EVALUATION OF A STANDARDIZED NURSE-LED CHEST TUBE REMOVAL PROTOCOL

Sonia Joanisse

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School of Nursing
Faculty of Health Sciences
University of Ottawa

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	Sonia Joanisse	**Dr. Chantal Backman**	**Dr. Denise Harrison**	**Dr. Sebastien Gilbert**
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Abstract

Background: A nurse-led chest tube removal protocol (CTR) was implemented on two units.

Aim: Evaluate the implementation of the protocol.

Methods: A two-group cohort study was completed. Phase 1: Chest tube indwell time, length of stay, and complication rates were analyzed. Phase 2: A knowledge survey, chart reviews and observational audits were used to evaluate the uptake post-implementation.

Findings: Phase 1: Reduction in chest tube indwell time (median 73.5 hours versus 52.7 hours, $p = 0.0164$) and length of stay (median 4.0 days versus 3.0 days, $p = 0.0008$) were noted in the post implementation group. Phase 2: Nurses completed patient assessments (n=22, 88% versus n=18, 72%) and teaching (n=22, 88% versus n=11, 56%) more frequently than they documented in the patient health record.

Conclusion: Findings show that delegation of CTR to nurses with a standardized CTR protocol is safe and effective. Development of CTR documentation templates could improve documentation accuracy.

Dedication

This thesis is dedicated to all the nurses on 6NW and 6OBS including Jan Leahy, Ley-Ann Mondor, Kathleen Sowinski. I would like to also dedicate this thesis to Dr. Sebastien Gilbert, Dr. James Villeneuve and as well as the rest of the thoracic surgery team. This would not have been possible without any of them! Their eagerness to learn and willingness to help made this project a joy to be a part of.

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List of Abbreviations

BMI- Body Mass Index

CL- Confidence Limit

CT- Chest Tube

CTR- Chest Tube Removal

CXR- Chest X-Ray

EHR- Electronic Health Record

FEV1- Forced Expiratory Volume over 1 Second

FVC- Forced Vital Capacity

ICU- Intensive Care Unit

ID- Identification

IPN- Integrated Progress Note

IQR- Interquartile Range

P.I.- Principal Investigator

RCT- Randomized Controlled Trial

SD- Standard Deviation

SQE- Subcutaneous Emphysema

TOH- The Ottawa Hospital

VATS- Video Assisted Thorascopic Surgery

Chapter 1: Introduction

1.1 Introduction

Pleural aspiration dates to the days of Hippocrates when it was primarily used for draining viscous pleural empyemas (Venuta, Diso, Anile, Rendina & Onorati, 2017). In 1876, the first continuous chest tube (CT) was placed with an underwater seal system for a patient who required recurrent intermittent aspirations due to an empyema (Gordon, Norton & Merrell, 1995; Venuta et al., 2017). The first reported case of a pleural catheter being inserted to drain the chest cavity post-thoracic surgery was in 1922 (Venuta et al., 2017). In the early 20th century, closed pleural drainage systems became the standard of care (Venuta et al., 2017). Currently, semi-flexible CTs are routinely inserted into the mediastinum or the intrapleural space after thoracic surgery and can be left in place to evacuate air or fluid and to help re-establish negative pressures in the pleural space (Hunter, 2008; Walsh, 2016). These drains are primarily placed by surgeons or radiologists percutaneously, or by surgeons intraoperatively. These CTs are removed once excess air or fluid are drained, which is typically 24-48 hours after surgery (Demir & Khorshid, 2010). Pleural drains are used frequently after thoracic surgery and are therefore removed regularly on thoracic surgery wards.

1.2 Background

Research has indicated that there is much debate in regard to the management of CTs, and that practices vary widely (French, Dilena, LaPlante, Shamji, Sundaresan, Villeneuve et al., 2016; Martin, Schall, Anderson, Kopari, Davis, Stevens et al., 2013). Chest tube removal (CTR) is a very common procedure that occurs nearly every day in hospitals (Cerfolio, 2013). Literature has shown that optimal management, including earlier removal of CTs leads to positive outcomes such as earlier ambulation (Claeys, Hammel & Wolf, 2015; Kirkwood, 2000;

Lijkendijk, Neckelman & Licht, 2018; Xie, Xu, Tang, Bian, Ma, Zhao, et al., 2015; Yao, Wang, Yao, Hang, Cao, Qian et al., 2016; Utter, 2013), increased patient comfort (Claeys, Hammel & Wolf, 2015; Kirkwood, 2000; Lijkendijk et al., 2018; Yao, Wang, Yao, Hang, Cao, Qian et al., 2016; Xie, Xu, Tang, Bian, Ma, Zhao, et al., 2015; Utter, 2013), decreased hospital stay (Claeys, Hammel & Wolf, 2015; Kirkwood, 2000; Lijkendijk et al., 2018; Utter, 2013) and decreased risk of infection (Lijkendijk et al., 2018; Yao, Wang, Yao, Hang, Cao, Qian et al., 2016; Xie, Xu, Tang, Bian, Ma, Zhao, et al., 2015; Utter, 2013). However, poor management of CTs, including delays in CTR can lead to numerous complications such as pain, increased length of stay as well as increased risk of morbidity and mortality (Charnock & Evans, 2001).

1.3 Problem Identification

Traditionally, at The Ottawa Hospital (TOH), nurses monitored and cared for patients with CTs, while medical residents were responsible for their management and removal. In a large teaching hospital such as TOH, medical residents and surgeons spend a large part of their day in the operating room, outpatient clinics, or other related care areas. Patients on the inpatient units would often be ready for discharge but had to wait until the resident completed their off-unit responsibilities before returning to the unit to remove their CT. This caused delays in discharge as well as increased CT indwell time. The additional wait time was also a source of additional pain due to the ongoing presence of CTs, as well as anxiety for patients. This was noted to be an area where significant improvements could be made for earlier discharge times, decreasing the CT indwell time and addressing patient uncertainty.

Medical residents tasked to remove CTs were often the most junior on the team and did not always have access to a standardized protocol for assessing and removing CTs if appropriate. Tooley (2002) stated that “patients are more likely to develop complications when practitioners

lack skills and knowledge in dealing with chest drains" (p. 48). At TOH, it was noted that the likelihood of a CT reinsertion after removal was approximately 6% (French et al., 2016).

As hospital systems continue to move towards optimal resource utilization, the goal is often to decrease length of stay and decrease cost without compromising patient care and outcomes (Martino, Merritt, Boyakye, Sernas, Koller, Hauser, & Lavery, et al. 1999). After identifying these areas for improvement, understanding the hospital's goal of decreasing costs and maintaining quality of care, a practice change was proposed. The proposed change was to shift the responsibility of CTR from the medical residents to the nurses on one inpatient unit and one level II Intensive Care Unit (ICU). Thoracic nurses possess significant expertise and knowledge regarding CTs and pleural drainage due to their specialized knowledge and daily exposure, which made them the ideal candidates to be responsible for safe CTR. Thus, we hypothesized that a standardized nurse-led CTR protocol would decrease CT indwell time and length of stay without compromising the complication rates.

1.4 Development of a Standardized Nurse-Led CTR Protocol

The aim of protocols, pathways and algorithms are to standardize patient care, reduce hospital length of stay and treatment costs (Martin-Ucar, Passera, Vaughan & Rocco, 2003), increase patient satisfaction (French et al., 2016) while improving patient outcomes and/or not increasing adverse events (Duman-Nizard, Guezennec, Parquin, Puyo, Sage, Abdat et al., 2016; French et al., 2016; Martin, Schall, Anderson, Kopari, Davis, Stevens et al., 2013). Many surgical disciplines have standardized protocols/pathways which outline the care patients should receive during different phases of their care.

A literature search was completed to determine the appropriate content for the CTR protocol, as well as existing standards or best practice guidelines surrounding the CTR criteria.

Clinical textbooks (McHale-Wiegand & Carlson, 2005), nursing standards (Walsh, 2016), articles, research papers and other centers practices were reviewed to guide the development of the protocol.

Nine centers in Canada were contacted via telephone and email to assess their CTR practices; Royal Columbian (Westminster, British Columbia), St. Paul's (Vancouver, British Columbia), Vancouver General Hospital, University Health Network (Toronto), Winnipeg Health Science Center, St John Regional Hospital, London University, Victoria London and the University of Ottawa Heart institute. It was noted that six of these nine centers had nurses removing pleural CTs with no reported negative changes in patient outcomes (unpublished data, 2016). These centers were asked to share their CTR content including policies, education models and certifications processes used. Three similar sized centers agreed to share their content with the principal investigator (P.I) of this research. These were reviewed to aid in the development of a standardized nurse-led CTR protocol for TOH. The development of this standardized CTR protocol was developed outside of this thesis work.

A CTR protocol was developed in our organization to specifically suit the needs of the thoracic patient population, and to act as standardized method for all nurses to remove CTs. Nurses use this protocol to aid in their assessment and support their decision-making process. The protocol consisted of a policy statement, definitions which relate to the CTR protocol, nursing alerts, required equipment for the CTR procedure, the procedure steps, required documentation, related policies, and the certification process. Added to the protocol in the form of appendices are the criteria for CT discontinuation, and management of complications associated with CTR.

Research has indicated that CTR education requires initial competency testing as well as ongoing evaluation of competence (Kirkwood, 2000). Therefore, an educational curriculum was also developed, and the certification process included a stepwise and competency-based approach. This included the completion of an educational session and obtaining a passing grade on an online quiz. This was followed by teaching in the clinical environment. Nurses needed to observe a minimum of three CTRs before completing a minimum of three observed CTRs (Hood, Henderson & Pasero, 2014). Nurses would receive constructive feedback for improvement during their observed CTRs. Once the nurses completed the prior steps and felt comfortable with their knowledge, skill and judgment, a competency skill checklist would be attempted (Appendix A). If the nurse demonstrated safe practices according to the standardized protocol, they were certified and allowed to remove CTs independently.

The overall purpose of this study was to evaluate the implementation of the standardized nurse-led CTR protocol for postoperative thoracic surgery patients admitted to an inpatient unit and a level II ICU of a large academic health science center. Specific objectives were to understand the impact of the standardized nurse-led CTR protocol on CT indwell time, length of stay, and complication rates (phase 1) and to evaluate the uptake of the nurse-led protocol two-years post implementation (phase 2). We hypothesized that the implementation of this standardized nurse-led CTR protocol would decrease CT indwell time and length of stay without compromising the complication rates.

1.4.1 Possible content for nurse-led CTR protocol.

When reviewing the literature, important components were found that could inform a nurse-led CTR protocol. The following were learnt by reviews and not primary research articles. These included: (1) patient identification prior to CTR (Walsh, 2016), (2) targeted patient

assessments (i.e., lung assessments and vital signs) (Allibone, 2015; Hunter, 2008; Muzzy, 2015; Walsh, 2016), (3) a review of the patient's anticoagulation status (Allibone, 2015), (4) a standardized method of assessing pain and providing pain control (Allibone, 2015; Hunter, 2008; Walsh, 2016), (5) a list of equipment and supplies needed for CTR (Allibone, 2015; Hood, Henderson & Pasero, 2014; Hunter, 2008; Muzzy, 2015; Walsh, 2016), (6) the use of personal protective equipment and the following of other infection control practices (i.e. technique sterility and hand hygiene) (Allibone, 2015; Hunter, 2008; Muzzy, 2015; Walsh, 2016), (7) when to clamp CT (Allibone, 2015; Hunter, 2008; Muzzy, 2015; Walsh, 2016), (8) required dressings (Hunter, 2008; Muzzy, 2015; Walsh, 2016), (9) differentiation of sutures (Allibone, 2015; Hunter, 2008; Walsh, 2016), (10) breathing technique required during removal (Allibone, 2015; Hunter, 2008; Muzzy, 2015; Venuta et al., 2017; Walsh, 2016), (11) patient education (Allibone, 2015; Hunter, 2008; Walsh, 2016), (12) management of complications (i.e. accidental removal of purse string sutures) (Allibone, 2015; Hunter, 2008; Muzzy, 2015; Walsh, 2016), and a step-by-step guide to CTR (Allibone, 2015; Hunter, 2008; Muzzy, 2015; Walsh, 2016). Authors recommended having two clinicians present for CTR when purse string sutures were used (Allibone, 2015; Hunter, 2008; Muzzy, 2015; Walsh, 2016). Some researchers noted that when two CTs were present, the posterior-lower one should be removed first (Venuta et al., 2017). One author promoted the use of aseptic non-touch technique (Walsh, 2016) while another stated it should be a sterile procedure (Muzzy, 2015). Finally, articles also included the importance of outlining readiness parameters for nurses, (i.e. degree of air leak required prior to removal and fluid output criteria) (Allibone, 2015; Hunter, 2008; Walsh, 2016). Suture removal was also identified as a key aspect to be outlined in a protocol (Allibone, 2015). These findings began the development of the CTR protocol.

1.4.2 Lack of clear standards/best practice guidelines for CTR practices.

Many clinician-researchers have attempted to create best practice recommendations for CTR criteria, however, there is no sound evidence to construct these guidelines as to the best timing of a CTR (Novoa, Jimenez & Varela, 2017; Satoh, 2016). Fluid threshold, suction versus water seal and digital drainage also lack consensus.

Fluid threshold.

Fluid threshold is the maximum amount of fluid drainage that is considered safe for removal of CTs. There is no universally accepted fluid threshold and it remains highly debated in research (Allibone, 2015). Fluid threshold alone has been found to have prolonged the duration in which CTs remain in place by two days (Utter, 2013). In the literature, a vast array of practices regarding fluid threshold have been reported. Fluid parameters of 100-300ml/24hours were most often reported (Hunter, 2008; Lijkendijk, Licht & Neckelman, 2015; Martin, Schall, Anderson, Kopari, Davis, Stevens, et al., 2013; Yao et al., 2016; Walsh, 2016; Xie, Xu, Tang, Bian, Ma, Zhao & Bin, 2015), but ranges up to 500ml/24-hours were also supported (Yap, Soon, Ong & Loh, 2017). This threshold has been continuously increasing over the last 15 years (French et al., 2016). Some authors calculated fluid threshold based on patient weight (French et al., 2016; Utter, 2013). Utter (2013) supported a fluid threshold of 2ml/kg/day, while French and colleagues (2016) supported a much higher weight-based calculation. French and colleagues (2016) argue that as anatomy and physiology can differ from person to person, drainage can also vary. The standardized protocol developed for our thoracic population was based on French's weight-based calculation as this research was done at our institution on our specific patient population and research found this to be a safe and dependable measure (French et al., 2016). This calculation considers total body lymphatic flows which differs based on patient size and

weight. It was determined that 20% of the patient's total body lymphatic flow allows an acceptable range from 172-715 ml/24 hours (median= 350ml; IQR= 58ml) (French et al., 2016).

Timing of removal during the respiratory phase.

The timing in which a CT is removed during the respiratory phase is also subject to debate in the literature (Allibone, 2015; Novoa, Jimenez, Varela, 2017). In one prospective randomized controlled trial (RCT), patients were randomized to either have their CT removed at peak inspiration with Valsalva manoeuver (n=179), or end expiration (n=163) with the Valsalva manoeuver (Cerfolio, Bryant, Skylizard & Minnich, 2013). Cerfolio and colleagues (2013) found that removing CTs at end inspiration led to statistically significant increases in rates of non-clinically significant pneumothoraces (p=.007). Due to these findings, the study was closed early, and was therefore underpowered to detect significant differences in clinically significant pneumothoraces which required intervention. However, another RCT found that there were no differences in patient pneumothorax rates based on the respiratory phase in which the tube was removed. (Bell, Ovadia, Abdullah, Spector & Rabinovici, 2001). Most current literature supports removing CTs at peak inspiration (Allibone, 2015; Hunter, 2008; Muzzy, 2015; Walsh, 2016; Venuta et al., 2017). This issue remains debated and both methods appear to be safe (Satoh, 2016). The commonality among both opposing views is the use of the Valsalva manoeuver during the time of CTR. The TOH standardized protocol therefore implemented CTR at peak inspiration with the Valsalva manoeuver, as it is the most commonly supported practice in literature.

Suction versus water seal.

Many articles also stated that a period of gravity/water seal should occur prior to removal to decrease the risk of pneumothorax (Martin et al., 2013; Martino et al., 1999; Muzzy, 2015;

Walsh, 2016). However, a systematic review by Coughlin and colleagues (2012) concluded that there was no clear evidence to recommend suction or water seal. French (2016) also reviewed seven RCTs and three meta-analyses and again found conflicting evidence. French (2016) deduced that this could be due to the lack of relationship between suction and water seal and the measurement outcomes, variation of management protocols, or the analog devices used in the trials. Analog devices are pleural drainage collection systems that use subjective assessments. These devices are prone to inter-observer variability due to subjectivity and are therefore unreliable. The standardized protocol developed for nurses at TOH, therefore had no stipulation regarding the amount of time a patient had to be on gravity prior to removal.

Digital drainage.

Digital drainage devices are electronic drainage collection systems that collect pleural drainage and electronically measures air, fluid and pressure (Gilbert et al., 2015; Zisis et al., 2015). These devices are becoming more prevalent in the CT management research due to their superiority in measurement objectivity. Some research has shown that use of digital drainage systems results in decreased air leak duration, decreased CT duration, decreased length of hospital stays and increased patient satisfaction rates (Pompili, Detterbeck, Papagiannopoulos, Sihoe, Vachlas, Maxfield et al., 2014). A best evidence topic article which assessed five papers (four RCTs and one prospective observational study) concluded that digital drains had the potential to lead to earlier CTR, but stated that the evidence was conflicting, and no definitive conclusion was reached (Afoke, Tan, Hunt & Zakkar, 2014). However, McGuire et al., (2015) found that digital drainage systems did lead to a decrease in clamping trials and increased observer agreement between healthcare professionals. Due to these findings, at our institution it

is a standard of care that all patients undergoing thoracic surgery are placed on a digital drainage device.

Chest X-rays (CXRs) post CTR.

Many articles stated that a CXR should be completed as a standard of care after CTR (Allibone, 2015; Hunter, 2008; Lijkendijk et al., 2015; Martin et al., 2013; Muzzy, 2015; Walsh, 2016), while two other papers stated this was not part of their routine practice (French et al., 2016; Yao et al., 2016). French and colleagues (2016) found that 77% of CXRs completed at our institution with the thoracic patient population, were unlikely to influence clinical decisions regarding CT management. Due to the question of usefulness and cost-effectiveness of these procedures, routine CXRs were omitted from our protocol. As an alternative, the thoracic department developed and followed a CT management protocol, which outlines the standards for use of CXR. CXR images are completed on postoperative day one and then only if clinically indicated (e.g. air heard escaping during removal, patient displaying signs of respiratory distress or increase in SQE) (Department of Thoracic Surgery, 2018).

1.4.4 TOH nurse-led CTR protocol.

Guided by the published literature, other institutional protocols, and in collaboration with the local team comprising of the thoracic surgeons, the unit leadership team and the clinical nurses, a standardized nurse-led CTR protocol was developed for the two TOH thoracic inpatient units. This protocol was developed to act as a standardized method for all nurses to remove CTs, and to specifically aid nurses in their assessments and their decision-making processes.

Content of the CTR protocol.

The CTR protocol is divided into multiple sections; policy statement, definitions which relate to the CTR protocol, nursing alerts, required equipment for the CTR procedure, the

procedure steps, required documentation, related policies, and the certification process. Added to the protocol in the form of appendices are the criteria for CT discontinuation, and management of complications associated with CTR (Appendix B).

CTR criteria.

For nurses to discontinue chest drainage, a written physician order is required. The following criteria must also be met:

- No positive pressure ventilation
- No air leak present in either the analog or digital drainage system
    - Analog drainage system- minimal or no bubbling when patient takes a deep breath and coughs
    - Digital drainage system- digital reading chart must read less than or equal to 30ml/min for the previous 8-hours
- A stable respiratory status (i.e. stable respiratory rate, oxygen saturations)
- Absent, mild or no increase in SQE
- Serous or serosanguinous CT drainage, with drainage less than or equal to 20% of total body lymphatic flow for the previous 24-hours.

Nurses are required to assess the patient for all the above criteria. If one of the above criteria is not met, or if the nurse is unsure, a follow-up discussion with the thoracic surgery team is needed to assess the safety of the CTR. The nurse and thoracic surgeon would need to agree on the safety of the CTR at that time.

As the key stakeholders in this process, the nurses were heavily involved in the development of the standardized CTR protocol by providing feedback as to how they would

proceed with this type of clinical skill. When possible, the order in which they preferred to accomplish tasks was respected and incorporated into the protocol.

1.5 Education

This change in practice was implemented in January 2017. See Appendix C for the implementation timeline.

As CTR is a clinical skill, Hood et al., (2014) and Kirkwood (2000) stated that the related education should include both didactic and clinical instructions. Educational materials were developed for all nurses on the two thoracic units. This curriculum included the prerequisite knowledge nurses would require to safely perform CTR, and included: review of anatomy and physiology, placement and purpose of CTs, indications for CT use, review of drainage systems utilized on the two units (Thopaz® and Sahara®), sutures (retention versus purse-string), criteria for CTR, pain control, nursing responsibilities pre-, intra- and post-procedure and a step-by-step protocol review which included management of complications and documentation. A knowledge survey including 25 multiple-choice, and true or false questions was also developed, with a required passing grade of 80% (Appendix D).

Education was provided in 4-hour small group sessions. Sessions were provided on 10 separate occasions and attendance was mandatory for all nurses of the two participating units. Nine sessions were held between January 24 and March 7, 2017. One additional class was held on November 8th, 2017 for nurses returning from a leave of absence, and for newly hired nurses. All nurses (100%) who were currently working on either of the two units, attended one of these educational sessions. This education was delivered using didactic lectures, hands on demonstrations and interactive games to increase engagement and knowledge uptake.

Two thoracic surgeons, Dr. Sebastien Gilbert and Dr. James Villeneuve, provided extensive education at the bedside to develop the knowledge and skills for the P.I. of this thesis, in removing CTs safely and effectively. Once thoracic surgeons were confident, they delegated the act of removing CTs to the P.I. of this thesis (from January- February 2017). The P.I. then provided additional education to approximately 8 clinical nurses to designate them as champions. These champions aided by providing clinical education to all the nursing staff (n=85) and were chosen based on their assigned role as charge nurse. This ensured there was a champion available on the unit 7 days a week, during day shifts to assist with CTR.

Certification Process.

Kirkwood (2000) states that the initial competency testing as well as ongoing evaluation of competence must be established. Therefore, the certification process included a stepwise and competency-based approach. This included: (1) attending the educational session and obtaining a passing grade of 80% on the knowledge survey; (2) observing a minimum of three CTRs, then performing a minimum of three CTRs (Hood, Henderson & Pasero, 2014) while being observed and receiving constructive feedback by a CT champion/educator. Once the above steps were completed and nurses felt comfortable with their knowledge, skills and judgment, a competency skills checklist was attempted (Appendix A). Each nurse needed to demonstrate safe practice to be certified. Once the nurse successfully completed the competency skills checklist, they were able to remove CTs independently. As of April 2020, 73/81 (90%) of nurses were certified. Thus, the majority of CTs are now being removed by nurses, with the exception of complex cases where the medical residents continue to remove the tubes (e.g. high risk of bleed).

1.6 Purpose of the Research Study

The overall purpose of this study was to evaluate the implementation of the standardized nurse-led CTR protocol for postoperative thoracic surgery patients admitted to the thoracic units at TOH.

1.7 Objectives of the Research Study

Specific objectives of this study were:

1. To understand the impact of the standardized nurse-led CTR protocol on CT indwell time, length of stay, and complication rates (phase 1)
2. To evaluate the uptake of the nurse-led protocol two-years post implementation (phase 2)

1.8 Significance of the Study

This study was aimed at evaluating a nurse-led CTR protocol. To our knowledge, this is the first study to analyze patient outcomes pre and post-implementation of nurses removing CTs. It was important to study this topic to ensure that this new process was indeed improving the quality of care of the thoracic patient population.

1.9 Thesis Outline

This thesis is composed of five chapters:

- **Chapter one** includes the introduction, the background, the purpose and the significance of the research study.
- **Chapter two** provides a detailed literature review of CTR by nurses, as well as nurse-initiated and nurse-led treatments.
- **Chapter three** describes the methodology of this thesis including the study design, the sample, the data collection, the outcome measures, and the data analysis for both phase 1 and phase 2 of this research study.

- **Chapter four** presents the results for both phase 1 and phase 2.
- **Chapter five** consists of an integrated discussion including the implications for nursing practice, education and research.

Chapter 2: Literature review

This chapter presents a review of the literature on the concept of CTR by nurses, as well as, more broadly, nurse initiated and nurse-led treatments.

2.1 CTR by Nurses

A literature search was completed to examine the concept of CTR by nurses. Utilizing Medline (OVID) and the Cumulative Index of Nursing and Allied Health Literature (CINAHL®), a variety of search terms were used in both platforms. Chest tube, chest, pleural, thoracic, were the main search terms. These terms were combined to other keywords such as drain, tube, catheter, as well as nurse, nursing care and medical-surgical nursing. Literature was searched up to 2018. Literature was limited to English articles. Inclusion criteria included: any literature that discussed outcomes related to CTR done by nurses. The majority of articles found were based on best practices concerning CT management and removal (Charnock & Evans, 2001; Dumans-Nizard, Guezennec, Parquin, Puyo, Sage, Abdat et al., 2016; Gordon, Norton & Merrell, 1995; Lijkendijk et al., 2015; Lijkendijk et al., 2018; Martino et al., 1999), knowledge regarding CTs, technical "how to" skills of CTR (Allibone, 2015; Hunter, 2008), practice questions regarding nurses' ability to remove CTs (Kirkwood, 2000), drainage system reliability (McGuire et al., 2015), and decision making (Christensen, 2002; Riley, 2003). Only one study was found that discussed removal of CTs delegated to nurses, but a comparison to pre-implementation was not discussed (Lijkendijk et al., 2015). There were also four conference abstracts (Backer & Pritchett, 2008; Claeys, Hammel & Wolf, 2015; Cox, 2011; Nellet & Ross, 2011) and two articles (Hood, Henderson & Pasero, 2014; Thomson, Wells & Maxwell, 1997) found that discussed outcomes related to CTR completed by nurses. These articles and conference abstracts are the base of this literature review.

Lijkendijk, Neckelmann and Licht (2015) completed a prospective, open-labelled RCT examining the differences in air leak in digital versus traditional water seal drainage systems in Denmark. A total of 105 patients participated in this research study over a 19-month period. All postoperative patients were treated with the same standardized care path but were randomized to either a digital (intervention group) or analog (control group) drainage system. The authors developed a strict algorithm which outlined specific criteria identifying the appropriate time to remove a patient's CT. In the intervention group, patients were placed on the digital drainage system and criteria for removal included: air leak less than or equal to 20ml/min for 6 consecutive hours, or less than or equal to 50ml/min for 12 consecutive hours without any visible spikes on the digital display; fully mobilized patient with no or low pain score on visual analog scale (2-3/10). The control group was placed on the traditional analog drainage system and criteria for removal included: no air bubbles visualized in the water seal chamber during coughing; fully mobilized patient with no or low pain score on visual analog scale (2-3/10). The earliest the CTs could be removed was 6-hours postoperatively and the fluid threshold was serous fluid with a total of <200ml the day of surgery, or <400ml if it was the day after. Utilizing this set criteria and algorithm, the assigned nurses would assess the patient once per shift (24 hours/8 hours shifts=3 assessments/day) and decide the appropriate time to remove a patient's CT. Researchers identified that there were no statistically significant differences between the systems and respective lengths of stay. The average time for CT duration in this study was 1.9 days for the digital drainage system, versus 2.2 for the traditional analog system. Mean length of stay for the patients in both arms of this study was 5 days which is comparable to findings in other studies. This indicated that when CTR is delegated to nurses, there seems to be no increase in adverse events or length of stay. The authors concluded that the use of a set algorithm with

both drainage systems allowed for safe delegation of CTR to the nurses. This study however, does not compare baseline data prior to the implementation of this algorithm.

A prospective cross-sectional multicenter study assessing procedural pain determined that CTR was the most painful procedure performed in the ICU (Puntillo, Max, Timsit, Vignoud, Chanques, Robleda et al., 2014). Hood, Henderson and Pasero (2014) focused on interventions for pain control during CTR with research reviewed on pharmacological and non-pharmacological interventions. They also discussed multimodal approaches to pain control. These authors concluded that CTR is often associated with moderate to severe pain, but adequate pain control is often overlooked. It was concluded that when nurses were educated and competent in CTR, there was a greater awareness of patients' pain related to removal. When medical staff were responsible for the removal of CTs, it resulted in a lack of control in relation to the timing of the procedure, limiting the ability of the nurse to pre-medicate patients for this procedure. Increasing the nurses' control over CTR improved pain management which was also identified in two of the published conference abstracts (Backer & Pritchett, 2008; Nellet & Ross 2011)

Findings reported in four conference abstracts, were that complication rates were lower or unchanged when nurses removed CTs compared to removal from medical staff (Backer & Pritchett, 2008; Claeys, Hammel & Wolf, 2015; Cox, 2011; Nellet & Ross, 2011), nurses had improved job satisfaction (Claeys, Hammel & Wolf, 2015; Cox, 2011; Nellet & Ross, 2011), patients' pain levels were reduced (Backer & Pritchett, 2008; Nellet & Ross 2011) and median time from order to removal decreased (Claeys, Hammel & Wolf, 2015). In addition, increased nursing knowledge (Claeys, Hammel & Wolf, 2015) and increased collaboration with the team (Claeys, Hammel & Wolf, 2015) were reported.

Cox (2011) worked collaboratively with nurses, cardiothoracic surgeons and ICU staff to develop a standardized protocol to have nurses remove pacing wires and CTs post open-heart surgery. A selected group of 6 experienced nurses were chosen to become the designated staff to remove pacing wires and CTs. These nurses received education in a didactic manner as well as clinical supervision. During a 90-day period, Cox (2011) completed an observational study on a total of 17 patients. Within this group of patients, there were no complications post removal. Patients, families and physicians were satisfied with the new model of CTR by nurses. The author stated that staff satisfaction correspondingly increased due to ascertaining a new skill and increased collaboration with the medical team.

Nellet and colleagues (2011) implemented CTR by nurses on a cardiovascular surgical ICU. Prior practice was CTR completed by physician assistants. Due to time limitations, pain medication was often not available or did not have enough time to adequately take effect, and patients often complained of pain during CTR. CTs were also removed at the end of the day when the physician assistants were available. The goal of the new process and protocol was to improve pain control, minimize complications and prevent delays in care. Nurses had to complete a written competency tool and then complete a return demonstration of the CTR procedure on a simulated chest. The return demonstration is a method in which the nurse can perform the skill in a simulated environment with direction as required by the instructor. The nurses would then have to complete five observed CTRs, prior to removing CTs independently. There was a total of 18 educated nurses that removed 181 sets of CTs. There were no reinsertions and no major complications noted. Pneumothoraces occurred in 2.2% of the patients; all were clinically insignificant and required no further clinical intervention. The pain rating was 4 on a

scale of 1-10 in 89.4% of CTRs. However, no pre-implementation data was provided. The authors concluded that nurses removing CTs was safe in their area.

Claeys and colleagues (2015) implemented a standardized protocol for CTR by nurses on a 33-bed thoracic surgery unit. Nurses completed online learning modules, observed CTR and then completed return demonstrations to allow the nurse to perform the skill in a simulated environment. The goal was to implement this change to improve patient care and satisfaction, prevent delays in discharge and allow nurses to work to their full scope as regulated by their college. During the first year, 40 nurses were educated and 800 CTs were removed. The researchers noted that time of physician order to the time of CTR decreased with no increase in complications. They also found an increase in job satisfaction related to increased knowledge and collaboration with the medical team as well as decrease in length of stay; however, no data are reported describing this outcome.

Thomson, Wells and Maxwell (1997) published an article that provided information to prepare nurses for CTR after cardiac surgery. The authors identified that CTs could have been removed in a timelier fashion by nurses after cardiac surgery, in comparison to their physician counterparts. The authors provided education to nursing staff and implemented a policy that allowed CTR to be completed by nurses which resulted in a reduction of the patients' length of stay by 1.5 days.

2.2 Nurse-Initiated and Nurse-Led Practices

Since the literature on CTR was limited, a broader literature search on nurse-initiated or nurse-led treatments was performed. Utilizing the Cumulative Index of Nursing and Allied Health Literature (CINAHL®) platform, the search terms nurse initiated, nursing interventions and nursing independent were used. Searches were limited to English publications in the last 7

years. To ensure an understanding of nurse-initiated and nurse-led interventions, articles were chosen that discussed outcomes in different areas of practice (emergency, long term care, short term care) and for different interventions (medications, procedures, protocols).

2.2.1 Nurse-initiated practices.

Nurse-initiated protocols are defined as protocols in which the nurse will assess, diagnose, and start treatment within agreed protocols prior to consulting the medical team (Chaney, 2004). Cabilan and Boyde (2017) stated that there were 7.5 million emergency room visits in Australia in 2015/2016. These high rates of visits lead to overcrowding, which in turn causes delays in treatment such as antibiotic administration, late initiation of thrombolytic therapy for patients suffering myocardial infarctions, and longer time for patients to receive pain medications (Cabilan & Boyde, 2017). Therefore, nurse-initiated protocols and interventions have been developed and are used in many emergency rooms as well as other practice areas to decrease delay to treatment, improve quality and patient safety, as well as improve patient satisfaction (Cabilan & Boyde, 2017; Center for evidence-based practice South Australia, 2011). Nurse-initiated protocols are therefore emerging in the literature as an increasing focus in health care (Cabilan & Boyde, 2017; Center for evidence-based practice South Australia, 2011; Dixon et al., 2014). Some examples found in the literature included administration of medications in emergency departments (Cabilan & Boyde, 2017), reduction of radial-head subluxation in a pediatric emergency department setting (Dixon et al., 2014), management of fever, hyperglycemia and swallowing in acute stroke units (Middleton et al., 2017) as well as enteral nutrition supplementation on a surgical unit (Ho et al., 2017).

The amount of time it takes to have patients receive medications in the emergency room is often seen a quality of care indicator. One of the most important strategies implemented to

achieve this goal is the implementation of nurse-initiated medications, allowing nurses to provide medications as deemed necessary by patients' conditions. Cabilan and Boyde (2017) completed a systematic review to evaluate the effectiveness of nurse-initiated medications in emergency departments on quality care indicators (safety, timeliness, effectiveness, equitability, patient-centered care and efficiency). The authors included studies focusing on both adult and paediatric patients. The systematic review included a review of five experimental studies (one RCT and four prospective pre-test post-test designs) with a total of 1272 participants (352 paediatric/920 adult). Findings showed that nurse-initiated medications are; safe with no adverse events and no reported medication errors; timely with a decrease in delivery time by 30 minutes; effective with clinically significant reduction in pain scores; and patient centered with higher patient and family satisfaction scores. Length of emergency room stay, and doctor wait time amongst children was not statistically different with nurse-initiated medications.

In the pediatric emergency department setting, Dixon et al., (2014) completed a cluster RCT comparing nurse-led identification and reduction of radial-head subluxations in children, compared to physician management. The authors hypothesized that nurse-led management could improve time spent in the emergency room, associated health care costs and patient/family satisfaction. A medical directive was developed, and 60 triage nurses received education on the medical directive and were able to reduce suspected subluxations. Multimodal education was provided for the nurses which included a video, a didactic lecture and a 1-hour hands on clinical sessions. Days were clustered for "physician-initiated treatment" or "nurse-initiated treatment". Nurses would have two attempts at 10-minute intervals to successfully reduce the subluxation. If the nurse could not successfully reduce the subluxation, the patient would be placed in the queue to be seen by the physician. A total of 268 children were included in this study. Dixon et al.,

(2014) reported the rate for successful reductions for the physician group was 96.7% compared to 84.7% for nurses. Only 78.9% of those reductions attempted by nursing had a second attempt completed by the nurse. When assessing only when the medical directive was strictly followed, and 2 attempts were made, the success rate for nurses increased to 90.5%. The researchers were unsure as to why nurses had a lower success rate than physicians but deduced that it was due to the lack of experience with the procedure. Since there was less than 1 child/day that would present with subluxation, it is unlikely that each nurse had the opportunity to reduce a few subluxations and it was assumed that as nurses gain more exposure to this skill, their comfort and success rate would increase. However, children who had successful reductions performed by nurses had statistically ($p<0.001$) and clinically significant shorter lengths of stay which could increase the efficiency of the emergency department.

In a quality in acute stroke (QASC) trial, three nurse-initiated protocols were implemented between 2005-2010, including management of fever, hyperglycemia and swallowing dysfunction within 72 hours after admission for patients who experienced a cerebral vascular accident. Middleton and colleagues (2017) completed a cluster RCT in Australia to research the efficacy of these nurse-initiated protocols. The intervention group included 600 patients who received nursing-initiated protocols, compared to 476 in the control group who received standard physician directed care. They monitored the rates of death and disability on these patients at 90 days and survival rate upon follow up (median follow up 4.1 years [range 0.3-70 months]). Results showed a significant improved survival of >20% in the intervention group. Findings showed that rigorous implementation of the nurse implemented protocols successfully reduced long-term mortality for patients surviving from strokes (Middleton et al., 2017).

Ho and colleagues (2017) utilized a pre-test and post-test design to study the effect of nurse-initiated enteral nutrition supplementation on nutritional deficiencies for patients receiving gastrointestinal resection surgeries in Hong Kong. Patients were recruited for two 9-month periods; one 9-month period was for observation before nurses received education, and the other was the intervention period after the nurses received the education. Malnutrition scores were assessed. During the intervention phase, nurses were given control to initiate enteral nutrition supplements. A total of 578 patients were enrolled in this study. When the control and intervention groups were compared, it was noted not only that nurses were compliant in prescribing the supplements, but also that patients had significantly reduced ($p < 0.001$) postoperative nutritional deficiencies including caloric and protein deficiencies.

2.2.2 Nurse-led practices.

Nurse-led means that nurses will assess a situation as per a previously agreed upon protocol and must contact the physician before initiating a protocol (Chaney, 2004**)**. There has been growing demand in the United Kingdom (UK) since the 1990's to have nurse-led clinics to meet the growing needs of the healthcare system. The increasing demand to decrease hospital costs while maintaining high standards of care and patient satisfaction, make nurse-led clinics an optimal choice. Nurses in these settings are responsible for reviewing and monitoring patients without direct medical supervision (Tcherveniakov, Desiqueira, Milton & Papagiannopoulos, 2012; Williams, Williams, Tcherveniakov & Milton, 2012; Zimmerman et al., 2016). These types of nurse-led clinics have been found to improve efficiency, decrease wait times and hospital length of stay, while not compromising the standard of care (Williams et al., 2012; Tcherveniakov et al., 2012).

An outpatient nurse-led clinic was established in the thoracic department of St. James University Hospital in the UK for patients who required any clinical intervention after discharge (e.g. CTR or chest wound follow up) (Williams et al., 2012). The authors completed a prospective cross-sectional survey for a two-month period. A questionnaire was developed to assess patient satisfaction in relation to the nurse-led clinic. Eighty-eight percent of all respondents believed that their needs were met during their visit to the nurse-led clinic and 99% of respondents described the overall satisfaction level to be either good, very good or excellent (Williams et al., 2012). This study demonstrated the support for nurse-led management for the care of outpatient thoracic patients.

Zimmerman and colleagues (2016) completed an open-label cluster RCT in 20 different clinic practices to assess the effectiveness of nurse-led support for patients with anxiety, depression or somatic symptoms. Patients attending the control clinics (n=10) received routine care which included care provided by a general practitioner, medications, referrals and psychotherapy as needed. Patients attending the clinics randomized to the intervention group (n=10) received case management by nurses, and counseling to help enhance patient's self-management. Utilizing a 10-point questionnaire completed by patients, it was found that patient's perceived levels of self-efficacy improved in the nurse-led intervention group by 1.65 points. The authors concluded that a "nurse can successfully complement the work of a general practitioner" (Zimmerman et al., 2016, p. 101).

2.3 Summary

Research suggests that CTR can be delegated to nurses, with lower or no increase in adverse events (Backer & Pritchett, 2008; Claeys et al., 2015; Cox, 2011; Lijkendijk, Neckelmann & Licht, 2015; Nellet & Ross, 2011), no increase in length of stay (Lijkendijk et al.,

2015), improved pain control during the removal (Backer & Pritchett, 2008; Hood et al., 2014; Nellet & Ross 2011), a decrease in median time from order to removal (Claeys et al., 2015), improved nursing job satisfaction (Claeys et al., 2015; Cox, 2011; Nellet & Ross, 2011), increased nursing knowledge (Claeys et al., 2015) and increased collaboration with the healthcare team (Claeys et al., 2015). Literature also supports nurse-initiated protocols and nurse-led care in critical care, inpatient and outpatient areas. In all areas, positive results related to patient health, cost outcomes and patient satisfaction were identified when nurses were responsible for initiating protocols. However, research findings for outcome measures related to nurses removing CT are currently lacking in the literature.

Chapter 3: Methods

This chapter describes the methodology for this research study including the study design, sample, data collection, outcome measures and data analysis. This research was designed as a 2-phase study. In phase 1, the goal was to compare patient outcomes pre- and post-implementation, while phase 2 focused on the sustainability and uptake of the protocol by the nurses two years after implementation.

3.1 Phase I

3.1.1 Study design.

A retrospective two-group cohort study was completed, whereby patient data for the pre- and post-implementation groups were accessed through an existing thoracic research database and compared. As the main objective of phase 1 was to understand the outcome measures impacted by the standardized nurse-led CTR protocol, CT indwell time, length of stay, and complication rates were assessed.

3.1.2 Sample.

Settings and participants.

TOH is one of Canada's largest academic multi-centered institutions. Located in the nation's capital region, it houses over 1100 beds (TOH, 2018). This study took place at the General Campus of TOH on a 32-bed inpatient thoracic unit and an 8-bed level II ICU. Critical Care Services of Ontario (2020) defines level II ICUs as "units capable of providing service to meet the needs of patients who require detailed observation or intervention, including support for a single failed organ system, short-term non-invasive ventilation or post-operative care"

Inclusion and exclusion criteria.

Inclusion criteria for the study included patients who have undergone thoracic surgery, were admitted to either of the thoracic units, with a CT on a digital chest drainage system. Exclusion criteria included patients who were on an analog chest drainage system.

Recruitment.

All patient records available in the thoracic database for the time periods of January 2016- January 2017 and April 2017- April 2018 were included in the study. These were all patients who have undergone thoracic surgery at TOH and were placed on a digital drainage device.

Sample size.

Prior research measuring the effectiveness of nurses removing CTs has been minimal. Therefore, to best evaluate whether there are positive associations between nursing removal of CTs and patient outcomes, consecutive sampling was used. Retrospective data from all patients on CT indwell time, length of stay and complication rates were collected.

3.1.3 Data Collection.

Group 1- Pre-protocol implementation retrospective chart reviews.

Patient data in the thoracic database were reviewed for the 1-year period prior to implementation of the standardized CTR protocol; January 2016- January 2017.

Group 2- Post protocol implementation retrospective chart review.

Patient data in the thoracic database were reviewed for a 1-year period after the implementation of the standardized CTR protocol; April 2017- April 2018. Data for the first 3-months post-implementation was omitted; January, February and March of 2017. During this time, both physicians and nurses removed chest drains. Due to the education model, there were

few nurses who were certified to remove CTs independently without the nurse educator or nurse champions on the weekend. Therefore, the data from January 2017 - March 2017 was not collected to decrease the amount of data contamination due to transition of CTR responsibility.

For both groups 1 and 2, data was collected on an excel spreadsheet. This included patient demographic information (sex, age, body mass index [BMI], smoking history and related pack years, forced expiratory volume over 1-second [FEV1], forced vital capacity [FVC], FEV1 over FVC ratio, primary procedure, approach, CT location) as well as study related outcomes (surgery end time, tube discontinue time, date of discharge, use of Pneumostat chest drainage device, pneumothorax size, SQE, pleural effusions, CT related events, event date, event time).

3.1.4 Outcome Measures.

Dependent variable.

The dependent variables of this study included the CT indwell time, length of stay, and complication rates (pneumothoraces, SQE, pleural effusions).

Independent variable.

The independent variable was the implementation of the nurse-led CTR protocol on the one inpatient unit and one level II intensive care unit.

Primary outcomes.

The primary outcome was the measure of CT indwell time, which is defined as the total amount of time in hours a patient has a CT insitu. This outcome was calculated in hours from the end of surgery time/or insertion, until discontinuation of the final drain. Patients who were discharged home with a valve (Heimlich or Pneumostat) were excluded from this calculation because their exact time of CTR could not be captured. The total number of patients who had a valve applied (Heimlich or Pneumostat) were reported. This data was extracted from the thoracic

database utilizing the surgery end time, CTR time, and Pneumostat/Heimlich valve application time.

Secondary outcomes.

The first secondary outcome was the length of stay, which is defined as the total amount of time in days, a patient remains in hospital. This outcome was calculated from the end of surgery until the patient left the hospital (Gilbert et al., 2015). If the patient did not undergo surgery, the time of admission was used. One day was added to length of stay at midnight. If the patient was discharged home the day of surgery before midnight, the length of stay would be 0. If the patient was discharged home before midnight the day after surgery, the length of stay would equal 1, and so on.

Rates of pneumothoraces, pleural effusions and SQE were analyzed. Patient CXR results were compared and were graded using the following scale; no CXR post therefore assumed no complication, no complication found on CXR, complication increase of 1 grade, complication increase of 2 grades, complication increase of 3 grades, no CXR available prior to compare. All CXR's in the thoracic database had previously been graded according to the following;

a) Pneumothoraces
    i) 0 = none
    ii) 1 = small < 3cm
    iii) 2 = large > 3cm - distance between lung apex and cupola
b) SQE
    i) 0 = none
    ii) 1 = mild - can only be detected by palpation of the chest wall or by CXR
    iii) 2 = moderate - ipsilateral hemithorax visible

iv) 3 = severe - beyond ipsilateral hemithorax

c) Pleural Effusion

i) 0 = none

ii) 1 = small - blunting of costal phrenic angle on CXR

iii) 2 = moderate - meniscus occupies <50% of hemithorax

iv) 3 = large - meniscus occupies >50% of hemithorax

Reinsertion of CT rates were to be investigated; however, it was noted that this information was not consistently available in the thoracic database. The outcome measure of reinsertion rates was therefore not analyzed.

3.1.5 Data Analysis.

The Ottawa Methods Center (OMC) supported the statistical analysis utilizing the Statistical Analysis Software (SAS). When the data was normally distributed, the results were represented using Means and Standard Deviations (SD). If the data was skewed/not normally distributed, the results were represented using Medians and IQRs.

The patient demographics were summarized utilizing descriptive statistics. The dependent variable of CT indwell time, was measured on a continuous level and was calculated in hours. To select the appropriate statistical test to compare the pre- and post-protocol implementation indwell means, the P.I. had to determine distribution. If the CT indwell time was normally distributed, an independent 2-tailed t-test was to be completed. If the CT indwell time was determined to be skewed, the Mann-Whitney U-test was to be used. The CT indwell time was found to be skewed/not normally distributed, therefore, the Mann-Whitney U-test was used and results were presented utilizing Medians and IQRs.

The difference in the length of stay between the pre- and post-implementation groups was measured as the secondary outcome. This dependent ratio level data was calculated in days. The length of stay was found to be skewed/not normally distributed, therefore, the Mann-Whitney U-test was used and results were presented utilizing Medians and IQRs.

Complication rates, also considered the dependent variable, were evaluated by investigating the rate of pneumothoraces, rate of SQE, as well as pleural effusions. The rates of increases in severity were also calculated. The rate of pneumothoraces, SQE and pleural effusions were measured on a nominal/categorical scale, and differences between groups were analyzed (pre- and post-implementation). Each patient CXR was assessed for each complication. The results were investigated utilizing a contingency table and Pearson's chi-square test.

Missing/incomplete data sets.

Incomplete data sets or those with missing values were excluded from final analysis. The *n* for each variable was calculated and missing data was identified.

3.2 Phase 2

Monitoring knowledge use and evaluation of outcomes is a key aspect to successfully applying practice changes (Registered Nurses' Association of Ontario [RNAO], 2012). The sustainability of this implementation was assessed by monitoring conceptual and behavioral/instrumental knowledge use. Conceptual knowledge is defined as the "understanding and internalization of new knowledge" (RNAO, 2012, p. 83). This knowledge can be successfully assessed by measuring learning acquisition and understanding through pre and post-surveys (RNAO, 2012). Behavioral/instrumental knowledge is defined as "application of new knowledge" (RNAO, 2012, p. 83). This type of knowledge can be assessed with spot audits and chart audits to determine if the practice changes are being followed (RNAO, 2012).

3.2.1 Study design.

Phase 2 was an evaluation of the uptake of the nurse-led protocol two-years post-implementation and consisted of a knowledge survey, chart reviews and observational audits.

3.2.2 Sample.

Setting and participants.

Phase 2 of this research was based at the General Campus of TOH. This included two units; one 32-bed inpatient unit, and an 8-bed level II ICU.

Inclusion and exclusion criteria.

To be considered eligible to participate in this study, participants had to be a registered nurse currently employed on the thoracic units and have been previously certified for CTR. Nurses working on the units who had not achieved certification for CTR were excluded from this study.

Recruitment.

Firstly, the P.I. sent a recruitment email to the manager of the units to share with their respective nursing staff (Appendix E). The email included the purpose and objectives of the study, described the observational audits and provided the contact information of the P.I.

Secondly, posters with study information were placed in common areas of both units; education boards, staff lounges and bathrooms (Appendix F). The poster included the purpose and objectives of the study, described the observational audits and provided the contact information of the P.I.

As the P.I. of this thesis was previously employed on the unit participating, staff had to initiate contact with the P.I. to express interest in participating in this research study. Staff who agreed to participate in this study but were not imminently removing a CT, were advised to

contact the P.I. when they were able to complete the observation audit. Staff who participated obtained a $5.00 Tim Horton gift card for partial compensation of their time. Prior to enrolling into the study, participants reviewed and signed an informed consent form (Appendix G).

Sample size.

Knowledge survey.

All staff who were certified in CT removal completed a knowledge survey as part of a yearly ongoing competency assessment. All staff currently certified (n=58), minus those who trialed the knowledge survey (n=4), were administered the knowledge survey.

Observation audits.

There was an average of 2.1 CTRs per day. To ensure unique observations and the ability to complete this audit within a 12-week period, a sample of 25 observation audits were targeted. This sample was chosen in order to audit approximately 35% of staff (25/69) and 15% (25/168) of CTRs which was deemed feasible. These 25 observations were chosen by convenience sampling. Nurses who were interested in participating in the research study and expressed interest to the P.I. were recruited for participation

Chart reviews.

Chart reviews (n=25) were also completed. This sample size was chosen by systematic sampling (Polit & Beck, 2012); When the P.I. of this research obtained the patient list from phase 1, group 2, every 4th chart was included in the review from the list until 25 entries were obtained.

3.2.3 Data collection.

The data collection consisted of the following:

Knowledge survey.

The knowledge survey, which was previously housed and delivered online, was revised and uploaded to Microsoft Forms. Prior to the start of the study, the survey was piloted by a small group (n=8) of non-participants who agreed to provide feedback. This small group consisted of nurses who were certified for CTR (n=4), the unit leadership (n=2), a physician (n=1) as well as a nurse educator with no experience with CTR (n=1). The purpose of this pilot was to obtain feedback on the questions, legibility, ease of understanding and question clarity. Modifications for question clarity were made to the survey based on feedback obtained. Once the survey was revised and deemed ready for distribution, staff were sent a link to complete the online survey by their nurse educator. To prevent expectation bias during observation audits, the knowledge survey results were not provided to the P.I. of this thesis until all the observation audits were completed (Polit & Beck, 2012). At which time, the unit nurse educator removed all personal identifiers and provided the anonymous answers and final scores to the P.I.. The data extracted from Microsoft Forms was directly downloaded into an excel spreadsheet.

Observation audits.

Observation audits were completed utilizing competency skill checklist (Appendix H) to assess the instrumental use/application of knowledge. Data was collected on a separate excel spreadsheet. Observations were labeled in order of occurrence (observation 1, observation 2, and so on) and observations and scores were entered into an excel spreadsheet. Nurses were asked to report on how many CTs they had removed in the last 12 months. To prevent expectation bias, nurses were only asked to report this finding once the audit had been completed. When unsafe practice was noted during the observation audits, the P.I. intervened to ensure patient safety. This

was noted in the observation audit comments section, and the nurse was marked as not successfully completing that step. The rest of the observations continued.

The standardized protocol states that assessments of CTs and drainage systems must be documented. This was not included in the observation audit tool. Due to this, the data for assessment of CTs and drainage systems was not analyzed.

Chart reviews.

As per RNAO's best practice guideline implementation guide (2012), chart audits can be utilized as a means of measuring behavioral knowledge use, to ensure that the practice is indeed being followed at the clinical level. Twenty five charts were audited based on the policy documentation standards. An excel data extraction sheet was utilized.

3.2.4 Outcome measures.

Knowledge survey.

The knowledge survey included 30 knowledge questions based on policy standards and education previously provided. The 30 questions were graded, and successful recertification was based on a passing grade of 80% (24/30). The passing grade of 80% was selected as it is the standard used in nursing education at TOH. Nurses were asked to assess their level of confidence in their perceived skill and ability to remove CTs utilizing a 6-point Likert scale. Nurses were then given the opportunity to comment on what contributed to their level of confidence. The survey also had demographic questions including number of CTs removed in the last 12 months, age, years of experience, employment status, level of education, as well as other education/qualifications.

Observation audits.

Each step on the competency list was counted as 1-point. There were a total of four competency checklists that could have been used depending on the specific situation;

1) Discontinuing chest drainage with purse-string sutures,
2) Discontinuing drainage without purse-string sutures,
3) Removal of chest drain without discontinuing chest drainage with purse-string sutures,
4) Removal of chest drain without discontinuing chest drainage with no purse string sutures.

For a nurse to be considered successful after completion of the competency skill checklist, all items labelled (*) had to be completed. For the outcomes, there were three available options as a result; yes, yes (verbal) and no. If 'yes' was selected, it meant that the action was directly observed by the researcher. If 'yes (verbal)' was selected, it meant that the nurse stated that this step was completed, but it was not directly observed by the researcher. If 'no' was selected, it meant that the nurses did not mention the step was completed, nor was it observed by the researcher.

There are expectations outlined by the standardized protocol as to what assessments are required pre-removal, immediately post CTR and 60-minutes post CTR, as well as patient teaching and documentation. The following are the pre-removal safety checks/assessments the nurse must complete prior to initiating the removal of a CT to ensure that patient meets all required criteria:

- Written order obtained from physician
- Patient is not on positive pressure ventilation
- No air leak present
- Stable respiratory status

- Absent, mild or no increase in SQE
- CT drainage is serous or serosanguinous
- CT drainage is less than or equal to 20% of total body lymphatic flow (patient's weight in kg multiplied by 5) for the previous 24-hours
- CXR was completed and reviewed by a physician (physician will write physicians order stating it has been reviewed)
- Anticoagulation status- must ensure aware if patient anticoagulated
- Chest assessment
- Vital sign assessment

The following assessments are required immediately post and 60-minutes post CTR to assess for any changes in patient baseline condition, which could signal a complication; breath sounds, SQE, shortness of breath, drainage at the insertion site and vital signs.

Teaching is required immediately post CTR to ensure patients are aware of post care as well as when to signal clinical changes to the nurse. The expected teaching as per the standardized protocol is; instruct patient to stay in bed for 30 minutes; notify RN if any shortness of breath, chest pain or any discomfort.

The standardized protocol outlines what should be documented in the medical record. This is outlined in the following section (chart reviews). Some differentiations were noted between the two units and were reported.

Nurses were also asked to report how many CTs they had removed in the last 12-months. To prevent expectation bias, nurses were only asked to report this once the audit had been completed.

Chart reviews.

Charts were assessed for areas of documentation required as per the CTR protocol:

- Assessment of patient and CT before removal; (within 1-hour)
    - Auscultate chest
    - SQE
    - Shortness of breath
    - Vital signs
- Date of CTR
    - Year, month, day
- Time of CTR
    - Hour, minutes
- Patient tolerance of procedure
- Patient condition post removal, including air entry, respiratory status and vital signs (immediately post and 60-minutes post removal)
    - Auscultate chest
    - Assess for SQE
    - Shortness of breath
    - Drainage at insertion site
    - Vital signs
- Patient teaching
    - Remain in bed for 30-minutes
    - Notify nurse if any shortness of breath, chest pain or discomfort

It was noted that there was an error in the documentation audit tool. No information was collected regarding assessments on CTs and drainage system. Therefore, this information was neither collected nor assessed.

Pre- and post-assessments are to be completed within 1-hour of CTR. When reviewing the patient charts, a 30-minute window was added to the 1-hour as a buffer (in case nurses may be tending to other situations). Therefore, there are three options that were selected during the chart audits. 'Yes' indicated that the nurse completed the assessments within 1.5 hours pre or post CTR. When assessments were completed, but not within the 1.5-hour window, it was captured as 'not within an hour'. If 'no' was selected, it meant that there was no documented evidence of the assessment in the charts.

3.2.5 Data analysis.

Knowledge survey.

The demographic questions and 30 knowledge questions were summarized utilizing descriptive statistics. The Likert scale question, being ordinal scale data, was summarized. Finally, the nurses' comments regarding what contributed to their level of confidence were analyzed and grouped by common topics; policy and resources, education and support, as well as frequency of practice.

Observation audits.

The observation audit scores were analyzed utilizing descriptive statistics: modality, central tendency (mean, median, mode), and variability (range, interquartile range, standard deviation) and 95% confidence intervals were calculated.

Chart reviews.

Chart reviews were also analyzed using descriptive statistics.

3.3 Data Management

All hardcopy research files are stored in a locked office at TOH. All data collected for this study are stored at TOH and only research team members, representatives from the Ottawa Hospital Research Institute (OHRI), the University of Ottawa Research Ethics Board (uOttawa REB) and the Ottawa Health Science Network Research Ethics Board (OHSN REB) had, and will continue, to have access. TOH electronic study files are stored on TOH servers and files with participant identifying information are password protected. Research records related to this project will be stored for a period of 10 years.

Other individuals that assisted with data validation (Ottawa Method Center and a clinical nurse) were tracked using the task delegation log from OHRI (Appendix I).

3.4 Data Validation

All data that was manually transcribed was verified for accuracy, as described below.

3.4.1 Phase I.

To obtain the final computable data for complication rates for this research, data from the thoracic database had to be transcribed from one excel page to another. The accuracy of this data was verified by the P.I. of this research and my supervisor (C.B.). Systematic sampling was used; every 10^{th} study identification (ID) number was reviewed and no errors were found in the demographic or complication rate data. For group 1, a total of 16 study ID's were reviewed. For group 2, a total of 14 study ID's were reviewed.

3.4.2 Phase 2.

Knowledge survey.

As the annual knowledge survey was delivered on Microsoft Forms, an online platform, the results were computer generated. As no transcriptions were required, data validation for this data was not required.

Observation audits.

The bedside competency audits were initially recorded on paper. The P.I. of this research then transcribed these findings into an excel spreadsheet for analysis. As this research was funded by a research grant, data validation was done by the Ottawa Methods Center (OMC). A total of 14/25 (56%) audit entrees were verified. The data validation noted that there were nine areas where both yes and no were chosen in the paper data recording tool. The P.I. of this research reviewed all the paper recording tools. These scenarios occurred when there were multiple items per line, and these were partially completed (some yes and some no). All entries with potential for double entries were verified. Any item that had a partial yes/partial no, had an overall selection of 'no' chosen. This was clarified on all paper records as well as the excel spreadsheet.

Chart reviews.

A clinical nurse from the level II ICU expressed interest in completing the data validation. She was recruited to review the patient charts and chart audit extraction tools. She was offered a total of $100 for partial reimbursement of her time. A total of 5 (20%) charts were chosen at random and were reviewed. This was based on availability of the clinical nurse as well as deemed a representative sample since random sampling was utilized. During the review, one discrepancy was noted. The P.I had missed one of the items in a progress note entry. The nurse

doing the verification caught the error. The P.I and the nurse reviewed the chart and agreed that it should have been a “yes” in the data extraction table. It was corrected on both the paper record as well as the excel spreadsheet.

3.5 Protection of Human Rights

Prior to initiation of this research study, ethics approval was obtained from the University of Ottawa’s research ethics committee as well as The Ottawa Hospital’s research ethics board. Permission for entry onto the study units was obtained through the management team and educator of the units. These members of the leadership team were approached and asked prior to posting information on units, and prior to collecting any data.

Participating nurses were provided a combined information sheet/written consent form (Appendix G) on the study explaining their rights, the purpose/aims, risks/benefits of the study, what participation involved, and information on confidentiality, storage, and destruction of research material. Participants were made aware that they had the right to refuse to participate in this research and also withdraw from the study at any time without negative impact on their current or future employment at the hospital. Participant’s identities and data were kept confidential as no identifiers were included on the any data collection tool made available to the P.I. of this thesis. Electronic data was encrypted and password protected, and information was only shared between the P.I., thesis supervisor, thesis committee members, and those members listed on the task delegation log.

Chapter 4: Results

Phase I

Characteristics of the study participants.

The sample size for group 1 (pre-implementation) was 153 patients. The sample size for group 2 (post-implementation) was 136 patients. The average age of participants in group 1 (pre) was 66.9 years and group 2 (post) was 62.2 years. In group 1, the majority of patients were female with an approximate 4:6 male: female ratio. Body mass index's (BMI) were categorized according to the government of Canada's body mass index nomogram. Patients were categorized as underweight, normal weight, overweight, obese class I, obese class II or obese class III. Both groups 1 and group 2 had similar mean BMI's (26.4 and 26.6 respectively; overweight). Group 1 had a much higher portion of patients placed on Heimlich/Pneumostat valves (13% and 2% respectively) (Table 1). Otherwise, the groups' demographic characteristics were similar.

Table 1

Demographics

	Group 1- n = 153		**Group 2- n =136**	
	n	**%**	**n**	**%**
Mean age (SD)	66.9 (10.2)		62.2 (15.97)	
Gender				
Male	59	39%	63	46%
Female	94	61%	73	54%
BMI				
<18.5 (underweight)	3	2%	7	5%
18.5- 24.9 (normal weight)	62	41%	50	37%
25.0- 29.9 (overweight)	52	34%	44	32%
30.0- 34.9 (obese class I)	26	17%	24	18%
35.0- 39.9 (obese class II)	5	3%	7	5%

>=40.0 (obese class III)	4	3%	3	2%
No data	1		1	
Mean (SD)	26.4 (5.5)		26.6 (6.3)	
Procedure primary				
Wedge	39	25%	44	32%
Lobectomy	95	62%	68	50%
Segmentectomy	13	8%	9	7%
Bilobectomy	5	3%	2	1%
Resection bleb or bulla	0	0%	4	3%
Decortication and attempted resection	0	0%	1	1%
Excision of mediastinal mass	0	0%	1	1%
Decortication	0	0%	1	1%
Apical bullectomy pleurectomy	0	0%	1	1%
Resection	0	0%	1	1%
Thorascopic	0	0%	1	1%
Thymectomy	0	0%	1	1%
No data	1		2	
Approach				
VATS= 0	128	84%	110	84%
Open = 1	24	16%	21	16%
No data	1		5	
Number of chest tubes				
1	75	50%	85	63%
2	72	48%	50	37%
3	2	1%	0	0%
No data	4		1	
Chest tube action				
Chest tube removal	109	87%	132	98%
Application of Pneumostat or Heimlich valve	17	13%	3	2%
No data	27		1	
Smoker				
Non-smoker	69	45%	41	30%
Smoker	84	55%	95	70%
Pack years, Mean (SD)	19.9 (20.89) n=151		17.2 (21.02) n=132	
FEV1 percent, Mean (SD)	64.0 (34.6) n=103		68.3 (35.9) n=101	

FVC percent, Mean (SD)	71.9 (35.1) n=95	68.4 (34.2) n=82
FEV1 over FVC ratio, Mean (SD)	57.6 (24.8) n=95	65.1 (20.8) n=78

CT indwell time.

As the CT indwell time was found to be skewed ($p < .0001$), data are presented as medians with IQRs the and the Mann-Whitney U test was used to analyze differences. It was identified that the CT indwell time was significantly decreased from a median of 73.5 (IQR 49.6, 100.6) hours in the pre group, to a median of 52.7 (IQR 30.6, 78.7) hours in the post-implementation group ($p=0.0164$). In the pre-implementation group, 44 patients were excluded from analysis (17 patients had valves applied and 27 patients had no reported CTR data) leaving a total of 109 patients; In the post implementation group, 5 patients were excluded from analysis (3 patients had valves applied and 2 patients had no reported CTR data) leaving a total of 131 patients.

Length of stay.

Similarly, to CT indwell time, length of stay was also found to be skewed ($p < .0001$). According to the Mann-Whitney U test, there was a statistically significant decrease in the length of stay from a median of 4 (IQR 3.0, 6.0) days in the pre group, to a median of 3 (IQR 2.0, 5.0) days in the post-implementation group ($p= 0.0008$). Data for four patients (three in the pre group [n=150] and one in the post group [n=135]) were excluded due to invalid date entries. It was noted that there were three outliers with lengths of stay of 125, 68 and 31 days. Outliers were noted only in the pre-implementation group. To ensure equal comparison, the outliers were removed, and the results were reanalyzed. According to the Mann-Whitney U test, a statistically

significant decrease in the length of stay from a median of 4 days (IQR 3.0, 6.0) in the pre group, to a median of 3 days (IQR 2.0, 5.0) in the post-implementation group (p= 0.0019).

Complication rates.

Patient CXR results were reviewed and complication gradings were compared. Patients who had an increase of 1 grade or more on their post removal CXR were identified as having a complication. Complication rates were compared between both groups and it was noted that all complications in the post-implementation group were decreased; however, the differences were not statistically significant (Table 2).

Table 2

Complication Rates

Complication	Group 1	Group 2	P-value
Pneumothorax, n (%)	13/160 (8.1%)	14/181 (7.7%)	0.8941
Pleural Effusion, n (%)	17/161 (10.6%)	17/181 (9.4%)	0.7189
SQE, n (%)	14/160 (8.8%)	8/180 (4.4%)	0.1072

Complication rates were then examined by differing grades. As noted in Table 3 below, the number of patients who experienced an increase by 1 grade in pneumothoraces were similar in both groups. Only one patient experienced a pneumothorax increase by 2 grades which occurred in group 1. Pleural effusions were noted in both groups; however, higher increases in grades of complications were noted in group 2 (increase by 2 grades n= 1; increase by 3 grades n= 1). Patients in both groups only had increases of 1 grade for SQE. However, group 2 had half the rate of grade increases noted in group 1.

Table 3

Grades of complications

Complication	Group 1	Group 2
Pneumothorax, n (%)		
Increase of 1 grade	12/160 (7.5%)	14/181 (7.7%)
Increase of 2 grades	1/160 (0.6%)	0
Pleural Effusion, n (%)		
Increase of 1 grade	17/161 (10.6%)	15/181 (8.3%)
Increase of 2 grades	0	1/181 (0.6%)
Increase of 3 grades	0	1/181 (0.6%)
SQE, n (%)		
Increase of 1 grade	14/160 (8.75%)	8/180 (4.4%)

Phase 2

Knowledge survey.

Study participants demographics.

Knowledge survey results were obtained from 54 participants. One participant completed the knowledge questions but did not provide any demographic details. Therefore, the following are characteristics of the 53 study participants (nurses) which were obtained from the demographic questions (Table 4).

Table 4

Phase 2- Participant Characteristics (N=53)

	n	%
Number of chest tubes removed in the last 12 months		
0	3	6%
1-3	1	2%

4-6	15	28%
7-9	14	26%
10-12	9	17%
12 or more	11	21%
Age		
20-29	18	34%
30-39	16	30%
40-49	12	23%
50-59	7	13%
Years' experience		
1-2	2	4%
2-3	3	6%
3-5	8	15%
5-10	17	32%
Greater than 10	23	43%
Current employment status		
Full time	41	77%
Part time	10	19%
Casual	2	4%
Highest level of education		
College diploma	13	25%
Bachelor's degree	38	72%
Master's degree	2	4%
Nurse practitioner	0	0%
Doctorate degree	0	0%

Knowledge questions

The overall mean quiz scores for the 30 knowledge questions were 26.8/30 (89%) (SD 1.96). Two nurses (4%) obtained scores below the passing grade of 80%. Their scores were 70% and 77%. The knowledge questions were assessed to identify potential learning needs. Questions that were answered incorrectly in more than 20% of the surveys are summarized below. See Appendix J for the knowledge survey questions and scores.

Table 5

Phase 2- Questions that were answered incorrectly in more than 20% of surveys (N=54)

Questions	Percent correct (n)
30. You are removing one of two of your patient's chest tubes that are currently to a dual Pleur-Evac Sahara. Arrange the following steps for removal in the proper order.	17% (9)
4. You must receive an order to place a chest tube on gravity prior to removal.	63% (34)
24. A new CXR is always required prior to chest to removal.	69% (37)
27. Your patient weighs 60kg therefore, their allotted output for a 24-hour period is 300ml (60kg x 5= 300). Patient has drained 400ml in the previous 24 hours. What are your next steps?	72% (39)
8. The following are criteria for chest tube removal (select all that apply).	78% (42)

Level of confidence question (question #37)

The participants were asked to answer the question "I am confident in my skill and ability to remove CTs" utilizing a 6-point likert scale. All respondents which provided a response (n=53), stated that they strongly agreed (n=25), moderately agreed (n= 26) or slightly agreed (n=2). No staff (n=0) disagreed with the statement.

Nurses' comments on their level of confidence.

A total of 45 comments were obtained for the question "I am confident in my skill and ability to remove CTs". As the participants' responses were all positive on the likert scale, the comments were assessed together and responses were grouped as follows: frequency of practice, policy and resources, education and support.

Twenty-five (56%) participants mentioned that frequency and practice were contributing factors to the level of confidence. Participants who strongly agreed stated that the high frequency

in which they perform CTR has led to their high level of confidence. Participants who moderately agreed were divided. Some participants stated that the frequency was linked to their high level of confidence, while other stated that the lack of frequency was the only reason they could not respond strongly agree. Frequency and practice were the only comments noted in the slightly agree category. Both participants stated that the lack of opportunity to perform CTR was directly linked to their level of confidence. Six respondents (13%) mentioned that policy and resources were contributing factors to their level of confidence. Sixteen (35%) participants mentioned that education and support, which they stated included the education model and certification process as well as the continued support from both the nurse educator and nurse champions on unit led to their levels of reported confidence (Appendix K). Participants who reported slightly agreeing with the above statement (n=2) reported removing between 4-6 CTs in the previous 12 months and were both employed on a part time basis. Those who moderately and strongly agreed had removed a varying number of CTs in the last 12 months; 0 n=3; 1-3 n=1, 4-6 n=13, 7-9 n=14, 10-12 n=9, 12 or more n= 11.

Observation audits.

Twenty-five audits were completed during a 4-week period using three observation audit competency checklists (Appendix H). Only three of the four competency checklists were used. There was no instance in the 25 audits, where a CT was being removed without discontinuing drainage with no purse strings. To ensure a representative sample, the number of reported CTRs performed in the last 12 months was compared between the observation audits and knowledge survey results. The results were similar, identifying that this was indeed a representative sample.

The differing competency lists had a variety of required steps and therefore each had different total scores (Table 6).

Table 6

Phase 2- Observation audit total scores (N=25)

	n	Mean	SD	Total points available
Discontinuing drainage without purse-string sutures	16	43.88	3.58	49
Discontinuing chest drainage with purse-string sutures	6	48.5	1.87	52
Removal of chest drain without discontinuing chest drainage with purse-string sutures	3	52.67	0.58	56

See Appendix L for further details on the observation audit competency checklists results. Participants were considered successful if all items labelled (*) were completed during the audits. Of the 25 audits completed, only three (12%) nurses were deemed successful.

The observation audits were analyzed in 5 categories:

1) Pre-removal safety checks- n=19 (76%) completed all mandatory pre-assessments

2) Procedural actions- n=3 (12%) completed all mandatory procedural actions

3) Post assessment- n=8 (32%) completed all mandatory post assessments

4) Patient teaching- n=19 (76%) completed all mandatory patient teaching

5) Documentation- n=7 (28%) completed all mandatory patient teaching

Actions that were completed in less than or equal to 80% of audits are reported below. The results for each individual step as outlined by the competency checklists are represented in Appendix M.

Table 7

Phase 2- Observation Audit Actions that were Completed in Less Than/Equal to 80% of Audits (N=25)

Category	Number in observation audit checklist and required action	Percent correct (n)
Pre-removal safety checks	8. Positive pressure ventilation	76% (19)
Procedural actions	30. If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube: Thopaz- turn on Thopaz	67% (2)
	30. If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube: Thopaz- unclamp chest tube left in	67% (2)
	24. Wash hands	28% (7)
	14. Provide analgesia	48% (12)
	40. No purse strings: while stabilizing the chest tube 48. Purse strings present: while stabilizing chest tube	68% (17)
	26. Don gown and face mask	72% (18)
Post assessment	59. Drainage at the insertion site	80% (20)
Patient teaching	62. Drainage at insertion site	76% (19)
Documentation	68. Patient teaching	56% (14)
	64. Assessment before tube removal	68% (17)
	67. Patient condition post removal	72% (18)

Note: * Item 40 and 48 are grouped together as they are the same step in the 2 different scenarios (chest tubes with purse strings and chest tubes with no purse strings).

It was noted that only seven nurses (28%) nurses completed the documentation according to the standardized protocol. During these audits, it was also noted that assessments were completed more frequently than they were being documented. Documentation of patient condition post removal was omitted in seven (28%) audits. Of these seven participants, four (57%) had completed relevant assessments but had not recorded all relevant information. Patient

teaching, was not correctly documented in 11 (44%) audits. Out of those 11 instances, eight (73%) participants had provided the appropriate teaching.

Since a high portion of nurses did not complete all documentation and since our institution had changed to an electronic health record (EHR), we removed the documentation assessment as well as patient teaching (error in the audit tool) and reassessed the outcomes. After re-examining the audit, it was noted that nine (36%) nurses could be deemed successful, leaving 16 participants (64%) unsuccessful. The nine successful nurses reported removing four or more CTs (4-6 n=1, 7-9 n=3, 10-12 n=4, 12 or more n=1).

The following are the reasons why the remaining audits (n=16) were deemed unsuccessful.

Table 8

Phase 2- Summary of Unsuccessful Observation Audits

Category	Number in observation audit checklist and required action	Frequency (n) of actions missed
Pre-assessment	5. Verify patients anticoagulation status	2
	8. Positive pressure ventilation	6
	11. Drainage is serous/serosanguinous	3
Procedural actions	30. If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube: Thopaz- turn on Thopaz	1
	31. If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube: Thopaz- unclamp chest tube left in	1
	38. Cleanse chest tube with Chlorhexidine and alcohol swab sticks	2
	40. No purse strings: while stabilizing the chest tube. 48. Purse strings present: while stabilizing chest tube	8
Post assessment	57. Assess respiratory status immediately post: subcutaneous emphysema	3

58. Assess respiratory status immediately post: shortness of breath	1
59. Assess respiratory status immediately post: drainage at insertion site	5

Note: * Item 40 and 48 are grouped together as they are the same step in the 2 different scenarios (chest tubes with purse strings and chest tubes with no purse strings).

Chart reviews

Twenty-five charts were chosen using systematic sampling which ensured a representative sample. During the chart reviews, it was noted that no charts (n=0) had all required documentation as per the standardized protocol. The chart audits were separated and analyzed in five categories: pre-assessment, date and time of CTR, patient tolerance, post assessment (immediately after removal and 60-minutes post) and patient teaching, to analyze the most common undocumented sections. Documentation that was completed in less than or equal to 80% of audits are reported below in Table 9, and in full in Appendix N.

Table 9

Phase 2- Chart reviews- Documentation Completed Less Than/Equal to 80% of Audits (N=25)

Category	Documentation	n/Total percent documented	n/Percent documented within allotted 1 hour time	n/Percent documented but not within 1 hour
Pre- assessment	5. Shortness of breath	5 (20%)	3 (12%)	2 (8%)
	3. SQE	17 (68%)	11 (44%)	6 (24%)
Date and time	12. Time of CTR: hour	16 (64%)	n/a	n/a
	13. Time of CTR: minutes	16 (64%)	n/a	n/a
Tolerance	14. Patient tolerance of CTR procedure	18 (72%)	n/a	n/a
		4 (16%)	n/a	n/a

Post assessment: Immediately post CTR	17. Shortness of breath			
	16. SQE	14 (56%)	n/a	n/a
	15. Auscultate chest	14 (56%)	n/a	n/ a
	18. Drainage at insertion site	5 (20%)	n/a	n/a
Post assessment: 60-minutes post CTR	24. Shortness of breath	4 (16%)	1 (4%)	3 (12%)
	20. Auscultate chest	14 (56%)	7 (28%)	7 (28%)
	22. SQE	10 (40%)	2 (8%)	8 (32)
	26. Drainage at insertion site	10 (40%)	4 (16%)	6 (24%)
Patient teaching	32. Notify nurse if any chest pain	16 (64%)	n/a	n/a
	33. Notify nurse if discomfort	16 (64%)	n/a	n/a
	31. Notify nurse if any shortness of breath	18 (72%)	n/a	n/a

Some differences in documentation were noted between the two units. These are represented in the table below.

Table 10

Phase 2- Chart Reviews- Differences Noted in Omitted Documentation Between Inpatient Unit and Level II ICU

Documentation subject	Documentation omitted n (%)	Inpatient n (%)	Level II ICU n (%)
Pre assessment: SQE	8 (32%)	6 (75%)	2 (25%)
Immediately post CTR: SQE	11 (44%)	5 (45%)	6 (56%)
60-minute post CTR: SQE	15 (60%)	9 (60%)	6 (40%)
60- minute post CTR: drainage at insertion site	15 (60%)	9 (60%)	6 (40%)

Note: SQE= Subcutaneous emphysema

The audits suggested that there is a lack of documentation in all five categories discussed above. However, there is a particular lack of documentation in the pre-assessment, immediate post assessment and 60-minute post assessment. These results also suggested that there are differences in documentation compliance between the units.

Chapter 5: Integrated discussion

In this chapter, the results of phase 1 and phase 2 of the study will be briefly summarized, then integrated with the findings from the literature. Implications for nursing practice, education and research are provided and strengths and limitations of the study are discussed.

5.1 Phase 1

The purpose of this phase of the study was to evaluate the implementation of the standardized nurse-led CTR protocol on patient outcomes – specifically, CT indwell time, length of stay and complication rates. To our knowledge, this is the first study to assess outcome measures after implementing a standardized nurse led CTR protocol. With this change, we hypothesized that a standardized nurse-led CTR protocol would decrease CT indwell time and length of stay without compromising the complication rates.

In this study, we reviewed records for a total of 153 patients for a 1-year period prior to implementation and compared the findings to 136 patients for a 1-year period post implementation.

5.1.1 Study demographics.

The use of Heimlich and/or Pneumostat valves on CTs decreased in the post implementation group (from 13% to 2%). This difference could be a result of the delegation of CTR to nurses. When physicians/residents/medical students were tasked with CTR, patient assessments would take place at one time in the early morning and once in the afternoon/evening. If patients did not meet criteria at the time of these rounds/assessments, the patients would either wait until the next medical team round, or have a valve placed on their CT. In the post-implementation group, nurses can monitor and assess patients more closely, allowing them to identify when patients meet criteria for CTR. This allows the CTR procedure to be

completed at any given time, resulting in a decreased use of Heimlich/Pneumostat valve as demonstrated in our results.

5.1.2 CT indwell time.

Our study identified that patients in the post implementation period had a significantly decreased median CT indwell time (p= 0.0164). This statistically significant change in CT indwell time identifies a relationship between the implementation of the standardized nurse led CTR protocol and CT indwell time. These results build on existing evidence by Thomson, Wells and Maxwell (1997) who also concluded that CTs were removed in a timelier fashion by nurses, in comparison to their physician counterparts. These findings also align with the nurse initiated/nurse led literature, in which timeliness was mentioned as an outcome related to nurse initiated and nurse led treatments (Cabilan & Boyde 2017; Dixon et al., 2014). Lijkendijk, Neckelmann and Licht (2015) reported their CT indwell time ranged from 1.9 days (45.6 hours) for digital drainage devices, and 2.2 days (52.8 hours) for the analog devices. In the study organization, we routinely utilize digital drainage devices post thoracic surgery. Our post-implementation indwell time was within the range of that reported by Lijkendijk and colleagues for their analog drainage device although not the digital device time. Of important note, Lijkendijk, Neckelmann and Licht (2015) delegated the decision to perform CTR to nurses. Nurses assess patients once per shift and follow an algorithm. Once the patient meets the criteria in the algorithm, the nurses can remove the CTs without a physician order.

5.1.3 Length of stay.

Supporting our original hypothesis, our study identified that there was a decrease in the length of stay by one day in the post-implementation group which was statistically significant (p= 0.0008). The Canadian Institute for Health Information (CIHI) stated that the current cost of

a standard hospital day at the General Campus is 6438$ per day. This reported decrease in length of stay has potential to lead to many cost savings for the hospital and province. Our findings are consistent with literature in which implementation of nurse-initiated procedures and nurse-led clinics resulted in decreased hospital length of stay (Dixon et al., 2014). This contrasted with Cabilan and Boyde's systematic review (2017) which found that nurse-initiated medications in the emergency department led to greater efficiencies but not decreased lengths of emergency rooms stays. This could be due to the fact that medications provided in the emergency room are required interventions for patient comfort but may not necessarily treat the underlying condition which required an emergency room visit- leading to the emergency room length of stay.

Our reported length of stay appears to be closely linked to the CT indwell time. In the pre-implementation group, the median CT indwell time was 73.5 hours (3.06 days) with a median length of stay of four days compared to the post-implementation group, where the median CT indwell time was 52.7 hours (2.2 days) with a median length of stay of three days. Therefore, the length of stay appears to be approximately the CT indwell time plus approximately one day. Interestingly, Lijkendijk, Neckelmann and Licht (2015) reported a shorter CT indwell time (1.9 days to 2.2 days), but a longer length of stay of five days. This decrease in length of stay could be due to the higher rate of Video Assisted Thorascopic Surgeries (VATS) in our institution which have lower rates of complications and shorter lengths of stay. Lijkendijk et al., (2015) reported a total of 41/105 (39%) VATS procedures, while our organization had rates of 84% in both the pre- and post-implementation groups.

5.1.4 Complication rates.

Consistent with other studies, comparisons between the pre- and post-implementation groups identified no statistically significant differences in complication rates (Claeys et al., 2015;

Cox, 2011; Lijkendijk et al., 2015; Nellet & Ross 2011). Although not statistically significant, it was noted that the complication rates were lower in the post-implementation group.

One difference noted in our study and the literature was the reported rates of pneumothoraces. Nellet and colleagues (2011) reported a pneumothorax rate of 2.2%, while our reported rate was 7.7%. Patient populations and education models could account for these differences in pneumothorax complication rates. Nellet and colleagues (2011) completed their study on cardiovascular patients, in which not all CTs are in the pleural space. Our population was based on thoracic patients, in which most CTs are in the pleural space, increasing the risk of pneumothoraces. Nellet et al. (2011) also studied complication rates when only a select proportion of nurses (n=18) were educated to complete a large proportion of CTR (n=181), averaging 10 CTR per nurse. Our study incorporated educating all nurses on the unit at one time (n=54), with the same amount of CTR (n=181), averaging three CTRs per nurse.

Complications were also examined post CTR. Pleural effusions were noted in both the pre and post-implementation groups at similar rates. However, there were higher grades of complications noted in the post implementation group. Although effusions are not a direct complication of CTR such as pneumothorax and SQE (Gilbert et al., 2015), it could identify that the CT was removed while the patient did not meet the CT drainage criteria.

5.2 Phase 2

The purpose of this phase of the study was to evaluate the implementation of the standardized nurse-led CTR protocol by evaluating the uptake by the nurses two-years post implementation.

5.2.1 Knowledge survey.

Knowledge questions

It was noted that only 17% (n=9) of respondents correctly answered the knowledge question "You are removing one of two of your patient's CTs that are currently to a dual Pleur-Evac Sahara- Arrange the following steps for removal in the proper order." When completing the bedside observation audits, only three (12%) nurses were removing one of two CTs. Of these three removal audits, all were connected to a Thopaz® drainage system (n=3), and none to a Sahara® drainage system. Removing one of two CTs connected to a Sahara® is the least likely scenario the clinical nurse will encounter when performing CTR, therefore it is recommended that this question be replaced by a more clinically relevant question.

As the P.I. of this thesis only had access to quiz scores, an analysis of what ordering the nurses were answering incorrectly could not be completed. During the bedside audits, it was also noted that nurses completed the mandatory steps in different orders to match their workflows. For example, some nurses would complete the patient criteria assessments prior to vital signs, while others completed vital signs first. While not all steps must be completed in a linear and sequential order, some must be completed prior to others for safety purposes.

Thirty-four (63%) of respondents correctly answered the knowledge question "You must receive an order to place a CT on gravity prior to removal". This step was embedded into the standardized CTR protocol (Appendix B) therefore it was decided that nurses would not require an order. If the patient's CT was on suction prior to CTR, the nurse is expected to place the patient on gravity during the removal process. Upon review of the standardized protocol, it was noted that the language used is unclear for the clinical nurse. The language states to "ensure patient is on gravity drainage" but there is no direct statement that outlines to place the patient on

gravity drainage. Clearer language in the protocol is needed to ensure the meanings are clear and unambiguous.

Level of confidence.

Frequency of practice was the most frequently mentioned factor for contributing to levels of confidence. Both of the nurses (4%) who reported slightly agreeing with the confidence statement reported removing only 4-6 CTs in the last 12 months, and were both employed part time. Most of those who moderately and strongly agreed had removed more than four CTs in the last 12 months, with 34 (64%) nurses removing more than seven CTs. These findings were similar to those found in the literature (Brown & Elias, 2016; Tabari-Khomeiran et al., 2007; Takase, 2012). Tabari-Khomeiran and colleagues (2007) analyzed competency and also found that nurses most frequently mentioned having "sufficient experience" (p. 212) was the most important factor in developing competency. Tabari-Khomeiran and colleagues (2007) therefore identified that experience and practice, was one of five key processes in competency which leads to consolidation of knowledge. Brown and Elias (2016) who describe a continuing competency model implemented by the College of Registered Nurses of Manitoba also concluded that although there is no quantified number of hours that can identify competence. However, practice is a crucial aspect to maintaining competence.

5.2.2 Observation audits.

Procedural actions.

During the observation audits, nurses often missed hand hygiene before applying their sterile gloves. This is likely due to nurses assuming that since they are wearing gloves, hand hygiene is not necessary for infection control purposes. However, research has demonstrated that wearing gloves alone is not enough to prevent infection transmission (Ghorbani et al., 2016). A

systematic review completed by Kingston, O'Connell and Dunne (2016), stated that a multifaceted approach to hand hygiene including education, reminders, feedback, changes in facility layout, product availability, and team leader/manager support was most effective in increasing hand hygiene compliance with health care workers. Nurses receive initial education in university and in hospital orientation. Adding some refresher education on hand hygiene to the CTR education sessions and providing feedback during observational audits, ensuring hand sanitizer is available at the point of care and having manager support would be the best multi-faceted to increase compliance.

Twelve nurses (48%) provided analgesia to their patients prior to CTR. Research shows CTR can be one of the most painful in hospital treatments (Puntillo et al., 2014). When nurses were asked why they did not provide analgesia to their patients, they stated the following reasons: Patients had received routine pain meds (n= 5); patients were offered analgesia, but refused (n=3), patients were on other modalities for pain control (PCA or epidural) (n=3). Therefore, even though a low number of nurses completed this task, this outlines that nurses are completing assessments to deem the necessity of this step. This finding is consistent with Hood and colleague's (2014) study which concluded that when nurses were educated and competent in CTR, there was a greater awareness of patients' pain related to CTR.

Patient teaching.

A total of six audits had incomplete patient teaching provided post CTR. It was noted that these 6 audits had omitted the same teaching point; instruct patient to notify RN if drainage at the insertion site. When the standardized protocol was reviewed, a discrepancy was noted between the competency/audit checklist and protocol. The expected teaching as per the standardized protocol is to instruct patient to stay in bed for 30-minutes; notify RN if any shortness of breath,

chest pain or any discomfort. The standardized protocol does not outline drainage at site as required education, however it is currently listed as a required teaching point on the observation audits (Appendix B). Since excess drainage at the CT site post CTR could signify that clinical interventions are required, it would be recommended that adding this point to the patient teaching would be most beneficial for patient safety.

5.2.3 Chart reviews.

Differences in documentation were noted between both the inpatient and level II ICU. Documentation of SQE was starkly different for the pre-assessment between the two units. When analyzing pre-assessment documentation that was omitted (n=8), it is apparent that higher rates of omission were noted on the inpatient unit (n=6, 75%). Higher rates of omission were also noted for the 60-minute post SQE assessment on the inpatient unit (inpatient n=9, 60%, level II ICU n= 6, 40%). The pre and 60-minute post assessment documentation are completed utilizing flowsheet documentation. The level II ICU and inpatient unit utilized two different flowsheets; the level II ICU utilized a specific Level II ICU flowsheet, while the inpatient unit utilized the corporate medicine/surgery flowsheet. The flowsheet for the level II ICU had a flowsheet row which included SQE assessment, but the flowsheet used by the inpatient unit did not. For the inpatient unit to document SQE, an integrated progress note (IPN) entry would need to be made.

Opposing this, the omission of documentation of assessments immediately post removal are nearly equal in both units (inpatient n=5, level II ICU n=6). The documentation of these assessments include both a flowsheet entry as well as an IPN entry. When utilizing the IPN, nurses are to enter the information that is not captured by the flowsheet documentation.

This suggests that the level II ICU had better compliance documenting SQE assessment pre and 60-minutes post, while both units were relatively equal for immediate post-assessments.

We believe this is linked to their flowsheet rows available to them, as the level II ICU had a more convenient way to document the SQE assessment pre and 60-minute post. However, other factors may also have contributed to this difference, such as unit documentation standard differences as well as nurse to patient ratios. Our organization has now implemented the use of an EHR which has standardized the documentation across both units, potentially decreasing documentation errors. This would align with a systematic review completed by McCarthy and colleagues (2019). They found that the implementation of EHR is associated with reduced rates of documentation errors. The following section further discusses documentation.

5.2.4 Documentation

It was noted that the documentation which was reviewed during this study was not an accurate representation of the care the nurses provided. During the observation audits, it was noted that assessments and interventions were completed more frequently than they were being documented. McCarthy and colleague's (2019) completed a systematic review which included six studies. They stated that many research studies reported poor quality of record keeping, which included insufficient information and incomplete data entries with paper documentation. McCarthy (2019) stated that implementation of EHR was associated with improvements in documentation practice, most notably, in the accuracy and completeness of documentation content. Our organization has recently adopted a new EHR, therefore we are recommending that a specific flowsheet template be built for CTR documentation, which would improve documentation accuracy (McCarthy et al., 2019).

5.2.5 Sustainability

Slaghuis and colleagues (2011) developed a framework to assess sustainability of work practices in long term care. Utilizing this framework, Slaghuis and colleagues developed and

tested a tool which could be used to assess the sustainability of implementations. The framework is based on the concept of routinization and institutionalization. Routinization is the development organizational routines where a new practice becomes part of everyday processes. Slaghuis and colleagues describe three dimensions that can support routinization; principles, practices and feedback. The first dimension, named principles, describes how principles can themselves form practice. An example of this for the CTR implementation in our case would be the CNO principle to "maintain patients' trust by providing safe and competent care" (CNO, 2019). This principle outlines how nurses should be performing new processes, once implemented; in a safe and competent way. The second dimension is practices, which concentrates on the concept that practice can shape, sustain and transform principles. The use of the practices implemented with the CTR protocol uphold the CNO principle in which nurses are diligently providing safe and competent care. The third and final dimension of routinization emphasizes the need for feedback in performance. The implementation in this current study consisted of a stepwise and competency-based approach. This approach required feedback on multiple occasions during initial certification, ongoing competency assessments, and continued feedback for clinical aspects (e.g. suture removal).

Institutionalization includes the processes and structure changes that support the implementation of new practices. Institutionalization has a total of four dimensions; skills, documentation materials, practice materials and team reflection. The first domain describes how many implementations may require a new set of skills which need to be taught, monitored, refined and updated as needed. The CTR protocol implementation required a new set of skills which nurses acquired through a stepwise and competency-based teaching approach. This included in class sessions, clinical teaching and feedback during observed CTRs. The second

domain for institutionalization is documentation materials. The development and use of the standardized CTR protocol is a form of documentation institutionalization used in this implementation. Practical materials are the third domain and emphasize the clinical tools or instruments needed. As this was a practice already routinely occurring in this current study by a different group, no new practical materials were required for this implementation. Team reflection is the final domain of institutionalization and speaks to the formal monitoring of the quality of performance between professionals. The CTR protocol is monitored and discussed routinely at thoracic quality meetings, which includes a variety of health care workers; physicians, nurses, management, education and allied health professionals.

As noted above, all the appropriate domains have been addressed to ensure the sustainability of the nurse-led CTR protocol in this study. This paired with the high rate of passing grades in the knowledge survey, high number of nurses routinely removing CTs (92% remove four or more per year; 67% remove 7 or more) are also indicators of a successful and sustainable implementation.

5.4 Implications for nursing practice, education and research

5.4.1 Nursing practice.

The implementation of the nurse-led CTR protocol has increased nurse's scope of practice when caring for patients with CTs. The additional skill allows nurses to work to full scope as per their licencing body, which research has shown is linked to higher rates of job satisfaction (Claeys et al., 2015; Cox, 2011; Nellet & Ross, 2011). The implementation of this protocol has allowed nurses to increase their autonomy, nursing knowledge, critical thinking and decision-making skills. After receiving a physician order to remove a CT, nurses can utilize this protocol to be more independent in their care for their patients. Nurses can use the criteria

outlined in the protocol to assess patient readiness for CTR. Nurses use advanced knowledge and critical thinking skills to complete targeted assessments. With resulting assessments and protocol criteria, nurses can make an independent decision as to whether or not the CT can be removed. A study completed by Christensen (2002), identified that when nurses had algorithms/protocols to follow, they were able to make decisions about CTR. Increasing nursing knowledge, critical thinking, skill and autonomy in managing CTs increases nursing ability to collaborate with the medical team, aligning with current literature findings (Claeys et al., 2015; Cox, 2011).

As this study and others suggest, allowing nurses to have more control over CTR reduces CT indwell time and length of stay without compromising complication rates. Timelier removal of CTs in patients leads to improved mobilization, pain management, decreased risk of infection, decreased length of stay (Lijkendijk et al., 2018) and increased patient satisfaction (Nellet, & Ross, 2011), all of which are important and clinically significant outcomes for patients.

These research findings suggest an association between the implementation of a standardized nurse-led CTR protocol and a decrease in CT indwell time and length of stay without compromising patient safety. Out of the CTR practices and policies ascertained in the nine centres in Canada (unpublished data, 2016), it was noted that there was a range of healthcare professionals responsible for CTR; critical care nurses, clinical nurse specialists/experts, inpatient nurses, nurse practitioner, physicians, and nursing associates. It was noted in four of the nine centers, nurses were removing CT in the ICU, while only two centers had nurses removing CTs on the inpatient wards. Although our results were assessed including both an inpatient and level II ICU, the outcomes are favorable for implementation on both units. These results suggest that thoracic nurses have the knowledge, skill and judgement to safely remove CTs when utilizing a standardized protocol, in both critical care areas and inpatient

wards. This should be considered for nurses working in inpatient wards where they are not empowered to perform CTR.

This study suggests that the implementation of this standardized protocol for CTR is a sustainable method of improving patient outcomes. To ensure that this practice remains safe and embedded into the daily clinical practice of the nurses on the inpatient unit and level II ICU, CTR should become a basic skill required for its clinical nurses. To achieve this, it is recommended that the education curriculum be delivered as routine onboarding practices to all newly hired nurses. Currently, nurses must also complete a yearly knowledge survey and ongoing competency audits and remove six CTs per year to keep their CTR certification.

The results of this research showed that participants had an average of 89% on the knowledge survey, with only two nurses (4%) obtaining grades below the 80% threshold. All participants also agreed with the statement "I am confident in my skill and ability to remove CTs" with 92% of participants reported removing four or more CT's per year. After reassessment, nine nurses (36%) were deemed successful in the observation audits, with only three pre-assessments (positive pressure ventilation [n=6], CT drainage [n=3], anticoagulation status [n=2]), four procedural actions (stabilizing CT once sutures cut [n=8], cleansing site [n=2], unclamp remaining CT [n=1], turn Thopaz® [n=1]), and three post assessments (drainage at insertion site [n=5], SQE [n=3], shortness of breath [n=1]) being reason for all remaining unsuccessful audits (n=16). In these audits, the nine successful nurses had also removed four or more CTs. Therefore, going forward, to maintain the high didactic knowledge found in the knowledge survey, high levels of reported confidence and satisfactory observation audits, it would be recommended that nurses continue to remove at least four CTs annually, complete a yearly knowledge survey and ongoing observation audits to maintain CTR competence.

Utilizing a standardized algorithm, Lijkendijk and colleagues (2015) have delegated the decision making of when to perform CTR to nurses. Lijkendijk and colleagues had a lower reported CT indwell time (1.9 days/45.6 hours) compared to our study. In our research, it was noted that nurses are consistently assessing the patient to ensure they meet criteria prior to performing CTR. Going forward, the thoracic team should consider delegating the decision of when to perform CTR to nurses by implementing a medical directive. This directive could include assessment criteria, guidelines and an algorithm for nurses to follow. Mirroring the model used by Lijkendijk's (2015) could be the next step in furthering nurses' autonomy with CT management and could lead to further decreases in our reported CT indwell time.

Our findings suggest that the standardized protocol be revised. The current language used for ensuring the patient is on gravity drainage is unclear. Currently, the protocol states "ensure patient is on gravity drainage" but there is no direct statement that outlines to place the patient on gravity drainage. Clearer language in the protocol is needed to ensure the meanings are clear and unambiguous.

Our institution has recently implemented an EHR system. Due to the low level of documentation accuracy noted in these findings, it would be recommended that a specific CTR template be created in the EHR which would outline the required documentation as per the standardized protocol. This could increase the issue of documentation accuracy noted in this study. In addition, since excess drainage at the CT site post CTR could signify that clinical interventions are required, adding this to the standardized protocol instead of removing from the observation audit checklist would be most beneficial for patient safety.

5.4.2 Nursing education.

Clinical competence is at the forefront for many nursing leaders, including managers and educators (Licen & Plazar, 2015). A systematic review completed by Licen and Plazar (2015) identified the goal of competency as ensuring "that nurses obtain the knowledge, skills and abilities expected and required for their practical settings" (p. 602). The implementation of this nurse-led CTR protocol utilized a step-wise competency-based certification model, which was based on literature findings. This included didactic education, clinical teaching, a progressive competency-based assessment for certification and a model for maintaining competency. This curriculum model could be replicated as a foundational guide for nurses in education roles for future implementations.

The education model we utilized included didactic and clinical teaching, as well as a competency based assessment, which was similar to the method that Cox and colleagues (2011) implemented. The use of online learning modules, as used by Claeys et al. (2011), is an appealing method of providing prerequired knowledge which could replace the current didactic sessions. Simulation education could also be implemented as part of the CTR curriculum for hands on practice prior to entering the clinical environment. Simulation education has consistently been shown to increase nurse's knowledge and comfort levels in the clinical environment (Hegland, Aarlie, Stromme & Jamtvedt, 2017). Therefore, going forward, a more innovative and cost effective curriculum including the use of online learning modules and simulation education could be employed for CTR education.

It was identified that hand hygiene was a frequently omitted clinical step in the CTR procedure. It is recommended that refresher education on hand hygiene be added to the CTR curriculum in both didactic and simulation education. This should be paired with clinical audits

to act as a means to provide in the moment feedback to clinical nurses and to ensure that hand sanitizer is available at the point of care.

The two procedural steps labelled “while stabilizing the chest tube” were omitted a total of eight times (32%). Once retention sutures are cut, indwelling CTs could potentially migrate. This could cause the eyelets of the tube to exit the pleural space, which could lead to a pneumothorax. Tube stabilization should therefore be reinforced in the CTR education. As mentioned previously, simulation education should be implemented, and CT stabilization could be an objective that is practiced in a simulated environment.

5.4.3 Nursing research.

As this was the first research study to assess patient outcomes pre and post-implementation of a nurse-led CTR protocol, additional research is required to strengthen this knowledge. Nurse-led CTR protocols should be implemented in other care areas while monitoring patient outcomes and sustainability. As the context of patients requiring CTR will differ between facilities and care areas, criteria and interventions will require tailoring to meet individual patient and nursing needs. With future research, an attempt should be made to implement an RCT, decreasing biases assumed with a retrospective analysis.

Our research suggests a decrease in the use of Heimlich/Pneumostat vales when CTR is shifted to nurses. Our study only assessed numbers of patients in each group who had these valves applied. Additional research should compare the application of Heimlich/Pneumostat valves in patients in the pre- and post-implementation groups to verify if there are any statistically significant differences noted.

Further to implementing nurse-led CTR in other care areas, monitoring of patient outcomes should be at the forefront of research implications. Our institution has recently

implemented the use of EHR. The thoracic team, including physicians and nursing, should identify ways in which patient outcomes can be monitored utilizing the EHR. Identifying reports that can be viewed at regular intervals and assessed in a quality assurance team will ensure that patient safety is continually monitored.

Although the lack of complications is an overall positive and clinically significant finding, further research is needed to confirm these results. A study with a larger sample size is needed to identify if the nurse-led CTR protocol does indeed affect complication rates.

Concepts developed by Slaghuis, Strating, Bal and Nieboet (2011) were utilized to assess the sustainability of this practice change implementation. Future researchers should attempt to utilize a similar framework to do formal evaluations when implementing comparable practice changes to assess sustainability.

Limitations

CT reinsertion rates were to be investigated. However, it was noted during the data collection, that CT reinsertion data was not always available in the thoracic database. This was due to the fact that we were performing a secondary analysis of an existing database in which this data was not always available. The outcome measure of reinsertion rates was therefore not analyzed.

As phase 1 of this research study was a retrospective study, other pre-existing differences between the pre and post-implementation groups could be a plausible explanation to the decrease in median CT indwell time, decreased in median length of stay without compromising the complication rates. However, based on findings from other studies, a more plausible explanation is that the implementation of the nurse led CTR protocol has significantly decreased both the CT indwell time and length of stay.

The complication rate findings should be interpreted with caution. There was a small sample size of patients experiencing complications therefore no formal comparisons could be made between differing grades of complications.

Data validation was completed on both phases of the data. Phase 2 data was validated utilizing a data verification method instead of independent data entry. This could have led to expectation bias.

There was an error in the observation audit tool regarding patient teaching. The observation audit tool outlined that "drainage at the insertion site" was a mandatory teaching point. This however was not an expectation in the standardized protocol. This led to a higher than actual number of nurses being unsuccessful on the observation audits. The standardized protocol states that CT assessments must be documented. This was not included in the observation audit tool. Due to this, we are missing this data which could further explain the documentation compliance.

Nurse reported their perceived level of confidence utilizing a 6-point Likert scale. As this is a reported and not an observable behaviour, we are unable to accurately measure if there is a correlation between the level of confidence and the nurse's actual skill level.

Finally, the observation audit checklist utilized was the initial certification list. A very small percentage of nurses were successful during the audits, therefore this observation audit tool should be reassessed for ongoing competency assessment.

Conclusion

A nurse-led CTR protocol was implemented to address assumed delays in CTR. Although the literature supported nurse-initiated and nurse-led protocols in different care areas, literature was lacking regarding patient outcomes with nurse-led CTR. Therefore, this is the first

study comparing patient outcomes pre and post-implementation with nurse-led CTR. This study identified a statistically significant decrease in CT indwell time and length of stay with no change in complication rates. This study also identified frequency of practice as the most important factor leading to competency and level of confidence. It was also identified that documentation was the most inconsistently completed aspect of CTR. Overall, this research study supports advocating that shifting CTR to nurses with a standardized protocol is a safe practice in both ward and level II intensive care units, leading to improved quality of care for thoracic patients. This study also suggests that the step-wise competency-based approach to implementing this practice change with a standardized protocol is a sustainable model. As the literature in this subject was lacking, this research study has laid the foundation for further evaluation of nurses removing CTs in clinical practice. Further investigations are required to ensure more robust knowledge regarding nurses removing CTs is available.

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Appendix A- Competency Audit Checklist

COMPETENCY AUDIT CHECKLIST

Removal of Pleural chest tubes

Date: _____ Assessment completed by: [redacted]

Unit: [redacted] (circle correct unit)

Total number of chest tubes removed in the last 12 months: [0], [1-3], [4-6], [7-9], [10-12], [12 or more] (circle correct range)

The nurse did	Yes	No	Points	Comments
Pre-removal				
1. Ensure written order obtained from physician	*		/1	
2. If CXR was completed, ensure reviewed by physician	*		/1	
3. Verify patient's anticoagulation status	*		/1	

4. Assess patient and chest drainage unit:
• No air leak present
  ○ Analog- no bubbling
  ○ Digital- less than 30ml/min for 8 hours
• Drainage less than 20% of total body lymphatic flow
• Not on positive pressure ventilation
• Stable respiratory status
• Absent, mild or no increase in subcutaneous emphysema
• Chest tube drainage is serous/ serosanguinous
• Auscultate chest (within 1 hour)
• Vital signs (within 1 hour)
	**
	**
	**
	**
	**
	**
	*
	*
			/1
			
			/1
			/1
			/1
			/1
			
			/1
			/1
			/1
				(** only needed if discontinuing chest drainage)

5. Provide analgesia as required	X		/1	X- not needed as not safety aspect. Not all patients require pain meds
6. Collect and assemble all necessary equipment	*		/1	
7. Ensure patient is on gravity	*		/1	
8. Prepare the patient by explaining the procedure and breathing techniques • Breath in and perform Valsalva manoeuver	*		/1	
9. Position patient • to expose chest tube site • comfortable working height	* X		/1 /1	X- not needed for safety
10. Don clean gloves	*		/1	
11. Place absorbent pad on bedding to prevent spillage onto patient or bedding.	X		/1	X- not needed for safety
12. Remove chest tube dressing and discard	*		/1	
13. Remove gloves	*		/1	
14. Wash hands	X		/1	X- not needed for safety
15. Aseptically prepare dressing tray	*		/1	
16. Don gown and face mask	X		/1	X- not needed for patient safety
17. Clamp chest tube(s)	*		/1	

18. If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube • Thopaz: Standby, Cap Y-connector, turn on, unclamp chest tube left in • Sahara: Scrub connection, disconnect dual Sahara, connect single, unclamp chest tube left in	**		/1	** only needed if removing one of multiple chest tubes
19. Don sterile gloves	*		/1	
20. Prepare the adaptic and 4x4 gauze dressing	*		/1	
21. Cleanse chest tube site with chlorhexidine/ alcohol swab sticks	*		/1	
PURSE STRINGS PRESENT <u>If purse strings not present, skip to #26</u>				
22. Differentiate between retention and purse string sutures Remove knot from end of purse string	*		/1	
23. Have second nurse hold purse string and tie a loose half knot in purse string (if present)	*		/1	
24. Cut and remove retentions sutures while stabilizing the chest tube with the other hand (use sterile 4x4 to maintain sterility).	*		/1	
25. Hold chest tube in dominant hand while holding dressing over chest tube site with non-dominant hand.	*		/1	
26. Instruct patient to take a deep breath, hold it and perform Valsalva manoeuver	*		/1	
27. Pull chest tube out quickly and steadily.	*		/1	
28. Maintain pressure over site with dressing while: • second nurse securely ties off the purse string suture • dressing secured	* *		/1 /1	

29. Instruct patient to breathe normally	*		/1	
30. Ensure chest tube is intact	*		/1	
31. Assess patient respiratory status (immediately post) • Auscultate chest • Assess for subcutaneous emphysema • Shortness of breath • Drainage at insertion site • Vital signs	 * * * * *		 /1 /1 /1 /1 /1	
32. Instruct patient to: • Stay in bed x 30 minutes • Notify RN if any shortness of breath, chest pain or discomfort and/ or drainage at the site	 * *		 /1 /1	
Post removal				
33. Dispose of chest tube and drainage canisters or systems Clean and return Thopaz pump to OR	*		/1	

34. Record pertinent information correctly on patient's chart • Assessment of patient and chest tube before removal • Date and time of chest tube removal • Patient tolerance of procedure • Patient condition post removal, including air entry, respiratory status, vital signs • Patient teaching	* * * *		/1 /1 /1 /1	
NO PURSE STRINGS				
35. Cut and remove retentions sutures while stabilizing the chest tube with the other hand (use sterile 4x4 to maintain sterility)	*		/1	
36. Hold chest tube in dominant hand while holding dressing over chest tube site with non-dominant hand.	*		/1	
37. Instruct patient to take a deep breath, hold it and perform Valsalva manoeuver	*		/1	
38. Pull chest tube out quickly and steadily.	*		/1	
39. Maintain pressure over site with dressing while dressing secured	*		/1	
40. Instruct patient to breathe normally	*		/1	
41. Ensure chest tube is intact	*		/1	

42. Assess patient respiratory status (immediately post) • Auscultate chest • Assess for subcutaneous emphysema • Shortness of breath • Drainage at insertion site • Vital signs	* * * * *		/1 /1 /1 /1 /1	
43. Instruct patient to: • Stay in bed x 30 minutes • Notify RN if any shortness of breath, chest pain or discomfort and/ or drainage at the site	* *		/1 /1	
Post removal				
44. Dispose of chest tube and drainage canisters or systems Clean and return Thopaz pump to OR	*		/1	
45. Record pertinent information correctly on patient's chart • Assessment of patient and chest tube before removal • Date and time of chest tube removal • Patient tolerance of procedure • Patient condition post removal, including air entry, respiratory status, vital signs • Patient teaching	* * * * *		/1 /1 /1 /1 /1	

EVALUATION CRITERIA

i. The skill performance is safe, competent and consistent with performance steps as outlined above
   a. (all * points performed to be deemed safe and competent)

Total score:

1) Discontinuing drainage
   a. With purse string sutures: ___/51 points

b. Without purse string sutures: ___/48 points

2) Removal without discontinuing drainage
   a. With purse string sutures: _____/ 45
   b. Without purse string sutures: _____/ 42

Satisfactory [ ] Unsatisfactory [ ]

Comments:

_____
_____
_____
_____
_____

Appendix B- Standardized CTR Protocol

The Ottawa Hospital | L'Hôpital d'Ottawa

NURSING POLICIES, PROCEDURES AND PROTOCOLS

REMOVAL OF CHEST TUBE BY RN
No.: (DOCUMENT NUMBER)

ISSUED BY: thoracic surgery team

APPROVED BY: [redacted]

CATEGORY: Nursing/ Clinical procedure

DATE OF APPROVAL: 2017/02/21

LAST REVIEW/REVISION DATE: 2017/02/08

IMPLEMENTATION DATE: 2017/02/21

POLICY STATEMENT:

Chest tube removal is an added nursing skill that may be performed by RN's on [redacted] ONLY who have received additional training from a nurse educator or delegate.
RN's who have acquired the appropriate knowledge, skill and judgement may remove chest tubes on [redacted]
This policy addresses removal of both small and large bore chest drainage tube.
This policy EXCLUDES the removal of intrathoracic Jackson Pratt drains.

DEFINITION(S):

1. **Purse string**: Suture that is threaded through the wound edges in a U shape with the ends left unknotted. Once the chest tube is removed, the purse strings are simultaneously pulled taught, approximating the wound edges.
2. **Air Leak Indicator**: The patient Air Leak Indicator approximates the degree of air leak from the chest cavity if present.
    a. **Analog drainage system**: The air leak indicator ranges from Low (1) to High (7). The higher the numbered column, the greater the degree of air leaks.
    b. **Digital drainage system**: The air leak indicator ranges from 0- 5000. The higher the number, the greater the degree or air leak.
3. **Valsalva Manoeuver**: is the forced exhalation against a closed airway. It decreases the pulse rate and the blood return to the heart; while increasing

venous and intrathoracic pressure from 3-4 mmHg to 60 mmHg or higher. It is contraindicated in patients with increased intracranial pressure.

ALERTS:

1. Verify patient's anticoagulation status. If other than DVT prophylaxis is ordered, verify with MD for orders regarding chest tube removal.
2. Patients do not have to meet all criteria in appendix A if 1 drain is to remain insitu post removal.
3. Chest drainage can be discontinued if patient meets all criteria for chest tube removal (appendix A).
4. Chest tubes are to be removed at peak inspiration, while patients hold their breath and perform the Valsalva manoeuver.
5. If patient is unable to hold their breath, remove chest tube at peak inspiration.
6. If chest tube is clamped (to assess readiness for removal) and a CXR has been completed and confirms lung re-expansion, it is not necessary to unclamp chest tube to assess for air leak.
7. If CXR was completed, the CXR must be assessed by an MD prior to removal of chest tubes.
8. A written order must be obtained
9. If more than 1 chest tube present, physicians are to specifically order which chest tube is to be removed.
10. If multiple chest tubes are to be removed, removal should be in the following order:
    a. Remove largest bore chest tube first
    b. If all chest tubes are of equal size, remove the most posterior or basal chest tube first.
11. If purse strings are present, 2 nurses will be needed for chest tube removal.
12. Purse string sutures are tied in such a way just to approximate the wound edges. If tied too tight, it can lead to increased discomfort and tissue necrosis.
13. If purse strings present, dressing remains insitu for 24 hours. Mark removal time on dressing. Reinforce if needed.
14. If no purse strings present, dressing remains insitu for 48 hours. Mark removal time on dressing. Reinforce if needed
15. Purse strings sutures can be removed 3 days following chest tube removal if the site is dry and intact or as otherwise ordered by a physician.
16. If patients are going home post chest tube removal with purse string sutures in place, instruct patient to follow up with family MD or walk in clinic to have sutures removed approximately 1-week post removal.

Equipment:

Quantity	Product	Order#
	Non-sterile gloves	
	Gown	
2	Toothless disposable clamps	
1-2	Face mask with shield	
1	Sterile dressing tray	213000
1-2	Sterile gloves	
2	Absorbent blue pad	211820
4	Chlorhexidine 2% with 70% alcohol swabsticks	210600

4	sterile 4x4 gauze	
1	Petrolatum based non adherent dressing	212135
	Adhesive fabric tape dressing	211350
1	Biohazard disposal bag	250620
1	Sterile scissors	280450
1	Thopaz cap for double tubing (if one chest tube to remain insitu)	204037
1	Sahara single chest drainage system (if one chest to remain insitu)	204030

PROCEDURE:

1. If discontinuing chest drainage (removing last chest tube), ensure patient meets criteria in appendix A.
2. Assess patient VS, breath sounds and ability to perform Valsalva manoeuver.
3. Ensure patient is on gravity drainage
4. Provide analgesia PRN and allow it to take effect
5. Explain procedure to patient
6. Position patient to expose chest tube insertion site.
7. Don clean gloves
8. Place blue absorbent pad to prevent spillage onto patient or bedding
9. Remove chest tube dressing and discard
10. Aseptically prepare dressing tray
11. Don gown and face mask
12. Clamp chest tube(s).
    a. If only removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube:
        i. Thopaz: put thopaz on standby. Cap Y-connector of thopaz double tubing. Turn thopaz on. Unclamp chest tube that will remain insitu.
        ii. Sahara: scrub connection end of chest tube to remain insitu. Disconnect dual sahara set. Connect single sahara system as per policy No.:00088
13. Don sterile gloves
14. Fold and place petrolatum based non adherent dressing on 4x4 gauze. Place on sterile field.
15. Cleanse chest tube site with chlorhexidine/ alcohol swabs

If no purse string sutures present, skip to step 26

16. Locate purse strings and differentiate from retention sutures.
17. Loosen purse string from around chest tube
18. Tie a loose half knot in the purse string
19. 2nd nurse holds purse string sutures
20. Use sterile scissors to cut retention sutures while stabilizing the chest tube with the other hand.
21. Hold dressing over chest tube site with non-dominant hand while holding chest tube in dominant hand.
22. Instruct patient to take deep breath, hold it and perform the Valsalva manoeuvre.
23. Grasp chest tube firmly with dominant hand and pull out steadily.

- If there is resistance, stop, apply occlusive dressing and notify MD.

24. As tube leaves chest opening, apply dressing while 2nd nurse ties several knots in the purse string suture (see Appendix B for management of complications associated with chest drain removal).
25. Continue to # 31

26. Use sterile scissors to cut retention sutures while stabilizing the chest tube with the other hand.
27. Hold dressing over chest tube site with non-dominant hand while holding chest tube in dominant hand.
28. Instruct patient to take deep breath, hold it and perform the Valsalva manoeuvre.
29. Grasp chest tube firmly with dominant hand and pull out steadily.
    - If there is resistance, stop, apply occlusive dressing and notify MD.
30. As tube leaves chest opening, apply dressing (see Appendix B for management of complications associated with chest drain removal)

31. Instruct patient to breath normally
32. Confirm chest tube is intact
33. Assess patient respiratory status (immediately post and 60mins):
    - Auscultate chest
    - Assess for subcutaneous emphysema
    - Shortness of breath
    - Drainage at insertion site
    - Vital signs
34. Instruct patient to stay in bed for 30 minutes and to notify RN if any shortness of breath, chest pain or any discomfort.
35. Dispose of chest tube and drainage canisters or systems according to hospital policy No.: 00088

Documentation:

1. Assessment of patient and chest tube before removal
2. Date and time of chest tube removal.
3. Patient tolerance of procedure
4. Patient condition post removal, including air entry, respiratory status and vital signs
5. Patient teaching

RELATED POLICIES / LEGISLATION:

No.: 00088 - CHEST DRAINAGE - ASSISTING WITH CHEST TUBE (CT) INSERTION, CARE OF PATIENT WITH A PLEUR-EVAC SAHARA SYSTEM AND REMOVAL OF A CT

Qualification Process:

- Complete learning package
- Comprehensive review of chest tube removal policy
- Successfully complete learning package quiz with a minimum grade of 80%
- Watch chest tube removal video (once available)
- Complete observation of chest tube removal with physicians or RN's already competent in removing chest tubes 3 times

- Assume the role of the second RN (with purse string sutures) times until comfortable with procedure (if applicable)
- Successfully complete return demo with educator or delegate
- Assume lead role for chest tube removal with assistance of nurse educator or delegate
- Once you feel confident in assuming the lead role, call the nurse educator or delegate to observe your performance and evaluate your competency.

COMMENTS / SIGNIFICANT REVISIONS:

References:

Hunter, J. (2008). Chest drain removal. *Nursing Standard. 22*(45), 35-38.

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Appendix A: Criteria for chest drain discontinuation

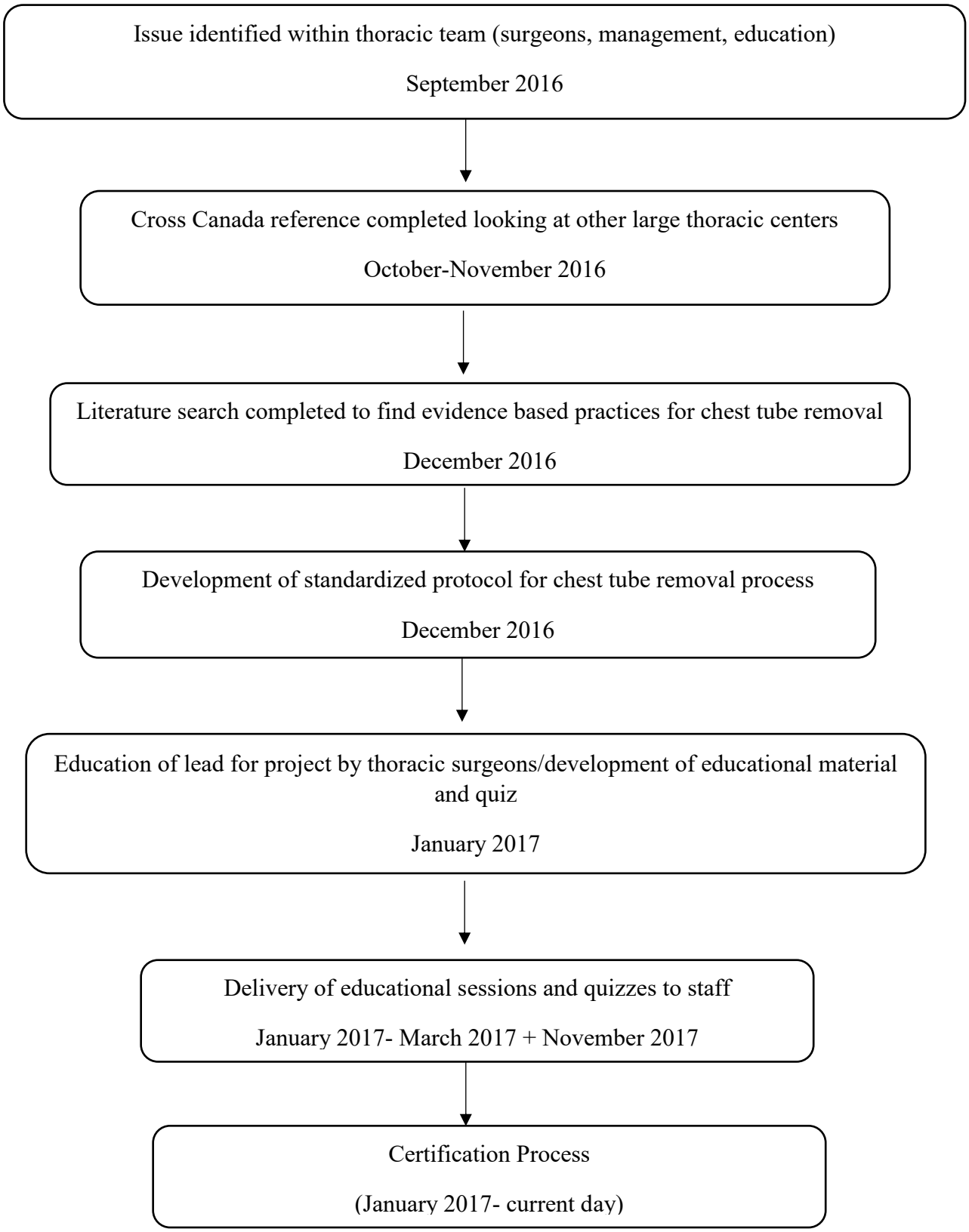
- Written order obtained from physician to remove chest tube.
- Patient is not on positive pressure ventilation (i.e. CPAP/ BiPAP)
- There is no air leak present
    - Analog drainage system- test by having patient take a deep breath and cough while simultaneously checking for bubbling in the air leak indicator of Sahara
    - Digital drainage system- checking digital reading chart. Must be less than or equal to 30ml/min for the previous 8 hours.
- Stable respiratory status
- Absent, mild or no increase in subcutaneous emphysema
- Chest tube drainage is serous or serosanguinous
- Chest tube drainage is less than or equal to 20% of total body lymphatic flow (patient's weight in kg multiplied by 5) for the previous 24 hours.

Appendix B: Management of complications associated with chest drain removal

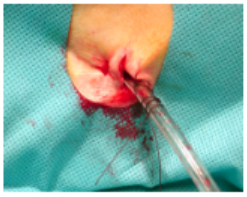
Potential complication	Solution
What if the purse-string suture snaps when tying the knot?	Apply the dressing. If possible, remove snapped purse string suture. Notify the doctor.
What if the purse-string suture is not sufficient to seal the wound?	Apply dressing and notify doctor if any issues
What if the patient is unable to hold his or her breath?	The removal of the chest tube needs to be staged according to the patient's ability to hold his or her breath. If patient unable to hold their breath, remove the tube at peak inspiration.
What if the nurse is unable to pull the drain out?	Stop pulling and cover it with a dressing. When removing the chest tube, some resistance will be felt, especially if the chest tube has been in for a while. Notify the doctor to assess the patient. The patient may need a chest x-ray to identify the position of the tube.
What if air is heard escaping from the wound when the chest tube is removed?	Apply dressing. Record the patient's observations, position him or her in an upright seated position, observe and monitor the patient for any signs of pneumothorax and notify the doctor immediately.

Chart obtained from: Hunter, J. (2008). Chest drain removal. *Nursing Standard*. 22(45), 35-38. Revisions made to meet criteria for TOH chest tube removal

Appendix C- Implementation Timeline



Appendix D- Knowledge Survey



Chest Tube Removal Re-Certification Annual Quiz (2018) (29 Points)

For currently certified [redacted] nurses ONLY to maintain competency in chest tube removal.
Please ensure to review the chest tube policy within 4 weeks BEFORE completing this quiz.

1. Have you reviewed the chest tube removal policy within the last 4 weeks? *
(1 Point)

- Yes ✓
- No

2. Under normal conditions, intrapleural pressure is *
(1 Point)

- Positive
- Negative ✓
- Zero
- Same as atmospheric pressure

---

3. True or False: A verbal order may be obtained for removal of chest tubes? *
(1 Point)

- True
- False ✓

4. True or False: You must receive an order to place a chest tube on gravity prior to removal. *
(1 Point)

- True
- False ✓

5. Purse string sutures: *
(1 Point)

- Are used to approximate wound edges once chest tube is removed
- Require 2 nurses for chest tube removal
- May be removed 3 days following chest tube removal if site is dry and intact, with a physician's order
- Should not be tied too tight. If tied too tight, it can cause tissue necrosis and patient discomfort
- All of the above ✓

6. True or False: Chest tubes are removed at end expiration *
(1 Point)

- True
- False ✓

7. True or False: if patients are unable to hold their breath, or follow instructions, chest tubes should be removed at peak inspiration *
(1 Point)

- True ✓
- False

8. The following are criteria for chest tube removal (select all that apply) *
(1 Point)

- [ ] telephone order from thoracics
- [ ] written order from thoracics ✓
- [ ] patient is not on positive pressure ventilation (CPAP, BiPAP) ✓
- [ ] there is no air leak present (no bubbling with deep breath & cough Sahara, airleak less than or equal to 30 ml/min for previous 8 hours) ✓
- [ ] stable respiratory status ✓
- [ ] increasing subcutaneous emphysema
- [ ] drainage is less than 50ml/24hours

9. Your patient weights 75 kg. How much fluid would be the maximum amount of acceptable drainage in the previous 24 hours if considering chest tube removal? *
(1 Point)

- ○ 75 ml
- ○ 150 ml
- ○ 375 ml ✓
- ○ 750 ml

10. True or False: I can remove my respirology patient's chest tube *
(1 Point)

- ○ True
- ○ False ✓

11. How do I check for an air leak with the Sahara Pleur-Evac system? *
(1 Point)

- Monitor for bubbling in the air leak meter while the patient is breathing normally.
- Monitor for bubbling in the air leak meter while having the patient take a deep breath and cough ✓
- Monitor for fluctuation in chest tube tubing
- I don't know... stop asking me these questions!

12. How do I check for an air leak with the Thopaz digital system? *
(1 Point)

- Must check the digital reading chart. Must be less than 30ml/min in previous 24 hours
- Must check the digital reading chart. Must be less than 50ml/min in previous 24 hours
- Must check the digital reading chart. Must be less than 30ml/min in previous 8 hours ✓
- Must check the digital reading chart. Must be less than 50ml/min in previous 8 hours

13. Your patient has a 24Fr and a 28Fr chest tube to the right chest after undergoing a right sided upper lobectomy.
Your patient has subcutaneous emphysema that is visible on inspection and can be palpated.
This patient's subcutaneous emphysema can be palpated along the right lateral, anterior and posterior chest.
How would you class this patient's subcutaneous emphysema? *

- Mild
- moderate ✓
- Severe

14. True or False: With this new policy, I can now remove intrathoracic Jackson-Pratt drains as well *
(1 Point)

- True
- False ✓

15. How many patient identifiers must be used when identifying a patient prior to chest tube removal? *
(1 Point)

- 1
- 2 ✓
- None
- What are patient identifiers?

16. Before removing the chest tube, the site will be cleaned with: *
(1 Point)

- Chlorhexidine swabsticks
- Chlorhexidine/ alcohol swabsticks ✓
- Normal saline
- Sterile water

17. Once the chest tube is removed, assessments will be completed: *
(1 Point)

- Immediately post and at 60 minutes post ✓
- Immediately post, 30 mins post, 60 mins post and 120 mins post
- Immediately post, 15 mins post, 30 post and 45 mins post and before discharge
- Immediately post, 30 mins post and 60 mins post

18. Once chest tube removed, assessments will be completed immediately post and at 60 minutes post. Assess for: *
(1 Point)

- Shortness of breath
- Auscultate for air entry
- Subcutaneous emphysema
- Drainage at insertion site
- Vital signs
- All of the above ✓

19. True or False: Once chest tube removed, patient should remain on bedrest for 1 hour. *
(1 Point)

- True
- False ✓

20. True or False: Once chest tube removed:
If purse strings are present, dressing to remain insitu for: 24 hours *
(1 Point)

- True ✓
- False

21. True or False: Once chest tube removed: if no purse strings present, dressing to remain insitu for 24 hours. *
(1 Point)

- True
- False ✓

22. The dressing applied to the site post chest tube removal will be: *
(1 Point)

- Petrolatum based non-adherent dressing (adaptic), gauze, covered with adhesive fabric tape ✓
- Parrafin gauze dressing (Jelonet), gauze, covered with adhesive fabric tape
- Gauze and adhesive fabric tape
- No dressing, leave open to air

23. Bubbling in the water seal chamber of a chest tube indicates: *
(1 Point)

- Normal functioning
- An air leak ✓
- The chest tube is ready to be removed
- Suction is too high

24. True or False: A new CXR is always required prior to chest to removal. *
(1 Point)

- True
- False ✓

25. True or False: A patient has 2 chest tubes to the right chest. A 28Fr and a 24Fr chest tube. Patient continues to have an airleak of 300ml/min. One chest tube can be removed. *
(1 Point)

- True ✓
- False

26. True or False: I received an order to remove the anterior and posterior chest tubes. I must wait 1 hour in between each tube. *
(1 Point)

- True
- False ✓

27. Your patient weighs 60kg therefore, their allotted output for a 24-hour period is 300ml (60kg x 5= 300).
Patient has drained 400ml in the previous 24 hours.
What are your next steps? *
(1 Point)

- Advise thoracics that they will need to remove the chest tube- as patient findings lie outside our policy
- Advise thoracics and request a CXR
- Remove the chest tube
- Advise thoracics and clarify if they are o.k. with the removal of the chest tube. ✓

28. You have a patient with a 28Fr and 24Fr chest tube to the right side.
Which chest tube should be removed first? *
(1 Point)

- 28Fr ✓
- 24Fr

29. You have a patient with two 24Fr chest tubes to the left chest; one anterior and one posterior.
Which chest tube should be removed first. *
(1 Point)

- Anterior chest tube
- Posterior chest tube ✓

30. You are removing one of two of your patient's chest tubes that are currently to a dual Pleur-Evac Sahara. Arrange the following steps for removal in the proper order: *
(1 Point)

Assess pt vital signs, breath sounds and ability to perform Valsalva manoeuvre

Assemble all required equipment & ensure patient is on gravity drainage (put to gravity if not already on gravity)

Provide analgesia as needed and allow time to take effect and position patient to expose chest tube insertion site

Don clean gloves, place absorbent blue pad to prevent spillage onto bed linens and patient and remove chest tube dressing

Aseptically prepare dressing tray and don gown and face mask

Clamp chest tubes

Disconnect dual Sahara set

Scrub connection end of chest tube to remain insitu

Connect single Sahara system as per policy no. 00088

Unclamp chest tube remaining insitu

31. Approximately how many chest tubes have you removed in the last 12 months?

- 0
- 1-3
- 4-6
- 7-9
- 10-12
- 12 or more

32. What is your age? *

- 20-29
- 30-39
- 40-49
- 50-59
- 60-69

33. How many years of nursing experience do you currently have? *

- 0-1
- 1-2
- 2-3
- 3-5
- 5-10
- greater than 10 years

34. Which answer below best describes your current employment status *

- Full time
- Part time 1
- Part time 2
- Casual

35. What is the highest level of education you have completed *

- College Diploma
- Bachelor's degree
- Master's degree
- Nurse practitioner
- Doctorate degree

36. Have you completed any other education/ specialty courses not already addressed (i.e. Emerg, OR, ICU). *

Enter your answer

37. I am confident in my skill and ability to remove chest tubes *

- Strongly agree
- moderately agree
- slightly agree
- slightly disagree
- moderately disagree
- strongly disagree

38. Please comment on question 37. What has contributed to your current level of confidence? *

Enter your answer

Appendix E- Recruitment Email

Dear [redacted] nurses,
Sonia Joanisse, [redacted] is conducting a research study to evaluate the practice change of nurses removing chest tubes on your units.

She will be assessing the implementation of the standardized nurse-led chest tube management protocol for patients who undergo thoracic surgery.
The specific objectives for the research study are:

1. To understand the impact of the standardized nurse-led chest tube management protocol on chest tube indwell time, length of stay, and complication rates.
2. To evaluate the uptake of the nurse-led protocol one-year post implementation.

What does participation mean for this study?
Providing consent to be part of this research study means that you would agree to have Sonia Joanisse, personally observe you perform a chest tube removal process.
Participation in this study is voluntary. You do not have to participate and if you choose to participate, you have the right to withdraw at any time with no effect to you personally or professionally.

The results of these observation will be anonymous and in no way will any information be linked directly to you. The observations will NOT be used as a means of performance evaluation.

If you are interested in participating or would like more information, please contact Sonia at:

Email sent on behalf of Sonia Joanisse
(Principal investigator)

Appendix F- Recruitment Posters

Requesting Volunteers for a Research Study

Evaluation of a Standardized Nurse-led Chest Tube Management Protocol

Study Purpose and Aims of the Study:
The purpose of this quantitative study is to understand the impact of the standardized nurse-led chest tube management protocol on chest tube indwell time, length of stay, and complication rates, as well as to evaluate the uptake of the nurse-led protocol one-year post implementation.

This study is being done by Sonia Joanisse, a registered nurse and a Master of Science in Nursing student at the University of Ottawa under the supervision of Dr. Chantal Backman, Assistant Professor in the School of Nursing, Dr. Denise Harrison, Professor in the School of Nursing and Dr. Sebastien Gilbert, Chief of Thoracic Surgery.

Who can participate?

- Registered nurses (RNs) currently employed on [redacted]
- Certified for chest tube removal

What is involved?
Participation in this study means that you will be observed by Sonia Joanisse while completing the chest tube removal process. These observations will be done at a time that is convenient for you during your prescheduled shift hours.

Participation is completely voluntary, and you may withdraw from participation at any time. The results of these observation will be anonymous and in no way will any information be linked directly to you. The observation will NOT be used as a means of performance evaluation.

Your participation in this research will contribute to our evaluation of the standardized nurse-led chest tube management protocol.

If you are interested in participating in this research study, please contact Sonia Joanisse for more information

Appendix G- Informed Consent

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Minimal Risk Informed Consent Form for Participation in a Research Study

Study Title: Evaluation of a standardized nurse-led chest tube management protocol

OHSN-REB Number: *20190110-01H*

Principal Investigator: Sonia Joanisse [redacted]

INTRODUCTION

You are being invited to participate in a research study. You are invited to participate in this study because we would like to assess the uptake of the nurse-led chest tube removal protocol one-year post implementation. This consent form provides you with information to help you make an informed choice. Please read this document carefully and ask any questions you may have. All your questions should be answered to your satisfaction before you decide whether to participate in this research study.

Please take your time in making your decision. You may find it helpful to discuss it with your friends and family.

Taking part in this study is voluntary. Deciding not to take part or deciding to leave the study later will not result in any penalty or affect current or future employment.

IS THERE A CONFLICT OF INTEREST?

There are no conflicts of interest to declare related to this study.

WHY IS THIS STUDY BEING DONE?

The purpose of this quantitative study is to understand the impact of the standardized nurse-led chest tube management protocol on chest tube indwell time, length of stay, and complication rates, as well as to evaluate the uptake of the nurse-led protocol one-year post implementation.

HOW MANY PEOPLE WILL TAKE PART IN THIS STUDY?

It is anticipated that about 25 people will take part in this study from the both [redacted]

This study should take 3 months to complete and the results should be known in about 12 months.

WHAT WILL HAPPEN DURING THIS STUDY?

Participation in this study means that you will be observed by Sonia Joanisse while completing the chest tube removal process. These observations will be done at a time that is convenient for you during your prescheduled shift hours.

The information that will be collected will be used for research purposes only.

WHAT ARE THE RESPONSIBILITIES OF STUDY PARTICIPANTS?

If you choose to participate in this study, you will be expected to:

- Participate in one chest tube removal observation

HOW LONG WILL PARTICIPANTS BE IN THE STUDY?

Your participation on this study will occur on one occasion, and the length of time it will take will be dependent on the procedure.

CAN PARTICIPANTS CHOOSE TO LEAVE THE STUDY?

You can choose to end your participation in this research (called withdrawal) at any time without having to provide a reason. If you choose to withdraw from the study, you are encouraged to contact the research team.

You may withdraw your permission to use information that was collected about you for this study at any time by letting the research team know. However, this would also mean that you withdraw from the study.

If you decide to leave the study, you can ask that the information that was collected about you not be used for the study. Let the research team know if you choose this.

CAN PARTICIPATION IN THIS STUDY END EARLY?

Your participation on the study may be stopped early, and without your consent, for reasons such as:

- The Principal Investigator no longer feels this is the best option for you
- The Ottawa Health Science Network Research Ethics Board withdraw permission for this study to continue

If you are removed from this study, the research team will discuss the reasons with you.

WHAT ARE THE RISKS OR HARMS OF PARTICIPATING IN THIS STUDY?

You may become uncomfortable while being observed performing this skill.

WHAT ARE THE BENEFITS OF PARTICIPATING IN THIS STUDY?

You may not receive direct benefit from participating in this study. We hope the information learned from this study will help improve the knowledge and understanding of the newly implemented standardized nurse-led chest tube management protocol.

HOW WILL PARTICIPANT INFORMATION BE KEPT CONFIDENTIAL?

If you decide to participate in this study, the research team will only collect the information they need for this study.

Records identifying you at this center will be kept confidential and, to the extent permitted by the applicable laws, will not be disclosed or made publicly available, except as described in this consent document.

Authorized representatives of the following organizations may look at your original (identifiable) study records at the site where these records are held, to check that the information collected for the study is correct and follows proper laws and guidelines.

- The Ottawa Health Science Network Research Ethics Board who oversees the ethical conduct of this study at The Ottawa Hospital

Information that is collected about you for the study (called study data) may also be sent to the organizations listed above. Your name or other information that may directly identify you will not be used. The records received by these organizations may contain your participant code, age, and years of nursing experience. Coded study data will also be sent to the University of Ottawa for analysis.

If the results of this study are published, your identity will remain confidential. It is expected that the information collected during this study will be used in analyses and will be published and presented to the scientific community at meetings and in journals.

Your de-identified data from this study may be used for other research purposes. If your study data is shared with other researchers, information that links your study data directly to you will not be shared.

Even though the likelihood that someone may identify you from the study data is very small, it can never be completely eliminated.

WHAT IS THE COST TO PARTICIPANTS?

Participation in this study will not involve any additional costs to you.

ARE STUDY PARTICIPANTS PAID TO BE IN THIS STUDY?

You will receive a $5.00 Tim Horton's gift card for participating in this study.

WHAT ARE THE RIGHTS OF PARTICIPANTS IN A RESEARCH STUDY?

You will be told, in a timely manner, about new information that may be relevant to your willingness to stay in this study.

You have the right to be informed of the results of this study once the entire study is complete. If you would like to review or be informed of the results of this study, please let us know how you would like to be contacted at the time of your observation.

Your rights to privacy are legally protected by federal and provincial laws that require safeguards to ensure that your privacy is respected.

By signing this form, you do not give up any of your legal rights against the research team or involved institutions for compensation, nor does this form relieve the research team or their agents of their legal and professional responsibilities.

You will be given a copy of this signed and dated consent form prior to participating in this study.

WHOM DO PARTICIPANTS CONTACT FOR QUESTIONS?

If you have questions about taking part in this study, you can talk to the primary investigator who oversees the study at this institution. That person is:

Sonia Joanisse
Principal Investigator Name [redacted]

If you have questions about your rights as a participant or about ethical issues related to this study, you can talk to someone who is not involved in the study at all. Please contact The Ottawa Health Science Network Research Ethics Board, [redacted]

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Study Title: Evaluation of a standardized nurse-led chest tube management protocol

SIGNATURES

- All my questions have been answered,
- I understand the information within this informed consent form,
- I have read, or someone has read to me, each page of this participant informed consent form,
- I do not give up any of my legal rights by signing this consent form,
- I agree to take part in this study.

I consent to future contact to review and comment on the combined results (please initial):
_____ Yes _____ No

Signature of Participant	Printed Name	Date

Investigator or Delegate Statement
I have carefully explained the study to the study participant. To the best of my knowledge, the participant understands the nature, demands, risks and benefits involved in taking part in this study.

Signature of Person Conducting the Consent Discussion	Printed Name and Role	Date

Appendix H- Observation Audit Competency Checklists

COMPETENCY AUDIT CHECKLIST
Removal of Pleural chest tubes

Observation #: _____ Date: _____
Assessment completed by: Sonia Joanisse Unit: [redacted] (circle correct unit)

Type of removal:
Discontinuing drainage Without purse string sutures: ___/49 points

The nurse did	Yes	No	Points	Comments
Pre-removal				
1. Ensure written order obtained from physician	*		/1	
2. If CXR was completed, ensure reviewed by physician	*		/1	
3. Verify patient's anticoagulation status	*		/1	

4. Assess patient and chest drainage unit:
• No air leak present
  ○ Analog- no bubbling
  ○ Digital- less than 30ml/min for 8 hours
	*		/1	

• Drainage less than 20% of total body lymphatic flow	*		/1	
• Not on positive pressure ventilation	*		/1	
• Stable respiratory status	*		/1	
• Absent, mild or no increase in subcutaneous emphysema	*		/1	
• Chest tube drainage is serous/ serosanguinous	*		/1	
• Auscultate chest (within 1 hour)	*		/1	
• Vital signs (within 1 hour)	*		/1	
5. Provide analgesia as required	X		/1	X- not needed as not safety aspect. Not all patients require pain meds
6. Collect and assemble all necessary equipment	*		/1	
7. Ensure patient is on gravity	*		/1	
8. Prepare the patient by explaining the procedure and breathing techniques • Breath in and perform Valsalva manoeuver	*		/1	
9. Position patient • to expose chest tube site	*		/1	
• comfortable working height	X		/1	X- not needed for safety
10. Don clean gloves	*		/1	
11. Place absorbent pad on bedding to prevent spillage onto patient or bedding.	X		/1	X- not needed for safety
12. Remove chest tube dressing and discard	*		/1	
13. Remove gloves	*		/1	
14. Wash hands	X		/1	X- not needed for safety
15. Aseptically prepare dressing tray	*		/1	
16. Don gown and face mask	X		/1	X- not needed for patient safety

17. Clamp chest tube(s)	*		/1	
18. If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube • Thopaz: Standby, Cap Y-connector, turn on, unclamp chest tube left in • Sahara: Scrub connection, disconnect dual Sahara, connect single, unclamp chest tube left in	**		/1	** only needed if removing one of multiple chest tubes
19. Don sterile gloves	*		/1	
20. Prepare the adaptic and 4x4 gauze dressing	*		/1	
21. Cleanse chest tube site with chlorhexidine/alcohol swab sticks	*		/1	
NO PURSE STRINGS				
22. Cut and remove retentions sutures while stabilizing the chest tube with the other hand (use sterile 4x4 to maintain sterility)	*		/1	
23. Hold chest tube in dominant hand while holding dressing over chest tube site with non-dominant hand.	*		/1	
24. Instruct patient to take a deep breath, hold it and perform Valsalva manoeuver	*		/1	
25. Pull chest tube out quickly and steadily.	*		/1	
26. Maintain pressure over site with dressing while dressing secured	*		/1	
27. Instruct patient to breathe normally	*		/1	
28. Ensure chest tube is intact	*		/1	
29. Assess patient respiratory status (immediately post) • Auscultate chest • Assess for subcutaneous emphysema • Shortness of breath • Drainage at insertion site • Vital signs	 * * * * *		 /1 /1 /1 /1 /1	
30. Instruct patient to: • Stay in bed x 30 minutes • Notify RN if any shortness of breath, chest pain or discomfort and/ or drainage at the site	 * *		 /1 /1	
Post removal				
31. Dispose of chest tube and drainage canisters or systems Clean and return Thopaz pump to OR	*		/1	

32. Record pertinent information correctly on patient's chart • Assessment of patient and chest tube before removal • Date and time of chest tube removal • Patient tolerance of procedure • Patient condition post removal, including air entry, respiratory status, vital signs • Patient teaching	* * * * *		/1 /1 /1 /1 /1	

EVALUATION CRITERIA

i. The skill performance is safe, competent and consistent with performance steps as outlined above
   a. (all * points performed to be deemed safe and competent)

Total score:

1) Discontinuing drainage
   a. Without purse string sutures: ___/49 points

Satisfactory [ ] Unsatisfactory [ ]

Total number of chest tubes removed in the last 12 months: [0], [1-3], [4-6], [7-9], [10-12], [12 or more] (circle correct range)

Comments:

_____
_____
_____
_____
_____

COMPETENCY AUDIT CHECKLIST
Removal of Pleural chest tubes

Observation #: _____ Date: _____
Assessment completed by: Sonia Joanisse Unit: [redacted] (circle correct unit)

Type of removal:
Discontinuing drainage With purse string sutures: ___/52 points

The nurse did	Yes	No	Points	Comments
Pre-removal				
1. Ensure written order obtained from physician	*		/1	
2. If CXR was completed, ensure reviewed by physician	*		/1	
3. Verify patient's anticoagulation status	*		/1	
4. Assess patient and chest drainage unit:				
• No air leak present				
○ Analog- no bubbling	*		/1	
○ Digital- less than 30ml/min for 8 hours				
• Drainage less than 20% of total body lymphatic flow	*		/1	
• Not on positive pressure ventilation	*		/1	
• Stable respiratory status	*		/1	
• Absent, mild or no increase in subcutaneous emphysema	*		/1	
• Chest tube drainage is serous/ serosanguinous	*		/1	
• Auscultate chest (within 1 hour)	*		/1	
• Vital signs (within 1 hour)	*		/1	
5. Provide analgesia as required	X		/1	X- not needed as not safety aspect. Not all patients require pain meds
6. Collect and assemble all necessary equipment	*		/1	
7. Ensure patient is on gravity	*		/1	
8. Prepare the patient by explaining the procedure and breathing techniques	*		/1	
• Breath in and perform Valsalva manoeuver				
9. Position patient				
• to expose chest tube site	*		/1	
• comfortable working height	X		/1	X- not needed for safety
10. Don clean gloves	*		/1	
11. Place absorbent pad on bedding to prevent spillage onto patient or bedding.	X		/1	X- not needed for safety
12. Remove chest tube dressing and discard	*		/1	
13. Remove gloves	*		/1	
14. Wash hands	X		/1	X- not needed for safety
15. Aseptically prepare dressing tray	*		/1	
16. Don gown and face mask	X		/1	X- not needed for patient safety

17. Clamp chest tube(s)	*		/1	
18. If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube • Thopaz: Standby, Cap Y-connector, turn on, unclamp chest tube left in • Sahara: Scrub connection, disconnect dual sahara, connect single, unclamp chest tube left in	**		/1	** only needed if removing one of multiple chest tubes
19. Don sterile gloves	*		/1	
20. Prepare the adaptic and 4x4 gauze dressing	*		/1	
21. Cleanse chest tube site with chlorhexidine/alcohol swab sticks	*		/1	
PURSE STRINGS PRESENT				
22. Differentiate between retention and purse string sutures Remove knot from end of purse string	*		/1	
23. Have second nurse hold purse string and tie a loose half knot in purse string (if present)	*		/1	
24. Cut and remove retentions sutures while stabilizing the chest tube with the other hand (use sterile 4x4 to maintain sterility).	*		/1	
25. Hold chest tube in dominant hand while holding dressing over chest tube site with non-dominant hand.	*		/1	
26. Instruct patient to take a deep breath, hold it and perform Valsalva manoeuver	*		/1	
27. Pull chest tube out quickly and steadily.	*		/1	
28. Maintain pressure over site with dressing while: • second nurse securely ties off the purse string suture • dressing secured	* *		/1 /1	
29. Instruct patient to breathe normally	*		/1	
30. Ensure chest tube is intact	*		/1	
31. Assess patient respiratory status (immediately post) • Auscultate chest • Assess for subcutaneous emphysema • Shortness of breath • Drainage at insertion site • Vital signs	 * * * * *		 /1 /1 /1 /1 /1	
32. Instruct patient to: • Stay in bed x 30 minutes • Notify RN if any shortness of breath, chest pain or discomfort and/ or drainage at the site	 * *		 /1 /1	
Post removal				

33. Dispose of chest tube and drainage canisters or systems Clean and return Thopaz pump to OR	*		/1	
34. Record pertinent information correctly on patient's chart • Assessment of patient and chest tube before removal • Date and time of chest tube removal • Patient tolerance of procedure • Patient condition post removal, including air entry, respiratory status, vital signs • Patient teaching	* * * * *		/1 /1 /1 /1 /1	

EVALUATION CRITERIA

i. The skill performance is safe, competent and consistent with performance steps as outlined above
   a. (all * points performed to be deemed safe and competent)

Total score:

1) Discontinuing drainage
   a. With purse string sutures: ___/52 points

Satisfactory [ ] Unsatisfactory [ ]

Total number of chest tubes removed in the last 12 months: [0], [1-3], [4-6], [7-9], [10-12], [12 or more] (circle correct range)

Comments:

_____
_____
_____
_____
_____

COMPETENCY AUDIT CHECKLIST
Removal of Pleural chest tubes

Observation #: _____ Date: _____

Assessment completed by: Sonia Joanisse Unit: [redacted] (circle correct unit)

Type of removal:
Removal without discontinuing drainage Without purse string sutures: _____/ 49

The nurse did	Yes	No	Points	Comments
Pre-removal				
1. Ensure written order obtained from physician	*		/1	
2. If CXR was completed, ensure reviewed by physician	*		/1	
3. Verify patient's anticoagulation status	*		/1	
4. Assess patient and chest drainage unit:				
• No air leak present				
○ Analog- no bubbling	X		/1	
○ Digital- less than 30ml/min for 8 hours				(** only needed if discontinuing chest drainage)
• Drainage less than 20% of total body lymphatic flow	X		/1	
• Not on positive pressure ventilation	X		/1	
• Stable respiratory status	X		/1	
• Absent, mild or no increase in subcutaneous emphysema	X		/1	
• Chest tube drainage is serous/ serosanguinous	X		/1	
• Auscultate chest (within 1 hour)	*		/1	
• Vital signs (within 1 hour)	*		/1	
5. Provide analgesia as required	X		/1	X- not needed as not safety aspect. Not all patients require pain meds
6. Collect and assemble all necessary equipment	*		/1	
7. Ensure patient is on gravity	*		/1	
8. Prepare the patient by explaining the procedure and breathing techniques	*		/1	
• Breath in and perform Valsalva manoeuver				
9. Position patient				
• to expose chest tube site	*		/1	
• comfortable working height	X		/1	X- not needed for safety
10. Don clean gloves	*		/1	
11. Place absorbent pad on bedding to prevent spillage onto patient or bedding.	X		/1	X- not needed for safety
12. Remove chest tube dressing and discard	*		/1	
13. Remove gloves	*		/1	
14. Wash hands	X		/1	X- not needed for safety
15. Aseptically prepare dressing tray	*		/1	
16. Don gown and face mask	X		/1	X- not needed for patient safety

17. Clamp chest tube(s)	*		/1	
18. If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube • Thopaz: Standby, Cap Y-connector, turn on, unclamp chest tube left in • Sahara: Scrub connection, disconnect dual sahara, connect single, unclamp chest tube left in	**		/1	** only needed if removing one of multiple chest tubes
19. Don sterile gloves	*		/1	
20. Prepare the adaptic and 4x4 gauze dressing	*		/1	
21. Cleanse chest tube site with chlorhexidine/alcohol swab sticks	*		/1	
NO PURSE STRINGS				
22. Cut and remove retentions sutures while stabilizing the chest tube with the other hand (use sterile 4x4 to maintain sterility)	*		/1	
23. Hold chest tube in dominant hand while holding dressing over chest tube site with non-dominant hand.	*		/1	
24. Instruct patient to take a deep breath, hold it and perform Valsalva manoeuver	*		/1	
25. Pull chest tube out quickly and steadily.	*		/1	
26. Maintain pressure over site with dressing while dressing secured	*		/1	
27. Instruct patient to breathe normally	*		/1	
28. Ensure chest tube is intact	*		/1	
29. Assess patient respiratory status (immediately post) • Auscultate chest • Assess for subcutaneous emphysema • Shortness of breath • Drainage at insertion site • Vital signs	 * * * * *		 /1 /1 /1 /1 /1	
30. Instruct patient to: • Stay in bed x 30 minutes • Notify RN if any shortness of breath, chest pain or discomfort and/ or drainage at the site	 * *		 /1 /1	
Post removal				
31. Dispose of chest tube and drainage canisters or systems Clean and return Thopaz pump to OR	*		/1	

32. Record pertinent information correctly on patient's chart • Assessment of patient and chest tube before removal • Date and time of chest tube removal • Patient tolerance of procedure • Patient condition post removal, including air entry, respiratory status, vital signs • Patient teaching	* * * * *		/1 /1 /1 /1 /1	

EVALUATION CRITERIA

i. The skill performance is safe, competent and consistent with performance steps as outlined above
   a. (all * points performed to be deemed safe and competent)

Total score:

1) Removal without discontinuing drainage
   a. Without purse string sutures: _____/ 49

Satisfactory [ ] Unsatisfactory [ ]

Total number of chest tubes removed in the last 12 months: [0], [1-3], [4-6], [7-9], [10-12], [12 or more] (circle correct range)

Comments:

_____
_____
_____
_____
_____

COMPETENCY AUDIT CHECKLIST
Removal of Pleural chest tubes

Observation #: _____ Date: _____

Assessment completed by: Sonia Joanisse Unit: [redacted] (circle correct unit)

Type of removal:
Removal without discontinuing drainage With purse string sutures: _____/ 56

The nurse did	Yes	No	Points	Comments
Pre-removal				
1. Ensure written order obtained from physician	*		/1	
2. If CXR was completed, ensure reviewed by physician	*		/1	
3. Verify patient's anticoagulation status	*		/1	
4. Assess patient and chest drainage unit:				
• No air leak present				
○ Analog- no bubbling	X		/1	
○ Digital- less than 30ml/min for 8 hours				(** only needed if discontinuing chest drainage)
• Drainage less than 20% of total body lymphatic flow	X		/1	
• Not on positive pressure ventilation	X		/1	
• Stable respiratory status	X		/1	
• Absent, mild or no increase in subcutaneous emphysema	X		/1	
• Chest tube drainage is serous/ serosanguinous	X		/1	
• Auscultate chest (within 1 hour)	*		/1	
• Vital signs (within 1 hour)	*		/1	
5. Provide analgesia as required	X		/1	X- not needed as not safety aspect. Not all patients require pain meds
6. Collect and assemble all necessary equipment	*		/1	
7. Ensure patient is on gravity	*		/1	
8. Prepare the patient by explaining the procedure and breathing techniques	*		/1	
• Breath in and perform Valsalva manoeuver				
9. Position patient				
• to expose chest tube site	*		/1	
• comfortable working height	X		/1	X- not needed for safety
10. Don clean gloves	*		/1	
11. Place absorbent pad on bedding to prevent spillage onto patient or bedding.	X		/1	X- not needed for safety
12. Remove chest tube dressing and discard	*		/1	
13. Remove gloves	*		/1	
14. Wash hands	X		/1	X- not needed for safety
15. Aseptically prepare dressing tray	*		/1	
16. Don gown and face mask	X		/1	X- not needed for patient safety

17. Clamp chest tube(s)	*		/1	
18. If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube • Thopaz: Standby, Cap Y-connector, turn on, unclamp chest tube left in • Sahara: Scrub connection, disconnect dual sahara, connect single, unclamp chest tube left in	**		/1	** only needed if removing one of multiple chest tubes
19. Don sterile gloves	*		/1	
20. Prepare the adaptic and 4x4 gauze dressing	*		/1	
21. Cleanse chest tube site with chlorhexidine/ alcohol swabsticks	*		/1	
PURSE STRINGS PRESENT				
22. Differentiate between retention and purse string sutures Remove knot from end of purse string	*		/1	
23. Have second nurse hold purse string and tie a loose half knot in purse string (if present)	*		/1	
24. Cut and remove retentions sutures while stabilizing the chest tube with the other hand (use sterile 4x4 to maintain sterility).	*		/1	
25. Hold chest tube in dominant hand while holding dressing over chest tube site with non-dominant hand.	*		/1	
26. Instruct patient to take a deep breath, hold it and perform Valsalva manoeuver	*		/1	
27. Pull chest tube out quickly and steadily.	*		/1	
28. Maintain pressure over site with dressing while: • second nurse securely ties off the purse string suture • dressing secured	* *		/1 /1	
29. Instruct patient to breathe normally	*		/1	
30. Ensure chest tube is intact	*		/1	
31. Assess patient respiratory status (immediately post) • Auscultate chest • Assess for subcutaneous emphysema • Shortness of breath • Drainage at insertion site • Vital signs	 * * * * *		 /1 /1 /1 /1 /1	
32. Instruct patient to: • Stay in bed x 30 minutes • Notify RN if any shortness of breath, chest pain or discomfort and/ or drainage at the site	* *		/1 /1	
Post removal				

33. Dispose of chest tube and drainage canisters or systems Clean and return Thopaz pump to OR	*		/1	
34. Record pertinent information correctly on patient's chart • Assessment of patient and chest tube before removal • Date and time of chest tube removal • Patient tolerance of procedure • Patient condition post removal, including air entry, respiratory status, vital signs • Patient teaching	 * * * * *		 /1 /1 /1 /1 /1	

EVALUATION CRITERIA

i. The skill performance is safe, competent and consistent with performance steps as outlined above
   a. (all * points performed to be deemed safe and competent)

Total score:

1) Removal without discontinuing drainage
   a. With purse string sutures: _____/ 56

Satisfactory [ ] Unsatisfactory [ ]

Total number of chest tubes removed in the last 12 months: [0], [1-3], [4-6], [7-9], [10-12], [12 or more] (circle correct range)

Comments:

_____
_____
_____
_____
_____

N2 NETWORK OF NETWORKS RÉSEAU DES RÉSEAUX

Task Delegation Log

PROTOCOL NUMBER:	PRINICIPAL INVESTIGATOR (PI): QUALIFIED INVESTIGATOR (QI): *(if different from PI)*	SITE NUMBER :
FULL STUDY TITLE :	INSTITUTION:	SPONSOR NAME:

Name (N) and Role (R) (PRINT CLEARLY)	Full Signature	Initials	Authorized Responsibilities, Write Numbers (see list)	Dates of Study Involvement *(yyyy-mmm-dd)*	PI/QI Signature to Authorize Delegation and affirmation of identity of individual	Date of Signature *(yyyy-mmm-dd)*	PI/QI Signature for End of Study or End of Role	Date of Signature *(yyyy-mmm-dd)*
[redacted]			22 - data validation	Start: Oct 25/19 Stop: Oct 29/19				
			22 - Data validation	Start: October 30 2019 Stop: October 30 2019				
				Start Stop				
R								
N				Start				
R				Stop				
N				Start				
R				Stop				
N				Start				
R				Stop				

Instructions:
Identification of study role includes but is not limited to sub-investigators, study nurses, clinical nurses, study coordinators, pharmacist (when appropriate, technicians, nurse practitioners, physician assistants, residents, and data recorders). List individual's delegated study-related tasks (ICH GCP 4.1.5) as described in the Responsibility List. Signatures/Initials required for all persons authorized to make entries and/or corrections to Case Report Forms (ICH GCP 8.3.24). When tasks are delegated by the PI/QI, the PI/QI is responsible for providing adequate supervision and training of those to whom tasks are delegated. PI/QI affirmation and delegation, by means of signature and date above, must occur after individual has completed all required training and prior to conducting any study-related tasks. Note: If a research team members' role changes, reassign remaining study-related tasks from the Responsibility List to a qualified site research team member by creating a new line and include the new start date.

Task Delegation/Responsibility List:

1 Subject Identification, recruitment	7 Instruction on Investigational Product Administration	13 e-CRF Signature	19 Training Staff	25 Other: _____
2 Obtain Informed Consent	8 Investigational Product Dispensing	14 Vital measurements (i.e. BP, HR, temp, weight, ECG)	20 Filing and Archiving Data	26 Other: _____

Appendix J- Knowledge Survey Questions and Scores

1. Have you reviewed the chest tube removal policy within the last 4 weeks?	**Frequency**	**Percent**
Correct	54	100
2. Under normal conditions, intrapleural pressure is		
Correct	54	100
3. True or False: A verbal order may be obtained for removal of chest tubes?		
Correct	50	92.59
4. True or False: You must receive an order to place a chest tube on gravity prior to removal.		
Correct	34	62.96
5. Purse string sutures:		
Correct	53	98.15
6. True or False: Chest tubes are removed at end expiration		
Correct	50	92.59
7. True or False: if patients are unable to hold their breath, or follow instructions, chest tubes should be removed at peak inspiration?		
Correct	54	100
8. The following are criteria for chest tube removal (select all that apply)		
Correct	42	77.78
9. Your patient weights 75 kg. How much fluid would be the maximum amount of acceptable drainage in the previous 24 hours if considering chest tube removal?		
Correct	53	98.15
10. True or False: I can remove my respirology patient's chest tube		
Correct	54	100
11. How do I check for an air leak with the Sahara Pleur-Evac system?		
Correct	53	98.15

12. How do I check for an air leak with the Thopaz digital system?		
Correct	53	98.15
13. Your patient has a 24Fr and a 28Fr chest tube to the right chest after undergoing a right sided upper lobectomy. Your patient has subcutaneous emphysema that is visible on inspection and can be palpated. This patient's subcutaneous emphysema can be palpated along the right lateral, anterior and posterior chest. How would you class this patient's subcutaneous emphysema?		
Correct	52	96.3
14. True or False: With this new policy, I can now remove intrathoracic Jackson-Pratt drains as well		
Correct	54	100
15. How many patient identifiers must be used when identifying a patient prior to chest tube removal?		
Correct	51	94.44
16. Before removing the chest tube, the site will be cleaned with:		
Correct	50	92.59
17. Once the chest tube is removed, assessments will be completed:		
Correct	50	92.59
18. Once chest tube removed, assessments will be completed immediately post and at 60 minutes post. Assess for:		
Correct	54	100
19. True or False: Once chest tube removed, patient should remain on bedrest for 1 hour.		
Correct	49	90.74
20. True or False: Once chest tube removed: If purse strings are present, dressing to remain insitu for: 24 hours		
Correct	51	94.44
21. True or False: Once chest tube removed: if no purse strings present, dressing to remain insitu for 24 hours.		
Correct	52	96.3
22. The dressing applied to the site post chest tube removal will be:		
Correct	54	100

23. Bubbling in the water seal chamber of a chest tube indicates:		
Correct	52	96.3
24. True or False: A new CXR is always required prior to chest to removal.		
Correct	37	68.52
25. True or False: A patient has 2 chest tubes to the right chest. A 28Fr and a 24Fr chest tube. Patient continues to have an air leak of 300ml/min. One chest tube can be removed.		
Correct	48	88.89
26. True or False: I received an order to remove the anterior and posterior chest tubes. I must wait 1 hour in between each tube.		
Correct	44	81.48
27. Your patient weighs 60kg therefore, their allotted output for a 24-hour period is 300ml (60kg x 5= 300). Patient has drained 400ml in the previous 24 hours. What are your next steps?		
Correct	39	72.22
28. You have a patient with a 28Fr and 24Fr chest tube to the right side. Which chest tube should be removed first?		
Correct	46	85.19
29. You have a patient with two 24Fr chest tubes to the left chest; one anterior and one posterior. Which chest tube should be removed first.		
Correct	52	96.3
30. You are removing one of two of your patient's chest tubes that are currently to a dual Pleur-Evac Sahara. Arrange the following steps for removal in the proper order:		
Correct	9	16.67

Appendix K- Nurses Comments on What Led to Reported Level of Confidence

Strongly agree- 25/54= 46%			Moderately agree- 25/54= 48%				Slightly agree- 2/54= 4%
Policy and resources	Education and support	Frequency and practice	Policy and resources	Education and support	Frequency and practice	Other	Frequency and practice
"I feel I have a good understanding of the policy and have seen multiple types of chest tubes on the floor that were put in by different MD's which have allowed me to gain confidence in chest tube removal"	"Involved in training and certification of other nurses"	"Methodically think about steps. amount of chest tubes being pulled over time"	"Training, resources always available"	"Had good teaching"	"Practice"	"I worry I don't tie the chest tube purse string sutures tight enough"	"Not having the opportunity to remove them and my discomfort in actually removing them"

"I've been trained by previous nurse educator. I've seen a few being pulled out. I've pulled a few chest tubes as per policy. I follow the procedure and policy of chest tube removals"	"Good teaching and support"	"Practice"	"Readily available resources"		"Pulling more tubes"	"No comment"	"I only do so many in a year that I feel I may have forgotten something"
"Readily available resources"	"Adequate training and practice"	"Removing them"		"Years of experience, watching procedure by MD and training for procedure"	"Experience?"	"No problems"	

“I can always look at the policy on chest tube removal prior to removing it to refresh my memory”	“Good amount of training and the opportunity to pull chest tubes fairly frequently”	“We frequently remove chest tubes”		“I am still sometimes unable to identify what kind of stitch the doctor has chosen and therefore prefer second opinion from another RN”	“If I don't remove chest tubes often, I forget steps. I need more time to check the categories. Sometimes I was very busy and I needed to remove the chest tube early enough so the patient can be discharged before 11:00. I found that put pressure on me and I'm afraid if I forget something when I'm in a rush”	“No problems”	
	“Excellent teaching of the policy”	“Frequency of pulling the tubes”		“I am relatively confident when removing chest tubes however still require	“Being part time, I haven't had an opportunity to remove as many as my colleagues”		

				guidance at times with the various suture types and examining chest X-rays”			
	“Proper training/education and having support at the beginning of pulling chest tubes”	“Performing an increasing amount of CT removals increases my confidence”		“Training”	“If I have removed a chest tube recently, I feel quite confident. However, sometimes it is months between pulls and I feel less confident”		
	“The availability and assistance of champions to answer my questions and assist me when I did not pull for x amount of time”	“Adequate training and practice”		“Having support from educators and nurse champions”	“Experience with chest tube removal, still have to double check the sutures, still feel unsure”		

	"The process needed to become certified: Class, watch 3, pull 3 with assistance Also knowing the staff is always available and happy to help with any questions!"	"Good amount of training and the opportunity to pull chest tubes fairly frequently"		"At times still need a second opinion on the stitching being used aside from this I am confident in my skills"	"Overall, I feel comfortable and confident but at times there are long periods of time where I do not get the opportunity to pull chest tubes. This is the only reason I cannot say strongly agree"		
		"The fact that I have successfully removed many with out post removal complications and very aware of what the policy states"		"Still difficulty at times differentiating purse string vs normal suture ties"	"The more opportunities to pull chest tubes and practice, the more confident I get"		
		"I have taken a lot of chest tubes out. I have assisted to take out		"Training, resources always available"	"Been on mat leave for a year, therefore have not removed a		

		tubes with the Residents and other nurses. I wouldn't do it if I was confident I could do it safely"			tube in a while"		
		"I've been trained by previous nurse educator. I've seen a few being pulled out. I've pulled a few chest tubes as per policy. I follow the procedure and policy of chest tube removals"			"It is hit or miss in [redacted] when it comes to discontinuing chest tubes. I will often go a few weeks between opportunities to take out a chest tube"		
		"Number of tubes I have removed"					

Appendix L- Observation Audit Competency Checklists Results

Discontinuation of chest drainage with no purse strings

N	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Median	Lower Quartile	Upper Quartile	Mode	Minimum	Maximum
16	43.88	3.58	41.97	45.78	44	43	46.5	44	36	49

Discontinuation of chest drainage with purse strings

N	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Median	Lower Quartile	Upper Quartile	Mode	Minimum	Maximum
6	48.5	1.87	46.54	50.46	48.5	47	50	.	46	51

Removal of chest tube without discontinuing drainage with purse strings

N	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Median	Lower Quartile	Upper Quartile	Mode	Minimum	Maximum
3	52.67	0.58	51.23	54.1	53	52	53	53	52	53

Appendix M- Observation Audit Competency Checklist Individual Steps and Scores

	Unit	Frequency	Percent
	Inpatient	16	64
	Level II ICU	9	36
2	**Type of removal**		
	Discontinuing drainage with purse strings	6	24
	Discontinuing drainage with no purse strings	16	64
	Removal without discontinuing drainage with purse strings	3	12
3	**Ensure written order obtained from physician**		
	No	0	0
	Yes	17	68
	Yes (Verbal)	8	32
4	**If CXR was completed, ensure reviewed by physician**		
	No	0	0
	Yes	17	68
	Yes (Verbal)	8	32
5	**Verify patient's anticoagulation status**		
	No	3	12
	Yes	12	48
	Yes (Verbal)	10	40
6	**Assess patient and chest drainage unit: No air leak present**		
	No	0	0
	Yes	13	52
	Yes (Verbal)	12	48
7	**Assess patient and chest drainage unit: Drainage**		
	No	0	0
	Yes	13	52
	Yes (Verbal)	12	48
8	**Assess patient and chest drainage unit: Positive pressure ventilation**		
	No	6	24
	Yes	8	32
	Yes (Verbal)	11	44
9	**Assess patient and chest drainage unit: stable respiratory status**		
	No	0	0
	Yes	10	40
	Yes (Verbal)	15	60
10	**Assess patient and chest drainage unit: subcutaneous emphysema**		
	No	0	0
	Yes	17	68
	Yes (Verbal)	8	32
11	**Assess patient and chest drainage unit: drainage is serous/serosanguinous**		

	No	3	12
	Yes	11	44
	Yes (Verbal)	11	44
12	**Assess patient and chest drainage unit: Auscultate (within 1 hour)**		
	No	0	0
	Yes	19	76
	Yes (Verbal)	6	24
13	**Assess patient and chest drainage unit: Vital signs (within 1 hour)**		
	No	0	0
	Yes	18	72
	Yes (Verbal)	7	28
14	**Provide analgesia**		
	No	13	52
	Yes	12	48
15	**Collect and assemble equipment**		
	No	1	4
	Yes	24	96
16	**Ensure patient is on gravity**		
	No	0	0
	Yes	25	100
17	**Prepare patient by explaining and breathing technique**		
	No	0	0
	Yes	25	100
18	**Position patient: expose chest tube site**		
	No	0	0
	Yes	25	100
19	**Position patient: comfortable working height**		
	No	0	0
	Yes	25	100
20	**Don clean gloves**		
	No	1	4
	Yes	24	96
21	**Place absorbent pad on bedding to prevent spillage onto patient or bedding**		
	No	1	4
	Yes	24	96
22	**Remove chest tube dressing and discard**		
	No	0	0
	Yes	25	100
23	**Remove gloves**		
	No	2	8
	Yes	23	92
24	**Wash hands**		

	No	18	72
	Yes	7	28
25	**Aseptically prepare dressing tray**		
	No	0	0
	Yes	25	100
26	**Don gown and face mask**		
	No	7	28
	Yes	18	72
27	**Clamp chest tube(s)**		
	No	0	0
	Yes	25	100
28	**If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube: Thopaz- Standby**		
	Yes	3	100
	Not applicable	22	
29	**If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube: Thopaz- Cap Y-connector**		
	Yes	3	100
	Not applicable	22	
30	**If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube: Thopaz- turn on Thopaz**		
	No	1	33.33
	Yes	2	66.67
	Not applicable	22	
31	**If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube: Thopaz- unclamp chest tube left in**		
	No	1	33.33
	Yes	2	66.67
	Not applicable	22	
32	**If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube: Sahara- scrub connection**		
	Not applicable	25	100
33	**If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube: Sahara- Disconnect dual Sahara**		
	Not applicable	25	100
34	**If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube: Sahara- Connect single Sahara**		
	Not applicable	25	100
35	**If removing 1 of 2 chest tubes, ensure proper setup for remaining chest tube: Sahara- unclamp chest tube left in**		
	Not applicable	25	100
36	**Don sterile gloves**		
	No	0	0
	Yes	25	100

37	**Prepare adaptic and 4x4 gauze dressing**		
	No	0	0
	Yes	25	100
38	**Cleanse chest tube with Chlorhexidine and alcohol swab sticks**		
	No	2	8
	Yes	23	92
39	**No purse strings: cut and remove retention sutures**		
	Yes	16	100
	Not applicable	9	
40	**No purse strings: while stabilizing the chest tube**		
	No	4	25
	Yes	12	75
	Not applicable	9	
41	**No purse strings: hold chest tube in dominant hand and dressing over chest tube site**		
	No	0	0
	Yes	16	100
	Not applicable	9	
42	**No purse strings: Instruct patient to perform Valsalva**		
	No	0	0
	Yes	16	100
	Not applicable	9	
43	**No purse strings: pull chest tube out quickly and steadily**		
	No	0	0
	Yes	16	100
	Not applicable	9	
44	**No purse strings: maintain pressure over site with dressing while dressing secured**		
	No	0	0
	Yes	16	100
	Not applicable	9	
45	**Purse string present: differentiate between retention and purse string sutures and remove knot from end of purse string**		
	No	0	0
	Yes	9	100
	Not applicable	16	
46	**Purse strings present: have second nurse hold purse string and tie a loose half knot in purse string**		
	No	0	0
	Yes	9	100
	Not applicable	16	
47	**Purse strings present: cut and remove retention sutures**		
	No	0	0

	Yes	9	100
	Not applicable	16	
48	**Purse strings present: while stabilizing the chest tube**		
	No	4	44.44
	Yes	5	55.56
	Not applicable	16	
49	**Purse strings present: hold chest tube in dominant hand and dressing over chest tube site**		
	No	0	0
	Yes	9	100
	Not applicable	16	
50	**Purse strings present: Instruct patient to perform Valsalva**		
	No	0	0
	Yes	9	100
	Not applicable	16	
51	**Purse strings present: pull chest tube out quickly and steadily**		
	No	0	0
	Yes	9	100
	Not applicable	16	
52	**Purse strings present: Maintain pressure over site with dressing while second nurse ties purse string sutures**		
	No	0	0
	Yes	9	100
	Not applicable	16	
53	**Purse strings present: Maintain pressure over site with dressing while dressing secured**		
	No	0	0
	Yes	9	100
	Not applicable	16	
54	**Instruct patient to breath normally**		
	No	0	0
	Yes	25	100
55	**Ensure chest tube is intact**		
	No	0	0
	Yes	25	100
56	**Assess respiratory status immediately post: auscultate chest**		
	No	0	0
	Yes	25	100
57	**Assess respiratory status immediately post: subcutaneous emphysema**		
	No	3	12
	Yes	22	88
58	**Assess respiratory status immediately post: shortness of breath**		

	No	1	4
	Yes	21	84
	Yes (Verbal)	3	12
59	**Assess respiratory status immediately post: drainage at insertion site**		
	No	5	20
	Yes	18	72
	Yes (Verbal)	2	8
60	**Assess respiratory status immediately post: vital signs**		
	No	0	0
	Yes	25	100
61	**Instruct patient to: stay in bed x 30 minutes**		
	No	0	0
	Yes	25	100
62	**Instruct patient to: notify RN if any shortness of breath, chest pain, or discomfort and/or drainage at the site**		
	No	6	24
	Yes	19	76
63	**Dispose of chest tubes, drainage canisters or systems as applicable. Clean and return Thopaz pump to OR**		
	No	0	0
	Yes	25	100
64	**Record pertinent information correctly on patient's chart: assessment of patient and chest tube before removal**		
	No	8	32
	Yes	17	68
65	**Record pertinent information correctly on patient's chart: date/time of chest tube removal**		
	No	1	4
	Yes	24	96
66	**Record pertinent information correctly on patient's chart: patient tolerance of procedure**		
	No	4	16
	Yes	21	84
67	**Record pertinent information correctly on patient's chart: patient condition post removal including air entry, respiratory status, vital signs**		
	No	7	28
	Yes	18	72
68	**Record pertinent information correctly on patient's chart: patient teaching**		
	No	11	44
	Yes	14	56
69	**Audit results**		

	Satisfactory	3	12
	Unsatisfactory	22	88
70	**Total number of chest tubes removed in last 12 months**		
	0	1	4
	4-6	7	28
	7-9	7	28
	10-12	7	28
	12 or more	3	12

Appendix N- Chart Audit Results

	Unit	Frequency	Percent
	Inpatient	13	52%
	Level II ICU	12	48%
1	**Assessment of patient and chest tube before removal (within 1 hour): Auscultate chest**		
	Yes	15	60%
	No	2	8%
	Not within an hour	8	32%
3	**Assessment of patient and chest tube before removal (within 1 hour): Subcutaneous emphysema**		
	Yes	11	44%
	No	8	32%
	Not within an hour	6	24%
5	**Assessment of patient and chest tube before removal (within 1 hour): Shortness of breath**		
	Yes	3	12%
	No	20	80%
	Not within an hour	2	8%
7	**Assessment of patient and chest tube before removal (within 1 hour): Vital signs**		
	Yes	22	88%
	No	1	4%
	Not within an hour	2	8%
9	**Date of chest tube removal: Year**		
	Yes	25	100%
10	**Date of chest tube removal: Month**		
	Yes	25	100%
11	**Date of chest tube removal: Day**		
	Yes	25	100%
12	**Time of chest tube removal: Hour**		
	Yes	16	64%
	No	9	36%

13	**Time of chest tube removal: Minutes**		
	Yes	16	64%
	No	9	36%
14	**Patient tolerance of procedure**		
	Yes	18	72%
	No	7	28%
15	**Patient condition post removal- immediately: Auscultate chest**		
	Yes	14	56%
	No	11	44%
16	**Patient condition post removal- immediately: Assess subcutaneous emphysema**		
	Yes	14	56%
	No	11	44%
17	**Patient condition post removal- immediately: Shortness of breath**		
	Yes	4	16%
	No	21	84%
18	**Patient condition post removal- immediately: Drainage at insertion site**		
	Yes	5	20%
	No	20	80%
19	**Patient condition post removal- immediately: Vital signs**		
	Yes	23	92%
	No	2	8%
20	**Patient condition post removal- 60 minutes post removal: Auscultate chest**		
	Yes	7	28%
	No	11	44%
	Not within an hour	7	28%
22	**Patient condition post removal- 60 minutes post removal: Assess subcutaneous emphysema**		
	Yes	2	8%
	No	15	60%
	Not within an hour	8	32%

	Patient condition post removal- 60 minutes post removal:		
24	**Shortness of breath**		
	Yes	1	4%
	No	21	84%
	Not within an hour	3	12%
	Patient condition post removal- 60 minutes post removal:		
26	**Drainage at insertion site**		
	Yes	4	16%
	No	15	60%
	Not within an hour	6	24%
	Patient condition post removal- 60 minutes post removal:		
28	**Vital signs**		
	Yes	21	84%
	No	2	8%
	Not within an hour	2	8%
30	**Patient teaching: Remain in bed x 30 mins**		
	Yes	21	84%
	No	4	16%
31	**Patient teaching: Notify nurse if any shortness of breath**		
	Yes	18	72%
	No	7	28%
32	**Patient teaching: Notify nurse if any chest pain**		
	Yes	16	64%
	No	9	36%
33	**Patient teaching: Notify nurse if discomfort**		
	Yes	16	64%
	No	9	36%