships with clinicians as well other executive branches of the Ministry. This guideline differ from previous guideline in that it has adopted Subglottic suctioning technique which was added because there is high level evidence supporting this practice for the prevention of ventilator-associated pneumonia (VAP). (30)

Emirates nursing association (ENA) has also provided an online clinical practice guideline for endotracheal suctioning. ENA is a nonprofit organization and was founded on January 2003. The guidelines discussed several issues including environment monitoring, patients and equipments safeguard, patient’s preparation, nursing documentation, patient’s education and training. It also provided a wide range of information regarding endotracheal suctioning indications, contraindications, complications and other things. It also emphasized on infection control and aseptic technique of the procedure. (31)

2.6 The importance of suctioning a tracheal tube:

Tracheal suction is an important procedure in the management of adults with artificial airways. Tracheal suction through an artificial airway; endotracheal, tracheostomy, or nasotracheal tube bypasses the normal protective mechanisms such as the cough reflex that the upper airways (30). Critically ill patients often have an increase in the production of mucous and an impaired ability to clear secretions. If secretions are not cleared effectively then the patient may be at risk of infection, atelectasis and alveolar collapse (32). Appropriate management of the patient with an artificial airway can have an impact on reducing complications such as the development of ventilator-associated pneumonia (VAP), length of ICU stay, duration of mechanical ventilation and mortality and morbidity (30).
2.7 Indications for endotracheal suctioning:

Endotracheal suctioning is indicated to maintain patency of an artificial airway, or to remove secretions via endotracheal tube (ETT) or tracheostomy tube, which may obstruct the airway and cause hypoxia, pneumonia, bronchitis or atelectasis (31). Endotracheal suctioning is performed when adventitious breath sounds are detected or whenever secretions are obviously present. Unnecessary suctioning can initiate bronchospasm and mechanical trauma to the tracheal mucosa. Suctioning should be based on individual need and should not be a scheduled procedure. Limiting suctioning prevents excessive mucosal damage and decreases exposure to bacterial colonization (33).

The Final suction guidelines of intensive care coordination and monitoring unit (ICCMU) 2010 aimed at providing the nurses of Intensive Care Units (ICU) with recommendations related to ‘Suction of an adult with an artificial airway’. It has also identified several indications for endotracheal suction. Visible or audible secretions such as sputum, blood or gurgling; Respiratory: desaturation, rising peak inspiratory pressure, decreasing tidal volume, increased respiratory rate, increased work of breathing or coarse breath sounds on auscultation; Cardiovascular: increased heart rate and blood pressure; Other: restless patient or diaphoresis (34).

Obstruction to the small airways, large airways and endotracheal tube/ tracheostomy tube will result in changes to the expiratory flow curve. This practice point addresses the changes that may be seen with significant obstruction to large airways and endotracheal/tracheostomy tube. A prospective observational study examined the value of a number of clinical signs including patient agitation, oxygen fall, respiratory sounds, and changes in respiratory pattern and a saw-tooth pattern on the flow-volume loop as indicators of retained secretions in a cohort of 66 consecutive ventilated patients. In this group, only a saw-tooth pattern and respiratory sounds appeared to be of value. However, for two-thirds of patients there was only one observer who was not blinded to outcomes, limiting the value of these findings (35).

There have been no new studies since this landmark research. Two Systemic reviews and one literature review consistently support this recommendation. Identification of these clinical signs will require the use of flow-volume loop analysis and/or expiratory-flow time waveform for assessment when suctioning is indicated and the clinician to constantly review the patient and ventilator. The recommendation is to suction as indicated represented by a saw-tooth pattern on
ventilator graphics or based upon the clinician's respiratory assessment as per Recommendation (4, 36,37).

2.8 Assessment for the need of endotracheal suction:

Assessment of the patient to identify the need to suction a tracheal tube should be continuous with chest auscultation performed every two hours or more frequently as indicated by clinical signs. The decision to suction a tracheal tube must be made on the basis of the clinical need to maintain the patency of the tracheobronchial tree. A tracheal tube should only be suctioned when clinically indicated by signs which could include visible, palpable or audible secretions such as sputum, gastric or upper airway contents or blood. Desaturation, rising peak inspiratory pressure during volume-controlled mechanical ventilation/modes, decreasing tidal volume during pressure-controlled ventilation/modes, increased respiratory rate, increased work of breathing or coarse breath sounds on auscultation. Increased heart rate and blood pressure. Restless/agitated or diaphoretic patient. A saw-tooth pattern on a flow-volume loop or expiratory flow-time waveform as illustrated on the ventilator graphics. Prior to suctioning, consideration should be given to the potential complications and contraindications in individual patients (4).

To reduce patient anxiety and to promote patient understanding of, and compliance with, the suctioning procedure patients should be given clear information regarding the suction procedure including: the need for suction, the consequences of not suctioning when it is required and the effects of suctioning. Furthermore, this information should be repeated with each suction procedure as some patients may not recall previous instructions (34). Patient assessment before, during and post suction should include an evaluation of the effects on the patient’s pre-suction signs and symptoms. This should include monitoring of cardiac rate and rhythm, blood pressure, pulse oximetry, airway reactivity, tidal volumes, peak airway pressures, or intracranial pressure. Some patient groups require constant/continuous monitoring of ECG and pulse oximetry before, during and post suctioning (35).

A saw-tooth pattern on flow-time waveform and flow/volume loop appear because secretion build-up in large airways, ETT/tracheostomy tube or condensate in ventilator circuit. The expiratory flow curve should be triangular in shape and expiratory flow should be complete between 1 to 2 seconds, 80% of tidal volume should be expired in the first 1 second of expiration (30). The need for suctioning may be indicated by decreasing oxygen saturation, audible gurgling,
adventitious breath sounds, or restlessness. Another indication may be to obtain a sputum culture for laboratory analysis, or to stimulate a deep cough reflex in patients that are sedated or neurologically impaired in order to mobilize secretion into the larger airways \(^{(38)}\).

A recommendation concerning the minimum time between suctions was deleted after internal validation and before external validation occurred. It was considered that it was contradictory to recommend a minimum time when the consensus of the group was to suction only when indicated. It was also felt that tube patency could be assessed in other ways, such as ventilator graphics, other than passing a suction catheter down an artificial airway \(^{(30)}\).

2.9 **Assessment pre/during/post suction/outcome measures:**

Prior to suctioning consideration should be given to the potential complications and contraindications in individual patients. Monitoring of baseline physiological variables such as respiratory, ventilator, cardiovascular, and neurological parameters should be undertaken by the clinician. In a descriptive study, suctioning has been identified by patients as causing anxiety and discomfort \(^{(39)}\).

To reduce patient anxiety and to promote patient understanding of and compliance with suctioning, patients must be given clear information regarding the suction procedure including: need for suction, consequences of not suctioning when it is required and effects of suctioning. Explain that the procedure is likely to be uncomfortable, but will be brief and that the procedure may need to be done more than once. This information should be repeated because patients may not recall previous instructions \(^{(40)}\).

If the clinician’s perceive this procedure is causing undue discomfort or distress to the patient, then clinicians should align this procedure with sedation if prescribed \(^{(35)}\). Breathe sounds, SpO2, Respiratory rate, Pattern of breathing, Sputum colour, amount, and viscosity, Palpation, ABGs all should be assessed pre and during suction. Saw-tooth pattern, Tidal volume, Peak airway pressure, Compliance. Should be assessed pre suction. ECG rate (HR), ECG rhythm, BP, MAP. Should be assessed pre and during suction. ICP, is assessed only if indicated. \(^{(30)}\)
2.10 Endotracheal suction Contraindications:

Most contraindications are relative to the patient’s risk of developing adverse reactions or worsening clinical condition as result of the procedure. When indicated, there is no absolute contraindication to endotracheal suctioning, because the decision to withhold suctioning in order to avoid a possible adverse reaction may, in fact, be lethal (8).

2.11 Infection control:

The scientific knowledge on which nurses base their clinical practice is often lacking. Nurse’s lack of adherence to aseptic technique may be a factor in transmitting infection or cross infection. When an infection can be prevented by ordinary and reasonable care, nurses must use such care. Adequate knowledge is required to follow the aseptic technique. Aseptic technique should be considered an essential component of the endotracheal suctioning procedure to reduce the risk of infection. It is recommended that hands should be washed before and after suctioning and that apron, gloves and goggles should be worn during suctioning (41).

Significant treatment-related discrepancies were observed in critical-care nurses’ performance in relation to current recommendations in their daily practice prior to and during ETS events. The most significant discrepancies were observed in ETS practices related to infection-control practices. Infection-control practices (e.g., hand hygiene, protection of practitioners and patients from secretions as well as adequate disposal of the used catheter and gloves, and maintenance of the sterility of the suction catheter) are crucial elements in the prevention of cross-infections and transmission of pathogens via hands or equipment. Adequate hand hygiene has been associated with a significant reduction in VAP. As found in previous studies, the principal deficiency was in hand disinfection practices prior to and post ETS events. In addition to infection-control practices, significant treatment-related discrepancies were observed in maintaining an optimal cuff pressure prior to and post ETS events, which is essential for the prevention of micro-aspiration of colonized oropharyngeal secretions (42).

2.11.1 Hand hygiene:

The NSW Health Hand Hygiene Policy states that all staff must perform hand hygiene as per the 5 Moments for Hand Hygiene. Hand hygiene must occur on entering the patient bed area; prior to donning gloves to perform the suctioning procedure; on completion of the suctioning procedure following glove removal and on leaving the patient bed area (30).
2.11.2 Personal protective equipment:

The Australian Guidelines for the Prevention and Control of Infection in Health Care and the NSW Infection Control Policy state that all procedures that generate or have the potential to generate secretions or excretions require that either a face shield or a mask worn with protective goggles is to be used by healthcare workers. Therefore, the use of personal protective equipment (PPE) to prevent mucosal or conjunctival splash injury is mandatory while suctioning the patient both open and closed suction. This must include mask and goggles or face shield; gloves and gown/apron (30).

Suctioning of the artificial airway is to be completed using a clean technique for closed system suction and aseptic non-touch technique for open suction to minimize the potential for introduction of exogenous organisms into the respiratory tract of the critically ill patient. Mask/goggles or face shield, and Gown/apron are worn with both closed and open system suction. Sterile gloves are worn with open system, whereas Non – Sterile gloves are worn with closed system. A Clean field is used with closed system while aseptic field is used with open system suctioning (4).

2.11.3 Workplace health and safety:

Prevention of work injury is an important aspect of any clinical practice guideline. Users are directed to the following policy directives covering work health and safety. Local policy must also be consulted. organisations must eliminate risks to the health and safety of workers where at all possible. When it is not possible to eliminate risks, the risk must be minimised as far as reasonably practicable. Organisations must provide appropriate PPE for use by staff. Staff have a responsibility to use that PPE according to policy. The worker has an obligation to take all reasonable care for their own safety, take care that their acts or omissions do not adversely affect the health and safety of other persons, comply with any reasonable instruction they are given (30).

2.11.4 above cuff/subglottic suction:

The mouth and oropharynx become colonised with pathogenic organisms after ICU admission. The main condition necessary for the development of ventilator-associated pneumonia (VAP) is the aspiration of small amounts; micro-aspiration of secretions past the cuff of an endotracheal or tracheostomy tube. Factors such as impaired laryngeal function, e.g. translaryngeal tube, diminished upper airway reflexes, gastroesophageal dysfunction, and passive
regurgitation of gastric contents, continuous enteral feeding and supine body position are associated with the development of VAP\textsuperscript{(43)}.

2.12 Infection risks:

2.12.1 Ventilator associated pneumonia:

There are abundant bacteria and organisms in the hospital. They can spread in number of ways including contaminated respiratory equipment’s, inadequate hand washing and improper or infrequent suctioning\textsuperscript{(44)}. Ventilator-associated pneumonia (VAP) is the most common infectious complication among patients admitted to critical care units, it refers to pneumonia that has developed in patients who are receiving mechanical ventilation and develop it within 48 to 72 hours after tracheal intubation\textsuperscript{(45)}. VAP represents a common nosocomial complication arising in the ICU, affecting 8 to 20\% of ICU patients and up to 27\% of mechanically ventilated patients\textsuperscript{(46)}. VAP is the leading cause of hospital-acquired infections in the ICUs\textsuperscript{(47)}.

In 2002, an estimated 250,000 healthcare-associated pneumonias developed in U.S.A. hospitals and 36,000 of these were associated with deaths. Patients with mechanically-assisted ventilation have a high risk of developing healthcare-associated pneumonia. For the year 2010, National Health care Safety Network (NHSN) facilities reported more than 3,525 VAPs and the incidence for various types of hospital units ranged from 0.0-5.8 per 1,000 ventilator days\textsuperscript{(48)}. Mortality rate in patients with VAP range from 20 to 50\% and may reach more than 70\% when the infection is caused by multi-resistant and invasive pathogens\textsuperscript{(49)}.

The Closed Suction System (CSS) provides a barrier to separate the contaminated (colonized) catheter from the caregiver and other patients. One study has shown a significant reduction in the VAP rate with closed suctionin\textsuperscript{(50)}. The recently revised clinical practice guideline published by the American Association for Respiratory Care (AARC) recommends the use of the Closed Suction System (CSS) as part of a VAP prevention strategy. In addition to reducing the risk of microbial contamination as compared to the open suctioning technique, closed suctioning permits continuous ventilation reducing respiratory stress and vulnerability\textsuperscript{(4)}.

A study was conducted on prevalence of ventilator associated pneumonia in intensive care units of Sainte marguerite hospital of France. The study findings showed that the prevalence of ventilator associated pneumonia ranged from 5.6 to 21.1 cases per 1000 ventilator days. In addition patients who developed ventilator associated pneumonia had significantly longer
hospital days and higher mortality rates than those who had not developed ventilator associated pneumonia. (51)

A descriptive study conducted by Al-Khadir M, in Al-Shaab teaching Hospital, Sudan (2012), to assess the level of ICU nurses knowledge and practice regarding VAP guidelines, included 40 ICU nurses, found that; 25% of participants had poor knowledge level, 57.5% of them had fair knowledge level and 17.5% of them had good knowledge level. Regarding practice level found that; 42.5% of participants had fair practice level, 32.5% poor practice level and 2.5% of them had good practice. (52)

An experimental study was conducted at KLE institute, Belgaum to study the effect of multimodality chest physiotherapy in mechanically ventilated patients for the prevention of VAP. Study consisted of 101 patients with 51 in controlled group and 50 in study group. Manual hyperinflation and suctioning were administered to patients in controlled group while the study group received positioning and chest wall vibration in addition to hyperventilation and suctioning. Results of the study showed that there was significant decrease in mortality rate among study group (24%) as compared to controlled group (49%). (53)

A nurse led VAP surveillance program was conducted in PICU and NICU of UK hospital to assess the effectiveness of VAP care bundle in reducing VAP. All nursing staff had multiple training opportunities. VAP project education became a routine part of staff induction. The major features of the bundle of care were (1) elevation of bed to maximum, (2) mouth care using chlorhexidine, (3) clean suctioning practice, (4) all patients not on full feeds commenced on ranitidine and (5) 4-hourly documentation. bAfter the institution of the bundle, no pediatric case of VAP was recorded over a 12-month period. The study concluded that, pediatric VAP bundle was associated with reduced VAP. (54)

A 2008 evidenced-based clinical practice guideline strongly recommended the use of subglottic secretion drainage when patients were expected to require mechanical ventilation for greater than 72 hours. This recommendation was based upon the review of five good quality studies and took into account the increased availability of tubes designed for subglottic suction. (55)
A recent systematic review and meta-analysis consistently supports the earlier recommendations. This meta-analysis included 13 randomised controlled trials of the effect of subglottic suction on the development of VAP and reported an overall risk ratio for subglottic suction versus standard care of 0.55 with no heterogeneity. (56)

Another meta-analysis suggested that subglottic secretion removal may be associated with reduced duration of mechanical ventilation and intensive care length of stay. In RCT, both continuous and intermittent subglottic secretion drainage have been associated with reduction of the incidence of VAP. Tracheal tubes with subglottic suction capability should be used for mechanically ventilated patients who are expected to be ventilated >72hours. If a tracheal tube does not have subglottic suction capability, a Y-catheter should be used to remove “above the cuff” secretions. (57)

2.12.2 Endotracheal tube (ETT) colonization:
Colonized secretions reside in both the gastrointestinal tract and oropharynx. Basic nursing care principles are the first line of defense. Incorporating the following key points and practices can reduce colonization (58).

The bulk of existing evidence, regarding colonisation of the tube, as distinct from VAP incidence, weakly favours the use of OSS. An systemic review found greater respiratory tract and ETT colonisation in CSS than open suction system (OSS) (59), while a study found a significantly increased risk of 49% for CSS ETT tube bacterial colonisation over OSS (60).

2.12.3 Environmental contamination:
The 2010 clinical practice guidelines identified only one study that examined whether suctioning technique should be clean or sterile; there was insufficient evidence to make a recommendation. Since that time, there have been two small case series. One study examined the contamination of ETS equipments; the other was a case series that examined droplet spread with suctioning. Contamination of the suction device was common in both studies, yielding positive cultures in 94% and 80% of the devices, respectively. Both studies also reported a concern with the storage of suctioning equipment. Suction devices were found in beds, on medical equipment and even on the floor. Furthermore, it found slightly lower contamination rates on the proximal end of the suction tubing (83%) and connection port of the inline suction catheter (61%). Also
the study found that visible droplets were scattered over a distance of 60±39 cm from the ETT and 30% of the bacteria were similar to those found in the trachea of OES patients. Bedside storage of suctioning devices in a clean holder or other set up should be considered. Health care professionals must be cognizant of regional guidelines and standards for high-risk respiratory procedures. This will generally include the use of personal protective equipment such as masks for suctioning (61).

Studies highlight variation of health worker clinical practice according to the type of suction system in use. One prospective crossover design Randomized control trial found OSS groups to be better than CSS for the use of hand hygiene, glove, mask and eye protection by staff pre suction (100% OSS Vs. 91% CSS) (62). In one pre/post convenience sample study of a patient population with multi-drug resistant pathogens, CSS use was found to be preferable for decreasing glove and airway equipment contamination during tracheal suction (74% OSS vs. 6% CSS) (63).

2.13 Preoxygenation:

Suctioning may frequently lead to hypoxemia, which can cause cardiac dysrhythmia, hypotension and even cardiac arrest and death. In order to prevent these complications preoxygenation is recommended prior to suctioning. Oxygen should be reduced to baseline levels post suctioning to prevent oxygen toxicity. Preoxygenation of the patient using 100% oxygen delivered by the ventilator or through hyperventilation has been a standard of care for many years however the change to CSS raised questions around the need for this practice to continue (64). Historically, Preoxygenation through the delivery of an increased fraction of inspired oxygen (\(\text{FIO}_2\)) via the mechanical ventilator or manual resuscitator has been implemented to reduce the risk of hypoxia during suctioning on intubated mechanically ventilated adults. While routine pre-oxygenation has often been recommended as a precautionary measure to prevent possible instances of desaturation, it cannot be assumed that the administration of high concentrations of oxygen for this use is without risk to the patient. Most ventilators include a facility whereby 100% oxygen can be delivered for a preset period, and less hemodynamic effects have been reported with this method (65).
2.14 Techniques of endotracheal suction:

ETS is performed as open-circuit suction system (OSS) or closed-circuit suction system (CSS). Open-circuit suction system (OSS) refers to the suctioning technique in which patients are disconnected from the ventilator and a single use catheter is inserted into the ETT to suction secretions before the patient is reconnected. The closed-circuit suction system (CSS) is the suctioning technique in which the suction catheter is enclosed in a plastic sleeve and can be inserted into the ETT without the need for disconnection from the ventilator. CSS was initially developed for preventing arterial desaturation complicating ventilator disconnection. Although significantly reduced in comparison to OSS, the loss of lung volume resulting from CSS remains dependent on the negative pressure applied during the procedure (38).

Disconnecting the ETT from the ventilator circuit may cause substantial loss of lung volume, which is further exacerbated by suctioning. CSS have the advantage over OES in maintaining lung volume. However, there are risks associated with OSS; generation of large negative airway pressures and auto cycling of the ventilator. A study by Fernandez demonstrated reductions in lung volume during CSS but significantly greater loss of lung volume with the OSS. In addition, OSS may lead to a marked decrease in arterial oxygen tension and increase in arterial carbon dioxide tension. During OSS, there is still controversy over the impact of the duration of suctioning on gas exchange (41).

2.15 Normal saline instillation (NSI):

Some critical care areas still practice routine instillation of saline as part of the suctioning procedures. There is no evidence to indicate that saline provides any benefit to suctioning. The studies reviewed relating to saline use had only small sample sizes and provide little evidence of serious complications. Despite there being no major complications recorded in the studies, NSI may contribute to VAP as the biofilm on the ETT is flushed into the lower airways. Therefore the recommendation to routinely use saline is prohibited due to various side effects and complication (66).

One study indicated no statistical difference in VAP rates in patients receiving saline administration during suctioning (67). But another study did not indicate a significant reduction in VAP rates in patients receiving saline administration as part of the suctioning procedure. Thus, there is inconsistent evidence in the use of saline to reduce VAP (68).
A study was conducted in England in NSI during suctioning to study its effect on oxygen saturation measured by pulse oximetry on 40 male subjects requiring ventilation. It was found that the oxygen saturation decreased at 2, 3, 4 and 5 minutes in 85% of the patients after endotracheal suctioning with NSI. The investigator recommended that NSI may not be a routine or standard intervention and it could be regarded as potential hazard. NSI is not only associated with decrease in oxygen saturation, but also may increase the risk of infection. It was proved by positive cultures for staphylococcus causing pneumonia cultured from disposable vials of saline after the vials was opened and used. Conclusion of the study was that the number of bacteria dislodged increased 5 folds with NSI. So it was recommended that the NSI before suctioning should be abandoned (69).

On reviewing a Systemic review, there continues to be little or no data to indicate that administration of saline during the suction procedure provides any benefit to suctioning, and some evidence that it may be detrimental (60). The administration of saline during the suctioning procedure was evaluated in terms of effect on: haemodynamics, oxygenation, tracheal aspirate yield, ventilator associated pneumonia (VAP) rates and tracheal tube occlusion rates. A study reviewed hemodynamic parameters following saline instillation and were consistently unable to identify a statistical significance between administration and non-administration and there appears to be little evidence of serious complications despite some minor changes in heart rate (67).

Likewise a systemic review and a randomized controlled trial of tracheal tube occlusion rates did not differ between administration of saline and non-administration in adult patients undergoing the suction procedure (36, 37). There is inconsistent and conflicting evidence in regard to oxygenation, while some have shown a significant decrease in oxygenation following saline administration during suction others have found no difference between saline administration and non-administration (70). An argument for the use of saline during the suction procedure is that it may facilitate removal of tracheal tube secretions. There is inconsistent evidence, documented in a systemic review and a randomized controlled trial to either support or refute this theory (36, 37).
2.16 Size of suction Catheter:

The size of the suction catheter and the duration of suctioning i.e. application of negative pressure will directly influence the volume of secretions removed, however, there are potential adverse effects on respiratory function. In agreement with previous research, a systemic review, a literature review and an interrupted time series/crossover design consistently support limiting the diameter of the suction catheter to less than 50% of the internal diameter of the tracheal tube (4, 36, 37).

Suction catheter size (Fr) = [ETT size (mm) minus 1] then multiply by 2 (13) or 3FG = 1mm diameter (1FG approx. 0.3mm diameter). For example, for a size 8 ETT: Using the first formula, \{8 minus 1\} then multiply by 2 = 14Fr (this formula will give a slightly larger catheter size), or Using the second formula half the diameter of 8mm = 4mm. Then multiply this number by 3 = size 12 FG (30).

2.17 Suction catheter insertion depth:

For patients deemed at low risk of adverse events it was agreed at the consensus meeting that the suction catheter may be inserted to the point of resistance or until a cough is stimulated. The catheter should then be withdrawn 1-2cm prior to the application of suction to ensure it is not against the airway wall. Suction should then be held continuously as the catheter is slowly withdrawn from the airway. It may be necessary to hold the suction catheter in the same place for a period of time if a large amount of secretions are present. The consensus opinion of the group is that patient participation always be included when possible with active large inspiration and active cough when possible rather than by catheter stimulation. To clear secretions from the primary and secondary bronchus into the trachea where they may be removed an intubated patient must cough or provide faster expiratory to inspiratory flow ratios. It was agreed to at the consensus meeting that patients who are found to have adverse reactions to suctioning, such as those with unstable cardiovascular system (CVS), high intracranial pressure (ICP), lack of cough reflex, coagulopathy or high risk of bronchospasm should have the stimulation of their carina avoided. This may be achieved by measuring the length of the suction catheter against the length of the ETT or tracheostomy tube and only inserting until the catheter just emerges out of the lumen of the tube. As no cough will be stimulated, the patient may be encouraged to cough to command, or suction may be combined with expiratory vibrations, assisted cough or other...
techniques to increase expiratory flow rates to improve suction effectiveness, limiting the number of required passes. As consistently reported in two systemic reviews and one Literature review, stimulation of the carina by the suction catheter has a number of potential adverse effects including patient distress, severe coughing and bradycardia as well as causing damage to the tracheal mucosa (4, 36, 37).

2.18 Endotracheal suction pressure:

A number of studies recommended the use of the lowest suction pressure to reduce the risk of atelectasis, hypoxia and damage to the tracheal mucosa at the same time the suction pressure must be sufficient to clear the secretion. The recommended suction pressure is 100 to 120 mmHg for adults. Higher suctioning pressure increases the risk of atelectasis and trauma (34). As consistently reported in two systemic reviews and one literature review, stimulation of the carina by the suction catheter has a number of potential adverse effects including patient distress, severe coughing and bradycardia as well as causing damage to the tracheal mucosa (4, 36, 37).

2.19 Endotracheal suction duration:

Stimulation of the carina by the suction catheter has a number of potential adverse effects including patient distress, severe coughing and Bradycardia as well as causing damage to the tracheal mucosa (1). Each pass of the suction catheter into the artificial airway should last no longer than 10 to 15 seconds and a maximum of two suction passes are recommended (34).

A recent systemic review and a literature review consistently found that suction time should be limited to a maximum of 10-15 seconds in order to minimize the risk of hypoxia, atelectasis and trauma (4, 37). It was also recommended that suction should be performed in a continuous manner only as the suction catheter is being removed. This is also the consensus opinion of the group (40).

In Sudan, there was one study conducted on the assessment of ICU nurses knowledge and practice regarding endotracheal suction of mechanically ventilated patient by Elbokhary R. the aim of this study was to assess knowledge and practice of ICU nurses regarding mechanically ventilated patients endotracheal suctioning in Khartoum teaching hospital 2014. This is a descriptive cross-sectional hospital based study. A total coverage sampling technique was used to select nurses. All nurses working in Khartoum teaching hospital ICU included in the study. It found out that the majority of nurses working in Khartoum teaching hospital
(35.7%) have 2 mon-1 year working experience, (85.7%) have poor knowledge level, (76.7%) have fair practice level, and there is no significant relationship between working experience & levels of knowledge & practice. Nurses have better practical level than knowledge level and they were not affected by nurse’s length experience as there should be. It’s essential to assess their knowledge level and the practical competence because ventilated patients are prone to a great deal of infections that could cause serious complications if not handled properly and skilfully.\(^{(13)}\)

Despite the potential hazards associated with suctioning little empirical evidence exists of how well it is performed. Other authors like Celik have also identified that current endotracheal suctioning practices within cardiac intensive care unit of Austria were not based on current recommended practice. Although no previous researchers have investigated actual suctioning practices of general ward nurses, some studies explored nurses’ knowledge and identified a need for further education and training, and identified that nurses are unaware of current suctioning recommendations and practice is often based on ritual and tradition as opposed to empirical evidence.\(^{(71)}\)

Furthermore, a study conducted by Mary in intensive care units in India aimed at evaluating effectiveness of ETS technique of ICU nurses, as well as their scientific knowledge regarding endotracheal suction. This descriptive study was performed in 34 nurses to analyze the performance of endotracheal suctioning by direct observation, using the data collection of a structured grid that included 19 aspects to evaluate. Grouped into 6 categories, which evaluated the same aspects observed. The total mean score obtained in the practice observation grid (P) was 12.09 for a maximum score of 19, while it was 14.24 in the knowledge questionnaire (Q). When the total score obtained were compared, both in practice and knowledge, with the years of experience in ICU, no statistically significant differences were found. It is concluded that the study nurses have scientific knowledge of the suctioning procedure that are better than their practice competence. Discrepancies between practice and knowledge were also found in several aspects evaluated which orients towards the scientific needs of training in this procedure.\(^{(72)}\)

Moreover, a study was conducted in Finland by jansson to evaluate ETS practices of Critical-care nurses. This structured, non-participatory, observational study (n=40) was conducted using a 25-item best-practice information sheet to assess critical-care nurses’ ETS practices in a mixed medical-surgical intensive-care unit. One sample- and independent-samples
t-tests were used to compare critical-care nurses’ ETS performance against current Recommendations within different ICU experience groups. The study found out that the quality of observed ETS practices was significantly lower than the required quality of care. The most significant discrepancies were observed in ETS practices related to infection-control practices. It concluded that Critical-care nurses are currently not following current ETS recommendations. Significant discrepancies, which may constitute a risk factor for VAP by increasing microbial colonization of the lower airway, were identified. Unsafe ETS practices may jeopardize patient safety, and thus the quality of nursing care. Educational interventions, Clinical guidelines and adequate support need to be provided to critical-care nurses to assess and improve their professional capabilities and current practice. (73)

Another study by day and Wainwrigh designed to explore nurses’ knowledge and competence in performing endotracheal suctioning in acute and high dependency ward areas and to investigate discrepancies between knowledge and practice using method triangulation in London, United Kingdom. Twenty-eight nurses were observed using nonparticipant observation and a structured observation schedule. Each subject was interviewed and questioned about their endotracheal suctioning practices, and subsequently completed a knowledge based questionnaire. Scores were allocated for knowledge and practice. The findings demonstrated a poor level of knowledge for many subjects. This was also reflected in practice, as suctioning was performed against many of the research recommendations. Many nurses were unaware of recommended practice and a number demonstrated potentially unsafe practice. In addition, there was no significant relationship between knowledge and practice. However, during the interviews, many nurses were able to provide a rationale for specific aspects of practice that were perhaps not based on current research recommendations. The study raised concern about all aspects of tracheal suctioning and has highlighted the need for changes in practice, clinical guidelines and focused practice-based education. (74)

Another study was conducted by day and Wainwrigh on the assessment of knowledge and practice of 30 nursing personnel regarding ETS procedure for clients of post-operative cardiac surgeries in selected hospitals in Hyderabad. The study revealed that 60% of nurses had below average knowledge and practice, and 40% had above average knowledge and practice. The findings of the study showed that they did not have special training in the care of patients on mechanical ventilator. (75)
A descriptive comparative study design was used with a convenience sample of 41 nurses and 25 respiratory therapists who perform suctioning and airway management of patients who are critically ill. Several differences in practice between the two groups were noted. For hyperoxegenation, nurses tended to use the ventilator while respiratory therapists opted for bag-valve devices. Respiratory therapists instilled saline and rinsed closed systems after suctioning more often than nurses did. Nurses suctioned secretions, brushed patients’ teeth, and used swabs to clean the mouth more often than respiratory therapists did. The two groups consistently used gloves, suctioning above the cuff of the endotracheal tube and suctioning the mouth after suctioning the endotracheal tube. Conclusions Communication among all groups treating patients is vital for improving outcomes and reducing the risk of ventilator-associated pneumonia. A consistent plan of care that follows current practice guidelines is imperative for patient safety and to reduce risk. (64)

Furthermore, a study was carried out with the aim of assessing gap between the knowledge and performance of nurses' working in intensive care units (ICU) in tracheal suctioning. In this cross sectional study, knowledge and performance of 44 nurses working in three ICUs in Shahid Beheshti Hospital, Kashan, Iran, was analyzed in three areas of prior, during and post suctioning, using a 26 item questionnaire and check list in 2010. kruskalwallis test, spearman correlation coefficient and SPSS14 software were used for data analysis. In the 8 items in question of prior suction the average score for knowledge and performance were 5.4 (±1.12) and 0.81 (±0.71) respectively and in the analysis of ten items during suction an average score of 7.7 (±1.09) and 4.6 (±0.75) were obtained for knowledge and performance respectively. In 8 items of post suction the average score of knowledge was 6.47 (±0.69) and that of performance was 3.86. In general, from 26 possible points, the average score of knowledge and performance were 19.59 and 8.75 respectively. The type of ICU and nurses' working experience were not significantly related to their knowledge and performance. This study revealed that despite acceptable knowledge, nurses’ performance in endotracheal suctioning is poor. This shows that education alone is not sufficient for observance of the standards. (76)

A study done by nishamol .y. N in trivandrum, India aimed To identify the knowledge of endotracheal suctioning among nurses in neuro medical ICU. 30 Neuro Nurses include permanent and temporary were selected from neuro medical ICU in Sree Chitra Tirunal Institute for Medical Sciences and Technology ,Trivandrum. Convenient sampling technique was used for
selecting sample. Total period of study was from August 2011 to November 2011. An observational checklist was maintained in order to record the steps of the procedure and the knowledge assessed by using questionnaire. The knowledge score of staff nurse with less ICU experience ranged from 10 to 14 with a mean of 12.06 (1.48). The knowledge of staff nurse with more ICU experience ranged from 11 to 14 with a mean of 12.08 (1.19). There was no statistically significant difference in the mean knowledge score of both group. Thirty Endotracheal suctioning episodes of 19 staff nurses both permanent and temporary were observed during all three shifts. However there was no statistically difference in the mean practice score of both groups. Conclusion: This study was designed to identify intensive care nurses' knowledge and practice of endotracheal suctioning. Based on the findings of the study Neuro Nurses have average knowledge about ET suctioning but in practice they are not practicing some critical care elements. (77)

2.20 Endotracheal suction adverse effects:

Suctioning is an uncomfortable and distressing procedure for the critically ill adult with an artificial airway. Nonetheless, tracheal tube suction may be necessary to clear secretions, maintain airway patency and to optimize oxygenation and ventilation. There are a number of potential adverse effects, however, on several body systems including: reduction in lung volumes, hypoxia, alveoli collapse, introduction of infection and trauma to the trachea, bradycardia and hypertension, increase in intracranial pressure and reduction in cerebral blood flow (30).

Despite the relative frequency of this procedure the body of evidence is limited. A systematic review recommended only suctioning when clinically indicated because of the potential adverse effects associated with the procedure. and this is congruent with local clinical practice. The recommendation is therefore to suction only when clinically indicated (4, 36, 37).

2.21 Endotracheal suction complications:

Endotracheal suctioning is a common procedure but has been associated with potentially and life-threatening complications. Some of these complications are Hypoxia, Dysrhythmia, cardiac arrest, Respiratory arrest, bronchospasm, increased bronchial mucus production, Hypertension, vagal nerve stimulation, increased intracranial pressure, Atelectasis, damage to tracheo-bronchial mucosa, pulmonary hemorrhage, Nosocomial infection, death, Decrease in dynamic lung compliance, Atelectasis, Hypoxia/hypoxemia, Tissue trauma to the tracheal and/or
bronchial mucosa, Bronchoconstriction/bronchospasm. Patients at risk for these complications are those who have acute pulmonary hemorrhage, Lack of cough reflex, High risk of bronchospasm/reactive airways, Hypertension, Hypotension, Cardiac dysrhythmias. Patients at risk are also those who have Unstable CVS. Unstable/high ICP, Spinal injury with autonomic, dysreflexia, Coagulopathy i.e. platelets <20, INR>2.5 (30).

Prolonged suctioning may cause hypoxia, atelectasis, hypercardia, or stimulation of the cough reflex which increases blood volume and intracranial pressure. Caution usage is advised when providing respiratory care to a patient with a head injury by limiting suctioning to duration and number of passes per suction event. A study by Bourgault noted some increase in heart Rate post suctioning at the 4th and 5th minute (70).

2.22 Hyperinflation:

Hyperinflation is using ambu-bag to deliver 100% oxygen or the ventilator by setting FIO₂ to deliver 100% oxygen. Hyperinflation using a manual resuscitator bag or the ventilator has been used as a method of both hyper oxygenation and as a lung recruitment maneuvers. Hyperinflation is not a benign procedure and has been associated with adverse effects including significant increases in mean arterial pressure, cardiac output, pulmonary artery pressure and pulmonary airway pressure. Two recent cross-over studies evaluated the effects of hyperinflation on respiratory mechanics and found improvements in lung compliance and sputum return without adverse effects, however the methodology and small convenience sample preclude the application of these results on a routine basis. Nonetheless, it is recognized that there may be occasions where hyperinflation during suctioning is clinically warranted, such as when a patient has a sputum plug (38).

It has been recognized that there may be occasions where hyperinflation during suctioning is clinically warranted, for example sputum plug, excessive secretions or volume loss as evidenced on a chest x ray due to lobar or lung collapse. In this instance, hyperinflation is used by clinicians as a therapeutic intervention. This can be performed either manually or via a ventilator depending on level of positive end expiratory pressure (PEEP). Manual hyperinflation (MHI) or ventilator hyperinflation (VHI) sometimes results in increased lung compliance in patients on mechanical ventilation and decreased airway resistance in patients with VAP (78). The adverse effects of hyperinflation including significant increases/decreases in mean arterial pressure, cardiac output, pulmonary artery pressure and pulmonary airway pressure have been
well described in the literature. \(^{(79)}\). Recent evidence contained in a systemic review and a literature review consistently supports the 2007 recommendation that hyperinflation should not be performed on a routine basis prior to suctioning \(^{(70, 68, 40)}\).

A study was conducted on the effect of hyper oxygenation and hyperinflation on arterial oxygen tension after endotracheal suctioning in Kyoto University, Japan. The investigator examined the hypoxemic response to suction during the four to six hour post-operative period in 28 cardiac surgical patients. Protection from hypoxemia was achieved by hyperinflation in 255 of sample, with pre oxygenation alone through an increase in FIO2 to 100% in 75% of the sample, and with combination of hyperinflation and an FIO2 of 100% in 96% of the sample. The investigator recommended that protection from hypoxemia can be achieved with combination of hyperinflation and hyper oxygenation \(^{(80)}\).

**2.23 Documentation:**

Documentation should occur following assessment of the patient, identifying the indications for suctioning, following or after suction. The documentation at a minimum is to include physical assessment of the patient pre and post-suctioning patient tolerance of suctioning procedure if pre-oxygenation was used results/product of suctioning (including amount, colour and viscosity of secretions). A thorough clinician’s assessment would be performed at the beginning of each shift, which may identify indications for a suction to be performed. Periodic assessment throughout the day may also identify the need for artificial airway suction, such as the performance of second hourly auscultation or ventilator observations. Documentation of adverse events during the suctioning procedure should also occur, particularly, sustained changes in physiological parameters. Some critical care areas may have respiratory assessment charts with documentation of the suction procedure; either paper or computerised, in which suction can be documented with mandatory fields and annotations concerning adverse events can be added \(^{(4)}\).
Chapter three
Methodology
3.1 Study design:

A quasi-experimental study design one group pre and post intervention assessment for the effect of the educational program on ICU nurse’s knowledge and practice of endotracheal suction procedure in Omdurman military hospital 2019.

3.2 Study area:

The study was conducted in Omdurman military hospital which is located in Omdurman state beside the Nile in the Mogran area. It provides all health services for army forces and their families (during service and retirement).

3.3 Study setting:

It consist of many clinics and many wards such as; medical wards, obstetrics and gynecology, pediatrics wards, nursery, ICU and CCU and surgical wards. The ICU department receive the medical and surgical cases, in addition to emergency admissions provide a comprehensive intensive care. There are 2 ICUs, one in the emergency unite and the other is located inside. There are 22 beds in the two ICU and covered by 109 nurses, working in two shift; 8 hours morning shift and 16 hours afternoon and night shift with 1: 1 nurse to patient ratio.

3.4 Study population:

All Registered Staff Nurses working at Omdurman Military Hospital ICU during study period (February-October 2016).

3.5 Inclusion and exclusion criteria:

3.5.1 Inclusion criteria:

1) Nurses with permanent job.

3.5.2 Exclusion criteria:

1) Nurses with diploma degree.

3.6 Sampling:

3.6.1 sampling technique:

Total coverage technique was used to include all nurses working in the ICU of Omdurman military hospital.

3.6.2 Sample size:

(50) Nurses agreed to participate.
3.7 Study Variables:

3.7.1 Dependant:
Nurse’s knowledge and practice of endotracheal suction.

3.7.2 Independent:
Demographic characteristics which include age, sex, years of experience, and qualification.

3.8 Data collection tools:
The data for this research was collected within a period of (9) months. Two tools were used for collecting data, a well-designed structured questionnaire and observational checklist which were formulated after carefully reviewing literature. Both the tools were drawn from American association for respiratory care (AARC) guidelines, Australian new south whales (NSW) agency for clinical innovation (ACI) guidelines, emirates nurses’ association (ENA) guidelines, and shubhasini study (29, 30, 31, 17).

3.8.1 Tool I: self-administered questionnaire:
The questionnaire was constructed by the researcher based on research objectives and literature review. It consisted of two parts. The first part was related to basic and preliminary knowledge about endotracheal suction. The second part was related to endotracheal suction procedure performance. It all consisted of 29 questions. After the end of the nurses’ shift the researcher gathered the nurses and the questionnaire was handed out to them and they self-administered it.

3.8.2 Tool II: observation checklist:
An observation checklist was used to assess practice of nurses during endotracheal suction procedure (preparatory phase, performance phase, and evaluation phase). It consisted of 3 sections of (35) items. The researcher observed nurses perform ETS procedure and collected the data during their shift.

3.8.3 Validity and reliability:
Structured data collection instrument was examined by view of two assistant professor working at Shendi University, discussion was held to gather with the researcher to look into issues of clarity, specificity of variable to be measured and relevance of the content of the questionnaire. Nurses practice checklist constructed according to literature review.
3.8.4 Pilot study:
The structured data collection instrument was pilot tested using (10) nurses at Omdurman by the researcher to find out unclear or ambiguous questions, ambiguous questions were reworked or removed, the pilot testing of the structured data collection instrument helped to estimate the time that could be taken to respond to the questionnaire which was an average of 20 minutes, and determined whether or not the items were understood by the nurse, nurses involved in pilot were not included in the main study.
Cronbach’s alpha= 0.76 degree of confidence=0.76=0.87
Nurse understood the method used to fulfil each tool, some items needed to be modified, rephrasing, omission, whether these items stay as they were or by adding some words.
Based on pilot results the modification was done and further the researcher refined tool, finally making assurance that tool as a whole achieved the aim of the study.

3.8.5 Data collection technique:
Data collected in two phases, before the application of nurses guidelines (phase I) in which the questionnaire was distributed for nurses and each nurse was allowed to sufficient time to fill it in (February-March 2016), after collection of pre-test data nurses were received the educational program, the training was continued, questionnaire was filled after explaining verbally the purpose of the study, consent was taken, then nurses filled the questionnaire, after that the researcher implemented the teaching program.
The researcher had a meeting with the day shift nurse at the end of their shift, and with the night shift in the early morning in a form of small group discussion and discussed the theoretical part of the teaching program with a 5-7 small group providing each group with a 2 hours discussion period for the first day, and 2 hours in the second day after carefully organizing the nurses’ schedule between working time and training time (March-April 2016). The total hours for administering the theoretical part of the program were 14.
The hospital provided a lecture hall for the administration of teaching program with picture of the slides and videos demonstration and a mannequin for the implementation of the procedure on with the nurse’s practice and later perform the procedure on an actual living patient.
The implementation for the preparatory phase took 3 hours in day one and 3 in day two, the performance phase took 3 hours in day third day and 3 in the forth day, and the
evaluation phase took 2 hours in the fifth day and 2 in the seventh day. The total hours for administering the practical part of the program were 16.
Five months later for the identified group the same tool used in pre-test was used to collect post-test (phase II) in (September-October 2016).

3.8.6 Data management:
The following statistics measures were used:
Descriptive statistics was used, frequency and percentage distribution was used, paired T test was used, chi square test was used, the mean and standard deviation distribution was used, and data was recorded.

3.8.7 Data entry and analysis:
Data was entered into the computer using SPSS software program, data was cleaned before being subjected to analysis, data analysis was performed using SPSS version (22) software program, information was summarized using frequency tables, p- value was done of equal or less that 0.05 was considered a statistically significant.

3.8.8 Scoring system:
Each correct answer was given a score of ‘one’ mark and wrong answers ‘zero’ score.

\[
\text{Obtained score} = \frac{\text{Percentage}}{\text{Total score}} \times 100
\]

To find out the association with the selected variables, the knowledge aspect was categorized into three groups.
Below 50% = poor knowledge.
51–75% = average knowledge.
Above 75% = good knowledge.
The items observed to be done were scored (1), the items not done and not applicable were scored (0). For each area, the scores of the items were summed up and the total divided by the number of the items, giving a mean score for the part. These scores were converted into a percent score.
To find out the association with the selected variables, the practice aspect was categorized into three groups.
Below 50% = poor practice.
51–75% = average practice.
Above 75% = good practice.

3.9 Ethical consideration:

a) The research is respecting the rights of participants, treat data with confidentiality no harm for the subject.

b) All study participants provided a consent prior to participation in the study.

c) Approval from University was taken.

d) Permission from study area was taken (Omdurman military hospital).
Chapter four

Results
Result summary:

Table (1): demographic background of study subjects:

Showed that 72.0% were females, 86.0% of them aged between 20-25 year, 86.0% are Bachelor holders 66.0% of them have Less than 1 year experience years and 62.0% have never attended training program on endotracheal suction procedure.

Table (2): study subjects knowledge about basic knowledge regarding endotracheal suction:

Showed that 40.0% of study subjects in phase I can identify types of artificial airways, the percentage increased to 70.0% in phase II, 42.0% know the indications for insertion of an artificial airway in phase I which increased to 74.0% in phase II. And 32.0% in phase I know the definition of endotracheal succioning, the percentage increased to 70.0% in phase II.

While 44.0% are familiar with the methods for decreasing environmental contamination in phase I improved to 88.0% in phase II. 12.0% in phase I know suction system to prevent ventilator associated pneumonia, improved to 44.0% in phase II. 30.0% in phase I know adverse effects of hyperinflation, improved to 70.0% in phase II.

Table (3): study subjects knowledge about endotracheal suction performance:

Revealed that 32.0% know the importance of Preoxygenation in phase I increased to 64.0% in phase II, 22.0% and 32.0 know about Normal saline instillation and its effect in phase I increased to 56.0% and 70.0% respectively in phase II.

About 30.0% and 36.0% identify recommended size of the suction catheter and depth in phase I, upgraded to 36.0% and 64.0% respectively in phase II, 30.0% and 42.0% and 56.0% identify suction pressure, duration and Frequency in phase I upgraded to 64.0% and 88.0% and 76.0% in phase II.
Figure (1): pre-test and post-test total knowledge level

Table (4): study subjects performance regarding preparation for endotracheal suction:

clarified that nurses performance regarding preparing for endotracheal suction procedure, 100% assess for need of suction in phase I, the percentage remained the same 100% in phase II (P value =0.000), 16.0% Monitor heart rate in phase I, increased to 60.0% in phase II (P value =0.000), 20.0% Record blood pressure in phase I, increased to 70.0% in phase II (P value =0.000), 10.0% Monitor oxygen saturation in phase I, increased to 54.0% in phase II (P value =0.000), 18.0% Auscultate breath sounds in phase I, increased to 64.0% in phase II (P value =0.000).

Table (5): study subjects performance regarding performing the suction procedure:

illustrated that nurses performance of the procedure itself, 12.0% Withdraw the catheter while rotating it back in phase I upgraded to 52.0% in phase II (P value =0.000), 10.0% Limits suction time to 10-15 seconds in phase I upgraded to 50.0% in phase II (P value =0.000), 16.0% Don't perform more than 4suction per suctioning in phase I upgraded to 56.0% in phase II (P value =0.000), 12.0% Don't reinsert the suction catheter into endotracheal tube in phase I upgraded to 64.0% in phase II (P value =0.000).

Table (6): study subjects performance regarding evaluation after endotracheal suction:

Elaborated that nurse’s evaluation after the suction procedure, 98.0% Rinse the catheter and connecting tube with normal saline until clear in phase I upgraded to 100.0% in phase II (P value =0.000), 14.0% Assess for secretion clearance in phase I upgraded to 42.0% in phase II (P value =0.000), 84.0% Perform hand hygiene in phase I upgraded to 100.0% in phase II (P value =0.000), 94.0% Document the procedure and any changes in phase I upgraded to 100.0% in phase II (P value =0.000).
Figure (2): pre-test and post-test total practice level

**Section I:**

Table (1): study subjects demographic background (n=50):

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<th>MC no</th>
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<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Less than 1 year</td>
<td>33</td>
<td>66.0</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>(1-3) years</td>
<td>14</td>
<td>28.0</td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>(4-6) years</td>
<td>2</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>More than 6 years</td>
<td>1</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>6. training programs on endotracheal suctioning:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Yes</td>
<td>19</td>
<td>38.0</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>No</td>
<td>31</td>
<td>62.0</td>
<td></td>
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Table (2): Coorelation between knowledge and practice with background information of study subjects (n=50)

<table>
<thead>
<tr>
<th>No</th>
<th>item</th>
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<th>practice</th>
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<tr>
<td></td>
<td></td>
<td>good</td>
<td>average</td>
<td>poor</td>
<td>Good</td>
</tr>
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<td>----</td>
<td>-----------</td>
<td>-----------</td>
<td>----------</td>
<td>----------</td>
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<td></td>
<td></td>
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<tr>
<td>Qualification</td>
<td></td>
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<td></td>
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<td>2.</td>
<td>Bachelor</td>
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<td>26</td>
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<td>0</td>
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<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.498</td>
<td>0.975</td>
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<tr>
<td>Experience</td>
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<td></td>
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</tr>
<tr>
<td>1.</td>
<td>&lt; 1 year</td>
<td>4</td>
<td>5</td>
<td>28</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>1- 3 years</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>4 - 6 years</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>More than 6 years</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>total</td>
<td>50</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p-value</td>
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</table>
Section II:

Table (3): comparison between pre and post-test knowledge in endotracheal suction (n=50):

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre-test</th>
<th></th>
<th>Post-test</th>
<th></th>
<th>Paired “t” test p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>P</td>
<td>F</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>types of artificial airways</td>
<td>20</td>
<td>40.0</td>
<td>35</td>
<td>70.0</td>
<td>0.000*</td>
</tr>
<tr>
<td>indications for insertion of an artificial airway</td>
<td>21</td>
<td>42.0</td>
<td>37</td>
<td>74.0</td>
<td>0.000*</td>
</tr>
<tr>
<td>definition of endotracheal suctioning</td>
<td>16</td>
<td>32.0</td>
<td>30</td>
<td>70.0</td>
<td>0.000*</td>
</tr>
<tr>
<td>clinical indications for endotracheal suctioning</td>
<td>20</td>
<td>40.0</td>
<td>32</td>
<td>64.0</td>
<td>0.000*</td>
</tr>
<tr>
<td>assessment before suctioning</td>
<td>8</td>
<td>16.0</td>
<td>40</td>
<td>80.0</td>
<td>0.000*</td>
</tr>
<tr>
<td>contraindications for endotracheal suction</td>
<td>15</td>
<td>30.0</td>
<td>25</td>
<td>50.0</td>
<td>0.000*</td>
</tr>
<tr>
<td>Prevention of nosocomial infections in ventilated patients</td>
<td>6</td>
<td>12.0</td>
<td>21</td>
<td>42.0</td>
<td>0.000*</td>
</tr>
<tr>
<td>decreasing environmental contamination</td>
<td>22</td>
<td>44.0</td>
<td>44</td>
<td>88</td>
<td>0.000*</td>
</tr>
<tr>
<td>suction systems that prevents ventilator associated pneumonia (VAP)</td>
<td>6</td>
<td>12.0</td>
<td>22</td>
<td>44.0</td>
<td>0.000*</td>
</tr>
<tr>
<td>adverse effects of hyperinflation</td>
<td>15</td>
<td>30.0</td>
<td>35</td>
<td>70.0</td>
<td>0.000*</td>
</tr>
</tbody>
</table>
Table (4): comparison between pre and post-test knowledge in endotracheal suction procedure performance (n=50):

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Paired “t” test p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>the importance of Preoxygenation</td>
<td>16</td>
<td>32.0</td>
<td>32</td>
</tr>
<tr>
<td>Normal saline instillation</td>
<td>11</td>
<td>22.0</td>
<td>28</td>
</tr>
<tr>
<td>effect of instilling saline</td>
<td>16</td>
<td>32.0</td>
<td>35</td>
</tr>
<tr>
<td>recommended size of the suction catheter</td>
<td>15</td>
<td>30.0</td>
<td>18</td>
</tr>
<tr>
<td>appropriate suction catheter depth</td>
<td>18</td>
<td>36.0</td>
<td>32</td>
</tr>
<tr>
<td>recommended suction source pressure</td>
<td>15</td>
<td>30.0</td>
<td>32</td>
</tr>
<tr>
<td>recommended time duration</td>
<td>21</td>
<td>42.0</td>
<td>44</td>
</tr>
<tr>
<td>Frequency of endotracheal suctioning</td>
<td>28</td>
<td>56.0</td>
<td>38</td>
</tr>
<tr>
<td>adverse effect of endotracheal suctioning</td>
<td>15</td>
<td>30.0</td>
<td>35</td>
</tr>
<tr>
<td>Situations require stopping the procedure</td>
<td>19</td>
<td>38.0</td>
<td>37</td>
</tr>
<tr>
<td>complication of endotracheal suction</td>
<td>15</td>
<td>30.0</td>
<td>30</td>
</tr>
<tr>
<td>Documentation</td>
<td>24</td>
<td>48.0</td>
<td>44</td>
</tr>
</tbody>
</table>
P value = 0.000

Figure (1): pre-test and post-test total knowledge level of study subjects (n=50):
Table (5): comparison between pre and post-test performance regarding preparation for endotracheal suction (n=50):

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre-test</th>
<th>Post-test</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Done</td>
<td>Not done</td>
<td>Done</td>
<td>Not done</td>
</tr>
<tr>
<td></td>
<td>f</td>
<td>P</td>
<td>f</td>
<td>P</td>
</tr>
<tr>
<td>Preparatory phase:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assess for the need for suction</td>
<td>50 100</td>
<td>0 0</td>
<td>50 10</td>
<td>0 0</td>
</tr>
<tr>
<td>Monitor heart rate.</td>
<td>8 16%</td>
<td>42 84%</td>
<td>30 60</td>
<td>20 40</td>
</tr>
<tr>
<td>Record blood pressure.</td>
<td>10 20%</td>
<td>40 80%</td>
<td>35 70</td>
<td>15 30</td>
</tr>
<tr>
<td>Monitor oxygen saturation.</td>
<td>5 10%</td>
<td>45 90%</td>
<td>27 54</td>
<td>23 46</td>
</tr>
<tr>
<td>Auscultate breath sounds.</td>
<td>9 18%</td>
<td>41 82%</td>
<td>32 64</td>
<td>18 36</td>
</tr>
<tr>
<td>Hand washing with soup and water.</td>
<td>7 14%</td>
<td>43 86%</td>
<td>29 58</td>
<td>21 42</td>
</tr>
<tr>
<td>Explain the procedure to the patient.</td>
<td>16 32%</td>
<td>34 68%</td>
<td>37 74</td>
<td>13 26</td>
</tr>
<tr>
<td>Position the patient in fowler’s position.</td>
<td>31 62%</td>
<td>19 38%</td>
<td>46 92</td>
<td>4 8</td>
</tr>
</tbody>
</table>

**P value** = 0.000
Table (6): comparison between pre and post-test performance regarding performance of endotracheal suction (n=50):

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Done</td>
<td>Not done</td>
</tr>
<tr>
<td></td>
<td>f</td>
<td>P</td>
</tr>
<tr>
<td>Put on the sterile gloves; designate one hand as clean (non-dominant hand).</td>
<td>47</td>
<td>94%</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Preoxygenate the patient before suctioning.</td>
<td>21</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>42</td>
<td>84</td>
</tr>
<tr>
<td>Don’t apply suction while inserting catheter.</td>
<td>43</td>
<td>86%</td>
</tr>
<tr>
<td></td>
<td>49</td>
<td>98</td>
</tr>
<tr>
<td>Pull back the catheter 1-2 cm if resistance is met.</td>
<td>44</td>
<td>88%</td>
</tr>
<tr>
<td></td>
<td>48</td>
<td>96</td>
</tr>
<tr>
<td>Withdraw the catheter while rotating it back</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>52</td>
</tr>
<tr>
<td>Limits suction time to 10-15 seconds.</td>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Don't perform more than 4 suction per suctioning.</td>
<td>8</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>56</td>
</tr>
<tr>
<td>Don't reinsert the suction catheter into endotracheal tube.</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>64</td>
</tr>
</tbody>
</table>

**P value** = 0.001
Table (7): comparison between pre and post-test performance regarding evaluation after endotracheal suction (n=50):

<table>
<thead>
<tr>
<th>Item</th>
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<th></th>
<th>Post-test</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Done</td>
<td>Not done</td>
<td>Done</td>
<td>Not done</td>
</tr>
<tr>
<td></td>
<td>f</td>
<td>P</td>
<td>f</td>
<td>P</td>
</tr>
<tr>
<td><strong>Evaluation phase:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rinse the catheter and connecting tube with normal saline until</td>
<td>49</td>
<td>98% 1    2%</td>
<td>50</td>
<td>100 0</td>
</tr>
<tr>
<td>clear.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assess for secretion clearance.</td>
<td>7</td>
<td>14% 43 86%</td>
<td>21</td>
<td>42 29 58</td>
</tr>
<tr>
<td>Perform hand hygiene.</td>
<td>42</td>
<td>84% 8 16%</td>
<td>50</td>
<td>100 0</td>
</tr>
<tr>
<td>Document the procedure and any changes.</td>
<td>47</td>
<td>94% 3 6%</td>
<td>50</td>
<td>100 0</td>
</tr>
</tbody>
</table>

P value = 0.000
P value = 0.000

Figure (2): pre-test and post-test total practice level of study subjects (n=50):
Chapter five

discussion

conclusion

recommendations
5.1 Discussion:

Tracheal suction is an important procedure in the management of adults with artificial airways. Tracheal suction through an artificial airway; endotracheal, tracheostomy, or nasotracheal tube bypasses the normal protective mechanisms such as the cough reflex that the upper airways (20).

This study was conducted to evaluate the effect of educational program on nurses’ knowledge and practice of endotracheal suction at Omdurman military hospital ICU 2016, 50 nurse who work at the Omdurman military hospital ICU participated in the study.

More than two thirds 66.0% of the study subjects has less than 1 year experience, two third 62.0% of nurses did not attend previous training on endotracheal suction, the findings indicated that the hospital is hiring more bachelor staff as evident by low experience years, this may precipitate to increase in complication rates and thus increase in length of stay. these results disagree with Haghighat S (75) Which stated that “About 42.5% of nurses had more than 2–4 years of ICU experience”.

This study revealed that there’s insignificant relationship between both the level of knowledge and practice and the nurses qualification (P-value= 0.498, 0.975 respectively), but there’s a significant relationship with the nurses experience (P-value= 0.000, 0.000 respectively).

The study revealed that the total knowledge of study subjects has increased in the percentage of nurses with good knowledge from 30% in phase I to 68% in phase II with highly significant results (P value =0.000). These findings agree with Shubhasini result which stated that “(66.7%) of the staff nurses attained good knowledge score in the pre-test, whereas in the post test (56.7%) of the staff nurses attained very good knowledge score and (43.3%) of the staff nurses had good knowledge score” (17). Nurse’s knowledge before teaching program showed that study subjects knowledge was poor before beginning of the implementation of the program and the improvement was clearly observed through phase II and the improvement due teaching program.

These findings also agree with the result of Kargar M which stated that “the level of knowledge between the two groups at the beginning of the study had no significant difference (p = 0.71), while the average score in the two groups 2 days and 2 months after the intervention (education) had significant difference (p = 0.001)” (77).

Furthermore, the knowledge of study subjects about types of artificial airways, indications for insertion of an artificial airway, definition of endotracheal suctioning, was low in phase I which indicates that nurses are working with-out preliminary knowledge of artificial airways. The lack
of knowledge about artificial airways makes it hard to manage and maintain an open airway which is vital for sustaining optimum lung function and oxygen saturation.

Moreover, knowledge level about clinical indications for endotracheal suctioning, contraindications for endotracheal suction, assessment before suctioning was decreased in phase I. nurses lack knowledge about the inability to identify clinical indications and suction a contraindicated patient and thus prone the patient to sputum accumulation and infections e.g. VAP and increase in intracranial pressure.

Also the knowledge about Prevention of nosocomial infections, decreasing environmental contamination, suction systems that prevents ventilator associated pneumonia (VAP), Normal saline instillation and its effect was low in phase I. nurses were unaware of infection prevention which leads to VAP, Also the instillation of saline into the tracheal tube increase the number of bacterial with the respiratory tract. Nurses lack knowledge about saline instillation which results in increase in days of hospital stay prone the patient and the hospital staff to more and more infections. these findings come in agreement with Pethyoung W (76) results on prevention of ventilator associated pneumonia (VAP) which stated that “Observation process revealed several problems, such as, lack of knowledge on prevention of VAP, lack of awareness of the importance to prevent VAP, lack of practice guidelines and few sinks were available for hand washing”. A study by Kollef MH (53) stated that “The number of bacteria dislodged increased 5 folds with NSI. So it was recommended that the NSI before suctioning should be abandoned”.

Pertaining Preoxygenation and adverse effects of hyperinflation, the study elaborated that knowledge level in phase I was low. The lack of application of Preoxygenation leads to hypoxia during suctioning which can participate in a various amount of systemic problems due to the lack of oxygen.

As regards to study subject’s knowledge about the procedure it-self, the result elaborated that the knowledge about size, depth of the suction catheter, suction pressure, duration, and Frequency, was low in phase I. nurses were unaware of the correct size, depth and pressure. This is hazardous to the patient lungs. It can cause injury at cellular level and more distress for the patient.

Pertaining the study subject’s knowledge about adverse effect and complications of endotracheal suctioning, Situations require stopping the procedure was low in phase I, nurses were unaware of
complications and adverse effects even when to stop the procedure, this can prone the patient to more serious complications and injuries, even death.

Regarding the total practice of study subjects the result illustrated that there is an increase in the percentage of nurses with good practice from 12% in phase I to 80% in phase II with highly significant results in preparatory, performance, and evaluation phases (P value =0.000, 0.001, 0.000) respectively. Nurses practice pre-implementation of teaching program showed that study subjects practice was acceptable before the implementation of the teaching program and the improvement was clearly observed through phase II and the improvement due to and the result of application of teaching program.

These findings agree with shubhasini (69) result which he stated that “there was a considerable gain in the skill score after the demonstration of endotracheal suctioning procedure”. these findings also agree with the result of sharma S (72) which stated that “the mean post 1st, 2nd, 3rd and 4th implementation practice scores of nursing personnel regarding endotracheal suctioning was 32.60, 39.07, 47.77 and 50.25 respectively which was higher than the mean pre-implementation practice score (22.80)”. Moreover, the findings agree with what day (66) found in her study, she stated that in Areas of particular concern identified at baseline level were largely addressed, with improvements seen for the majority of interventions. Notably, appropriately sized suction catheters were used by each participant, accompanied by recommended suctioning pressures and durations.

The study discussed the nurse’s practice of endotracheal suction and it elaborated that the practice of nurse in preparatory phase regarding monitoring the heart rate, recording the blood pressure, auscultating the breath sounds was low in phase I. the study showed that nurses lack the ability to assess for suction need and thus prone the patient to secretion pooling down the tracheal tree. These findings agree with day’s (69) result which stated “only two were observed performing chest auscultation in practice.”

Moreover, the practice regarding Hand washing with soup and water, procedure explanation, Position the patient in fowler’s position and pre-oxygenation was low in phase I and upgraded in phase II. These findings disagree with what Lima (73) found in her study which stated that “there were no significant differences regarding the assessment of vital signs pre- and post-procedure,
hand hygiene pre- and post-procedure, the explanation of the procedure to patient or the performance of pre-oxygenation”.

The study showed that nurses don’t perform hand washing which leads to infection spreading from nurse to patient and vice versa. Again the study showed that nurses lack the ability to prepare the patient for the procedure or explain it which precipitate to increased level of stress. This proves that nurses are not following practice guidelines for patient preparation both physically and psychologically.

The study also discussed performance phase and it elaborated that the nurses practice was low in phase I. nurses lack the practice of not applying catheter while catheter insertion, pulling catheter back if resistance is met, catheter rotation while suctioning for 10-15 seconds and no more than 4 suction per suctioning which emphasize that nurses are working without guidelines for endotracheal suction procedure performance. Wrongful performance of suctioning procedure leads to injury to lung cells and increased intracranial pressure among various complications. These findings agree with what day (69) found in her study, she stated that “many subjects did not know how to calculate catheter size accurately.”

The study discussed the practice of nurse regarding evaluation phase and after care and it elaborated that the practice regarding catheter rinsing with normal saline, assessing for secretion clearance, hand washing and documentation was low in phase I. the study illustrated that nurses don’t rinse catheter nor do they wash their hands after suction or assess for secretion clearance. This leads to infection spread and contamination of the catheter. These findings agree with what jansson (68) found which stated that “Significant treatment-related discrepancies were observed in critical-care nurses performance in relation to current recommendations in their daily practice prior to and during ETS events. The most significant discrepancies were observed in ETS practices related to infection-control practices”

Also nurses don’t document the procedure which is a vital aspect of nurse’s duty, it may also cause procedure repetition by other staff members due to the fact that it was not documented. Documentations also preserve patient and nurses rights.
5.2 Conclusion:

A quasi-experimental approach was adopted to assess the effectiveness of Structured Teaching Program on knowledge and practice compliance regarding endotracheal suction among adult ICU nurses at selected hospital, Omdurman state.

The data was collected from 50 subjects through total coverage sampling technique.

Further the conclusion was drawn on the basis of the findings of the study which includes:

The overall percentage of pre-test good knowledge scores on endotracheal suction procedure was found out to be (30%) which increased to (68%) post-test.

The overall percentage of pre-test good practice scores on endotracheal suction procedure was found out to be (12%) which increased to (80%) post-test.

There’s insignificant relationship between both the level of knowledge and practice and the nurses qualification (P-value= 0.498, 0.975 respectively) and a significant relationship with the nurses experience (P-value= 0.000, 0.000 respectively)

The overall gain in knowledge and practice is due to the implementation of teaching program.
5.3 Recommendations:

This research recommends that:

1. Manual information booklets and self-instruction should be developed, disseminate knowledge by publications and organizing journal clubs, workshops, seminars, conferences on endotracheal suction.

2. The hospital administers should put plan for mandatory in-services education in endotracheal suction procedure.

3. The hospital administer should provide the ICU staff with a written guidelines for endotracheal suction procedure.
5.5 Limitation of the study

Small number of subjects limits generalization of the study.

The sample for the study was limited to 50 ICU nurses only.

Data collection be observation is likely to be influenced by environmental factors or investigator’s personal bias.

One obvious limitation is the effect of the “observer” on the “observed”.

The investigator had no control on the event that took place between pre-test and post-test.
Chapter six

references
References:


52. Al-Khader MA. Assessment of ICU nurses knowledge and practice regarding Ventilator Associated Pneumonia prevention guidelines Sudan: Al-Neelin; 2012.


77. nishamol. Y. N. A study to assess the knowledge and Practice of endotracheal suctioning Among neuronurses setimst. 2011


Educational hand book summary:
The hand book has been developed as a guideline for ICU nurses to learn how to properly suction an individual with an endotracheal tube, and become guidance for nurses to improve their knowledge and practice in hospital ICUs.
The hand book is designed to help nurses to practice endotracheal suction procedure safely and to protect patients from complications.
The hand book will become a guidance for nurse’s progress, and insure that a safe level of practice has been achieved according to the definitions given.

Content of the program:
1. Definition of airway
2. Types of artificial airways
3. Indications for artificial airways insertion
4. Definition of endotracheal suction
5. Indications for endotracheal suction
6. Contraindications for endotracheal suction
7. Assessment before suctioning.
8. Assessment of need for endotracheal suction
9. Preoxygenation
10. Infection and infection control
11. Endotracheal suction technique
12. Size of suction catheter
13. Suction catheter insertion depth
14. Endotracheal suction pressure
15. Normal saline instillation
16. Endotracheal suction duration
17. Endotracheal suction complication
18. Endotracheal suction adverse effects
19. Hyperinflation
20. Documentation
1. Upper airways and endotracheal suction:

<table>
<thead>
<tr>
<th>topic</th>
<th>Duration of session</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day (1)</td>
</tr>
<tr>
<td>Anatomy of upper airways</td>
<td>1 hour</td>
</tr>
<tr>
<td>Types of artificial airways</td>
<td>1 hour</td>
</tr>
<tr>
<td>Indications and contraindications for endotracheal suctioning</td>
<td>1 hour</td>
</tr>
<tr>
<td>Pre assessment</td>
<td>1 hour</td>
</tr>
<tr>
<td>Infection risks and control measures</td>
<td>1 hour</td>
</tr>
<tr>
<td>Endotracheal tube suction procedure</td>
<td>2 hour</td>
</tr>
</tbody>
</table>
Time table for training of nurses about endotracheal suction procedure:

<table>
<thead>
<tr>
<th>procedure</th>
<th>duration</th>
<th>content</th>
<th>Day (1)</th>
<th>Day (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preparatory phase</strong></td>
<td>2 hour</td>
<td>Assess for the need for suction&lt;br&gt;Monitor heart rate.&lt;br&gt;Record blood pressure.&lt;br&gt;Monitor oxygen saturation.&lt;br&gt;Auscultate breath sounds.</td>
<td>1 hour</td>
<td>1 hour</td>
</tr>
<tr>
<td></td>
<td>2 hour</td>
<td>Hand washing with soap and water.&lt;br&gt;Assemble equipment’s&lt;br&gt;Check function of suction apparatus&lt;br&gt;Explain the procedure to the patient.</td>
<td>1 hour</td>
<td>1 hour</td>
</tr>
<tr>
<td></td>
<td>2 hour</td>
<td>Position the patient in fowler’s position.&lt;br&gt;Wear the face mask.&lt;br&gt;Wash hands with antimicrobial agents.&lt;br&gt;Pour normal saline into the bowl/ kidney dish.</td>
<td>1 hour</td>
<td>1 hour</td>
</tr>
<tr>
<td><strong>Performance phase</strong></td>
<td>2 hour</td>
<td>Put on the sterile gloves; designate one hand as clean (non-dominant hand).&lt;br&gt;Hyper-oxygenate the patient before suctioning by increasing ventilatorFIO2 to 100%.&lt;br&gt;Disconnect the patients from the ventilator.&lt;br&gt;Use the sterile hand (dominant hand) to remove the suction catheter.&lt;br&gt;Gently but quickly insert catheter into artificial way using sterile/ dominant hand.</td>
<td>1 hour</td>
<td>1 hour</td>
</tr>
<tr>
<td></td>
<td>2 hour</td>
<td>Don’t apply suction while inserting</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Step</td>
<td>Action</td>
<td>Duration</td>
<td>Additional Notes</td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>Pull back the catheter 1-2 cm if resistance is met.</td>
<td>hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Apply suctioning by placing and releasing the dominant thumb on the vent of the catheter.</td>
<td>hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Withdraw the catheter while rotating it back</td>
<td>hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Limits suction time to 10-15 seconds.</td>
<td>2 hour</td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td>Discontinue if heart rate is below or above normal.</td>
<td>1 hour</td>
<td></td>
<td></td>
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<tr>
<td>6</td>
<td>Don't perform more than 4 suction per suctioning.</td>
<td>1 hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Don't reinsert the suction catheter into endotracheal tube.</td>
<td>1 hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Return the patient to the ventilator.</td>
<td>1 hour</td>
<td></td>
<td></td>
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<tr>
<td>Evaluation phase:</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>9</td>
<td>Rinse the catheter and connecting tube with normal saline until clear.</td>
<td>2 hour</td>
<td></td>
<td></td>
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<tr>
<td>10</td>
<td>Turn off the suction device.</td>
<td>1 hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Assess patient’s cardiopulmonary status.</td>
<td>1 hour</td>
<td></td>
<td></td>
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<tr>
<td>12</td>
<td>Assess for secretion clearance.</td>
<td>1 hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Discard gloves.</td>
<td>2 hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Perform hand hygiene.</td>
<td>1 hour</td>
<td></td>
<td></td>
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<tr>
<td>15</td>
<td>Document the procedure and any changes.</td>
<td>1 hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Wash and replace the articles.</td>
<td>1 hour</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A thesis submitted in requirement for doctoral degree in medical surgical nursing

Questionnaire to assess effect of educational program on nurse’s knowledge and practice regarding endotracheal suctioning.

Section i-- demographic data

Please indicate the following:
Name: ………………………… telephone number: …………………… ICU area: …………………………

1. Sex: ☐
   a) Male.
   b) Female.

2. Age: ☐
   a) 20-25 years.
   b) 26-30 years.
   c) More than 30 years.

3. Professional educational qualification in nursing: ☐
   a. Diploma (   )
   b. Bachelor (   )
   c. Master (   )
   d. PhD (   )

4. Working experience in ICU: ☐
   a. <1 year (   )
   b. 1-3 years (   )
   c. 4-6 years (   )
   d. > 6 years (   )
5. Have you attended training programs on endotracheal suctioning?  
   a. Yes.  
   b. No.

6. If yes, how many times have you attended the programs?  
   a. Never ( )  
   b. Once ( )  
   c. Twice ( )  
   d. 3 or more ( )

Section- ii- about knowledge:

7. Which of the following are types of artificial airways:  
   a. Oro & nasopharyngeal airway.  
   b. Cricothyroidotomy tube.  
   c. Endotracheal tube.  
   d. Tracheostomy tube.  
   e. All of the above.

8. What are the indications for insertion of an artificial airway:  
   a. Secure or maintain a patent airway.  
   b. Facilitate the removal of tracheal secretions.  
   c. Deliver high concentrations of oxygen.  
   d. Assist in the delivery of mechanical ventilatory support.  
   e. All of the above.

9. What is the definition of endotracheal suctioning:  
   a. Bronchial hygiene therapy.  
   b. Mechanical aspiration of pulmonary secretions form an artificial airway.  
   c. Used to maintain a patent airway.  
   d. The insertion of a catheter to remove ETT secretions.  
   e. All of the above.
10. **What are the clinical indications for endotracheal suctioning:**
   a. Agitated patient.
   b. Desaturation.
   c. Saw-toothed respiratory waves on the ventilator monitor.
   d. Presence of adventitious breath sounds.
   e. All of the above.

11. **What is the assessment that should be done before suctioning:**
   a. Breath sounds.
   b. Any saw-toothed pattern.
   c. Vs.
   d. Spo2.
   e. All of the above.

12. **What are the contraindications for endotracheal suction:**
   a. The pt with an increased intracranial pressure.
   b. Pt with severe HTN.
   c. Risk of developing adverse reactions.
   d. All of the above.

13. **What are the interventions used to prevent nosocomial infections in a ventilated patients?**
   a. Wash hands and maintain aseptic technique.
   b. Wear the PPEs.
   c. Maintain workplace health and safety.
   d. Subglottic suctioning.
   e. All of the above.

14. **What are the interventions to decrease environmental contamination:**
   a. Bedside storage of suctioning devices in a clean holder.
   b. Follow droplet precaution with open system suction.
   c. Avoid touching suction devices with the patient or his cloth, linen, and bed.
   d. Wear the PPEs especially masks.
e. All of the above.

15. What is the suction systems recommended to prevent ventilator associated pneumonia (VAP):
   a. Open suction systems.
   b. Closed suction systems.
   c. All of the above.

16. What is the importance of Preoxygenation before suctioning:
   a. It minimizes hypoxia.
   b. It increases blood flow to the lungs.
   c. It prevents possible instances of desaturation.
   d. It prevents subsequent cardiac dysrhythmia.
   e. All of the above.

17. What do you think about saline instillation during endotracheal suction:
   a. It’s recommended.
   b. It’s not recommended.
   c. It’s not frequently recommended.

18. What is the effect of instilling saline in endotracheal suction procedure:
   a. It causes tachycardia.
   b. It is associated with decrease in oxygen saturation.
   c. It increases the risk of infection.
   d. It causes ventilator associated pneumonia.
   e. All of the above.

19. What is the recommended size of the suction catheter:
   a. Less than half the internal diameter of the tracheal tube.
   b. More than half the internal diameter of the tracheal tube.
   c. Equal to the internal diameter of the tracheal tube.
   d. All of the above.

20. What is the appropriate suction catheter depth:
a. Is inserted to the point of resistance.
b. Is inserted until a cough is stimulated.
c. Until the catheter just emerges out of the lumen of the ETT tube.
d. After insertion withdraw 1-2cm.
e. All of the above.

21. What is the recommended suction source pressure:
   a. 60 -100 mmhg.
   b. 100-120 mmhg.
   c. 100 -140 mmhg.
   d. >140 mmhg.
   e. I don’t know.

22. What is the recommended time duration for suctioning:
   a. 10 -15 seconds.
   b. 15 -20 seconds.
   c. 20 -25 seconds.
   d. 25 -30 seconds.
   e. I don’t know.

23. When should the endotracheal suctioning be performed:
   a. Only when clinically indicated.
   b. 1-2 times/day.
   c. 2-3 times/day.
   d. 3-4 times/day.
   e. More than 5 times/day.

24. What is the adverse effect of endotracheal suctioning:
   a. Reduction in lung volume.
   b. Hypertension.
   c. Increased cerebral blood flow.
   d. Alveoli collapse.
   e. All of the above.
25. During endotracheal suction, when the nurse should stop the procedure:  
   a. Heart rate is above or below normal level.
   b. Cardiac ectopy is observed.
   c. Dysrhythmia.
   d. Hypoxia.
   e. All of the above.

26. What is the complication of endotracheal suction:  
   a. Cardiac arrest.
   b. Bronchospasm.
   c. Increased intracranial pressure.
   d. Atelectasis.
   e. All of the above.

27. What are the adverse effects of hyperinflation:  
   a. Increases in mean arterial pressure.
   b. Increases cardiac output.
   c. Increases pulmonary airway pressure.
   d. Increases pulmonary artery pressure.
   e. All of the above.

29. What should the documentation include:  
   a. Physical assessment of the patient pre and post-suctioning.
   b. Patient tolerance of suctioning procedure.
   c. If pre-oxygenation was used.
   d. Results/product of suctioning (including amount, color and viscosity of secretions).
   e. All of the above.
Critical behaviour: | done | Not done |
--- | --- | --- |
**Preparatory phase:**
1. Assess for the need for suction
2. Monitor heart rate.
3. Record blood pressure.
5. Auscultate breath sounds.
6. Hand washing with soup and water.
7. Assemble equipment’s
8. Check function of suction apparatus
9. Explain the procedure to the patient.
10. Position the patient in fowler’s position.
11. Wear the face mask.
12. Wash hands with antimicrobial agents.
13. Pour normal saline into the bowl/ kidney dish.

**Performance phase:**
14. Put on the sterile gloves; designate one hand as clean (non-dominant hand).
15. Pre-oxygenate the patient before suctioning by increasing ventilator FIO2 to 100%. 
16. Disconnect the patients from the ventilator.

17. Use the sterile hand (dominant hand) to remove the suction catheter.

18. Gently but quickly insert catheter into artificial way using sterile/dominant hand.

19. Don’t apply suction while inserting catheter.

20. Pull back the catheter 1-2 cm if resistance is met.

21. Apply suctioning by placing and releasing the dominant thumb on the vent of the catheter.

22. Withdraw the catheter while rotating it back

23. Limits suction time to 10-15 seconds.

24. Discontinue if heart rate is below or above normal.

25. Don't perform more than 4 suction per suctioning.

26. Don't reinsert the suction catheter into endotracheal tube.

27. Return the patient to the ventilator.

**Evaluation phase:**

28. Rinse the catheter and connecting tube with normal saline until clear.

29. Turn off the suction device.

30. Assess patient’s cardiopulmonary status.


32. Discard gloves.

33. Perform hand hygiene.

34. Document the procedure and any changes.

35. Wash and replace the articles.
الاسم: الله الرحمن الرحيم
جامعة شندي
كلية الدراسات العليا والبحث العلمي

التاريخ: 1/11/2016م

الأخ/ مدير إدارة التدريب والبحوث – السلاح الطبي
oyer السلام عليكم ورحمة الله وبركاته

الموضوع: الطلبة/ رغدة البخاري، الأمين

بالإشارة إلى الموضوع أعلاه ننذكم بأن المذكورة من ضمن الطلاب المسجلين بكلية الدراسات العليا والبحث العلمي - جامعة شندي ببرنامج الدكتوراه في التمريض - باطلبي جراحي، ونعتذر بحثا:

Effect of teaching program on ICU nurses knowledge and practice of endotracheal suction.

نرجو شراكم تحسين مهامها البحثية.

والف، المرفق

/ مدير المركز
د. عطا حاكم عثمان

البرقات العامة للجامعة
للأعمال الإدارية
Omdurman military hospital location “Alslah altabi” (from google map)