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EVALUATION OF A SIMULATION-BASED, E-LEARNING INTERVENTION TO DEVELOP PRELICENSURE NURSING STUDENTS' CLINICAL COMPETENCY TO RECOGNIZE TRACHEOSTOMY AIRWAY COMPLICATIONS

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by

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DISSERTATION

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ABSTRACT

EVALUATION OF A SIMULATION-BASED, E-LEARNING INTERVENTION TO DEVELOP PRELICENSURE NURSING STUDENTS' CLINICAL COMPETENCY TO RECOGNIZE TRACHEOSTOMY AIRWAY COMPLICATIONS

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Tracheostomy airway patient safety errors are a global, yet preventable problem. Unrecognized tracheostomy airway complications lead to patient deterioration, resulting in hypoxic brain damage and death or permanent disability. The majority of preventable tracheostomy events occur after patient discharge from the intensive care setting. These catastrophic events are attributed to deficiencies in competent and safe nursing care. Prelicensure nursing students have few clinical opportunities to learn tracheostomy management and may enter nursing practice lacking the clinical competency (CC) to recognize a tracheostomy airway problem. Simulation is a modality for learning high-risk skills such as tracheostomy care (TC) in a setting that eliminates patient harm. There is a lack of research exploring nursing students' tracheostomy management. The purpose of this study was to explore the effectiveness of a simulation-based, e-learning intervention to prepare prelicensure nursing students to provide safe TC and recognize a tracheostomy airway complication. A quasiexperimental pretest-posttest pilot study was conducted with a convenience sample of 34 baccalaureate prelicensure nursing students. A tracheostomy competency survey was administered before and after the intervention. The pretest and posttest CC scores were compared via a paired samples *t*-test and linear mixed model (LMM) for repeated measures. The *t*-test and LMM results demonstrated a significant increase ($p < .001$) in CC scores over time. These results support the adoption of a simulation-based, e-learning modality to teach high-risk TC skills into prelicensure nursing curricula. Learning to recognize a tracheostomy airway complication will enable graduate nurses to provide safe care to tracheostomy patients upon entry to nursing practice.

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DEDICATION

This work is dedicated to my husband, Dr. Howard Tobin, for his unwavering support, encouragement, and love as I pursued my dream of earning a Ph.D. You believed in me and never doubted my ability to succeed. Your pride in me was a motivation to persevere. Thank you for the sacrifices you made while I was on this journey and for the many meals you prepared when I was immersed in studying and writing. I am deeply grateful.

I further dedicate this work to my family. My parents gave me constant support and love along the journey. Your pride in my accomplishments brings me joy. And I am grateful to Dr. Jack Bargainer, who encouraged me to begin the Ph.D. journey.

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CHAPTER 1

Tracheostomy placement has doubled in the last twenty years in the United States (Mehta et al., 2015). Hospitalized patients who have tracheostomy artificial airways are at risk for clinical deterioration and death due to deficiencies in health care professionals' clinical competency to provide safe tracheostomy care (McGrath & Thomas, 2010; Sodhi et al., 2014; Szmuk et al., 2008). Registered nurses (RNs) are frontline managers of patient care and often the first to respond to clinically deteriorating patients, yet many new RNs have not developed the clinical competency to recognize a tracheostomy complication (Benner et al., 2010; Fisher & King, 2013; Hart et al., 2014; McGrath et al., 2012). Due to patient safety concerns, prelicensure nursing students have few clinical opportunities to manage tracheostomy airways and consequently learn to care for these vulnerable patients by "trial and error", in the rapid-changing, high-acuity setting of their initial job placement (American Association of Colleges of Nursing, 2008 [AACN]; Dorton et al., 2014; Fisher & King, 2013; Heffner et al., 2005, p. 140; McDonough et al., 2016; McGrath & Thomas, 2010; Smith-Miller, 2006). Simulation is used extensively in nursing education to develop learners' clinical competency in a safe setting, where patient harm is avoided (Gaba, 2004; Levett-Jones & Guinea, 2017; National Council of State Boards of Nursing [NCSBN], 2016). Yet, research exploring the use of simulation as an educational strategy to develop prelicensure students' clinical competency to provide safe tracheostomy care (TC) is lacking.

Background and Significance

Six and a half million adults and children in the United States (U.S.) have tracheostomies, with a global annual incidence of new tracheostomy placement estimated at 100,000 (U.S.), 37,000 (Germany), 15,000 (United Kingdom), and 7000 in Australia and New Zealand (Cheung

& Napolitano, 2014; Garrubba et al., 2009; Joseph, 2011; Klemm & Nowak, 2017; Lalabekyan et al., 2016; Sodhi et al., 2014). Reports from professional medical organizations indicate the global rate of tracheostomy placement has further increased since the outbreak of the coronavirus disease 2019 (COVID-19) pandemic (American Academy of Otolaryngology - Head and Neck Surgery, 2020; ENT UK, 2020). The increase is attributed to the effects of COVID-19 on the respiratory system and a corresponding dependence on mechanical ventilation (AOA-HNS, 2020; Benito et al., 2021; Volo et al., 2020). Subsequently, the patient undergoes tracheotomy to mitigate the complications of prolonged laryngeal intubation (AOA-HNS, 2020; Benito et al., 2021; COVIDTrach Collaborative, 2021). In Italy, one of the first countries to experience the outbreak, the incidence of tracheostomy placement in one intensive care unit (ICU) went up by 69.5% (Volo et al., 2020). During a three-week period in March to April 2020, 1400 tracheostomies were performed in Spain (Martin-Villares et al., 2021). United Kingdom (U.K.) hospitals participating in the COVIDTrach study in 2020 study reported that 564 mechanically ventilated patients received a tracheostomy in a one-month period (COVIDTrach Collaborative, 2021; Mehta et al., 2015).

Internationally, the mortality rate of hospitalized patients who have a tracheostomy airway (subsequently described as *tracheostomized*) is 17% to 29% (Halum et al., 2012; Martinez et al., 2018; Martinez et al., 2009; Shah et al., 2012). It is estimated that 1000 life-threatening tracheostomy events and 500 tracheostomy-related deaths–deaths during tracheostomy placement and post-operative tracheostomy tube complications–occur annually in U.S. hospitals (Das et al., 2012; Halum et al., 2012). Many clinicians and researchers, however, assert that deaths due to unrecognized tracheostomy airway complications are underreported and the mortality rate is rising (Cramer et al., 2019b; Das et al., 2012; Fernandez-Bussy et al., 2015; Klemm & Nowak, 2017; Rassekh et al., 2015; Shah et al., 2012).

Tracheostomy Complications

The two most common tracheostomy complications are accidental decannulation (dislodgement or removal) of the tracheostomy tube and obstruction of the tube with a mucus plug (Dawson, 2014; Farida et al., 2016; Rassekh et al., 2015; Wilkinson et al., 2015). Risk factors include the presence of tenacious secretions (due to the potential for airway blockage), obesity (due to unrecognized displacement of the tube into a false passage external to the trachea), and heart failure (Halum et al., 2012; Martinez et al., 2009; McGrath & Haley, 2017; Rassekh et al., 2015; Shah et al., 2012). When a tracheostomy complication goes unrecognized, the patient's status will rapidly deteriorate, resulting in catastrophic events such as hypoxic brain damage and death (Das et al., 2012; Halum et al., 2012; McGrath & Thomas, 2010; Wilkinson et al., 2015).

A common denominator for the occurrence of tracheostomy complications is that the majority of events occur to patients hospitalized outside of the ICU setting, on medical-surgical, geriatric, oncology, and rehabilitation units, collectively referred to as *nursing unit* (McGrath & Thomas, 2010; Smith-Miller, 2006; Wilkinson et al., 2015). Between 3% to 60% of tracheostomized patients hospitalized on nursing units experience at least one life-threatening complication (Freeman et al., 2013; McGrath & Thomas, 2010; Shah et al., 2012; Spataro et al., 2017). In a UK National Patient Safety Agency investigation, 75% of patients sustained identifiable harm such as cardiac arrest, respiratory arrest, and hypoxic brain damage (Wilkinson et al., 2015; Wilkinson et al., 2014, June 13). Furthermore, the 30-day all-cause readmission rate post tracheostomy is 23.9% (one in four patients), one of the highest rates for less frequently performed procedures such as tracheotomy (Weiss et al., 2013).

Nursing Competency

Accidental decannulation and tracheostomy tube obstruction are preventable complications, yet these life-threatening incidents have occurred due to deficiencies in the competent performance of basic nursing skills such as hand-off report, patient repositioning, patient transfer and transport, and the use of oxygen and suction equipment (Das et al., 2012; Halum et al., 2012; McGrath & Thomas, 2010; Wilkinson et al., 2015). Omissions in safe management of the tracheostomy airway, including verifying the tracheostomy tube ties are secure before turning a patient, placing emergency equipment at the bedside, ensuring alternate communication methods when the tracheostomy patient is non-verbal, and recognizing airway complications have led to permanent disability and death (Das et al., 2012; Fernandez-Bussy et al., 2015; Halum et al., 2012; Wilkinson et al., 2015).

Nursing Education

The RN shortage and retirement boom has created instability on nursing units as newer RNs may lack the expertise to recognize and manage patient deterioration incidents (AACN, 2019b; Buerhaus et al., 2017; Halum et al., 2012). Concerns for patient safety when the health care team is inexperienced have led to health care organizations prohibiting student performance of high-risk skills such as TC (Buerhaus et al., 2017; Smith-Miller, 2006). Further, a shortage of acute care hospital clinical sites, the setting where nursing students traditionally learn nursing skills, is a barrier to providing consistently equitable clinical experiences (AACN, 2019a; Benner et al., 2010; Lee et al., 2017). Inequitable clinical experiences limit evaluation of student clinical competency at program end (Lee et al., 2017). As clinical competency, including the ability to safely perform TC, is expected when graduating nurses enter the workforce, academic educators have adopted simulation as a teaching method that preempts learning on vulnerable patients (Bolsega & Sole, 2018; Buerhaus et al., 2017; Woods et al., 2015).

Simulation

Simulation is a core educational technique and mainstay of prelicensure nursing curricula as well as an adjunct to developing skills competency when access to high-risk procedures is unavailable (Decker et al., 2008; Gaba, 2004; NCSBN, 2016; Smiley, 2019). Nursing organizations recommend simulation as an evidence-based alternative that omits the patient safety concerns of traditional clinical experiences (AACN, 2019a; Kohn et al., 2000; NCSBN, 2016). Simulation provides nursing students with hands-on practice to learn the psychomotor, cognitive, and affective skills needed to recognize and respond to the deteriorating patient *before* they arrive at the patient's bedside (Berndt, 2014; Fisher & King, 2013; Kardong-Edgren et al., 2010; National League for Nursing [NLN], 2014). In 2019, the AACN charged academic nursing leaders with ensuring nursing students receive a mixture of "real life" (hospital) and simulated clinical experiences with high-acuity, low-opportunity (HALO) patient situations, such as the vulnerable tracheostomized patient (AACN, 2019a, p. 2; Pritchett et al., 2016; Smith-Miller, 2006). However, the outcome of simulation on the development of prelicensure nursing students' clinical competency to recognize a tracheostomy complication is unknown and is the purpose of this study.

Theoretical Framework

Experiential Learning Theory (ELT) is a widely used educational theory that describes how learners' experiences are transformed into reliable knowledge (Kolb, 2015). Kolb (2015) describes learning as " … the process whereby knowledge is created through the transformation of experience." (p. 49). During and after an experience, the self-evaluation, thinking, and planning for future, similar experiences leads to a change in the way a person thinks and behaves (Chmil et al., 2015; Lisko & O'Dell, 2010). Educators in business, education, and the health professions use ELT as a framework for understanding how students learn (Kolb, 2015). ELT is used as a guide for designing, implementing, and evaluating simulation-based clinical experiences in nursing, medicine, and other health professions education (Cooper et al., 2017; Kaakinen & Arwood, 2009; Laschinger, 1990; Poore et al., 2014; Rourke et al., 2010).

ELT Description

Organizational behavior expert and educator David Kolb developed ELT in the 1970s to address contemporary educational problems (Kolb, 1984; Laschinger, 1990). Kolb (2015) was dissatisfied with the influence of the prevailing positivism philosophy on traditional educational methods, manifested as a denial of the subjective, unobservable experience in learning (Moore, 2010; Weaver & Olson, 2006). Kolb (2015) turned to the works of foundational education scholars for guidance and became inspired by John Dewey's (1905) pragmatism, William James's (1912, 2010) radical empiricism, Kurt Lewin's (1951) action research, and Jean Piaget's (1970) cognitive development theory. The works of these post-positivist scholars enabled Kolb to focus his writings on the holistic elements of learning and emphasize the central role of a subjective experience on the development of knowledge and learning (Kolb, 2015; Laschinger, 1990; Moore, 2010). Thus, ELT originates in the three traditions of experiential learning described by Dewey, Lewin, and Piaget and is further influenced by James, Jung, and Vygotsky as well as other scholars (Kolb, 1984; 2015).

The seminal text describing ELT was published in 1984, with a second edition in 2015 (Kolb, 1984; Kolb, 2015). Each chapter in the new text includes updates and reflections in which

Kolb (2015) provides clarification of previous writings along with new thoughts addressing contemporary societal and educational problems and practices such as simulation-based learning. Kolb's philosophies and assertions about learning are unchanged in the second edition.

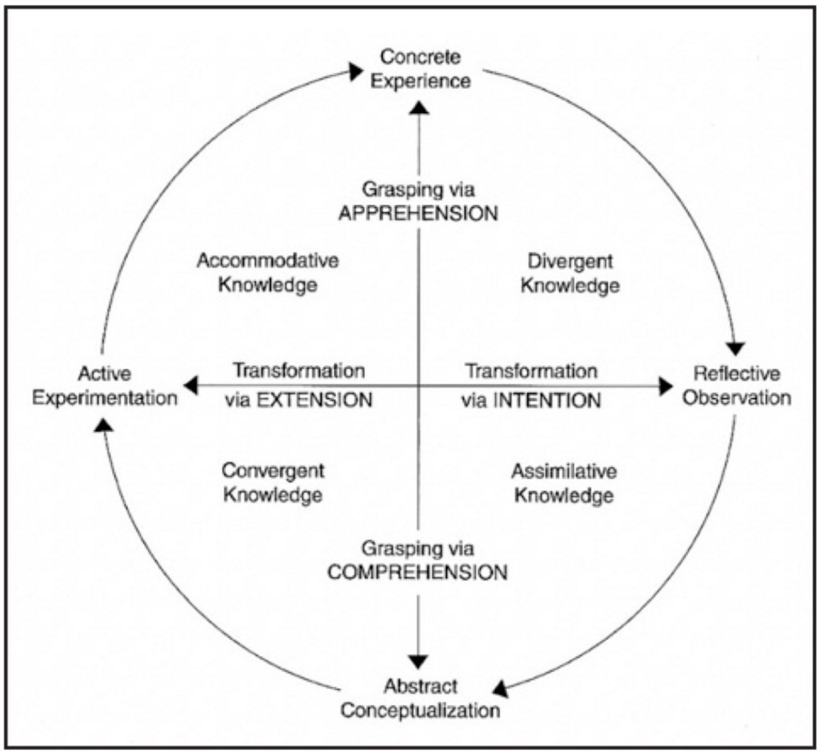
ELT is not a nursing theory; however, many nursing theories are derived from behavioral and humanistic sciences (Peterson & Bredow, 2013). ELT been used as a framework for nursing research for over 40 years (Laschinger, 1990). Recently, ELT was used as a theoretical underpinning for a simulation-based nursing theory, the National League for Nursing (NLN) Jeffries Simulation Theory (Jeffries, 2014; NLN, 2016). ELT represents the goals of a theory in that it may be used to describe, explain, predict, and prescribe how learning occurs (Peterson & Bredow, 2013). The ELT constructs and concepts are moderately abstract, limited in scope, empirically testable, and suitable for the development of nursing educational activities and nursing practice as well as research (Fawcett, 2000; Kolb, 2015; Laschinger, 1990; Peterson & Bredow, 2013; Walker & Avant, 2011).

Constructs and Concepts

ELT is comprised of three constructs (bolded) and eight concepts (italicized) that collectively explain how the phenomenon of experiential learning leads to the attainment of reliable knowledge (Gray & Grove, 2021; Grove et al., 2013; Kolb, 2015; LoBiondo-Wood & Haber, 2014, 2021). A conceptual model (Figure 1) depicts the process of experiential learning as a cyclical phenomenon, beginning at the top of the model, with the learner engaging in a concrete experience (Kolb, 2015). Two of the constructs, **grasping** and **transformation,** are depicted at dialectic (opposing) ends of two poles (Kolb, 2015). **Grasping** represents the taking in of information during an experience and **transformation** represents learners' interpretation of the experience and actions (behaviors) taken with the new knowledge upon encountering similar situations in the future (Kolb, 2015; Laschinger, 1990). Tension is created between the two poles as the learner grasps an experience and transforms the experience into knowledge (Kolb, 2015). Kolb (2015) echoes Lewin (1951) in asserting that learning occurs within this context of tension (Johnson, 2018).

Figure 1

Experiential Learning Theory Conceptual Model



Note. Reprinted by permission of Pearson Education, Inc. (see Appendix A)

Modes of Knowing

Four abstract concepts comprise Kolb's modes of knowing. Experiences are independently **grasped** via the concepts *apprehension* and *comprehension* and **transformed** into knowledge via the concepts *intention* and *extension* (Kolb, 2015). *Apprehension* is a sensation of knowing that occurs when a learner participates in a hands-on, tangible learning experience (Johnson, 2018; Kolb, 2015; Lisko & O'Dell, 2010). Apprehension is an internal understanding of an experience and the understanding exists due to taking part in the experience (Kolb, 2015; Perkins, 1971). Thus, the learner apprehends and takes in (grasps) the experience.

Conversely, *comprehension* is at the opposite end of the grasping pole, and occurs outside the experience, when a learner interprets and symbolically recreates the apprehended experience (Kolb, 2015). Comprehension involves conceptual theorizing regarding the experience and introducing logic, order, and predictions about the experience (Johnson, 2018; Kolb, 2015). Whereas engaging in an experience is a fleeting occurrence and soon replaced with new experiences, comprehension is longer-lasting (Kolb, 2015): The logical models created in the mind of the participant as a result of the experience may be communicated to others and drawn upon for future experiences (Kolb, 2015). Thus, the learner comprehends the experience.

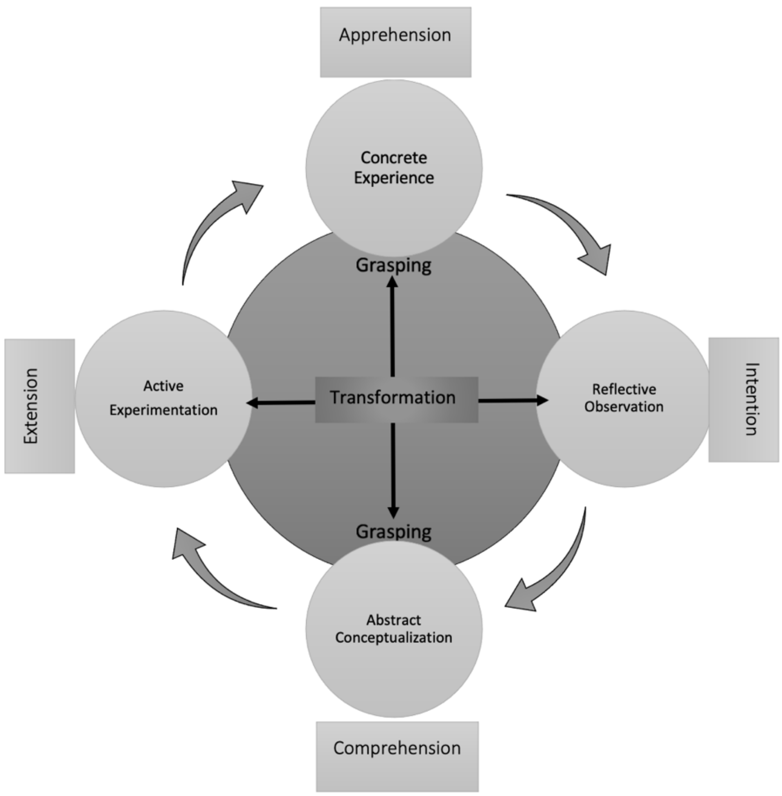
Once experiences have taken place, the learner goes through a process to transform the experience into knowledge. The grasping experiences of *apprehension* and *comprehension* are transformed into learning via the processes *intention* and *extension* (Kolb, 2015). *Intention* is an intellectual operation, an internal reflection in response to the apprehension of an immediate experience (Kolb, 2015). Intention has an affective component, whereby the learner looks back and considers feelings associated with the learning experience (Kolb, 2015; Schön, 1983).

Extension, on the other hand, is a behavioral operation, whereby the learner acts on the grasped experience, transforming it into active manipulation of the environment (Kolb, 2015). Extension is the process of acting on (extending) the apprehended experience when the learner encounters new, yet similar situations (Kolb, 2015). The learner replicates the integrated experience and tests the new knowledge (Lisko & O'Dell, 2010; Stiles, 2013).

Kolb (2015) describes the four modes of knowing as “equipotent” (p. 66), with each opposing mode possessing equal importance in the grasping and transformation processes of learning and acquiring knowledge. The most abstract of the ELT concepts, *apprehension*, *comprehension*, *intention*, and *extension* are depicted in Figure 2 as rectangles, at the periphery of the model, touching the concrete learning concepts of the ELT adaptive learning modes.

Figure 2

Experiential Learning Cycle



Note. Adapted from Kolb (2015).

Adaptive Learning Modes (Learning Cycle)

The third ELT construct, the **learning cycle**, is comprised of four concepts Kolb (2015) calls adaptive learning modes (Figure 2 and Table 1): *Concrete experience* (CE), *reflective observation* (RO), *abstract conceptualization* (AC), and *active experimentation* (AE). The concepts offer a concrete representation of the more abstract modes of knowing and explain and predict how learning occurs. CE represents *apprehension*, AC represents *comprehension*, RO represents *intention*, and AE represents *extension*. Similar to the equipotency of the modes of knowing, Kolb stresses there is no dominance of one learning mode over another (Kolb, 2015). These learning modes visually encircle (Figure 1 and Figure 2) the grasping-transformation poles, depicting the cyclical, recurring process of learning and knowledge generation (Poore et al., 2014).

Table 1

ELT Constructs and Concepts

Constructs	Concepts (Knowing)	Concepts (Learning)	Operational measurement
Grasping	Apprehension	CE	Tracheostomy competency survey (TCS)
Transformation	Intention	RO	Debriefing
Grasping	Comprehension	AC	Debriefing
Transformation	Extension	AE	TCS; debriefing
Learning Cycle		CE, RO, AC, AE	TCS; debriefing

Note. CE = concrete experience; RO = reflective observation; AC = abstract conceptualization; AE = active experimentation; TCS = tracheostomy competency survey.

Concrete Experience. Learning begins with the CE phase of the learning cycle, when the learner participates in an immediate tangible and sensory experience that does not require analysis or inquiry (Johnson, 2020; Kolb, 2015). CE may be referred to as the “doing” (Chauvin, 2015; Kolb, 2015) or “performing” (Chmil et al., 2015) phase, such as providing patient care during a simulated clinical scenario. A CE also occurs when a learner uses his/her senses to observe a simulated patient care scenario (Johnson, 2020; Zull, 2002, 2011). The CE begins the grasping of a seamlessly flowing experience, a phase Kolb (2015) uses the analogy of experiencing a shock to describe.

Reflective Observation. After the CE, the learner engages in reflection, looking back to begin making sense of and ascribing meaning to the experience (Johnson, 2020; Kolb, 2015; Lisko & O'Dell, 2010; Schön, 1983). The RO phase may be referred to as “debriefing” (Chmil et al., 2015) or “remembering” (Zull 2002, 2011) where the learner voices thoughts and views the experience from the multiple perspectives expressed by scenario participants (Kolb, 2015; Lisko & O'Dell, 2010). In RO, the learner considers the expected outcomes with the actual outcomes of the learning experience (Chmil et al., 2015). RO begins the process of transforming the experience into learning (Kolb, 2015).

Abstract Conceptualization (AC). In AC, the grasping of the experience is solidified into learning as the learner verbally recreates (describes) the CE (Johnson, 2018, 2020). AC occurs during debriefing, as the learner symbolically engages in critical thinking and analysis in order to understand the experience and plan for problem-solving in future experiences (Johnson, 2020; Kolb, 2015; Lisko & O'Dell, 2010; Stiles, 2013). Chauvin (2015) describes AC as learning from experience, a process of formulating concepts, generalization, principles, and rules about the preceding CE, a state of learning from experience. After engaging in AC, the grasping of the learning experience is complete.

Active Experimentation (AE). AE represents the final learning cycle phase, where learners apply and test the new knowledge gained from the previous experiences in new, yet similar situations (Johnson, 2020; Kolb, 2015). The abstract theories the learner formulated during RO and AC are tested when future situations are encountered (Lisko & O'Dell, 2010). AE completes the process of transformation of experience into knowledge as the learner extends the information to solve problems and make decisions (Kolb, 2015).

The tension that exists between the dialectic grasping and transforming poles of the learning cycle is resolved as the learner engages in the CE, RO, AC, and AE phases of experiential learning (Kolb, 2015). With resolution of the tension, new knowledge, skills, attitudes, and behaviors are gained (Kolb, 2015).

Zull (2002, 2011) asserts that the phases of the learning cycle arise from the structure and functions of the brain: CE = sensing, RO = remembering, AC = theorizing, and AE = acting. Learning occurs in the transactions between the four modes and the opposing grasping-transformation orientations of CE/AC and RO/AE. The learning mode concepts are pragmatic and therefore extensively serve as the theoretical underpinning for nursing and simulation-based research studies.

Forms of Knowledge

To recognize diverse ways of learning, Kolb (2015) identified four elementary forms of knowledge and four individual learning styles, represented in the four quadrants of the ELT learning cycle (Figure 1). Divergent knowledge is gained when an experience is grasped via apprehension (the CE) and transformed during intention (RO); diverging learners prefer hands-on learning in groups (Kolb, 2015). Assimilative knowledge is gained when an experience is grasped via comprehension (AC) and transformed via intention (RO); assimilating learners prefer abstract concepts and putting information into logical order (Kolb, 2015; Poore et al., 2014). Convergent knowledge is gained when an experience is grasped during AC and transformed via extension during the AE; converging learners learn best via problem-solving and technical tasks (Poore et al., 2014). Lastly, accommodative knowledge is gained when an experience is grasped via apprehension during a CE and transformed when extended to new situations during an AE; accommodating learners learn best via hands-on experiences (Kolb, 2015; Poore et al., 2014).

All of the concepts within the ELT learning cycle must be experienced for effective learning to occur, a process Kolb describes as occurring when the learner “touches all the bases” (Kolb, 2015, p. 51). Not all learners, however, engage in every phase equally (Lisko & O'Dell, 2010). In a seminal study, Laschinger (1990) found CE as the predominant way that nursing students learn, via tangible, hands-on clinical experiences and group discussions (accommodating learners). However, the ability to learn via AC, such as via lecture or debriefing was higher in BSN students (assimilating learners). Assimilation (knowledge of previous frames) and accommodation (knowledge opposed to existing frames) were subsequently identified as components of judgment, reasoning, and metacognition (conscious awareness of learning), which are capabilities displayed by an expert nurse and the ultimate goal of a practice profession (Benner et al., 1996; Chmil et al., 2015; Dreifuerst, 2009; Johnson, 2020).

Propositions

The ELT concepts include relational and non-relational propositional statements that describe, explain, and predict how learning occurs (Peterson & Bredow, 2013). The following relational propositions are correlational and positively or neutrally associated (Peterson & Bredow, 2013).

- Learning occurs via the transactions between the four conceptual modes of the learning cycle, CE, RO, AC, and AE, in a learning environment that is present at the intersection of grasping and transforming an experience (Kolb, 2015).

- Tension exists between the opposing conceptual orientations (poles) within the grasped experiences (CE versus AC) and transformed experiences (RO versus AE) (Kolb, 2015).
- The tension existing between the opposite modes of learning (CE/AC and RO/AE) must be resolved for learning to occur (Kolb, 2015).
- The tension between the opposing poles of the learning cycle is resolved when the learner engages in the CE, RO, AC, and AE phases of experiential learning (Kolb, 2015)
- The CE, RO, AC, and AE conceptual modes of learning are inseparably linked and must each be experienced for learning to be effective (Kolb, 2015; Stocker et al., 2014)
- Resolution of the conflict and tension between the dialectic grasping (CE/AC) and dialectic transformation (RO/AE) experiences results in the creation of new knowledge, skills, attitudes, and behaviors (Kolb, 2015).

Kolb further clarified the conceptual meanings in ELT via three adjunct, nonrelational descriptive statements (Walker & Avant, 2011):

- Learning is a process that results in the creation of knowledge through the taking in of and transformation of experiences (Kolb, 2015).
- The ELT concepts encompass a continuously recurring cycle, modified with every revolution of the cycle whereby no two thoughts are ever the same because each experience leads the learner to adapt and change (Kolb, 2015; Poore et al., 2014).
- Learning is a holistic process of learning from experience and includes experiencing, reflecting, thinking, and acting (Kolb, 2015).

Application to a Simulation-based Research Study

ELT is widely regarded as an underpinning of simulation pedagogy, with the four phases of the learning cycle contributing to the design of simulation educational activities and research

(International Association for Clinical Simulation and Learning [INACSL] Standards Committee, 2016; Jeffries, 2014; Johnson, 2020; Laschinger, 1990; Stocker et al., 2014). The constructs *grasping* and *transformation* and the accompanying learning cycle concepts *CE, RO, AC*, and *AE* provide a theoretical foundation for simulation learning experiences (Johnson, 2020). The grasping of an experience refers to the learning that takes place during the simulation activity (Johnson, 2020) and this occurs as the learner participates in the immediate concrete experience. Grasping further occurs when the learner verbally or cognitively recreates the experience (AC) during the debriefing that follows the CE (Johnson, 2020; Kolb, 2015; Stocker et al., 2014). The transformation of an experience refers to the interpretation of the simulation scenario and the demonstration of new behaviors (Kolb, 2015). Transformation occurs as learners are guided to internally reflect by examining and attaching meaning to the CE during debriefing (RO) (Kolb, 2015; Stocker et al., 2014). Transformation further occurs when the learner implements the new knowledge in future simulation scenarios, clinical patient encounters, or via presentation of a similar yet different parallel hypothetical scenario (AE) during debriefing (Johnson, 2020; Kolb, 2015; Lisko & O'Dell, 2010).

Statement of the Purpose

The purpose of this study was to evaluate the effectiveness of simulation as an educational strategy to develop prelicensure nursing students' clinical competency to provide safe care to tracheostomized patients. The study specifically aimed to investigate whether a simulation-based, e-learning intervention could be used to prepare prelicensure BSN students to recognize and respond to a tracheostomy airway complication,

The four phases of the ELT learning cycle (Figure 1 and Figure 2) underpinned the study design, as the nursing students grasp and then transform a clinical experience into knowledge

(Kolb, 2015). The students participate in a simulated tracheostomy patient experience (CE), debrief and integrate the new knowledge (RO and AC), and actively experiment (AE) via problem-solving during future encounters with a tracheostomized patient in a simulated or clinical setting. Hence, development of the higher order thinking, reasoning, and application skills of assimilation and accommodation and the outcomes of the ELT Learning Cycle facilitates students' progress towards meeting the goals of the nursing practice profession (Dreifuerst, 2009; Johnson, 2018, 2020). The experiential learning and transformation into knowledge that takes place during the phases of the ELT Learning Cycle provides a theoretical basis for addressing the lack of research exploring the use of simulation as an educational strategy to develop prelicensure students' clinical competency to provide safe care to tracheostomized patients.

Research Question and Hypothesis

The study asked the following question:

1. Is there a difference in prelicensure nursing students' clinical competency to recognize a tracheostomy airway complication after participation in a simulation-based, e-learning experiential tracheostomy care learning activity?

The study posed the following hypothesis:

1. Prelicensure nursing students' participation in a learning activity depicting the management of patients who have a tracheostomy airway will improve students' clinical competency to recognize a tracheostomy airway complication.

Assumptions

The following assumptions reveal the unstated implications of Kolb's theoretical values and add support for using ELT as a philosophical foundation for this study (Gray & Grove, 2021;

Grove et al., 2013; Kolb, 2015; Meleis, 1997; Peterson & Bredow, 2013). The prelicensure baccalaureate nursing student was considered in identifying the assumptions:

- The nursing student demonstrates readiness to learn and the ability to fully engage in the four modes of the learning cycle (Kolb, 2015).
- Past experiences influence each nursing student's learning style and ways of processing the new experience and experimenting with the new knowledge (Johnson, 2018; Kolb, 2015).
- The ELT concepts are measurable in the baccalaureate nursing student population (Fawcett, 2000).
- ELT is a suitable theoretical foundation for the development, implementation and evaluation of a simulation scenario for the undergraduate nursing student population (Chmil et al., 2015; Johnson, 2020; Lisko & O'Dell, 2010; Stocker et al., 2014)
- ELT is a suitable theoretical underpinning for the design and interpretation of a simulation-based research study in the undergraduate nursing student population (Chmil et al., 2015; Gray & Grove, 2021; Grove et al., 2013; Kolb, 2015; Stocker et al., 2014)
- Simulation is an effective technique for developing clinical competency in nursing students (Dreifuerst, 2009; Hayden et al., 2014).

Definition of Terms

- Clinical competency: The application of affective (feeling), cognitive (thinking), psychomotor (doing) nursing skills necessary to recognize, prioritize, and communicate patient assessment data in order to intervene to maintain or restore patient safety (Decker et al., 2008; Hayden et al., 2014; INACSL, 2016; Kavanagh & Szweda, 2017; Moghabghab et al., 2018; Prion et al., 2017; Theisen & Sandau, 2013; Tilley, 2008).
- E-learning: An online, computer-based educational modality that uses electronic multimedia to facilitate learners' acquisition of knowledge, skills, and attitudes via asynchronous, self-paced learning (Barari et al., 2022; Elcullada Encarnacion et al., 2021; George et al., 2014; Roye, 2023; Sangrà et al., 2012).
- High-acuity, low opportunity (HALO): A tracheostomy airway is considered a high acuity (risk or severity), low-opportunity (frequency or volume) clinical situation that has the potential to severely harm the patient if mismanaged but yet is not a common patient presentation encountered by nursing students (Chiniara et al., 2013).
- Patient deterioration: "An evolving, predictable, and objective/subjective symptomatic process of worsening physiology towards critical illness" that is treatable when recognized yet leads to death when unrecognized (Lavoie et al., 2016, p. 68; Needleman & Buerhaus, 2007; Silber et al., 1992).
- Prelicensure nursing student: A student enrolled in an associate degree or baccalaureate nursing program who has not taken the National Council Licensure Examination for Registered Nurses (NCLEX-RN) exam (Hayden et al., 2014; Smiley, 2019).
- Simulation: An educational technique that uses realistic full body manikins, simulated patients (trained human actors), task trainers (body-part models), and computer-based or

virtual reality modalities to provide students with guided learning experiences that mimic real-life patient situations in a safe setting where patient harm is avoided (Fisher & King, 2013; Gaba, 2004; Levett-Jones & Guinea, 2017; Lioce et al., 2020; NCSBN, 2016).

- Tracheostomy care (TC): The technical (psychomotor) tasks that maintain tracheostomy airway patency and skin integrity, including cleaning and changing the inner cannula, stoma skin care, changing the stoma dressing and tracheostomy tube ties, suctioning secretions, and the delivery of humidified air (Halfpenny & McGurk, 2000; Joseph, 2011; Stanley et al., 2019). TC also includes the higher-level affective (feeling) and cognitive (thinking) skills required to recognize, communicate, and manage potential and existing airway complications and emergencies (Joseph, 2011; Oermann & Gaberson, 2014; Stanley et al., 2019)
- Traditional clinical experience: A clinical experience that takes place in an inpatient, ambulatory care, or community setting where students are assigned patients and provide nursing care under the guidance of an instructor or preceptor (Alexander et al., 2015; Hayden et al., 2014; NCSBN, 2019).

CHAPTER 2

The focus of this literature review was to provide empirical support for a simulation-based research study designed to develop prelicensure nursing students' clinical competency to recognize a tracheostomy airway complication. The findings are organized in alignment with the key concepts identified in the research question: *Prelicensure nursing student*, *clinical competency*, *tracheostomy care*, and *simulation*.

Relevant Literature

No studies were found describing prelicensure students' experiences with tracheostomy airway complications nor educational methods for developing their clinical competency to manage or recognize complications. To capture studies describing the population most closely aligned with nursing students, the search and scope of the review was expanded to graduate nurses (GNs) and newly-licensed RNs (NLRNs), RNs who completed a prelicensure nursing program within the previous 12 months (Blegen et al., 2017; Duchscher, 2008). One study was found describing GN experiences with tracheostomy care. Studies were found describing hospital-based educational interventions designed to promote tracheostomy airway competency among RNs and other health professions' interprofessional (IP) team members. This gap suggested GNs and NLRNs may be entering practice with limited tracheostomy care skills and are developing the higher-level affective and cognitive skills required to recognize a tracheostomy airway complication at the patient bedside (Dorton et al., 2014).

Prelicensure Nursing Student

The prelicensure nursing student describes a student enrolled in an associate degree, diploma, or baccalaureate degree nursing program who becomes eligible to take the National Council Licensure Examination for Registered Nurses (NCLEX-RN) upon successful program completion (Hayden et al., 2014; Smiley, 2019). Prelicensure programs are designed to teach entry-level nursing skills and competencies, including tracheostomy care (TC) and tracheal suctioning, and prepare students to deliver safe and effective patient care upon entry to practice (American Association of Colleges of Nursing [AACN], 2008; AACN, 2021; NCSBN, 2018, May).

Learning Environments: Traditional and Simulated

Today's nursing students receive clinical experiences in the acute care inpatient hospital or ambulatory care (traditional) setting and in the simulated patient care setting (Hayden et al., 2014). Traditional clinical experiences have historically been considered the gold-standard for learning nursing skills, yet educators' enduring reliance on the traditional clinical model was recently challenged in an empty systematic review in which Leighton, Kardong-Edgren, McNelis, et al. (2021) found no evidence to support the effectiveness of this method of learning. The authors' exhaustive review did not yield reliable and valid research studies evaluating the effectiveness of student learning outcomes of traditional clinicals (Leighton, Kardong-Edgren, McNelis, et al., 2021). A follow-up review of qualitative studies yielded similar findings–a lack of support for the achievement of student learning outcomes in the traditional clinical setting (Leighton et al., 2022). Furthermore, due to the impossibility of standardizing learning opportunities and guaranteeing all students obtain the same clinical experiences in the fast-paced, ever-changing hospital environment, the traditional model produces random learning opportunities that may not align with program curricula (AACN, 2019a; Benner et al., 2010; LeFlore et al., 2007; Leighton, Kardong-Edgren, & Gilbert, 2021).

The traditional model offers nursing students more opportunities to observe and participate in communication and discussions between the patient, patient's family, and the IP healthcare team than the simulation setting (Leighton, Kardong-Edgren, & Gilbert, 2021). When attending traditional clinical experiences, nursing students are socialized to the *real-world* of nursing (Leighton et al., 2022). Opportunities to apply elements of the nursing process was perceived as being more effective in the traditional hospital setting (Leighton, Kardong-Edgren, & Gilbert, 2021).

In contrast, the simulated clinical environment, offers nursing students standardized, consistent learning experiences via planned patient scenarios, and allows students to develop clinical competency in high-risk patient situations and skills, such as tracheostomy care, without the risk of patient harm (Leighton, Kardong-Edgren, & Gilbert, 2021; Leighton, Kardong-Edgren, McNelis, et al., 2021). In a meta-analysis to identify the effects of simulation in nursing education, Shin et al. (2015) found a large effect size for learning psychomotor skills (0.94) and affective skills (0.83) and a medium effect size for learning cognitive skills (0.37) when compared to traditional learning methods. Another advantage of simulation is that nursing students learn faster in the simulated clinical setting and demonstrate a higher level of clinical reasoning (Sullivan et al., 2019). Both clinical environments provide nursing students with salient learning opportunities, yet due to safety concerns surrounding inexperienced students performing procedures on real patients and the challenges of clinical placement site and preceptor shortages, the simulated clinical setting has become a mainstay of preparing nursing students for safe nursing practice (AACN, 2015; Lee et al., 2017; Leighton, Kardong-Edgren, & Gilbert, 2021).

Education-Practice Gap

Regardless of the clinical learning environment, a gap exists between the clinical competencies demonstrated by prelicensure nursing students at program end and hospital leaders' and nursing stakeholders' expectations of clinical competency and work readiness of newly hired graduate nurses (Haddeland et al., 2018; Kavanagh & Szweda, 2017; Woods et al., 2015). Nationwide assessments of entry-level competencies of new nursing graduates measured by the Performance Based Development System (PBDS) tool revealed steep declines in initial competency between 2005 and 2020 (Del Bueno, 2005; Kavanagh & Sharpnack, 2021). PBDS scores in the *safe* and *acceptable* range progressively declined from 35% (2005), 23% (2011-2015), 14% (2016-2020), to only 9% demonstrating acceptable competency in 2020 (Del Bueno, 2005; Kavanagh & Sharpnack, 2021; Kavanagh & Szweda, 2017).

A 2017 NCSBN practice analysis survey of the nursing knowledge needed by new RNs upon entry to practice identified that NLRNs are expected to demonstrate knowledge of 295 items (NCSBN, 2018, May). Survey participants (NLRNs, educators, supervisors, and nursing subject experts) rated each item on a scale ranging from 1 = *not important* to 5 = *critically important* (NCSBN, 2018, May). The NLRNs consistently rated airway management as most important (4.77) and change in client condition (recognizing the deteriorating patient; 4.71) in the top five items (NCSBN, 2018, May). NLRNs rated TC and suction techniques at 4.01 and 4.17, respectively, in level of importance (NCSBN, 2018, May). When the analysis was repeated in 2021, NLRNs continued to rate airway management as the most important nursing skill (4.79), yet TC was removed as a stand-alone skill and integrated into "provide ostomy care", the word "tracheostomy" or "tracheal" decreased from 10 entries in 2017 to 1 entry in 2020, and the number of knowledge items (skills) needed by NLRNs increased from 295 to 338 items (NCSBN, 2022). The 2021 NCSBN survey findings imply a *decreased* emphasis on tracheostomy airway knowledge and patient safety and a concerning contrast to the finding that final year nursing students rated the management of airway and respiratory complications in the top ten list of skills in which they lack clinical competency and confidence (Woods et al., 2015).

Clinical Competency

Derived from conceptual, educational, regulatory, and simulation literature, clinical competency was defined as the application of affective (feeling), cognitive (thinking), and psychomotor (doing) nursing skills necessary to recognize, prioritize, and communicate patient assessment data in order to intervene to maintain or restore patient safety (Decker et al., 2008; Hayden et al., 2014; INACSL Standards Committee, 2016; Kavanagh & Szweda, 2017; Moghabghab et al., 2018; Prion et al., 2017; Theisen & Sandau, 2013; Tilley, 2008). Clinical competency is one behavioral outcome of prelicensure nursing students' immersion in traditional clinical and simulation-based experiential learning and a measure of readiness for nursing practice (Chmil et al., 2015; Kolb, 2015; Lisko & O'Dell, 2010).

Clinical competency is a fundamental expectation of nursing practice and a benchmark for nursing program outcomes and new GN success (AACN, 2008, 2021; Kelly et al., 2014; Moghabghab et al., 2018). The Joint Commission, health care employers, and other nursing stakeholders use the measurement of new GN competency as predictors for quality care and positive patient outcomes (American Nurses Association, 2014; Jamison & Lis, 2014; Theisen & Sandau, 2013). A growing concern surrounds the evidence that graduating nursing students possess the knowledge to pass the NCLEX-RN examination yet demonstrate deficiencies in the ability to competently perform in today's high-stakes practice settings, prompting declaration of a "crisis in competency" (AACN, 2019a; Kavanagh & Sharpnack, 2021; Kavanagh & Szweda, 2017, p. 58).

Patient Deterioration

Despite the expectation that nursing students are educationally prepared to enter the workforce and improve patient outcomes, many new RNs lack the clinical competency to recognize and respond to deteriorating patient situations in the rapidly-changing, high-acuity setting of their initial job placement (AACN, 2008; Fisher & King, 2013; Kavanagh & Szweda, 2017). The skills needed to recognize and respond to a deteriorating patient include clinical decision-making, situational awareness, and team work (Haddeland et al., 2018). Final year nursing students have not fully developed the ability to apply the learned concepts of assessment, recognition, and response to the management of a deteriorating patient situation, such as occurs when a patient presents with a tracheostomy complication or incident (Fisher & King, 2013; Kavanagh & Szweda, 2017; McGrath & Thomas, 2010).

Nursing students' unpreparedness to recognize and manage patient deterioration was revealed in several simulation-based studies. Aronson et al. (2012) found final-semester BSN students participating in a heart failure patient scenario did not perform timely physical assessments, recognize cues, signs, or trends indicating deterioration, and did not promptly notify the provider when the patient deteriorated. In an standardized Objective Structured Clinical Examination (OSCE) depicting cardiac, respiratory, and shock scenarios, 91% of student teams failed to demonstrate the expected clinical performance in rescuing a deteriorating patient (Bogossian et al., 2014). Furthermore, the failure to recognize clinical deterioration extends beyond nursing school, to NLRNs and RNs employed in acute care clinical settings (Kelsey & Claus, 2016; Martin et al., 2016). In a longitudinal competency study, Kavanagh and Sharpnack (2021) found 29% of NLRNs did not recognize an urgent patient presentation or a change in patient status.

These findings, along with evidence that health care mistakes, such as the failure to rescue a deteriorating patient, are the third leading cause of death in the United States, has propelled efforts to prepare prelicensure nursing students to demonstrate clinical competency in responding to deteriorating patient situations (Aiken et al., 2011; AACN, 2014; Makary & Daniel, 2016). Academic nurse educators are charged with shifting the focus from what a student *knows* to what the student can *do* and developing competency-based interventions that promote students' ability to recognize and respond to cues and trends indicating patient deterioration (AACN, 2019a; AACN, 2021; Hart et al., 2014; Lavoie et al., 2015). The failure to rescue a patient experiencing a tracheostomy airway complication is a cause of catastrophic patient outcomes, however, minimal emphasis has been placed on student nurses' clinical competency to recognize and respond to tracheostomy airway complications (Aronson et al., 2012; Halum et al., 2012).

Tracheostomy Care

The TC introduced in most prelicensure nursing programs is limited to movement-oriented, psychomotor (technical) tasks necessary to maintain airway patency and skin integrity: Cleaning and changing the inner cannula, stoma skin care, changing the stoma dressing and tube ties, suctioning secretions, and delivering humidified air (Cowperthwait et al., 2015; Halfpenny & McGurk, 2000; Joseph, 2011; Kardong-Edgren et al., 2010; Oermann & Gaberson, 2014). While there is a cognitive component to basic TC (for example, understanding the steps to performing tracheal suctioning), higher level cognitive and affective skills are required to assess, recognize, prioritize, and communicate potential and existing airway complications (Joseph, 2011; Oermann & Gaberson, 2014; Stanley et al., 2019). Although the clinical competency required to recognize a tracheostomy complication exceeds the basic, low-level psychomotor (procedural or technical) skills-based tracheostomy care learned in in nursing programs, recognizing when airway patency is threatened is an essential nursing skill (INACSL, 2016; NCSBN, 2018, May; Oermann & Gaberson, 2014; Stanley et al., 2019).

Tracheostomy Care Clinical Competency Challenges

Expansion of the literature search to GN and RN experiences managing tracheostomized patients yielded evidence of deficiencies in new and experienced nurses' clinical competency to manage a tracheostomy airway. Only one study sampling GNs, the population with attributes closest to final-semester prelicensure nursing students in TC knowledge and skills, was found (Smith-Miller, 2006). Smith-Miller (2006) examined the comfort and knowledge of 103 GNs and 31experienced hospital RNs participating in a tracheostomy educational session. GN and RN knowledge was measured before the education intervention via an 8-item multiple-choice questionnaire that revealed mean knowledge scores of 53% for GNs and 55% for RNs (Smith-Miller, 2006). Comfort level was measured on a 10-point Likert scale (1 = *very comfortable* to 10 = *very uncomfortable*) (Smith-Miller, 2006). GNs reported a baseline comfort level of M = 5.95 and post-session comfort level of M = 4.12; the RNs reported a baseline comfort level of M = 8 but were not surveyed post-session because they did not attend the educational session (Smith-Miller, 2006). No correlation was found between comfort level and knowledge.

Smith-Miller's (2006) study revealed patient safety and educational concerns: First, the tracheostomy knowledge level of GNs who were attending a GN residency program prior to working on the nursing unit and experienced RNs (possessing up to 34 years of experience) was similar, suggesting novice and experienced RNs have knowledge deficits in providing safe care to tracheostomized patients. Second, the absence of a correlation between knowledge and comfort levels suggests that theoretical knowledge may not indicate comfort (a proxy for skills competency). Third, a prevalent yet unsafe practice identified was for RN preceptors to teach the GNs tracheostomy skills at the bedside of vulnerable tracheostomized patients.

Although Smith-Miller's (2006) study contained methodological limitations–absence of a theoretical underpinning and instrument psychometric testing, self-reported surveys, a small sample size, and exclusion of the RNs from the educational session and post-test–it is one of the few studies assessing GN performance of TC. This seminal study has been cited in the IP tracheostomy literature and underscores the known phenomena that (a) subjective comfort level and objective knowledge may not indicate clinical competency and (b) *knowledge* may overestimate or underestimate actual skills *performance* (Agarwal et al., 2016; Day et al., 2009; Dorton et al., 2014; Khademi et al., 2012; Liaw et al., 2011; Smith-Miller, 2006). Along with Halfpenny and McGurk (2000), Smith-Miller's recognition that mismanagement of a tracheostomy airway results in catastrophic patient outcomes was forward-thinking and the findings provided early support for the recommendation that both new and experienced RNs need recurrent tracheostomy competency evaluations.

Hospital Setting Challenges. Further deficiencies in tracheostomy competency were found in studies surveying RNs working in acute care hospitals. A lack of comfort, confidence, and knowledge to safely manage a patient's tracheostomy airway was a prevalent theme among RNs and other health care team members working in non-ICU areas of acute care hospitals (Dorton et al., 2014; Yelverton et al., 2015). In a multi-disciplinary tracheostomy education program that included 30 RNs, teams took over two minutes to begin oxygenation and ventilation during a simulated airway emergency scenario (Dorton et al., 2014). During evaluation of an RN training program, researchers identified deficiencies in nurses' competency to perform basic and emergency TC and a lack of understanding of airway anatomy and physiology (McDonough et al., 2016). When surveyed, 19% of the RNs reported low self-efficacy to perform basic TC and 40% doubted their ability to perform emergency TC (McDonough et al., 2016). A comparison of pediatric hospital ICU and nursing unit RN tracheostomy management demonstrated significant differences in comfort with tracheostomy tube changes (Pritchett et al., 2016). The results showed 56% of ICU nurses reporting comfort versus 28% of unit RNs ($p = .002$) and 73% of unit RNs versus 33% of ICU RNs reporting being completely uncomfortable managing accidental decannulation ($p = .006$) (Pritchett et al., 2016).

Procedural knowledge and patient safety deficits were observed in a study of RNs working on a tertiary care hospital ICU and step-down unit: All of the participants used hydrogen peroxide to clean the stoma, only 40% wore sterile gloves for tracheal suctioning, and 20% cut a 4-inch gauze to make a fenestrated dressing instead of using a precut surgical gauze (Bolsega & Sole, 2018). Hydrogen peroxide is an irritant that may be harmful to tissues and inhibit healing, cutting gauze risks fiber inhalation into the trachea and infection, and tracheal suctioning is a sterile procedure; these are all unsafe practices nursing students are taught to avoid when learning basic TC skills (Assessment Technologies Institute Inc, 2021; Callahan, 2019; Dawson, 2014; Johnson, 2017; Seckel, 2017). Only one participant performed the TC steps according to the American Association of Critical Care Nurses procedure (Bolsega & Sole, 2018). Other researchers have reported omissions in basic safe nursing care of the tracheostomized patient, including untied or loose tracheostomy tube ties, tracheostomy tube dislodgement during patient transfer and turning in bed, omitting measurements of cuffed tracheostomy tubes, and absence of bedside suction equipment, an emergency tracheostomy insertion tray, and spare tracheostomy tubes (Das et al., 2012; Fernandez-Bussy et al., 2015; Wilkinson et al., 2015).

Years of nursing experience was not consistently associated with tracheostomy clinical competency. McDonough et al. (2016) explored RN knowledge and self-efficacy in the management of tracheostomy and laryngectomy airways and found experienced RNs (six or more years' experience) had lower knowledge scores than inexperienced RNs (five or less years' experience), although the result was not statistically significant. This was similar to Smith-Miller's (2006) finding that years of nursing experience did not correlate with knowledge and comfort level with managing tracheostomized patients' airways. In contrast, 60% of experienced nurses at one pediatric hospital reported greater comfort with routine tracheostomy care versus 25% of inexperienced nurses (Pritchett et al., 2016). These inconsistent findings corroborated other researcher's recommendations that to improve tracheostomized patients' outcomes, high-risk skills such as TC should be learned in controlled settings where patient harm is avoided and annual hands-on training and competency evaluation is needed (Chauvin, 2015; Dorton et al., 2014; McDonough et al., 2016; Smith-Miller, 2006).

Tracheostomy Care Education Challenges

Globally, researchers have emphasized that non-standardized, inconsistent, or absent tracheostomy policies and education programs are a threat to patient safety (McGrath et al., 2012; Mondrup et al., 2012; Yelverton et al., 2015). A "global insecurity" exists in the ability to perform safe tracheostomy care and recognize and respond to complications such as accidental decannulation or an obstructed airway (Pritchett et al., 2016; Yelverton et al., 2015, p. 343). This lack of educational preparation is most observed once the patient is discharged from ICU to a general nursing unit, where the presence of a tracheostomized patient is not an everyday occurrence (Dawson, 2014; Martinez et al., 2009; Wilkinson et al., 2014, June 13).

Organizational Factors. Over 90% of tracheostomy complications occur after the immediate post-operative period, a time frame coinciding with transfer of the patient from the ICU to the nursing unit (Das et al., 2012). Research teams in the United Kingdom and United States reported that tracheostomy management outside of the ICU is suboptimal and nurses working on nursing units may lack the competency to maintain the safety of tracheostomized patients (Das et al., 2012; Garrubba et al., 2009; McGrath & Thomas, 2010; McGrath et al., 2015; Smith-Miller, 2006; Wilkinson et al., 2015).

One organizational contributor to poor outcomes for tracheostomized patients is that a tracheostomy airway is considered a high acuity, low-opportunity (HALO) clinical situation (Chiniara et al., 2013). This refers simultaneously to the high potential for patient harm if the airway is mismanaged as well as the infrequent presence of tracheostomized patients on most nursing units (Pritchett et al., 2016; Smith-Miller, 2006). The low number of tracheostomized patients in the overall patient census leads to (a) few educational and fiscal resources being allocated to preparing RNs to provide safe care, and (b) few opportunities to maintain current TC competency (Eibling & Roberson, 2012; McDonough et al., 2016). McDonough et al. (2016), asserted that while the incidence of tracheostomized patients on nursing units is increasing and the patients are older and more at risk for accidental decannulation, cost-reduction staffing decreases have led to an increase in tracheostomy airway adverse events.

Another organizational contributor to poor outcomes is the inconsistency of tracheostomy policies and protocols, as found in a Danish study in which 76% of hospitals did not have accidental decannulation protocols and only 10 hospitals provided tracheostomy management training to nurses working on nursing units (Mondrup et al., 2012). The United Kingdom National Confidential Enquiry into Patient Outcome and Death (NCEPOD), a large study of surgical procedures in U.K. health organizations and tracheostomy management and care practices were surveyed to find 80.6% (n = 174) hospitals had a policy for blocked or displaced tracheostomy tubes, 54% had a policy for resuscitation of a tracheostomized patient with a patent upper airway, and 45% had a policy for patients completely dependent on the tracheostomy or laryngectomy airway (Wilkinson et al., 2015). Despite researchers' speculation that tracheostomy complications are underestimated and tracheostomy-related mortality is underreported, they acknowledged that many tracheostomized patients die from the underlying disease process, not the tracheostomy airway (Agarwal et al., 2016; Cramer et al., 2019b; Klemm & Nowak, 2017; Shah et al., 2012). Further, researchers consistently asserted that complications are preventable and death rates are modifiable by the implementation of safety protocols and procedures that extend beyond the operative period to the nursing unit and patient discharge (Cramer et al., 2019b; Das et al., 2012; Klemm & Nowak, 2017; Shah et al., 2012).

Tracheostomy Education Programs

The publication of landmark studies such as the NCEPOD and formation of The Global Tracheostomy Collaborative has increased attention to the patient safety concerns of tracheostomized patients and led hospital systems' educators to develop tracheostomy training programs (Global Tracheostomy Collaborative, 2018; Wilkinson et al., 2014, June 13). The implementation of standardized tracheostomy safety algorithms, protocols, and education/practice guidelines such as the U.K. National Tracheostomy Safety Project (NTSP), has reduced morbidity and mortality, prompting researchers to call for the leaders of academic institutions and health care organizations to train nursing students and RNs to provide safe care to these vulnerable patients (Cramer et al., 2019a; Khademi et al., 2012; Mark et al., 2015; McGrath & Thomas, 2010; Wilkinson et al., 2015; Wilkinson et al., 2014, June 13).

Tracheostomy education programs are best practice in promoting the safe care of tracheostomized patients, preventing tracheostomy adverse events, and decreasing length of stay (Bonvento et al., 2017; Garrubba et al., 2009).

Multidisciplinary Education Programs. IP team members who participated in tracheostomy educational programs demonstrated improvements in knowledge, skills performance, and comfort level with routine and emergency TC, and understanding of tracheostomy principles (Agarwal et al., 2016; Dorton et al., 2014; Ward et al., 2014; Yelverton et al., 2015). At the end of a two-day didactic and clinical workshop, physical medicine and rehabilitation residents' clinical proficiency increased from 0% pre-test to 100% post-test, prompting the researchers to recommend the curriculum for speech-language pathologists and nurses (Khademi et al., 2012). After a simulation-based tracheostomy education course for residents, faculty physicians, and advanced practice RNs, significant improvements in mean scores occurred between the pre- and post-course multiple choice exam (pre-test $M = 0.53 \pm .50$; post-test $M = 0.82 \pm 0.39$, $p < .0001$) with 15% of participants ($n = 5$) passing the pre-test and 80% ($n = 26$) passing the post test ($p < .001$) exam (Agarwal et al., 2016). In a comparison study exploring performance feedback on nurses' and physiotherapists' tracheal suctioning skills after participating in an educational session (lecture, suctioning demonstration, and observation of suctioning performance), the intervention group (hospital and simulation groups receiving feedback) demonstrated significant improvements ($p = .037$ to $p = .001$) in the performance of correct suctioning technique (Day et al., 2009). Specifically, the nurses' and physiotherapists' selection of correct suctioning pressure increased from 3% at baseline to 48% post-intervention ($p < .01$) and the delivery of performance feedback post-suctioning had a stronger positive effect ($p = .001$) in the simulation group (Day et al., 2009).

Asserting that all providers who manage tracheostomy patients need formal TC training, Dorton et al., (2014) measured physicians (residents and fellows), medical students, mid-level providers, ICU nurses, and nursing unit RNs comfort and performance with three simulation-based scenarios (tracheostomy assessment, accidental decannulation, and airway emergency). While significant improvements were demonstrated on the self-assessment and multiple-choice tests ($p < .0001$), during the tracheostomy airway emergency the participants demonstrated delays in auscultating breath sounds, suctioning, removing the inner cannula, beginning ventilation, and delayed recognition of the dislodged tracheostomy tube (Dorton et al., 2014). This suggested theoretical knowledge and comfort may not correlate with observed skills performance. Nevertheless, course evaluation revealed 71% “strongly agreed” and 25% “agreed” the simulation intervention was effective in teaching TC (Dorton et al., 2014). Interestingly, in comparison to the nurse and mid-level providers, physicians initially reported significantly less comfort with TC ($p = .0006$), which may be attributed to nurses’ role as frontline caregivers to tracheostomized patients (Dorton et al., 2014; McDonough et al., 2016).

Nurse-Focused Education Programs. Researchers evaluating tracheostomy education programs dedicated to training nurses working in non-ICU settings to competently manage tracheostomized patient care found positive outcomes. In response to a 34% rate of tracheostomy complications on general nursing units at one hospital in India, nurse educators implemented a four-month tracheostomy training program for nursing staff (Sodhi et al., 2014). Significant improvements occurred over the 10-month study period: Tracheostomy complication rates decreased from 34% to 6% ($p = .000$), patient average length of stay decreased from 36 to 27 days ($p = .027$), readmissions to ICU due to airway complications decreased from 24% to 1.87% ($p = .000$), and the number of tracheostomy tube obstructions decreased from 16 to 2 (Sodhi et al., 2014). The stringent program included didactic, skills lab practice, and hands-on skills performance with tracheostomized ICU patients under the supervision of experienced preceptors (Sodhi et al., 2014). The educational program led to practice changes, including certification of 70% of participants as a tracheostomy care nurse (TCN), the presence of a TCN on every nursing unit and every shift, and a requirement of quarterly tracheostomy skills reassessments (Sodhi et al., 2014). Similarly, in a tracheostomy and laryngectomy training program consisting of hands-on skills training and an online tutorial, McDonough et al. (2016) found statistically significant differences in the knowledge (p =.0001) and self-efficacy (p = 0.003) between RNs who received training and RNs who did not receive training.

A high fidelity simulation workshop simulating adult clinical emergencies improved medical-surgical RNs' non-technical (recognition and response) and technical (assessment and airway management) skills (Buckley & Gordon, 2011). In a three-month follow-up survey, RN participants reported the greatest improvements in *responding to an unstable patient in a systematic manner* (87%), *airway assessment* (73%), *breathing assessment* (80%), and *management of breathing difficulties* (79%) whereas less improvement (64%) was shown in *recognition of an unstable patient* (Buckley & Gordon, 2011). Thirty participants (79%) reported using the learned skills during 164 patient emergencies during patient encounters in the follow up period (Buckley & Gordon, 2011). A weakness of the study was that the survey was limited to RN perceptions and self-reported percentage measurements. Additionally, it is important to note the simulated patients were not tracheostomized; nevertheless, the findings supported the use of simulation as an effective strategy for improving RN competency to recognize and manage airway and respiratory complications (Buckley & Gordon, 2011).

Recommendations

There is a strong need to educate and prepare prelicensure nursing students with the tracheostomy skills to function as effective members of IP teams upon entry to practice (Paul, 2010; Pritchett et al., 2016). Because tracheostomy incidents are unpredictable and occur infrequently, it is neither practical nor safe to measure and evaluate tracheostomy management skills at the patient's bedside (Agarwal et al., 2016). Learning TC skills by trial and error, as on-the-job training at the patient's bedside, is no longer acceptable practice (Dorton et al., 2014; Heffner et al., 2005).

Khademi et al. (2012) recommended medical residents and other health professions students be required to demonstrate tracheostomy clinical competency *before* patient encounters. Deficits in tracheostomy knowledge and self-efficacy–a person's belief in his or her ability to perform certain behaviors–among nurses who regularly cared for tracheostomy patients supported the researcher's aim of demonstrating a need for standardized, annual training and competency evaluation (Bandura, 1997; McDonough et al., 2016). Algorithms and educational material developed by the NTSP decreased tracheostomy patient harm (National Tracheostomy Safety Project [NTSP], 2024). It is unknown, however, if such programs are effective in teaching nursing students to recognize tracheostomy airway complications. What is known, is that simulation offers a safe and controlled environment for learning TC skills and management of tracheostomy emergencies (McGrath et al., 2019; Rassekh et al., 2015).

Simulation

Simulation experiential learning has become a cornerstone of prelicensure nursing education, used in almost 90% of U.S. nursing programs as a strategy for introducing students to clinical situations that are restricted due to patient safety concerns or unavailable to students in the traditional clinical setting (Fisher & King, 2013; Smiley, 2019). When equitable, real-life clinical experiences are unavailable, simulation is an effective alternative for developing the higher-level psychomotor, cognitive, and affective skills needed to recognize deteriorating patients (AACN, 2019a; Decker et al., 2008; Fisher & King, 2013; Kardong-Edgren et al., 2010). Today's simulators enable replication of the traditional clinical setting via a multitude of learning modalities including wearable technology such as a tracheostomy vest worn by a human patient actors that is electronically designed to stimulate the cough reflex during tracheal suctioning (Cowperthwait et al., 2015; Lioce et al., 2020; McGrath et al., 2019). Simulation is an efficient learning environment, enabling students to learn and complete nursing tasks in less time and spend more time functioning independently as a nurse and engaging in higher levels of cognitive activity (critical thinking) than in the traditional clinical setting (Sullivan et al., 2019).

Simulation and the Tracheostomized Patient

Despite the evidence that simulation is a safe and equitable alternative to practicing high-risk skills at the patient's bedside, only one study demonstrating nursing students' care of a simulated tracheostomized patient was found (AACN, 2019a; Davies et al., 2012; Hayden et al., 2014). Aiming to expose nursing students to complex patient issues in a safe setting, Davies et al. (2012) simulated a pediatric unit hospital shift in which one of five patient scenarios depicted a seven-year old tracheostomized child with hypoxic brain damage. Participants were required to manage the artificial airway and perform TC (Davies et al., 2012). Few details were provided regarding the measurement of student performance. However, the key skills identified as objectives for the tracheostomy patient scenario included safety, communication, and prioritization, all fundamental nursing skills required to competently manage the care of a tracheostomized patient (Callahan, 2019; Davies et al., 2012; McGrath et al., 2012).

Simulation and the Deteriorating Patient

Despite the dearth of studies describing nursing students' clinical competency to recognize and manage tracheostomy airway complications, simulation interventions are effective in teaching students to recognize and respond to patient deterioration due to other causes (Buckley & Gordon, 2011; Fisher & King, 2013). In a repeated-measures cardiac arrest simulated scenario, 100% of patients died initially, 50% died at mid-intervention, and 100% survived the last measurement point (Hart et al., 2014). Significant improvements in the time it took the nursing students to initiate resuscitation (p = .004), chest compressions (p < .001), bag-valve-mask ventilation (p = .018), and defibrillation (p < .001) were found (Hart et al., 2014).

Aiming to develop final-year nursing students' skills to recognize and respond to rapidly deteriorating patients before entering nursing practice, Goldsworthy et al. (2019) compared student knowledge and self-efficacy before and after participation in six high-fidelity adult and pediatric simulation scenarios and two virtual simulation scenarios. The treatment group demonstrated significant improvements in knowledge after the virtual simulation scenarios *myocardial infarction* (p < .001) and *pediatric asthma* (p = .029) and the high-fidelity simulation scenario *septic shock* (p = .033) (Goldsworthy et al., 2019). Significant improvements were found within the treatment group pre- and post-intervention and between the treatment and control groups' self-efficacy in *responding to a patient not breathing* (p <.001), *inserting an oropharyngeal airway and using a bag-valve-mask* (p <.001), and *responding to a post-operative hemorrhage* (p < *0*.001) (Goldsworthy et al., 2019). Similarly, Kelly et al. (2014) found the outcome of a deteriorating patient simulation demonstrated improvements in senior BSN students' mean scores of their self-rated *skill to assess* a deteriorating patient pre- and post-simulation (M = 2.42, SD ± 0.66 vs. M = 2.67, SD ± 0.60), *confidence* in *communicating patient* *status changes* to the physician (*M* 2.62, SD ± 0.64 vs. *M* 2.78, SD ± 0.59), and *activating the rapid response team* (*M* = 2.35, SD ± 0.73 vs. *M* = 2.73, SD ± 0.63). Other deteriorating patient scenarios included hypoglycemic shock, bone fracture, pneumonia, sepsis, and stroke, suggesting the feasibility of developing tracheostomy airway scenarios for future research studies (Goldsworthy et al., 2019; Liaw et al., 2011).

Conversely, not all simulation researchers found improvements in nursing students' ability to recognize and respond to deteriorating patient situations. Aronson et al. (2012) found that during a simulated heart failure scenario, nursing students were disorganized, missed cues to patient deterioration, and failed to report abnormal data to the physician. The participants had low mean scores on the assessment, communication, and intervention subscales of a heart failure simulation measurement tool (Aronson et al., 2012).

Simulation Measurement Challenges

A prevalent theme found in the literature review was the scarcity of studies objectively measuring clinical competency as well as a lack of rigor (reliable and valid tools) in study measurement tools (Haddeland et al., 2018). Subjective variables such as comfort, confidence, knowledge, satisfaction, and self-efficacy are frequently used in simulation-based research as proxy measurements of clinical competency (Buckley & Gordon, 2011; Cant et al., 2018; Kardong-Edgren et al., 2010). Nurses' comfort level with tracheostomy procedures (suctioning, management of obstruction, and accidental decannulation) and knowledge were the most frequently measured variables in the educational interventions reviewed (Agarwal et al., 2016; Dorton et al., 2014; McDonough et al., 2016; Pritchett et al., 2016; Smith-Miller, 2006; Yelverton et al., 2015).

Measurement of Clinical Competency. Researchers have demonstrated, however, that self-reported perceptions of comfort, confidence, knowledge, self-efficacy, and technical/non-technical skill may not correlate with direct measurements of clinical competency and do not translate to effective nursing practice (Buckley & Gordon, 2011; Cant et al., 2018; Liaw et al., 2011; Pike & O'Donnell, 2010). Day et al. (2009) observed only a weak association between nurses' knowledge of tracheostomy principles and tracheostomy skills performance evaluations in both traditional clinical and simulation settings.

In a simulation intervention designed to teach final-year Australian nursing students to recognize and manage deteriorating patient situations, participants self-rated *knowledge*, *confidence*, and *competence* was significantly improved after participating in face-to-face (p = .000) and Web-based (p = .000) simulation scenarios Cooper et al. (2015). However, when clinical performance (competence) was rated by trained clinical observers using an OSCE checklist, only 49% of the student teams met the performance criteria in the face-to-face simulation and 69% of students individually met the Web-based simulation performance criteria (Cooper et al., 2015).

Liaw et al. (2012) conducted a randomized controlled trial (RCT) to determine whether BSN students' self-reported confidence and knowledge correlated with objectively measured simulation clinical performance during a deteriorating patient scenario. The variables were measured via a 53-item knowledge questionnaire developed by the research team, a 5-item confidence scale (C-scale), and a 31-item checklist and 1-item global rating scale (Rescuing a Patient in Deteriorating Situation Tool) psychometrically validated by Liaw et al. (2011). Liaw et al. (2012) found no significant post-test correlation between confidence and clinical performance (p = .43) and between knowledge and clinical performance (p = .73). Similarly, in a RCT comparing didactic with simulation-based teaching of the skills needed to recognize and respond to a deteriorating patient, there was no correlation between first-year nursing students' observed OSCE clinical performance and self-reported competence and self-efficacy (Stayt et al., 2015). These findings supported the phenomenon that subjective, self-reported perceptions are incongruent with objective, observer-rated competency.

The inequity between indirect (subjective) and direct (objective) measurement of clinical competency was a consistent finding in the studies reviewed. Among multidisciplinary and single profession (nursing, respiratory, medicine) samples, the subjective perception of competency did not transfer to objective, observer-measured skills-based clinical performance (Davis & Kimble, 2011; Day et al., 2009; Liaw et al., 2012; Pike & O'Donnell, 2010). Improvements in TC skills were demonstrated in multiple IP studies, however, the variables measured did not include clinical competency (Bonvento et al., 2017; Dorton et al., 2014; Hess & Altobelli, 2014; Yelverton et al., 2015). Simulation experts have declared that subjective variables such as satisfaction and self-confidence have been adequately measured and future studies should focus on measuring objective variables (Fey & Kardong-Edgren, 2017; Franklin et al., 2015).

Simulation Design Challenges

Weaknesses in simulation design rigor, such as a dearth of experimental studies, small sample sizes, use of educator/researcher-developed, and self-reported instruments lacking psychometric testing, and the omission of a theoretical underpinning are prevalent in simulation-based research (Cant & Cooper, 2017; Cant et al., 2018; Doolen et al., 2016; Haddeland et al., 2018; Pritchett et al., 2016). A systematic review and meta-analysis of management of deteriorating patients yielded a meager 14 articles (out of 4048 screened articles) that met the inclusion criteria, which included a rigorous pretest/posttest design (Haddeland et al., 2018). The use of self-reported measurements is problematic even when validated instruments are used due to the potential for introducing bias (Cant et al., 2018; Polit & Beck, 2012). An evaluation of the methodological quality of simulation studies, prompted Cant et al. (2018) to assign lower quality scores to self-reported research designs. The following simulation study design weaknesses have challenged the advancement and rigor of simulation research.

Theoretical Underpinning. A theoretical framework provides a foundation for the generation, interpretation, and communication of meaningful knowledge (Franklin et al., 2015; Haerling & Prion, 2017; Leighton et al., 2022; Meleis, 2007). Integration of theory into simulation-based education enables a systematic method for developing answerable questions and improves simulation educational experiences (Haerling & Prion, 2017; Nestel & Bearman, 2015).

The exclusion of a theoretical foundation was a weakness of simulation-based research studies, as evidenced by two landmark reviews in which approximately 10% of the studies evaluated identified use of a theory to design, inform, interpret, and evaluate the research (Kaakinen & Arwood, 2009; Levett-Jones & Guinea, 2017; Rourke et al., 2010). Less than half (n = 6) of the 14 simulation studies examining how nursing students respond to deteriorating patients reviewed by Haddeland et al. (2018) were underpinned by a conceptual or theoretical framework. The lack of a theoretical underpinning extends to qualitative simulation-based research designs. In a qualitative systematic review of prelicensure nursing education learning outcomes Leighton et al. (2022) noted the theoretical assumptions of qualitative research studies are based on theory and provide a foundation for the generation of new knowledge yet the findings revealed that a specific qualitative method was not described in five of the six studies (Leighton et al., 2022).

Sample Sizes. A small sample size was a consistent finding in reviews of simulation research (Cant & Cooper, 2017). Haddeland et al. (2018) deemed a small sample size as weakness in several of the reviewed studies. Sample sizes of less than 50 participants may limit the generalization of quantitative research findings and conceal the effect of simulation as a learning technique (Cant & Cooper, 2017; Haddeland et al., 2018). In a review of simulation reviews, Doolen et al. (2016) found a prevalence of small, heterogenous samples. This was attributed, in part, to challenges in the recruitment of undergraduate nursing students willing to participate in research studies that are not a part of the curriculum and not a program requirement or associated with a course grade (Doolen et al., 2016). Cant and Cooper (2017) emphasized two weaknesses of simulation research: (1) small sample sizes make it difficult to compare research studies and extract findings regarding the effect of simulation as a mode of learning, and (2) a prevalence of measurement tools, many lacking in confirmed validity.

Psychometric Testing. The use of educator-developed, non-validated instruments in simulation-based research was a frequent research design finding (Cant & Cooper, 2017; Doolen et al., 2016). There is a trend among educators to develop an instrument to fit a single study (for example, the patient scenario intervention) without the rigorous psychometric testing required to establish reliability and validity (Cant & Cooper, 2017). Without known reliability and validity of an instrument, measurement of study outcomes may be faulty (Franklin et al., 2015). These measurement weaknesses challenge the comparison and replication of research studies (Cant & Cooper, 2017).

Despite the preceding challenges, simulation researchers are beginning to heed the call to design robust studies demonstrating objectively measured outcomes of simulation education, experimental designs, and the inclusion of a theoretical foundation (Cant & Cooper, 2017; Cant & Cooper, 2019; Haddeland et al., 2018). Integrating theory into simulation-based research by designing quantitative studies guided by a theoretical framework that spans the entire research process, from start to finish, may elevate the rigor and reputation of future simulation research, and is a goal for the proposed research study (Franklin et al., 2015).

Summary

The expertise required to rescue a patient experiencing a life-threatening tracheostomy complication may exceed the clinical and cognitive skills possessed by the prelicensure nursing student. Airway assessment and the need to call for help if a problem is observed are fundamental skills taught in nursing school. Therefore, it is a reasonable expectation that a senior-level nursing student possess the clinical competency to recognize and communicate an abnormal assessment finding. Recognition of a problem and communication of the problem leads to an escalation of care may prevent patient deterioration and death. The existing scientific knowledge base surrounding the problem of the morbidity and mortality of tracheostomized patients and the knowledge gaps warranting further research presented in this review of literature are subsequently summarized.

Existing Knowledge Base of Research Problem

The tracheostomized patient is at risk for clinical deterioration and death due to deficiencies in new and experienced hospital nurses' clinical competency to recognize and respond to a tracheostomy airway complication. Patient safety errors in tracheostomy airway management are a global problem, attributed to insufficient tracheostomy airway education, lacking competency evaluations of tracheostomy management, and absent or inadequate safety protocols. A salient factor was that graduating prelicensure nursing students are unprepared to recognize deteriorating patient situations upon entry to practice. These educational and organizational deficiencies emphasized concerns that new RNs may be learning tracheostomy management and problem-recognition skills at the bedside of the vulnerable tracheostomized patient, instead of in a learning environment where patient harm is avoided.

A prevalent theme revealed in the literature review was that the development of airway problem recognition and response skills should begin in nursing school. Patient safety organizations and IP and nursing research teams recommended undergraduate nursing students be taught critical assessment skills and the provision of safe nursing care to tracheostomized patients. Beginning the development of tracheostomy management skills in nursing school may mitigate patient safety errors upon entry to practice and support organizational (hospital) stakeholders' expectation of clinically competent nursing graduates.

Development of the clinical competency to provide TC and recognize and communicate a tracheostomy airway problem should take place in a safe setting where patient harm is avoided. The simulation-based learning environment is best practice for learning high-risk skills such as tracheostomy management. Simulation is effective for teaching technical and non-technical skills and the psychomotor, affective, and cognitive skills required to recognize patient deterioration. The literature review revealed improvements in nursing students' clinical competency to recognize and communicate abnormal assessment findings of simulated patients experiencing clinical deterioration due to asthma, pneumonia, MI, sepsis, hypoglycemic shock, and stroke. However, only one study was found describing student nurses' care of a simulated tracheostomy patient and details regarding intervention design, student performance, and measurement and statistical results were lacking.

A weakness in the objective measurement of clinical competency is a known problem in simulation-based research and was salient in this review. Proxy measurements of clinical competency with variables such as comfort, confidence, satisfaction, and self-efficacy prevailed. The predominant measurement was via indirect (subjective), self-reported measurement of clinical competency. This is a problem, because one finding of the review demonstrated that subjective measurement inconsistently correlated with direct (objective) evaluator measurement of clinical competency. Furthermore, participant self-reported perceptions of competency did not transfer to effective nursing practice.

Similarly, deficiencies were found in the rigor of simulation-based research study designs. Weaknesses included infrequent integration of a theoretical underpinning, small sample sizes, and the use of educator-developed measurement instruments lacking adequate psychometric testing. These simulation research study design weaknesses negatively impact nursing contributions to the scientific knowledge base.

Gaps in Knowledge

No studies were found in which researchers examined prelicensure nursing students' clinical competency to recognize and communicate a tracheostomy airway complication. One study was found depicting a simulated tracheostomized patient, however, the study lacked a description of the tracheostomy scenario intervention details and did not depict a complication or deteriorating patient situation. Furthermore, no studies were found exploring the effectiveness of simulation as an educational method for preparing prelicensure nursing students to manage tracheostomy airways.

While it is known that simulation is effective in teaching nursing students to recognize when simulated patients are deteriorating due many other conditions, it is unknown if simulation is effective in teaching nursing students to recognize when a patient is experiencing clinical deterioration due to a tracheostomy airway complication. An additional knowledge gaps exists regarding the outcomes of direct, objective quantitative measurements of clinical competency using reliable and valid instruments.

A patent airway is imperative to patient safety and the consequences of an unrecognized tracheostomy airway complication are catastrophic. To promote the safety of tracheostomized patients, research is needed to explore whether it is possible to preempt new RNs entering the workforce lacking the clinical competency to recognize a tracheostomy airway complication. A simulation-based experimental study has the potential to contribute to a reduction in the morbidity and mortality rate of tracheostomized patients on non-ICU hospital units. The absence of research examining methods of preparing nursing students to provide safe care to vulnerable tracheostomy patients upon entry to practice is further justification for the proposed research study.

CHAPTER 3

To promote the safety of tracheostomized patients hospitalized on general nursing units and mitigate suboptimal tracheostomy care in nursing practice, the aim of the proposed simulation-based research study was to develop prelicensure nursing students' clinical competency to recognize and respond to threats to tracheostomy airway patency (Bryant et al., 2020; Dorton et al., 2014; Garrubba et al., 2009; Stanley et al., 2019). The dearth of research studies describing nursing students' clinical experiences with tracheostomized patients informed the secondary aim of exploring how simulation-based pedagogy may be best used to prepare prelicensure nursing students to recognize tracheostomy airway problems (Franklin et al., 2015). The study was designed to investigate the research question: *Is there a difference in prelicensure nursing students' clinical competency to recognize a tracheostomy airway complication after participation in a simulation-based, e-learning experiential tracheostomy care learning activity?* The researcher hypothesized that prelicensure nursing students' participation in a learning activity depicting the management of patients who have a tracheostomy airway will improve students' clinical competency to recognize a tracheostomy airway complication.

Research Design

A quasi-experimental, one-group pretest-posttest exploratory pilot study was proposed (Table 2). A common research design in nursing education and simulation-based education, participants served as their own comparison group, with pretest scores serving as the control and the comparison between pretest and posttest scores (Altmiller et al., 2023; Cant et al., 2018; Gliner et al., 2009, 2017; Gray & Grove, 2021; Grove et al., 2013).

Table 2

Study Variables

Variables	Levels (values) of IV	Level of measurement
IV: Simulation-based educational intervention	One level (treatment)	N/A
DV: Clinical competency	N/A	Interval
Demographic variables (see Table 5)	N/A	See Table 5
Demographic covariates (see Table 5)	N/A	See Table 5

Note. DV = dependent variable; IV = independent variable; N/A = not applicable.

The research question has not been explored in undergraduate nursing education; therefore, a pilot study was appropriate to test and refine the intervention, measurement tools, and procedures and to determine the sample size and examine the feasibility of the research plan for a larger study (Gray & Grove, 2021; Grove et al., 2013; LoBiondo-Wood & Haber, 2014, 2021). The ethical importance of offering the intervention to all potential participants and anticipated challenges in recruiting a sufficient number of nursing students for participation in an activity that is not associated with a course grade or a requirement of the nursing program further influenced the selection of a one-group, pretest-posttest pilot study research design (Doolen et al., 2016; Gliner et al., 2009, 2017).

Theoretical Framework

Experiential Learning Theory (ELT) underpinned the research design (Kolb, 1984; 2015). ELT is widely used as a foundation for designing, implementing, and evaluating simulation-based clinical experiences in nursing and other health professions (Cooper et al., 2017; Kaakinen

& Arwood, 2009; Laschinger, 1990; Poore et al., 2014). The ELT constructs *grasping* and *transformation* and the four concepts (phases) of the ELT learning cycle were used as the theoretical foundation for the simulation-based experiential learning experience and research design (INACSL Standards Committee, 2016; Johnson, 2020). Incorporating ELT into the research design supports the recommendation to move away from simulation designs that are *teaching* experiences towards simulation designs that are *learning* experiences and focus on learner outcomes (Levett-Jones & Guinea, 2017).

Simulation Design

An interventional design integrating best practices of simulation pedagogy in a setting that eliminates the risks of patient harm may enable the development of the essential nursing skill of recognizing threats to tracheostomy airway patency (Decker et al., 2008; Franklin et al., 2015; Haddeland et al., 2018; Stanley et al., 2019). A tracheostomy complication is a life threatening interruption of airway patency that, when unrecognized, leads to a deterioration in patient status and poor outcomes such as hypoxic brain damage and death (Das et al., 2012; Halum et al., 2012; McGrath & Thomas, 2010; Wilkinson et al., 2015).

The use of an interventional design supported the call for simulation researchers to move beyond descriptive studies to focus on how simulation affects learners' behaviors and patient outcomes (Adamson et al., 2013). Integrating best practices of simulation into a robust research design would inform educators of effective methods for using simulation-based pedagogy in preparing nursing students to develop the essential nursing skill of maintaining tracheostomy airway patency (Franklin et al., 2015; Haddeland et al., 2018; Stanley et al., 2019). The simulated patient setting enabled the researcher to control the environment, manipulate the simulation intervention, and closely control implementation of the protocol (Ignacio et al., 2015).

Sample

The strategy for selecting the sample was designed to enable the researcher to explore the effect of a simulation-based e-learning online educational activity on the clinical competency of nursing students' to recognize a tracheostomy airway complication (Gliner et al., 2009, 2017). Cost-effectiveness, convenience, recruitment, and representativeness of the target population were further considered (George et al., 2014; Gliner et al., 2009, 2017; Gray & Grove, 2021; Grove et al., 2013; LoBiondo-Wood & Haber, 2014, 2021).

Sampling Criteria

Prelicensure, Bachelor of Science in Nursing (BSN) students were eligible to participate in the research study. The prelicensure nursing student describes a student enrolled in an associate degree, diploma, or baccalaureate (BSN) degree nursing program who becomes eligible to take the NCLEX-RN exam upon successful program completion (Hayden et al., 2014; Smiley, 2019).

The target population was designated as prelicensure BSN students in the United States (U.S.). The accessible population (sampling frame) was expected to be representative of the theoretical population of prelicensure BSN students and includes upper-level (senior) prelicensure BSN students enrolled at a university in the southwestern U.S. (Gliner et al., 2009, 2017; Gray & Grove, 2021; Grove et al., 2013). The age, ethnicity/race, and gender demographic characteristics of the accessible sample were expected to mirror BSN student demographic trends in Texas and across the United States (AACN, 2023; NLN, 2022; Texas Department of State Health Services, 2023).

A selected sample of senior BSN students registered in either a campus-based (CB) program or an accelerated online (AO) program were invited to participate in the research study

(Table 3). Potential participants were classified as Senior 1 from the CB nursing program who are enrolled in an acute care medical-surgical course or Senior 2 from the CB or AO programs who are enrolled in a final-semester capstone transition to practice course. Projected student enrollment in the Senior 1 level acute care medical-surgical course during the study timeframe was 211 ($N = 211$); there was not an AO cohort during the study period (M. Reid, personal communication, December 25, 2023). Projected student enrollment in the Senior 2 level capstone course was 427 ($N = 427$), distributed between the AO program ($n = 247$) and CB program ($n =$ 180 (P. Allard & P. Pastwa, personal communication, December 20, 2023). The projections yielded a total potential selected sample size of 638 BSN students invited to participate in the study. The inclusion criteria extended to senior level prelicensure BSN students who wished to voluntarily participate in the research study. Prelicensure BSN students who were respiratory therapists and may have entered nursing school possessing clinical competency in managing tracheostomy airways were excluded from the study.

Table 3

Selected Sample

Group level	BSN program type	Nursing course	Size
Senior 1	Accelerated online campus-based	Acute care medical-surgical Acute care medical-surgical	$n = 0$ $n = 211$
Senior 2	Accelerated online campus-based	Capstone transition to practice Capstone transition to practice	$n = 247$ $n = 180$
Total			$N = 638$

Note. BSN = Bachelor of Science in nursing.

Sample size

A minimum sample size of 30 participants ($N = 30$) is appropriate for a one-group pilot study design measuring a single outcome variable (Gliner et al., 2009, 2017; Gray & Grove, 2021; Grove et al., 2013; LoBiondo-Wood & Haber, 2014, 2021). No studies were found measuring nursing students' clinical competency to recognize and identify a tracheostomy airway complication. Piloting the intervention enabled the researcher to evaluate whether the intervention and design are feasible for delivery to larger samples of the U.S. nursing student population (Gray & Grove, 2021; Grove et al., 2013). Ensuring an adequate number of participants decreased the risk of a Type II error and falsely retaining the null hypothesis (Grove & Cipher, 2017, 2025). Identifying an effect size provided statistical expression of the extent or magnitude of the simulation-based, e-learning intervention on the outcome variable within the target population (Berben et al., 2012; Polit & Beck, 2012).

Power Analysis

Statistical power for evaluation of the research question was calculated using G*Power 3.1.9.6 (Faul et al., 2007). A priori sample size power calculations were computed based on a two-tailed, dependent (paired) samples *t* test to identify differences between participants' pre-intervention and post-intervention clinical competency scores (Adamson & Prion, 2014; Grove & Cipher, 2017, 2025). Power analysis was based on a fixed sample size ($N = 30$) because this was a pilot study and a minimum enrollment of 30 participants is appropriate for exploratory, pilot studies in nursing education research (Gliner et al., 2009, 2017; Gray & Grove, 2021; Grove et al., 2013). Using a fixed sample size of 30 and an alpha of .05, two-tailed, generated multiple statistical power levels that provided a range of potential effect sizes (Table 4). The results indicated the primary analysis would need to yield a moderate effect size of Cohen's $d_z = 0.55$ and power = .83 to test the study hypothesis that prelicensure BSN students' participation in a simulation-based, e-learning activity depicting the management of a patient who has a tracheostomy airway is positively associated with students' clinical competency to recognize a tracheostomy airway complication(Berben et al., 2012; Cohen, 1988; Grove & Cipher, 2017, 2020, 2025).

Table 4

Effect Size and Statistical Power (N = 30)

Effect size		Moderate			Large	
Cohen's d_z	0.45	0.50	0.55	0.60	0.65	0.70
Statistical Power (1-*b*)	.66	.75	.83	.89	.93	.96

Attrition Rate

A goal for the study was to minimize threats to internal validity due to attrition (Gliner et al., 2009, 2017). The selected sample size of 638 (*N* = 638) was expected to yield a minimum actual sample size of 30 participants (*N* = 30) required for the pilot study, thereby mitigating attrition rate concerns. Weekly invitations to participate in the study, a four-week enrollment period, and researcher attentiveness and contact with participants during the study may further reduce attrition (Gliner et al., 2009, 2017).

Sampling Method

A non-probability, convenience sampling method was used to select a sample representative of the target population of prelicensure BSN students. Convenience sampling is the most used sampling method in educational, nursing, and social sciences research, when random sampling of the population is not feasible (Gliner et al., 2009, 2017; Gray & Grove, 2021; Grove et al., 2013; Grove & Cipher, 2017, 2025). The researcher expected the sample to be homogeneous regarding level of education and university admissions criteria, which would minimize the influence of extraneous variables on the interaction between the independent and dependent variables (Gray & Grove, 2021; Grove et al., 2013). Furthermore, the participants were anticipated to be readily accessible to the researcher and the sampling method incur minimal cost (Gliner et al., 2009, 2017; Gray & Grove, 2021; Grove et al., 2013). A selected sample of 638 students would infer confidence in the attainment of an actual sample size exceeding 30 participants after considering refusal and attrition rates (Gliner et al., 2009, 2017; Gray & Grove, 2021; Grove et al., 2013; Grove & Cipher, 2017, 2025).

Approval to invite the senior level prelicensure BSN students to voluntarily participate in the study was sought and received from the chair of the university undergraduate nursing department (J. Boyd, personal communication, October 10, 2023). Upon institutional review board (IRB) approval of the proposed study, potential participants received an email describing the study and an invitation to anonymously enroll in the study (see Appendix B).

Setting

The research study was conducted remotely and asynchronously via three online simulation-based e-learning tracheostomy modules. E-learning was defined as an online, computer-based educational modality that uses electronic multimedia to facilitate learners' acquisition of knowledge, skills, and attitudes via asynchronous, self-paced learning (Barari et al., 2022; Elcullada Encarnacion et al., 2021; George et al., 2014; Roye, 2023; Sangrà et al., 2012; Tait et al., 2008).

The three evidence-based tracheostomy modules were developed by an international multidisciplinary tracheostomy consultative service dedicated to promoting excellence in tracheostomy care, education, management, and safety (Austin Health & Tracheostomy Review and Managment service [TRAMS], 2021; Graham et al., 2021). The modules include video vignettes of simulated patient scenarios portrayed by standardized (simulated) patients and manikins, text-based information, animations, images, diagrams, and knowledge-check assessments such as select-all-that-apply questions and drag-and-drop and hotspot exercises (Austin Health & TRAMS, 2022a, 2022b, 2022c). Austin Health and Tracheostomy Review and Management Services (TRAMS) granted the researcher permission to use the modules in the present study (see Appendix C). The simulation-based, e-learning setting enabled the researcher to control the scenario environment, manipulate the intervention, and closely control implementation of the protocol. An advantage of the controlled simulation setting is the reduction of extraneous variables and an increase in confidence that pretest-posttest scoring differences may be attributed to the effect of the intervention on the dependent outcome (Gray & Grove, 2021; Grove et al., 2013; Ignacio et al., 2015).

Measurement Methods

A single concept–clinical competency–was measured as the outcome variable. Clinical competency was conceptually defined as the application of affective (feeling), cognitive (thinking), psychomotor (doing) nursing skills necessary to recognize, prioritize, and communicate patient assessment data in order to intervene to maintain or restore patient safety (Decker et al., 2008; Hayden et al., 2014; INACSL, 2016; Kavanagh & Szweda, 2017; Moghabghab et al., 2018; Prion et al., 2017; Theisen & Sandau, 2013; Tilley, 2008). Clinical competency was operationally defined as a researcher-developed, 19-item, 6-point Likert numerical scale survey designed to measure knowledge, skills, and attitudes of prelicensure BSN students regarding tracheostomy airway management (Appendix D).

Measurement of Clinical Competency

The pretest-posttest survey consisted of competency-based declarative statements encompassing patient assessment, nursing and procedural skills, clinical decision-making, and patient safety that are aligned with the domains and subcompetencies of the American

Association of Colleges of Nursing (AACN) *Core Competencies for Professional Nursing Education* (Altmiller et al., 2023; AACN, 2021; Gray & Grove, 2021; Grove et al., 2013). The six-point numerical Likert scale survey consisted of response categories (anchors) ranging from 1 = *strongly disagree* to 6 = *strongly agree* (Gray & Grove, 2021; Grove et al., 2013; Waltz et al., 2010). Employment of the 6-point Likert scale was implemented to promote participant selection of a clear choice, thereby avoiding neutral choice responses (Altmiller et al., 2023; Gray & Grove, 2021; Grove et al., 2013). To avoid response-set bias, the survey items were counterbalanced by wording statements positively or negatively (Gray & Grove, 2021; Grove et al., 2013). The values of the negatively worded items within the survey scale were reversed before analysis (Gray & Grove, 2021; Grove et al., 2013). The reverse scored items, tracheostomy topic areas (subscales), and source of the evidence for each item are identified in the survey; however, these identifiers were removed from the survey the participants will complete in QuestionPro.

Development of the Survey

The rationale for employing a researcher-developed survey originated in the lack of a psychometrically validated tool to measure nursing students' tracheostomy care knowledge, skills, and attitudes. In the study setting, clinical competency exists within the holistic, unique context of learning to manage the care of a tracheostomized patient and anticipated application of the learned skills in future patient encounters (Altmiller et al., 2023). The clinical competency required to care for the tracheostomized patient is driven by this unique clinical context (Altmiller et al., 2023).

Each declarative statement item measured an element of tracheostomy care clinical competency. The content of the 19 items was derived from evidence-based tracheostomy care literature, multidisciplinary tracheostomy guidelines and clinical consensus statements, global tracheostomy education and patient safety collaboratives, and from the three simulation-based, e-learning modules comprising the study intervention (Austin Health & TRAMS, 2021; Global Tracheostomy Collaborative, 2018; Gray & Grove, 2021; Grove et al., 2013; McDonough et al., 2016; McGrath et al., 2012; Mitchell et al., 2013; NTSP, 2024). Rationale for selection of the Likert numerical scale as the measurement format, the number of survey items, and the range of the item anchors (1 = *strongly disagree* to 6 = *strongly agree*) was made after a review of the recommendations of experts in the fields of measurement, research methods, and education and learning outcomes (Billings & Halstead, 2012; Gliner et al., 2009, 2017; Gray & Grove, 2021; Grove et al., 2013; McDonald, 2014; Waltz et al., 2010).

The researcher held credentials suitable for development of a survey for use in an academic nursing education setting: A Master of Science in Nursing Education and designation as a certified nurse educator (CNE) by the National League for Nursing (NLN, 2024). Professional experience as nursing faculty and program director in an prelicensure undergraduate BSN program employing a strong curricular emphasis on simulation-based education along with personal proficiency in simulation learning modalities, NCLEX-style test question writing, and electronic learning management systems were additional qualifying credentials.

Scoring Method

The pretest and posttest surveys were identical with survey items scored at the interval level of measurement. The scores attainable from the electronic survey ranged from 19 points to 114 points, with higher scores suggesting clinical competency. Each item was summed yielding a single score for a comparison of total mean scores between the paired pretest and posttest

(Gray & Grove, 2021; Grove et al., 2013). Additionally, pretest and posttest mean scores of each paired individual item were calculated (Altmiller et al., 2023).

Validity and Reliability

The survey currently lacks published reliability and validity psychometric testing. However, face validity was established because the researcher developed the study to specifically answer the research question by measuring nursing students' clinical competency within the unique context of tracheostomized patient needs (Gray & Grove, 2021; Grove et al., 2013; Kelly et al., 2014; Waltz et al., 2010). Biyik Bayram et al. (2023) experienced similar barriers to measuring tracheostomy care knowledge among prelicensure nursing students and consequently developed a tracheostomy care measurement tool to answer the study research question. Content validity may be considered due to the careful derivation of each survey item from the published works of tracheostomy content experts, including researchers, educators, tracheostomy safety organizations, and a robust clinical consensus statement (Duggal et al., 2023; Global Tracheostomy Collaborative, 2018; Gray & Grove, 2021; Grove et al., 2013; McGrath et al., 2012; Mitchell et al., 2013; NTSP, 2024).

Procedure

Participant enrollment, implementation of the study protocol, and data collection occurred during the Spring 2024 university semester, after approval by the university institutional review board (IRB). The timeframe coincided with the Senior 1 BSN students' third semester and Senior 2 BSN students' final semester of nursing school. A weekly email was sent by the BSN program advisor to potential participants for a total of four weeks. Data collection was expected to be completed in four weeks.

Sampling Procedures

Potential participants were assured enrollment in the research study would be anonymous, confidential, and voluntary and no grade would be associated with the learning activity. The Senior 1 and Senior 2 students were emailed an electronic description of the research study and an invitation to participate in the study (Appendix B). The researcher emphasized in the email that a decision to enroll in the study would not impact the nursing students' academic standing or program completion (Franklin et al., 2015; Ignacio et al., 2015). The freedom to withdraw at any time was reinforced at study onset and before each data collection point (Rossing McDowell, 2019; Spector et al., 2015). The one-group design eliminated the need for procedures describing assignment to groups.

Informed Consent

The informed consent procedure followed the best practices outlined in the Collaborative Institutional Training Initiative (CITI Program) recommendations for online consent forms and internet-based research (Martinez, 2022). At the end of the email containing the study description and confidentiality statements, a weblink to provide informed consent was visible to the potential participants. Selecting the weblink directed potential participants to QuestionPro (https://www.questionpro.com/), an online electronic survey software. The first item viewed was a yes/no question regarding the study exclusion criterion (respiratory therapist). Students who selected "yes" to being a respiratory therapist were dismissed from the QuestionPro platform. Students who selected "no" viewed the informed consent statement (Appendix E). Upon selecting the "Accept" option, the participants were enrolled in the study. Potential participants who selected the "Do Not Accept" option were terminated from the study.

Coding of Data

To enable analysis and comparison of the paired pretest and posttest survey responses, each participant self-selected a code. Immediately after providing informed consent, participants answered a series of questions that were complied to generate an alphanumeric code (Appendix F). The code was anonymous and identifiable only to the participant. The researcher did not know the identity of the participants associated with the codes.

Protocol

The data collection process was managed exclusively by the researcher. The informed consent, preparatory materials, demographic questionnaire, pretest-posttest survey, tracheostomy e-learning modules, debriefing, and post-study certificate of completion were all delivered sequentially via the QuestionPro software platform. A protocol flowchart depicts the steps of data collection and the components of the intervention procedure (Appendix G).

Intervention

In alignment with a one-group research design, all participants received the identical treatment (Raab et al., 2023). The elements of the intervention procedure are described in the following narrative. All elements were embedded within the QuestionPro platform and accessible to participants upon logging into QuestionPro.

Preparation Material

Upon providing informed consent, the tracheostomy preparatory material were visible to the participants (INACSL Standards Committee, McDermott, et al., 2021; INACSL Standards Committee, Watts, et al., 2021). Providing preparatory materials in advance met the criteria outlined in the Healthcare Simulation Standards of Best Practice (HSSOBP™) for pre-simulation preparation and strengthened learner success in meeting the learning objectives of the simulation-based e-learning activity (INACSL Standards Committee, McDermott, et al., 2021). The preparatory material consisted of a three-page document describing best practices for tracheostomy care (Appendix H). Permission to extract the preparatory material from a comprehensive clinical packet given to the Senior 1 BSN students at the beginning of their acute care medical surgical course was received from the course lead (M. Reid, personal communication, January 31, 2024).

Learning Objectives

The learning objectives for the simulation-based, e-learning activity were developed in alignment with Bloom's revised taxonomy of cognitive, psychomotor, and affective domains of learning and HSSOBP™ for outcomes and objectives (Adams, 2015; INACSL Standards Committee, Miller, et al., 2021). Consistent with the expectations that a senior-level BSN nursing student possesses a higher-level of knowledge, skills, and attitudes, the learning objectives reflected higher-order elements on Bloom's taxonomy hierarchy (Adams, 2015; INACSL Standards Committee, Miller, et al., 2021):

1. Demonstrate appropriate focused assessment of a patient who has a tracheostomy airway (Bloom's *application* element).
2. Recognize abnormal tracheostomy airway assessment data (Bloom's *analysis* element).
3. Initiate appropriate actions to restore airway patency (Bloom's *synthesis* element).

Demographic Questionnaire

Participants completed a 14-item demographic questionnaire developed by the researcher (Appendix I). The questionnaire was designed to collect information about demographic variables common to nursing, nursing education, and simulation-based research as well as information relevant to the focus of the research question (Bogossian et al., 2014; Gray & Grove, 2021; Grove et al., 2013). The items in the questionnaire were indirect identifiers of participant information (Rossing McDowell, 2019). A description of the procedure for anonymous coding for data analysis was previously provided.

Pretest Survey

Participants completed the 19-item pretest after completion of the demographic questionnaire and before the intervention prebrief and beginning the first simulation-based, e-learning tracheostomy module. Participants were asked to not refer to the tracheostomy preparation material or use other resources while completing the pretest survey and to refrain from sharing the pretest survey items with other participants or peers (Altmiller et al., 2023; Liaw et al., 2012).

Prebriefing

Prebriefing was defined as the orientation that takes place before a simulation-based experiential learning activity (Bryant et al., 2020; INACSL Standards Committee, McDermott, et al., 2021). Prebriefing participants promotes learner success, conveys ground rules for the intervention, and establishes a psychologically safe learning environment (INACSL Standards Committee, Watts, et al., 2021). Participants were briefed via a video of the researcher delivering directions for completing the simulation-based, e-learning modules. The video contents and script may be found in Appendix J. The video was embedded in QuestionPro and stored in a secure Microsoft OneDrive (https://www.microsoft.com/en-us/microsoft-365/onedrive/online-cloud-storage) folder in an account provided by the university. The researcher emphasized the voluntary nature of the intervention and provided assurance of anonymity, confidentiality, and privacy. A description of the learning objectives, intervention, directions for completion of the modules, posttest, and debrief was provided. Expectations for the time of completion of each module were discussed. Participants were asked to avoid sharing information about the pretest and posttest and the module content with other participants or peers (Liaw et al., 2012). The researcher's contact information was provided along with encouragement to call or email the researcher should questions or problems arise.

E-Learning Modules

Direct weblinks to the three modules were embedded and visible in QuestionPro. Participants were directed to complete the modules in the following sequence: Introduction to Tracheostomy Care, Routine Tracheostomy Care, and Tracheostomy Emergency Management (Austin Health & TRAMS, 2021). Cumulatively, the three modules were expected to take approximately 90 minutes to complete. Each module was self-paced; there was no time limit for completion.

Posttest

Participants completed the 19-item pretest after completion of the three simulation-based, e-learning modules (Liaw et al., 2012). The posttest was identical to the pretest. Participants were again asked to not refer to the tracheostomy preparation material, the e-learning modules, or other resources while completing the posttest survey and to and to refrain from sharing the posttest survey items with other participants or peers (Altmiller et al., 2023; Liaw et al., 2012).

Debriefing

Debriefing was defined as the process that promotes the transfer of learning into practice (INACSL Standards Committee, Decker, et al., 2021). It is during debriefing that learner knowledge increases (Shinnick et al., 2011). From a theoretical perspective, debriefing aligns with the reflective observation and abstract conceptualization phases of Kolb's Learning Cycle (Kolb, 2015). During these phases, learners begin to make sense of and give meaning to the tracheostomy care experience and plan for problem-solving in future encounters with tracheostomized patients (Kolb, 2015).

Guided reflection is an affective and intellectual debriefing technique that may take place after a simulation-based activity (INACSL Standards Committee, Decker, et al., 2021; Lioce et al., 2020). After completion of the three modules, participants engaged in a guided reflection that includes open-ended, Socratic questions designed to promote self-reflection and self-analysis about the simulation-based, e-learning experience (see Appendix K; INACSL Standards Committee, Decker, et al., 2021; Shinnick et al., 2011). The researcher's contact information was displayed along with the reflection questions should unexpected participant distress occur (INACSL Standards Committee, Decker, et al., 2021).

Certificate of Completion

Upon completion of all components of the intervention, participants were awarded a certificate of completion. To maintain anonymity, the format of the certificate enabled participants the option of enter their name into the certificate. The completed tracheostomy modules were listed on the certificate along with logos from the Austin Health and TRAMS.

Procedures to Standardize Treatments and Data Collection

The QuestionPro software platform was used to promote standardization of the intervention and data collection procedures. The elements of the protocol were delivered to participants sequentially on the QuestionPro platform. Participants had one opportunity to answer the demographic questionnaire, pretest survey, and posttest survey. Data from the questionnaire and surveys were collected in QuestionPro, eliminating the need for inter/intra reliability testing and the variances that may occur when observers score a learner's performance.

Intervention fidelity was maintained throughout the study. All participants experienced the same standardized online e-learning modules. The structure of the modules disallowed deviation from the standardized learning format (Austin Health & TRAMS, 2021). Participants were asked to take the pretest and posttest without referring to the preparatory material or the simulation-based, e-learning modules. During the prebrief video, the researcher requested the participants uphold confidentiality of the modules, similarly to the expectations of confidentiality imposed during a face-to-face simulation experience (Franklin et al., 2015). As the participants may be known to each other due to enrollment in the same nursing program, participants were asked to uphold ethical behavior and avoid sharing content of the learning modules and pretest/posttest with their peers (Liaw et al., 2012).

Ethical Considerations

Ethical approval was obtained from the university IRB. The researcher completed human subjects' protection training for social and behavioral research and has upheld the ethical standards in the design of the research study (Collaborative Institutional Training Initiative, 2021; Gray & Grove, 2021; Grove et al., 2013). The Healthcare Simulation Standards of Best Practice™ and the Healthcare Simulationist Code of Ethics were adhered to throughout the research study design, protocol, and procedures (INACSL Standards Committee, Bowler, et al., 2021; INACSL Standards Committee, Decker, et al., 2021; INACSL Standards Committee, McDermott, et al., 2021; INACSL Standards Committee, Miller, et al., 2021; INACSL Standards Committee, Watts, et al., 2021). Participants were assured of anonymity, confidentiality, and privacy from data collection to data entry and analysis and codes were assigned in lieu of participant names (Kelly et al., 2014). The researcher was not employed by the university, involved in participants' courses or programs, and was not known to the participants nor were the participants known to the researcher (Kelly et al., 2014).

Minimal risk to participants was anticipated as the study involved participation in a standardized online educational activity, a robust informed consent process and procedure, and participant names were de-identified. A possibility existed that participants may experience emotional distress due to a perception of a lack of clinical competency surrounding care of a tracheostomized patient. This was alleviated by the guided reflection debriefing designed to promote the processing of feelings that may emerge during the intervention and by the consistent availability of the researcher's contact information (INACSL Standards Committee, Decker, et al., 2021). Furthermore, with the format of the Likert scale survey there was no right or wrong answer that may cause distress. There were no potential conflicts of interest. Concerns about an obligation to participate were eliminated as the intervention was voluntary and was not associated with any university courses.

The benefits of participating in the study included the development of knowledge and clinical competency in the management of tracheostomy airways, recognition of tracheostomy airway complications, and actions to take to maintain or restore tracheostomy airway patency. These benefits may prevent patient harm and improve the safety and outcomes of tracheostomized patients. Upon graduation from nursing school, the participant may benefit professionally by entering nursing practice possessing tracheostomy management knowledge that is unavailable to most new graduate nurses. The certificate of completion may serve as a positive addition to the participants' resume and job seeking success.

Data Analyses

Upon completion of data collection, the data were coded and exported from QuestionPro into the IBM Statistical Package for the Social Sciences (SPSS) 29.0 for macOS software package (SPSS 29) for analysis of descriptive and inferential statistical data. Analysis comprised of descriptive statistics and inferential statistics. Data were stored in a secure university-sanctioned OneDrive platform. Data cleaning was performed to assess for errors (Gray & Grove, 2021; Grove et al., 2013).

The following describes the plan for handling missing data: The demographic questionnaire and the tracheostomy pretest/posttest survey datasets were visually assessed for missing values. Missing data were assessed to identify the extent (percentage) and pattern (random or non-random pattern) of missing data (Grove & Cipher, 2025). Due to potential threats to internal and external validity of the statistical analyses and distortion of the findings, a statistician was consulted for any occurrences of missing data prior to computing statistical analyses (Grove & Cipher, 2025). For random patterns of missing data, SPSS 29 would be used to test the assumption the data are missing completely at random by computing Little's test (Grove & Cipher, 2025). For any non-random patterns of missing data, SPSS 29 would be used to assess the continuum of non-random data missingness (Grove & Cipher, 2025). The statistician and researcher would collaborate to identify the pervasiveness of any patterns of missing data and identify an imputation method to accommodate the missing data (Grove & Cipher, 2025). Following missing data imputation, the researcher would proceed with the planned inferential statistical tests of the pretest/posttest survey dataset (Cipher, 2023).

Analysis of the Sample

Descriptive statistics were used to describe and analyze the sample characteristics as reported via the participants' demographic questionnaire. Table 5 depicts how measures of central tendency (mode, median, mean) and dispersion (range, standard deviation) were used to describe the sample demographic variables and evaluate sample homogeneity (Grove & Cipher, 2017, 2025).

Table 5

Sample Statistical Analyses

Demographic variable	Level of measurement Descriptive statistical procedures
Senior level classification [a]	Nominal; *f*, %, mode
BSN program type	Nominal; *f*, %, mode
Gender	Nominal; *f*, %, mode
Ethnicity/race	Nominal; *f*, %, mode
English second language	Nominal; *f*, %, mode
Healthcare experience [b]	Nominal; *f*, %, mode
Tracheostomy patient in nursing school	Nominal; *f*, %, mode
Performance of TC in clinical setting [c]	Nominal; *f*, %, mode
Practiced TC on manikin or SP	Nominal; *f*, %, mode
Type of TC performed	Nominal; *f*, %, mode
Previous college degree	Nominal; *f*, %, mode
Plan to work with tracheostomy patients	Nominal; *f*, %, mode
Educational level (highest degree)	Ordinal; *f*, %, mode, *Mdn, range*
Age	Ratio; *f, %, M, SD, range*

Table 5 (Cont.)

Note. *f* =frequency; *Mdn* = median; % = percent; SP = simulated patient; SD = standard deviation; *M* = mean; TC = tracheostomy care.

[a, b, c,] Denotes demographic covariates analyzed in linear mixed model computation.

Analysis of the Research Question

Inferential statistics were used to answer the research question via analysis of the pretest-posttest survey. Prior to data analysis, normality of the distribution of clinical competency scores were assessed via frequency distribution, skewness, and kurtosis statistics (Fogg et al., 2023; Grove & Cipher, 2017, 2025). The Shapiro-Wilk's W test was computed to assess for overall normality (Grove & Cipher, 2017, 2025). Should inspection of the frequency distribution suggest nonnormality and the Shapiro-Wilk result be significant, a non-parametric test such as the Wilcoxon Signed-Rank test would be considered (Grove & Cipher, 2017, 2025).

Assuming a normal distribution and sample homogeneity, a paired (dependent) sample *t* test was computed to compare pre- and posttest scores of the survey (Grove & Cipher, 2017, 2025). Other assumptions regarding the paired samples *t* test include: (a) interval/ratio level of measurement of the DV, (b) repeated measures of data collection from a single group (paired scores), and (c) the differences between the paired scores are independent with participants serving as their own control group (Grove & Cipher, 2017, 2025). The paired (dependent) samples *t* test is appropriate for comparison of scores for the same group of subjects before and after an intervention and may allow inference that the intervention had an impact on clinical competency (Adamson & Prion, 2014; Gliner et al., 2009, 2017). Overall mean score differences between the pretest and posttest and individual item level differences between pretest and posttest were analyzed (Altmiller et al., 2023; Fogg et al., 2023). A two-sided significance level was set at $p < .05$.

A linear mixed model for repeated measures (LMM) analysis was performed to identify changes in clinical competency over time after controlling for the presence of covariates. Demographic covariates such as experience performing TC, academic classification (Senior 1 or Senior 2), and previous healthcare experience may influence the participants' clinical competency scores. Computing the LMM enabled analysis of time on clinical competency (dependent variable) while holding constant the other covariates in the model. Time was specified as the repeated effect (pretest, posttest) and the types of covariance structures for repeated measures were compared for use in final interpretation based on goodness of fit indices (Cipher, 2018). Dummy coding was performed on the nominal covariates prior to performing LMM (Grove & Cipher, 2017, 2025).

Delimitations

The proposed study was delimited by the lack of simulation-based, hands-on learning of tracheostomy care skills in the potential participants' BSN program curriculum. This factor limited the design and modality of the study intervention and contributed to the decision to employ a one-group research design to answer the research question. The implications to patient safety of not offering the intervention to a comparison group and the educational implications of fewer new GNs entering nursing practice possessing the clinical competency to manage tracheostomy airways further affected selection of the research design and intervention.

The exclusion criterion (nursing students who are respiratory therapists) imposed upon the sample of BSN nursing students was intended to promote sample homogeneity and limit a contaminating effect on the measurement of clinical competency (LoBiondo-Wood & Haber, 2014, 2021). Further attempts to control for bias were to be established via the items on the demographic questionnaire that inquire about participants' previous experience with tracheostomy care. The goal of this delimitation was to increase the strength of the study and promote generalizability of the study findings (LoBiondo-Wood & Haber, 2014, 2021).

Summary

The research study was intended to explore the hypothesis that prelicensure BSN nursing students' participation in a simulation-based, e-learning activity depicting the management of patients who have a tracheostomy airway will improve BSN students' clinical competency to recognize a tracheostomy airway complication. A quasi-experimental, one-group pretest-posttest exploratory pilot study underpinned by Experiential Learning Theory was proposed. A non-probability, convenience sampling method was used to select a sample of senior level prelicensure BSN students. The setting for the study intervention was online and asynchronous. The concept *clinical competency* was measured via a 19-item, 6-point Likert scale numerical survey. A demographic questionnaire captured the sample characteristics. IRB approval was obtained prior to seeking informed consent and implementation of the procedure and protocol. Participants completed three simulation-based, e-learning modules depicting safe tracheostomy care practices. Differences in participants' clinical competency to recognize tracheostomy airway complications were measured before and after the learning module intervention. The researcher anticipated participation in the research study would promote senior-level prelicensure BSN students' clinical competency to maintain the safety of vulnerable tracheostomized patients upon entry to nursing practice.

CHAPTER 4

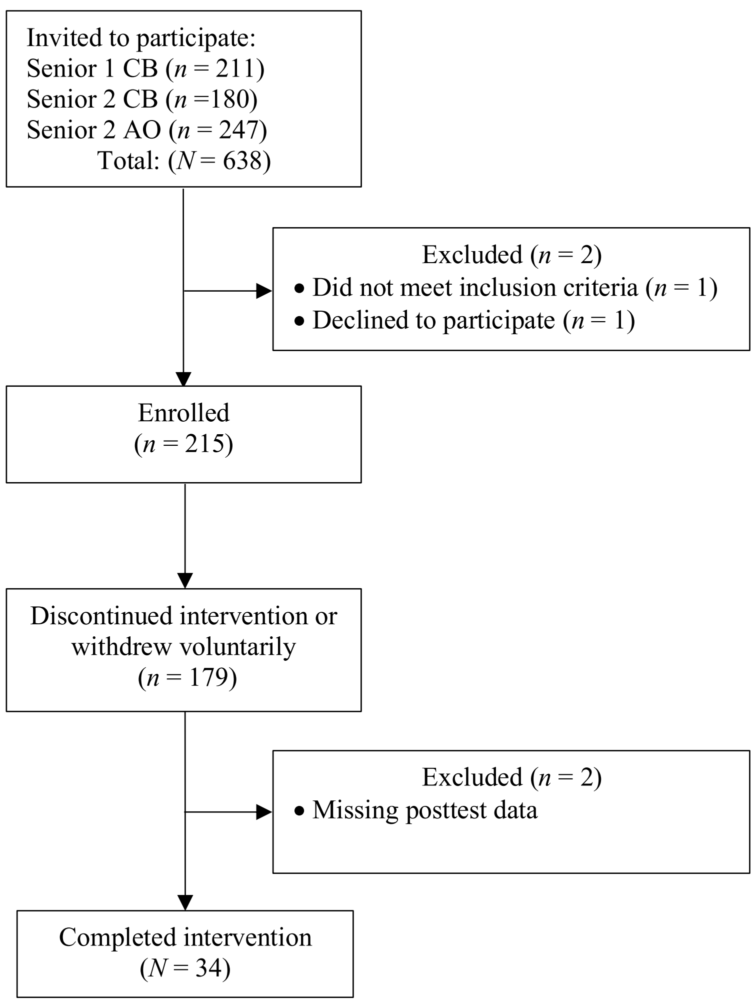
The findings of the quasi-experimental, one-group pretest-posttest pilot research study designed to answer the research question *Is there a difference in prelicensure nursing students' clinical competency to recognize a tracheostomy airway complication after participation in a simulation-based, e-learning experiential tracheostomy care learning activity?* are presented. Data analyses of the outcomes of the independent variable, a simulation-based, tracheostomy management e-learning intervention on the dependent variable (clinical competency scores) are reported. The sample characteristics are presented via descriptive statistical analysis of the participants' demographic questionnaire data. Inferential statistical analysis of the 19-item Likert scale pretest-posttest tracheostomy clinical competency survey was computed via a paired samples *t* test. A linear mixed model (LMM) for repeated measures was computed to determine whether changes in time between the pretest and posttest occurred after controlling for demographic covariates. Themes observed in the participants' responses to the post-intervention debriefing questions are presented.

Results

Participant enrollment (Figure 3) and data collection began with consent in the QuestionPro online electronic survey software. Once consent to participate was completed there was a second question asking if the student was a respiratory therapist, if the answer was "yes", they were excluded from the study. If the student was excluded, a thank you note and the reason for the survey not opening for them was provided. One nursing student was excluded from the study due to meeting the exclusion criterion of status as a respiratory therapist and one nursing student declined to enroll in the study. A total of 215 prelicensure senior-level Bachelor of Science in Nursing (BSN) students enrolled in the study; however, 179 participants did not complete the entire study. The most prevalent point of discontinuance occurred after taking the pretest. This time point coincided with completion of the three tracheostomy e-learning modules and was evidenced by participants choosing to not complete the posttest within the QuestionPro survey platform. Consequently, statistical analysis was not performed on the data collected from participants who discontinued the survey.

Figure 3

Enrollment Flowchart



Note: AO = accelerated online program; CB = campus-based program.

An application for modification of the study protocol to extend the study recruitment period from four weeks to six weeks was submitted to the IRB after two weeks of recruitment. This was due to a low study completion rate of 18 participants ($n = 18$) and a required sample size of 30 ($N = 30$). The IRB approved the modification request and invitations to participate were emailed to potential participants for a total of six weeks. A total of 34 participants completed the entire research study, which included informed consent, demographic data collection, pretest completion, intervention prebriefing, completion of three simulation-based tracheostomy e-learning modules, posttest completion, answering five debriefing questions, and downloading a certificate of completion. The sample size ($N = 34$) exceeded the minimum enrollment required to test the hypothesis that prelicensure BSN students' participation in a simulation-based, e-learning activity depicting the management of a patient who has a tracheostomy airway is positively associated with students' clinical competency to recognize a tracheostomy airway complication.

Data Collection and Cleaning

Data were collected in QuestionPro, downloaded into a Microsoft Excel file, and exported into the Statistical Package for the Social Sciences (SPSS) version 29 for analysis. Participants' answers to questions designed to create an anonymous code were compiled in SPSS 29, generating a five-character alphanumeric code identifiable only to the participant. Data cleaning was performed in SPSS 29 to ensure levels of measurement and variable values were coded correctly and to identify variable labels. Reverse scoring of three Likert scale items was performed. Two new variables were created to sum the pretest and posttest Likert scale data for each participant code: Total pretest score and total posttest score (Cronk, 2024).

During examination of the raw data in the Microsoft Excel spreadsheet, the researcher noted several participants completed the pretest more than once. The first attempt responses occurred as intended, before completion of the tracheostomy e-learning modules intervention, yet the subsequent pretest responses likely occurred after completion of the intervention modules. For example, on the 6-point Likert scale item "*I feel competent knowing what actions to take when a patient is experiencing a tracheostomy problem*", one participant responded 4 = *somewhat agree* on the first pretest attempt and 6 = *strongly agree* on the second pretest attempt, after completing the modules. Because the knowledge gained by completing the e-learning intervention may have influenced the later pretest responses, the first attempt pretest responses were considered the true pretest data and used in the data analysis.

Missing Data Management

Data were missing from two participants' responses to the 19-item Likert scale posttest. One participant response was missing one item, and one participant response was missing two items. After consulting with a statistician, the two responses were excluded from descriptive and inferential statistical analysis.

Descriptive Analysis of Sample Characteristics

The descriptive statistical analysis of the sample characteristics is presented in Table 6. Demographic statistics for age and gender mirrored student demographics in Texas professional nursing programs (Texas Department of State Health Services, 2023). The distribution of participant ages appears positively skewed, with the median age (25) and mode (age 22) falling below the mean age of 27.79 (Figure 4). This observation corresponds with 55.9% (n = 19) of participants falling into the 20 to 25 age range and 5.8% (n = 2) falling into the 46 to 50 age range. The majority of participants reported female gender at birth (82.4%; n = 28) and Hispanic or Latino race/ethnicity (41.2%; *n* = 14). The distribution of Asian participants (23.5%; *n* = 8) more than doubled the 10% enrollment of Asian students in generic baccalaureate programs of in the United States (American Association of Colleges of Nursing, 2023). English was not the second language for the majority of the participants (64.7%; *n* = 22).

Academic classification distribution included 70.6% (*n* = 24) Senior 2 students and 29.4% (*n* = 10) Senior 1 students, with 55.9% (*n* =19) enrolled in the campus-based BSN program and 44.1% enrolled in the accelerated online program. Over half of participants (52.9%) earned a previous degree. The most frequently reported degree was an associate degree (29.4%; *n* = 10); one participant (2.8%) earned a doctoral degree. Most participants did not have previous healthcare experience (64.7%; *n* = 22) although 4 participants reported dual healthcare professions (see Table 6 note).

A majority of the participants reported having a patient with a tracheostomy airway during nursing school clinicals (91.2%; *n* = 31). Fifty percent (*n* = 17) had performed TC in the clinical setting whereas 73.5% had not performed TC in the simulation setting. Fifty percent (*n* = 17) reported performing tracheal suctioning and 44.1% (*n* = 15) had not performed any TC skills. Most participants planned to work in a location with tracheostomy airway patients (88.2%; *n* = 30).

Table 6

Sample Demographic Characteristics

Characteristic (*N* = 34)	*n* (%)	Measures of central tendency
Age [a]		*M (SD)* 27.79 (7.69)
20-25	19 (55.9)	*Mdn* 25
26-30	7 (20.6)	Mode 22
31-35	2 (5.8)	
36-40	3 (8.8)	
41-45	1 (2.9)	
46-50	2 (5.8)	
Academic classification		
Senior 1	10 (29.4)	
Senior 2	24 (70.6)	
BSN program type		
Accelerated online	15 (44.1)	
Campus-based	19 (55.9)	
Gender		
Female	28 (82.4)	
Male	6 (17.6)	
Ethnicity/race		
African American or Black	2 (5.9)	
Asian	8 (23.5)	
Hispanic or Latino	14 (41.2)	
White	10 (29.4)	
English second language		
Yes	12 (35.3)	
No	22 (64.7)	
Healthcare experience [b]		
None	22 (64.7)	
Nurse tech, PCT, or extern	4 (11.8)	
CNA	3 (8.8)	
EMT/paramedic	2 (5.9)	
CST	1 (2.9)	
Chiropractor	1 (2.9)	
Dental assistant	1 (2.9)	
EKG technician	1 (2.9)	
MA	1 (2.9)	
Pharmacy technician	1 (2.9)	
Telemetry technician	1 (2.9)	

Table 6 (Cont.)

Characteristic (*N* = 34)	*n* (%)	Measures of central tendency
Highest educational level		*Mdn* Associate degree
None	16 (47.1)	
Associate degree	10 (29.4)	
Baccalaureate degree	7 (20.6)	
Master's degree	0 (0)	
Doctoral degree	1 (2.9)	
Tracheostomy patient in nursing school		
Yes	31 (91.2)	
No	3 (8.8)	
TC performance (clinical setting)		
Yes	17 (50)	
No	17 (50)	
TC performance (simulation setting) [c]		
Manikin	9 (26.4)	
SP	1 (2.9)	
None	25 (73.5)	
TC skill performed [d]		
Stoma care	5 (14.7)	
Stoma dressing change	9 (26.5)	
Changing tracheostomy tube ties	5 (14.7)	
Inner cannula care	2 (5.9)	
Suctioning	17 (50)	
None	15 (44.1)	
Plan to work in a location with tracheostomy patients		
Yes	30 (88.2)	
No	4 (11.8)	

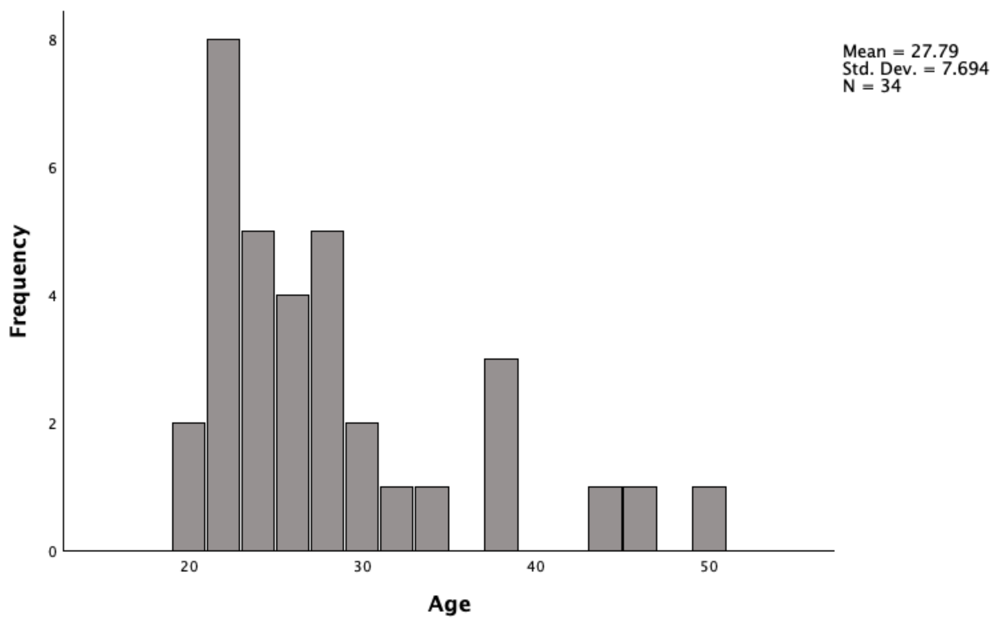
Note. CNA = certified nursing assistant; CST = certified surgical technician; EKG = electrocardiogram; EMT = emergency medical technician; *M* = mean; *Mdn* = median; MA = medical assistant; PCT = patient care technician; SP = standardized (simulated) patient; TC = tracheostomy care.

Table 6 (Cont.)

[a] See Figure 4. [b] Four participants had previous healthcare experience in more than one profession: CNA and Nurse Tech/PCT/Extern; CNA and EKG technician; Nurse Tech/PCT/Extern and EMT/paramedic; chiropractor and telemetry technician. [c] One participant performed TC in the simulation setting on both a manikin and a SP. [d] Ten participants performed more than one TC skill.

Figure 4

Age Frequency Distribution



Inferential Statistical Analysis

Inferential statistical analyses were computed to evaluate the hypothesis that prelicensure nursing students' participation in a learning activity depicting the management of patients who have a tracheostomy airway will improve students' clinical competency to recognize a tracheostomy airway complication. Prior to data analysis, the normality of the distribution of the dependent variable clinical competency scores (total pretest scores and total posttest scores) was assessed via frequency distribution, skewness, and kurtosis statistics. Visual inspection of the pretest scores distribution (Figure 5) revealed a positively skewed, mesokurtic distribution curve with the median (89.50) and mode (89) slightly below the mean (90.21). Visual inspection of the posttest scores distribution (Figure 6) revealed a negatively skewed, slightly platykurtic distribution curve with the median (104) and mode (104) slightly above the mean (103.03). The magnitude of the skewness and kurtosis statistics values of the pretest and posttest scores were not greater than 1.0 or -1.0 (Grove & Cipher, 2025).

Figure 5

Pretest Scores Frequency Distribution Histogram

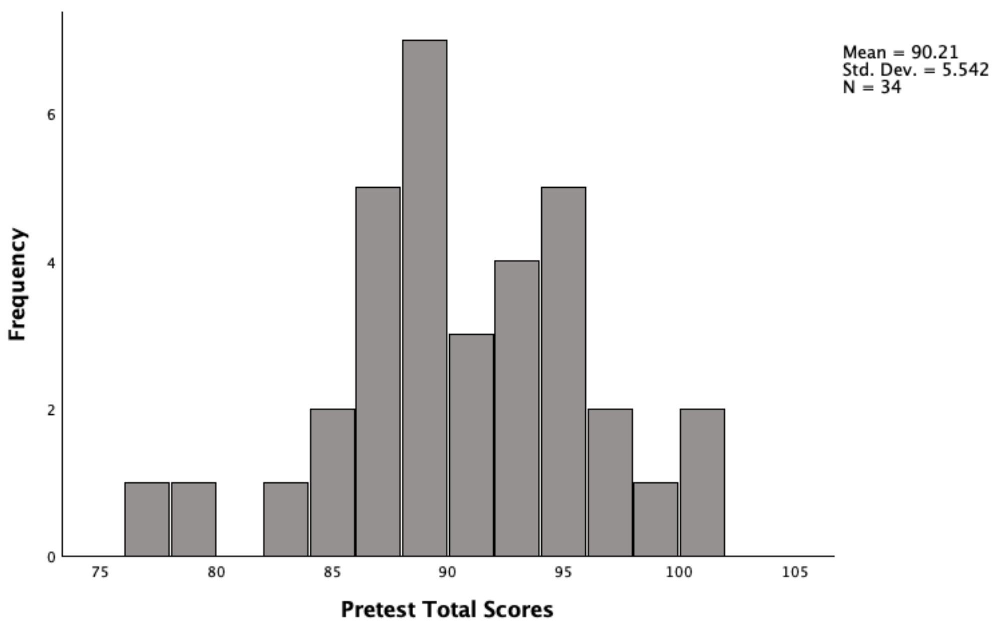
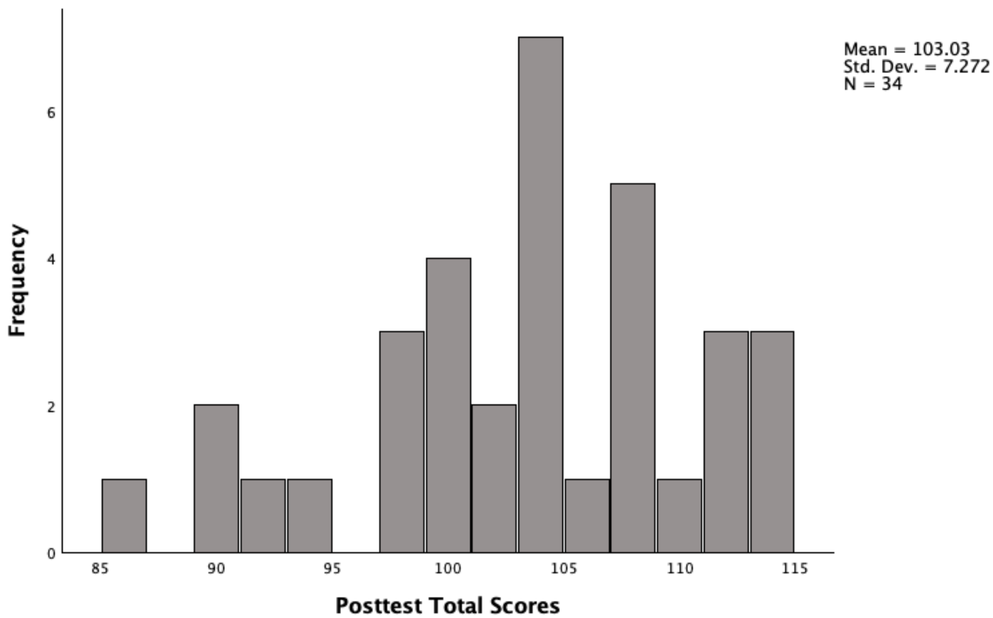


Figure 6

Posttest Scores Frequency Distribution Histogram



A Shapiro-Wilk's W test was computed to assess for overall normality of the pretest and posttest scores and yielded non-significant results. The pretest clinical competency scores did not yield skewness, kurtosis, or significant Shapiro Wilk's test values (p = .655) that indicated deviations from normality. The posttest clinical competency scores did not yield skewness, kurtosis, or significant Shapiro Wilk's test values (p = .189) that indicated deviations from normality. The findings met the assumptions of parametric statistics analysis.

Pretest and Posttest Analyses

After meeting the assumptions for normality, a paired-samples *t* test was computed to compare the mean pretest clinical competency score to the mean posttest clinical competency score. The mean on the baseline pretest was 90.21 (*SD* = 5.542), and the mean on the posttest was 103.03 (*SD* = 7.272), revealing an increase in mean clinical competency scores over time (Table 7). A significant increase in BSN nursing students' clinical competency scores from pretest to posttest $t(33) = -9.054$, $p < .001$, two-tailed, $M = 90.21$ versus $M = 103.03$, respectively, was found (Table 8). There was a large effect size (Cohen's $d_z = -1.553$).

Table 7

Paired Samples Statistics

Measure	*M*	*n*	*SD*	*SEM*
Pretest score	90.21	34	5.542	.950
Posttest score	103.03	34	7.272	1.247

Note. *M* = mean*;* *SD* = standard deviation*;* *SEM* = standard error of the mean.

Table 8

Paired Samples t Test

Measure			95% CI				
	M	SD	*LL*	*UL*	*t*(33)	*p*	Cohen's d_z
Pretest-posttest	-12.824	8.259	-15.705	-9.942	-9.054	< .001	-1.553

Note. Pretest-posttest clinical competency mean scores. CI = confidence interval; *LL* = lower limit; *M* = mean*;* *SD* = standard deviation*;* *UL* = upper limit.

Linear Mixed Models

Linear mixed models (LMM) for repeated measures were computed on clinical competency scores over time. Time was specified as the repeated effect with two levels (pretest and posttest) with a diagonal covariance structure. Results revealed scores to be significantly higher from pretest to posttest, $t(56) = -8.142$, p < .001, after controlling for academic classification, previous healthcare experience, and performance of tracheostomy care.

Reliability of Survey Instrument

Internal consistency reliability of the 19-item Likert scale survey was computed on the clinical competency pretest scores and posttest scores to examine Likert scale item intercorrelations. The pretest scores Cronbach's alpha coefficient ($\alpha = .322$) indicates low reliability of the Likert scale survey items (Grove & Cipher, 2025; Waltz et al., 2010). The posttest scores Cronbach's alpha coefficient ($\alpha = .662$) indicates moderate reliability of the Likert scale survey items (Grove & Cipher, 2025; Waltz et al., 2010). A low internal consistency reliability indicates correlations between the 19 Likert scale items is limited, a participants' score on one item is not a good predictor of a score on other items, and the Likert scale instrument may not consistently measure the concept clinical competency (Salkind & Frey, 2020; Waltz et al., 2010).

Debriefing

The intervention concluded with a self-guided debriefing consisting of five open-ended, Socratic questions about participant experiences with the simulation-based, e-learning modules (Appendix K). Participant responses to each question were analyzed and common themes were identified and presented:

1. What is the first thing that comes to mind about the tracheostomy modules you just completed?

   Prevalent first thoughts were that the tracheostomy modules were "informational", "easy to learn and understand", "enhanced my knowledge", and "increased my confidence". The importance of "maintaining a patent airway", understanding "signs of tracheostomy obstruction", and "assess [*sic*] airway and ensure airway is not compromised" were noted. One participant described feeling "more competent knowing more about tracheostomy care" and another felt "more ready to deal with patients who have trachs" [*sic*], yet several other participants observed a need to gain more knowledge about tracheostomies. Participants reported a lack of exposure to tracheostomy airway patients in nursing school clinicals, with one participant stating "… tracheostomy education and requisite care was lacking, both didactically and also in the clinical setting".

2. How did the care of the patients you saw in the tracheostomy learning modules make you feel?

Participants' responses regarding their feelings about the care of tracheostomy patients included positive adjectives such as "competent", "comfortable", "confident", "educated", and "empowered". Less positive adjectives included "adequate", "apprehensive", and "uncomfortable". Other descriptions included "more prepared", "less scared", "passionate to learn and eagerness to assist those with tracheal airways", and "urgent, because anything could go south at any moment and they [tracheostomy patients] could lose oxygen". One participant noted an increase in competency "because I was able to see exactly what was being done/performed versus reading/hearing about it [tracheostomy care]".

3. What did you learn about providing nursing care to a tracheostomy patient?

The most prevalent skill described was learning how to identify tracheostomy airway complications and the emergency steps to take when a complication occurs. A majority of participants reported learning how to perform tracheostomy care and the safety practices associated with each skill. The recognition of normal versus abnormal tracheostomy airway assessment findings and knowing when to "activate code blue" were other learned skills. Several participants recognized the need to know how to alleviate anxiety and discomfort in tracheostomy airway patients. Participants expressed surprise at the amount of nursing knowledge required to care for a tracheostomy patient, with one participant reflecting "tracheostomy care includes very skilled tasks that requires [*sic*] vigilant monitoring and assessment of patients".

4. How will you apply the knowledge you obtained in the tracheostomy modules to a future patient care scenario?

    Participants' responses regarding application of new knowledge to future patient encounters varied from broad statements asserting increased confidence, competence, knowledge, and preparation to specific statements such as "I will be able to go over the list of materials to have in the room and what to do during an emergency and how to do routine trach [*sic*] care". Many participants described the performance of safe TC, assessment of tracheostomy airway patency, and knowing when to call for help. Several respondents described using TC procedural checklists, such as "I will think about the steps used to care for these patients, look out fort clues that there is something wrong and start assessing and seeing how it should be fixed". One participant noted application of the newly gained knowledge of airway anatomy and another described having "conversations about tracheostomies with practitioners and understand what they are discussing".

5. What other thoughts or feelings do you have?

    Many participants expressed appreciation for the opportunity to learn about tracheostomy management. Participants enjoyed learning via the interactive, visual format of the e-learning modules and the intervention was considered "well worth the time”. One comment was related to challenges with computer technology and difficulty navigating between the QuestionPro software platform and tracheostomy modules website. The same participant wished “the learning materials could be printed out”. Another participant recommended accessing the QuestionPro platform and tracheostomy modules on a laptop computer instead of a mobile device. Several participants mentioned being hands-on learners and expressed a desire to “try all of these [skills] in person now” and expressed hope that the new information will be retained. Lastly, a participant noted that learning tracheostomy management should be included in nursing school curricula.

Summary

The findings of the quasi-experimental, one-group pretest-posttest pilot research study indicate there is a difference in prelicensure BSN students’ clinical competency to recognize a tracheostomy airway complication after participation in a simulation-based, e-learning tracheostomy management activity. A paired samples *t* test comparing mean pretest and mean posttest scores on a 19-item Likert scale survey revealed a significant increase in nursing students’ clinical competency scores from baseline pretest to posttest. A large effect size was found. LMM revealed clinical competency scores to be significantly higher from pretest to posttest even after controlling for academic classification, previous healthcare experience, and performance of TC. Internal consistency reliability of the 19-item Likert scale pretest and posttest revealed a low to moderate Cronbach’s alpha coefficient, indicating the instrument may not consistently measure clinical competency. Participants’ responses to the self-guided debriefing suggested positive experiences participating in the research study and the learning of essential tracheostomy management skills that will be used to promote and maintain the safety of tracheostomy patients upon entry to nursing practice.

CHAPTER 5

Chapter 5 expands upon the major study findings and provides interpretation of the results of the quasi-experimental, one-group pretest-posttest pilot study. Limitations of the study, implications for prelicensure nursing education and patient safety as well as recommendations for future research are presented. The discussion will relate the findings within the context of prelicensure nursing education and the theoretical foundation of the research study.

The purpose of the study was to answer the research question "Is there a difference in prelicensure nursing students' clinical competency to recognize a tracheostomy airway complication after participation in a simulation-based, e-learning experiential tracheostomy care learning activity?" The intervention consisted of baseline pretest measurement of tracheostomy care (TC) clinical competency, completion of three online simulation-based tracheostomy e-learning modules, posttest measurement of tracheostomy care TC, and self-guided responses to five debriefing questions. The concept, clinical competency, was operationalized via a 19-item, 6-point Likert scale survey. Design of the study was guided by the INACSL Healthcare Simulation Standards of Best Practice™: Simulation Design (INACSL Standards Committee, Watts, et al., 2021). The study was underpinned by Kolb's (1984; 2015) Experiential Learning Theory.

Interpretation of Major Findings

After data collection, the researcher analyzed the study findings via descriptive statistics analysis of the demographic questionnaire and inferential statistics analysis of the pretest/posttest survey instrument. Participant responses to the five debriefing questions were examined for common themes and notable observations. After data analysis, the researcher returned to the literature review to compare how previously published studies compared with the major findings of the present study. The lack of studies exploring nursing students' learning experiences with tracheostomy management and the measurement of concept clinical competency were barriers to comparison. However, the results of a recently published quasi-experimental one-group, pretest/posttest study exploring TC skills in a prelicensure nursing student population in Turkey provided a comparison and contrast to the findings of this study (Biyik Bayram et al., 2023).

Major Findings: Sample Characteristics

Participant age and gender at birth mirrored student demographics in professional nursing programs in Texas and the United States, with a majority of the sample under age 25 and female gender (NLN, 2022; Texas Department of State Health Services, 2023). The age and gender distribution of the sample was also similar to the distribution of prelicensure nursing students in an international study (Biyik Bayram et al., 2023). The sample was predominantly of Hispanic/Latino race/ethnicity (41%), slightly exceeding the current study with Texas RN student Hispanic/Latino distribution of 34%; Asian participants (23.5%) far exceeded the United States distribution in the current study of 9.8%, however, Asian race/ethnicity was not reported as a separate category in the Texas data (American Association of Colleges of Nursing [AACN], 2023; Texas Department of State Health Services, 2023). Overall, these findings are consistent with age, gender, and race/ethnicity data in Texas and the United States, providing support for generalizing the study findings to a larger population of prelicensure BSN students.

A majority of participants (70%) were academically classified as final-semester, Senior 2 students. As the study took place close to program completion and graduation, this finding was expected and likely due to participants' perceived sense of urgency to learn tracheostomy airway management skills before their imminent entry to nursing practice. Fifty three percent of participants had earned a previous degree, primarily associate and bachelor's degrees, with one participant earning a doctoral degree. Most participants (64.7%) had no previous healthcare experience.

An unexpected finding regarding the performance of TC was that 91% of participants reported having a patient with a tracheostomy airway during nursing school clinical experiences. Additionally, 50% of participants reported performing TC in the clinical setting, with tracheal suctioning being the most frequently performed TC skill and 26% of participants reported performing TC in a simulation center on a manikin or standardized (simulated) patient (SP). These findings are unlike a similarly designed study, where 91% of participants reported *not* having a tracheostomy airway patient during clinical experiences (Biyik Bayram et al., 2023).

The prevalence of TC performance among participants is concerning because TC skills were not taught during the participants' nursing program. This finding differs from a previous study where 100% of participants received TC training as part of the nursing program curriculum (Biyik Bayram et al., 2023). In this study, students' curricular exposure to TC was limited to a three-page written handout summarizing TC best practices and hands-on TC skills were *not* practiced in the safe setting of the university simulation center. The findings are puzzling because although the frequency of a tracheostomized patient on a nursing unit has increased since the COVID-19 pandemic, health care organizations may disallow nursing students from caring for patients with artificial airways due to patient safety concerns (Benito et al., 2021; Buerhaus et al., 2017; Smith-Miller, 2006). This researcher contacted course faculty to inquire about student exposure to tracheostomized patients in the clinical setting and explore the possibility that student clinical placements included a long-term acute care (LTAC) unit, where tracheostomized patients are prevalent. The researcher was unable to gain further insight about participant experiences.

The findings related to the performance of tracheostomy airway procedures imply nursing students may be learning TC skills at the bedside of vulnerable tracheostomy patients. Educators, researchers, and tracheostomy safety organizations have cautioned this is no longer acceptable practice and have repeatedly called for nursing students and RNs to learn psychomotor, cognitive, and affective TC skills in the safe setting of simulation, where patient harm is avoided (Agarwal et al., 2016; Dorton et al., 2014; Heffner et al., 2005; Smith-Miller, 2006). As demonstrated by this study, simulation-based training can improve nursing students' clinical competency to manage tracheostomy airways without a threat to patient safety.

Major Findings: Clinical Competency

The primary outcome of interest in this study was the measurement of differences in clinical competency to recognize a tracheostomy airway complication before and after completion of a simulation-based, e-learning tracheostomy management activity. Clinical competency scores were measured at baseline, immediately before and immediately after the concrete experience of engaging in the learning modules. Analysis revealed there was significant increase ($p < .001$) in the BSN students' mean clinical competency scores between the baseline pretest and the posttest, indicating the participants' clinical competency improved after completing the learning modules. Similar to these findings, Biyik Bayram et al. (2023) found significantly higher posttest scores ($p = .001$) than pretest scores on a 17-item multiple choice test designed to measure nursing students' TC knowledge.

A large effect size suggests that the simulation-based intervention was effective in developing participants' clinical competency and therefore, clinically important in the larger population of BSN students (Adamson & Prion, 2013; Berben et al., 2012). As recommended by Berben et al. (2012), clinical significance of the research results were judged using the four criteria suggested by Schulz et al. (2002): Participants experienced a change in clinical competency, the change in clinical competency has the potential to improve the quality of life (patient safety) of tracheostomized patients, the improvements in clinical competency are important to nursing education, nursing practice, and tracheostomized patients, and the outcome of promoting patient safety is acceptable (desirable) to stakeholders. The clinical importance of the increase in clinical competency may prompt the adoption of simulation-based tracheostomy skills e-learning modules into prelicensure curricula.

When considering the sample characteristics, the researcher recognized three covariates with the potential to impact the true measurement of clinical competency: Academic classification, experience performing TC, and previous healthcare experience. Computation of a linear mixed model (LMM) for repeated measures controlling for the three covariates revealed the change in clinical competency scores from pretest to posttest existed regardless of whether participants were classified as Senior 1 or Senior 2, had or did not have experience performing TC, and had or did not have previous experience in healthcare. Biyik Bayram et al. (2023) compared academic classification (program years 1, 2, 3, & 4) and unlike this study, found differences in scores, with first year students having significantly higher posttest scores (p = .001). This may be attributed to participants learning TC skills in the first year of the program curriculum and a decay of TC knowledge as time from training passed or an enthusiasm to learn among first year students whereas other students were experiencing learning fatigue. Nevertheless, exploring other possible explanations for why the scores in this study improved over time is important in a single-sample design as it yields a more powerful study. The results of the LMM suggests the change in clinical competency was real and, along with the clinical significance, adds strength to the one-group design.

This study aimed to answer a research question exploring prelicensure nursing students' clinical competency to recognize a tracheostomy airway complication, a situation that leads to patient deterioration if not recognized. Although no comparison studies were found within the context of measuring clinical competency to recognize a tracheostomy airway complication in a simulation-based prelicensure nursing education setting, comparisons may be made with studies exploring patient deterioration due to other clinical presentations. Kelly et al. (2014) developed a pretest/posttest survey to measure BSN students' recognition and response to a simulated patient deteriorating due to heart disease, and, as in this study, found significant increases in posttest mean scores ($p < .01$). Similar to the present study, the Likert scale instrument included items specifically intended to measure assessment, recognition, and response to a deteriorating patient (Kelly et al., 2014). In a comparable screen-based simulation study evaluating BSN students' competency to care for a renal patient in crisis, significant increases in Likert scale posttest scores ($p < .001$) were found on the researcher-developed instrument (Altmiller et al., 2023). These similarities lend support to the study findings of improvements in clinical competency to recognize a tracheostomy airway complication.

Major Findings: Instrumentation

Further analysis of the 19-item, 6-point Likert scale survey instrument designed to measure clinical competency in managing tracheostomy airways yielded low (pretest) to moderate (posttest) internal consistency reliability. This finding was not unexpected as the survey was developed by the researcher for this pilot study and represented the first administration of the instrument. The researcher acknowledges the Likert scale instrument items may not consistently measure clinical competency and are subject to measurement error. However, the lack of a psychometrically validated tool designed to measure clinical competency within the unique context of tracheostomy skills acquisition in prelicensure nursing education was a circumstance that necessitated development of an instrument (Altmiller et al., 2023; Franklin et al., 2015). Biyik Bayram et al. (2023) experienced similar measurement barriers and developed a 17-item multiple choice test to measure nursing students' TC knowledge. Like the present study, the internal consistency reliability of the instrument was low to moderate ($\alpha = .53$) when initially administered to the study participants.

The Likert scale instrument items addressed best practices in tracheostomy management, including basic TC (humidification, suctioning, stoma and inner cannula care), tracheostomy airway assessment, patient safety practices, recognition and management of tracheostomy complications/emergencies, and perceptions of tracheostomy clinical competency (Appendix D). The survey was carefully constructed with guidance from content experts, evidence-based tracheostomy literature, multidisciplinary guidelines and clinical consensus statements, and international tracheostomy education and patient safety collaboratives, including the three simulation-based, e-learning modules. Additionally, a review of the recommendations of test construction and measurement experts was employed.

Major Findings: Debriefing

The debriefing phase of the intervention supported the theoretical foundation of the study and enabled participants to think and reflect about the simulation-based experience and transform the experience into new learning via their responses to the open-ended format of the five debriefing questions (Appendix K). Themes observed in the participants' responses regarding the experiential learning experience and examples of salient quotes are presented (Table 9).

Table 9

Debriefing Findings

Experiential learning themes	Example quotes
Impressions of the learning activity	
Enhanced knowledge & competency	"I feel more competent knowing more about tracheostomy care"
Interactive, visual format of learning modules was appealing	"I was able to see exactly what was being done/performed versus reading/hearing about it [TC]"
TC skills should be taught in nursing school; tracheostomy education was lacking in didactic and clinical	
Tracheostomy skills learned	
Identification of tracheostomy airway complications	"TC includes very skilled tasks that requires vigilant monitoring and assessment of patients"
Emergency management of complications	
Performance of safe basic TC	"I want to try all of these [skills] in person now"
Recognition of normal versus abnormal airway assessment	
Application to future patient experiences	
Know when to call for help	"I will think about the steps used to care for these patients, look for clues that there is something wrong, and start assessing and seeing how it should be fixed"
Follow TC procedural checklists	"I will be able to go over the list of materials to have in the room and what to do during an emergency and how to do routine trach [*sic*] care"

Note. TC = tracheostomy care.

Although the intervention modality in the Biyik Bayram et al. (2023) study slightly differed from the present study – an online, web-based TC game versus and online simulation-based TC e-learning modules – the format of the open-ended debriefing questions was similar. As in this study, researchers inquired about learning experiences, competency, and application of knowledge and participants expressed feedback similar to this study by describing positive learning experiences and outcomes (Biyik Bayram et al., 2023). The self-guided debriefing format of both studies was effective for a situation when face-to-face debriefing is not possible, such as during a pandemic, as in the Biyik Bayram et al. (2023) study or when students are enrolled in an online program, as in this study. It is accepted in the simulation literature that debriefing is where learning occurs, a phenomenon that is operationalized when the simulation is underpinned by a theoretical framework (Adamson & Rodgers, 2016; Johnson, 2018).

Major Findings: Theoretical Support

The study findings are related to Experiential Learning Theory (ELT), the theoretical framework that underpinned the study and provided a conceptual basis for answering the research question (Franklin et al., 2015). Participants *grasped* (construct) the learning experience by engaging in the tangible *concrete experience* (concept) of the pretest, the tracheostomy simulation-based, e-learning modules, and the posttest (Kolb, 2015). Upon engaging in debriefing questions one, two, and three, the learning experience was *transformed* (construct) into new learning and clinical competency via *reflective observation* (concept), making sense of and attributing meaning to the experience, and via *abstract conceptualization* (concept), describing and analyzing the experience in preparation for future experiences (Johnson, 2018, 2020; Kolb, 2015). Finally, upon engaging in question four, *active experimentation* (concept) the learning experience was further transformed as the participant planned how to apply the newly gained knowledge about tracheostomy airway management to the outcome, clinical competency, upon entry to nursing practice (Kolb, 2015).

Support for ELT as the theoretical foundation of this study was demonstrated by several researchers whose simulation-based studies were similarly underpinned by ELT. In a virtual reality simulation study examining newly-licensed RN competency to recognize pediatric respiratory distress and failure, Raab et al. (2023) found significant increases ($p < .001$) on a pretest/posttest tool measuring self-perceived competency and positive attitudes about the VR experience. Chmil et al. (2015) designed a simulation to compare nursing students' clinical judgment and performance during a traditional simulation versus an experiential computer-based simulation extensively underpinned by the ELT concepts and constructs described in the previous paragraph of this study. The clinical judgement scores of the ELT-based simulation group were significantly higher than the traditional simulation ($p < .001$) and there was a strong, positive correlation between clinical judgment and performance ($r = 0.69$).

Johnson (2020) developed a theoretical framework based on ELT and explored differences in prelicensure BSN students' acquisition of knowledge after engaging in either the observer role or the active participant role during a respiratory distress simulation. No difference was found in knowledge acquisition, regardless of participant role. This lends support for the present study in which participants improvements in clinical competency was an outcome of an online electronic learning experience, not a hands-on patient care activity, and is further supported by Kolb's assertion that a learning activity does not have to be hands-on in order for learning to occur (Johnson, 2018; Kolb, 2015).

Limitations

A threat to internal validity was one limitation that may have influenced the changes in clinical competency found in this exploratory one-group, pretest/posttest pilot study. Maturation from the pretest to the posttest due to gaining experience with tracheostomy airway management, fatigue due to the time to complete the tracheostomy e-learning modules, and weariness due to participating in the study at the very end of a semester may have had an impact on the posttest. A testing effect, in which participants remembered the pretest items and modified their responses on the posttest may have occurred. Attempts to minimize this were made in the protocol by instructing participants to not use tracheostomy learning resources during the pretest and posttest. An attrition rate of 83% (n = 179) occurred, with participants most often discontinuing the study after taking the pretest and before or during completion of the tracheostomy e-learning modules. Discontinuance after the pretest was similarly found by Biyik Bayram et al. (2023). This poses a question about differences between participants who dropped out of the study and participants who completed the study. However, when the demographic survey completed by all participants (n = 215) was statistically analyzed, the group characteristics were homogenous. A likely explanation is that participants who left the study succumbed to maturation fatigue or end-of-semester activities such as graduation and changed their minds about spending 90 minutes to complete the e-learning modules.

The small sample size may present a threat to external validity and generalizability of the study findings to the theoretical population of BSN students. However, the sample size (n = 34) exceeded the requirements of the power analysis (n = 30) and the sample demographic characteristics of age, gender, and race/ethnicity were similar to the distributions for professional nursing programs in Texas and the United States. Another consideration of external validity is the reason for enrollment in the study. Senior 2 participants, whose graduation and entry to nursing practice was imminent, may have consented to enroll in the study only to receive the certificate of completion offered at the end of the study. However, the highly positive debriefing feedback suggests the participants were actively engaged in the intervention.

A further limitation was the development of a new instrument to measure tracheostomy clinical competency. The 19-item Likert scale survey was piloted for the first time during this study and needs further testing to strengthen its reliability in measuring the single concept, clinical competency.

A final limitation was imposed by challenges in the availability of a simulation intervention modality, necessitating a pivot from a virtual reality (VR) tracheostomy simulation to the online simulation-based, e-learning modules. The researcher explored the products of three VR companies and collaborated with VRPatients® to build a VR scenario depicting a patient experiencing clinical deterioration due to a tracheostomy airway obstruction. However, two limitations occurred that led to a change in modality: (a) The VRPatients® development team was unable to have the tracheostomy art needed for building the scenario ready according to this study's timeline, and (b) the researcher discovered that learning TC skills had been removed from the BSN curricula. The latter meant it would not be reasonable to expect potential subjects to participate in a tracheostomy deterioration scenario without prior learning of basic TC skills. Furthermore, the economic cost for the researcher to use the VR scenarios of two of the VR companies ranged from $7000 to $10,000. Consequently, the modality pivoted to the simulation-based, e-learning modules, enabling participants to *learn* basic TC skills and how to *recognize* and *respond* to tracheostomy complications in a multimedia environment.

Conclusions

Chapter 5 presented the findings of the study and answered a previously unexplored research question. The finding that prelicensure BSN students' clinical competency to recognize a tracheostomy airway complication increased after completing a simulation-based experiential learning activity has far-reaching reaching implications for safe nursing practice and prelicensure nursing education. A dearth of previous research examining this topic is a rich opportunity for future research.

Implications for Nursing Practice

The potential for improvement in the morbidity and mortality outcomes of tracheostomized patients is a salient outcome of this study. Exposing prelicensure nursing students to the high acuity skills of tracheostomy airway management before entry to nursing practice may save patient lives. Healthcare organization stakeholders expect new graduate nurses to enter the nursing workforce possessing the clinical competency to safely manage complex patients, including tracheostomized patients. Evidence, however, has demonstrated that their competency is lacking, requiring extensive training when inexperienced new RNs are hired. Integration of simulation-based, tracheostomy e-learning modules into new RN orientations or RN residency programs is a low cost, effective method of developing clinical competency. This would preempt newly licensed RNs learning tracheostomy management at the bedside of vulnerable tracheostomy airway patients.

Additionally, to strengthen the global recommendation that experienced RNs complete annual competency training in tracheostomy airway management, the simulation-based, e-learning module format may be easily integrated into healthcare organizations' annual RN competency evaluations. Such programs will promote the safety and improve the outcomes of tracheostomized patients.

Implications for Prelicensure Nursing Education

The study demonstrated that TC clinical competency can be developed in prelicensure nursing students via an online and asynchronous method. This addresses multiple contemporary nursing education challenges: First, with the recent focus on the core competencies for professional nursing programs (AACN, 2021) and need to add content to already full nursing curricula, the e-learning modules offer a simulation-based e-learning activity that students can complete independently. Second, an online, simulation-based activity reduces the economic and resource costs of teaching TC skills in a bricks-and-mortar simulation center, minimizes the workload on simulation staff and faculty, and eliminates the challenges of securing simulation center space. Third, the online, asynchronous modality is a good fit for prelicensure nursing distance education programs, enabling students to learn new skills regardless of their geographic location. Lastly, the study offers further support for simulation and e-learning modalities for developing tracheostomy clinical competency in an experiential learning setting where patient harm is avoided.

Recommendations for Future Research

Future research opportunities for expanding evidence and knowledge about the previously unexplored research question abound. Replicating this pilot study as a rigorous quasi-experimental, pretest and posttest design with a comparison group and larger sample size is a priority. A multisite sample will add further generalizability to the findings. Measurement of TC skills knowledge retention post-intervention would offer evidence about knowledge decay and guide educators in threading TC skills throughout nursing curricula. Similarly, a longitudinal study, in which participants are followed into their first year of nursing practice would provide evidence about the retention of learned tracheostomy clinical competency skills.

Another recommendation for future research is an exploration of the VR modality for developing tracheostomy management clinical competency. Collaboration with a university simulation center with fiscal, equipment, and space resources available for VR simulations would mitigate the cost burden to an individual researcher. The VR modality would enable students to learn TC skills competency in the VR immersive format and engage in a VR scenario depicting a patient experiencing clinical deterioration due to a tracheostomy airway obstruction.

A final future research recommendation is to strengthen the reliability and validity of the 19-item Likert scale tracheostomy competency survey piloted in this study. Further testing and validation of the instrument's psychometric properties via a methodological research study is needed. This is important research, as no similar instrument developed to measure prelicensure nursing students' clinical competency in managing tracheostomies exists.

Summary

This findings of this quasi-experimental, pretest and posttest exploratory pilot study reveal that statistically significant differences existed in prelicensure BSN nursing students' clinical competency to recognize a tracheostomy airway complication after participating in a simulation-based, e-learning experiential learning activity. The study design was guided by the INACSL Healthcare Standards of Best Practices™ and theoretically underpinned by ELT. Despite the study limitations, this pilot study contributes to the small body of research surrounding tracheostomy education in undergraduate nursing education. The findings are clinically significant, with the potential to mitigate the prevalence of catastrophic outcomes among tracheostomized patients across the globe.

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APPENDIX A

Permission to Reprint the Process of Experiential Learning Theory

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Allison Bulpitt (Jul 23, 2024 08:50 GMT+2)

Email: Allison.Bulpitt@pearson.com

APPENDIX B

Study Invitation Summary and Script

Would you like to improve your tracheostomy care skills? Would you like to add a certificate to your resumé to show you have completed extra learning on tracheostomy care?

I am a UTA PhD (Nursing) student conducting a research study to explore BSN students' clinical competency to provide safe care to patients who have tracheostomy airways.
The study includes three online simulation-based, e-learning tracheostomy modules that are self-paced and may be completed on your own time. It will take approximately 2.5 hours of your time to complete the study.

Study participation is voluntary and anonymous. Participation in the study is not associated with any course nor will it affect your grade in any course, your academic standing, or program completion and graduation. Nor will your faculty know if you choose to participate in the study or your results of the study. All results will be aggregated and presented as a whole and nothing individual will be disclosed.

Upon completion of the modules, you will receive a certificate of participation that can be added to your resumé and used as a selling point during your job interviews.

If you are interested in participating in this study, please click the weblink below to learn more and see the option to provide informed consent and enroll in the study.

Thank you for your consideration.

QuestionPro weblink: https://utaedu.questionpro.com/t/AYkwAZ1sPt

PhD Student: Ruth Bargainer Tobin (325)-668-7566 or ruth.bargainer@mavs.uta.edu

Dissertation Chair: Dr. Deborah Behan: dgreen@uta.edu

APPENDIX C

Permission to Use Austin Health and TRAMS Tracheostomy E-Learning Modules

Austin HEALTH
Tracheostomy Review and Management Service (TRAMS)

31st January 2024

Agreement between Ruth Bargainer Tobin and the Tracheostomy Review and Management Service (TRAMS), Austin Health, for the utilisation of e-learning modules in PHD research study titled *'Developing Prelicensure Nursing Students' Clinical Competency to Recognize and Manage Tracheostomy Complications'.*

Parties involved:

TRAMS, Austin Health, Melbourne, Australia

Ruth Bargainer Tobin, PHD Candidate, The University of Texas at Arlington, USA

Purpose:

This agreement outlines that PHD Candidate, Ruth Bargainer Tobin, will utilise the e-learning modules (*Introduction to Tracheostomy*, *Routine Tracheostomy Care*, and *Tracheostomy Emergency Management),* as available on the TRAMS external website, as a study intervention for prelicensure nursing students. It is agreed by Ms. Bargainer Tobin that the TRAMS resources are not to be used for any purpose other than that specified in the research study dissertation. Ms. Bargainer Tobin will appropriately acknowledge the intellectual property and/ or copyright of Austin Health/TRAMS in the research study dissertation.

Co-Authorship:

Both parties agree that TRAMS will recognised as co-authors on any publications resulting from the dissertation. Specifically recognising TRAMS Manager, Prudence Gregson and Project Manager for resource creation, Christine Knee- Chong (CNC). Both parties agree that Ruth Bargainer Tobin will be listed as first author on any publications resulting from the dissertation.

Any publications resulting from the collaboration must be mutually approved by both parties.

Intellectual Property:

Both parties agree that Ms. Bargainer Tobin retains ownership of her research study dissertation, while TRAMS have rights to the specific contributions relating to the e-learning modules.

Austin HEALTH
Tracheostomy Review and Management Service (TRAMS)

Prudence Gregson

TRAMS, Manager

Date February 14, 2024 **Signature** ______________________

Ruth Bargainer Tobin MSN, RN, CNE

PhD Candidate

Date **February 6, 2024**

Signature Ruth Bargainer Tobin

APPENDIX D

Tracheostomy Competency Survey

Indicate your degree of agreement with each of the following statements (Waltz et al., 2010)

Statement	Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Somewhat Agree (4)	Agree (5)	Strongly Agree (6)
Humidification						
Oxygen delivered via a tracheostomy airway should be humidified. (N4581 Clinical Packet; see Appendix H).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Humidification helps prevent the tracheostomy tube from becoming blocked with thick secretions. (Austin Health & Tracheostomy Review and Management Service [TRAMS], 2022b; Royal College of Anaesthetists, 2019c).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Suctioning						
Signs a patient may need tracheal suctioning include restlessness, cough, changes in heart rate and respiratory rate, coarse crackles, sweating, and decreased oxygen saturation. (Austin Health & TRAMS, 2022b; Royal College of Anaesthetists, 2019c).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
A patient should be preoxygenated with 100% oxygen before suctioning the tracheostomy. (Austin Health & TRAMS, 2022b; N4581 Clinical Packet)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Tracheal suctioning should be limited to no longer than 15 seconds. *Reverse scor*ed. (Austin Health & TRAMS, 2022b; N4581 Clinical Packet).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

Statement	Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Somewhat Agree (4)	Agree (5)	Strongly Agree (6)
Complications of suctioning include low oxygen saturation, tracheal bleeding, increased intracranial pressure, cardiac dysrhythmias, anxiety, and pain. (Austin Health & TRAMS, 2022b).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Tracheostomy Care						
Changing a patient's tracheostomy tube tape or ties is a two-person procedure. (Austin Health & TRAMS, 2022b; Royal College of Anaesthetists, 2019c).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
A 4 x 4 gauze dressing should be cut with scissors to fit around the tracheostomy stoma. *Reverse scored.* (N4581 Clinical Packet; Royal College of Anaesthetists, 2019c).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
A spare tracheostomy tube should be kept at the patient's bedside. (Royal College of Anaesthetists, 2019b).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
A patient who has a tracheostomy airway will never be able to speak. *Reverse scored.* (Austin Health & TRAMS, 2022a).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Tracheostomy Assessment						
Patient assessment should include tracheostomy tube patency, stoma condition, tube ties, mucus secretions (amount, color, consistency), cough effort, humidification, and cuff inflation pressure. (Austin Health & Tracheostomy Review and Management Service, 2022b; Royal College of Anaesthetists, 2019c).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Signs a patient is experiencing a tracheostomy airway problem may include increased respiratory rate and heart rate, accessory muscle use, agitation, changes in level of consciousness, sweating, and decreased oxygen saturation. (Royal College of Anaesthetists, 2019c).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

Statement	Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Somewhat Agree (4)	Agree (5)	Strongly Agree (6)
Tracheostomy Complications						
If a tracheostomy tube is accidentally dislodged the patient should be ventilated with a bag-valve-mask (Ambu bag). (N4581 Clinical Packet; Royal College of Anaesthetists, 2019b).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Risks for tracheostomy tube blockage include thick secretions, improper suctioning, lack of humidification, and obesity. (Royal College of Anaesthetists, 2019a).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
A feeling or resistance or difficulty advancing a suction catheter into the trachea may indicate a blocked tracheostomy tube. (Royal College of Anaesthetists, 2019b).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
A blocked or partially blocked tracheostomy tube should be treated as an emergency. (Austin Health & Tracheostomy Review and Management Service, 2022c).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
The first action the RN should take when suspecting a patient has a blocked tracheostomy tube is to call for help. (Austin Health & TRAMS, 2022c; Royal College of Anaesthetists, 2019b).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Competency						
I feel competent performing tracheostomy care (stoma care, inner cannula care, suctioning).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
I feel competent knowing what actions to take when a patient is experiencing a tracheostomy problem.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

APPENDIX E

Informed Consent

My name is Ruth Bargainer Tobin and I am a PhD nursing student at UT Arlington. I am asking you to participate in my UTA doctoral dissertation research study titled, "Exploration of a Simulation-Based, E-Learning Intervention to Develop Prelicensure Nursing Students' Clinical Competency to Recognize Tracheostomy Airway Complications". **This research study is about developing your clinical competency to provide safe care to patients who have tracheostomy airways**. You can choose to participate in this research study if you are at least 18 years old and are a UTA Senior 1 or Senior 2 BSN student enrolled in the accelerated online or campus-based programs. If you are a respiratory therapist you will not be eligible to participate in the study.

Reasons why you might want to participate in this study include improving your competency to provide safe tracheostomy care and advancing your knowledge about the management of tracheostomy artificial airways. You might not want to participate if you are unable to commit to about 2.5 hours to complete the self-paced training and questionnaires. Your decision about whether to participate is entirely up to you. If you decide not to be in the study, there won't be any punishment or penalty. Participating in the study is NOT required for any of your courses, will NOT affect your grade in any course, and will NOT affect your program completion or graduation. Your faculty will NOT know if you choose to participate in the study and your individual study results will NOT be shared. Whatever your choice, there will be no impact on any benefits or services that you would normally receive. Even if you choose to begin the study, you can also change your mind and quit at any time without any consequences.

If you decide to participate in this research study, the list of activities that I will ask you to complete for the research are:

1. Provide informed consent.
2. Answer 5 brief questions that will generate an anonymous code (your name or other identifiable information will never be asked).
3. Review the tracheostomy preparation material (a 3-page skills list)
4. View a prebriefing video (approximately 7-10 minutes)
5. Fill out a demographic information questionnaire.
6. Complete a pre-simulation tracheostomy knowledge survey.
7. Complete 3 online self-paced, simulation-based, e-learning modules:
    1) Introduction to Tracheostomy (about **20 minutes**)
    2) Routine Tracheostomy Care (about **50 minutes**)
    3) Tracheostomy Emergency Management (about **20 minutes**)
8. Complete a post-simulation tracheostomy knowledge survey.
9. Answer 5 debriefing questions.
10. Download a Certificate of Completion.

It should take about 2.5 hours to complete all the activities. You do not have to complete all the tracheostomy modules at one time. The potential direct benefits that you will receive include (1) a Certificate of Completion that that can be added to your resumé and used as a selling point during your job interviews and (2) entering nursing practice with greater knowledge about how to provide safe care to tracheostomy patients. The study activities are not expected to pose any additional risks beyond those that you would normally experience in your regular everyday life or during your simulation-based clinical experiences in nursing school. However, some of the questions that I will ask during the tracheostomy survey or the debriefing about your perceptions of your competency may be uncomfortable topics.

You will not be paid for completing this study. You will receive a Certificate of Completion for participating in this research study, which will be given to you after you finish all the activities described above. There are no alternative options to this research project.

The research team is committed to protecting your rights and privacy as a research subject. We may publish or present the results, but your name will not be used. While absolute confidentiality cannot be guaranteed, the research team will make every effort to protect the confidentiality of your records as described here and to the extent permitted by law.

If you have questions about the study, you can contact me at: Ruth Bargainer Tobin MSN, RN, CNE (325)-668-7566 or ruth.bargainer@mavs.uta.edu

For questions about your rights or to report complaints, contact the UTA Research Office at 817-272-3723 or regulatoryservices@uta.edu.

You are indicating your voluntary agreement to participate by clicking on the “Accept” button below.

APPENDIX F

Coding Questions

What is the first letter of your mother's name?

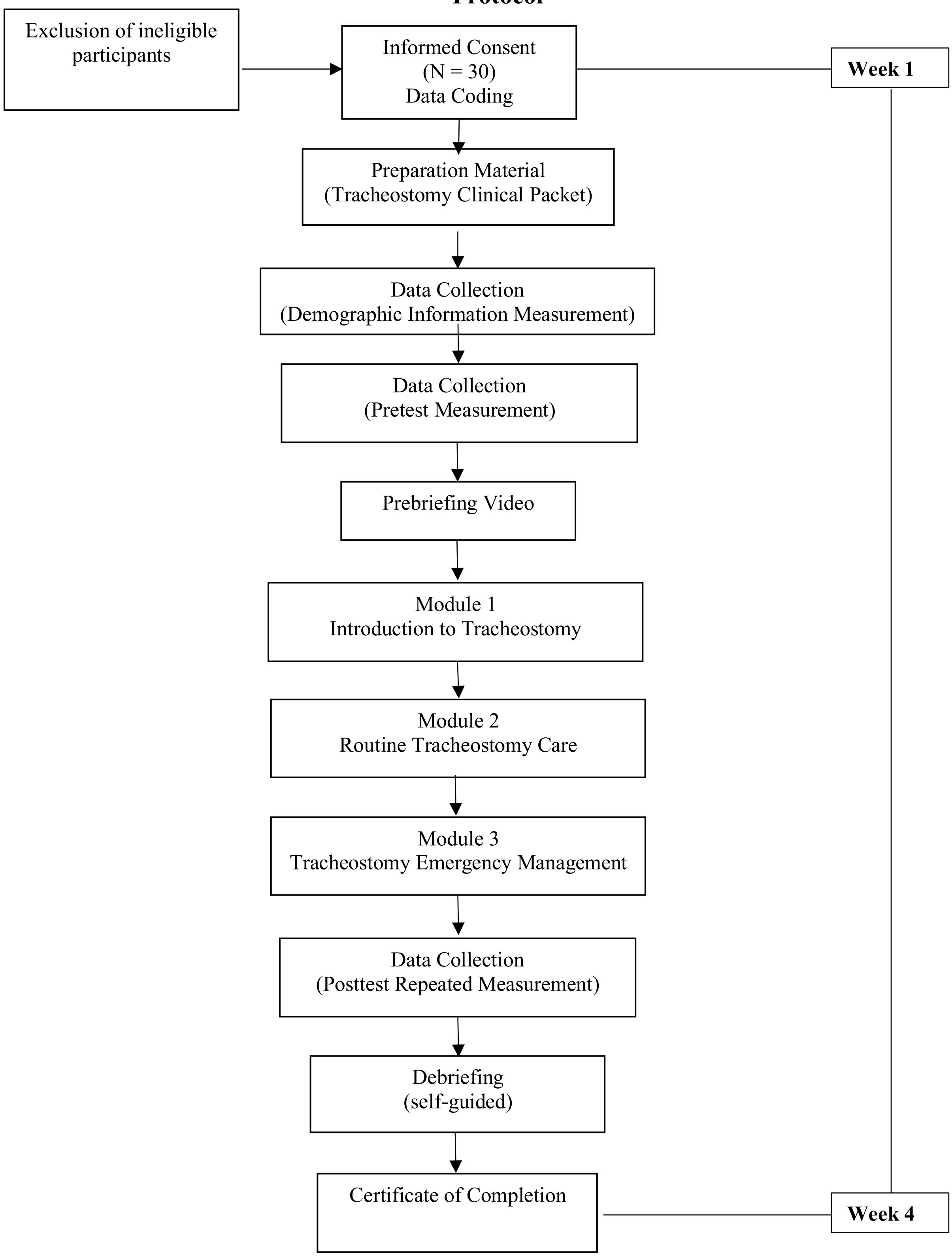
On what day of the month were you born? (Example: If you were born **June 2**, enter **02** and if you were born **August 12** enter **12**)

What is the first letter of the city/town you were born in?

What is the first letter of your middle name? (If you do not have a middle name, enter an A)

APPENDIX G

Protocol



APPENDIX H

N4581 Clinical Packet: Tracheostomy Study Preparation Material

Tracheostomy

Purposes:

1. Bypass an upper airway obstruction
2. Facilitate removal of secretions
3. Permit long-term mechanical ventilation
4. Permit oral intake and speech in the patient who requires long-term mechanical ventilation

Advantages:

1. Less risk of long-term damage to the airway
2. Patient comfort may be increased because no tube is present in the mouth
3. Patient can eat because the tube enters lower in the airway
4. The patient can speak, if the cuff can be deflated, or a speaking tube is used
5. Mobility may be increased

Nursing Responsibilities:

1. Keep obturator and extra trach at bedside (usually one size smaller), ambu, sterile hemostat
2. Assess respiratory status
3. Suction PRN
4. Perform trach care PRN
5. Maintain cuff inflation at approximately 20 mm Hg (+/- 5 mm Hg)
6. Maintain hydration and humidification of mucus membranes
7. If tube is accidentally dislodged, immediately attempt to replace it – spread stoma in cleanest manner possible, insert obturator into replacement tube, and apply water-soluble lubricant to tip of tube, and insert tube into stoma at a 45 degree angle, remove obturator immediately after successful insertion
8. If tube cannot be replaced, raise patient to semi-fowlers to alleviate dyspnea; if severe dyspnea causes a respiratory arrest, cover stoma with a sterile dressing and ventilate patient with bag-mask ventilation until help arrives

Tracheostomy care

Skill

1. Observe tracheostomy for size and type in order to determine needed supplies.
2. Obtain necessary supplies and take to room; use hand hygiene
3. Use standard precautions: goggles, gloves, and gown if needed
4. Explain procedure to patient
5. Don gloves, suction if necessary. Remove soiled dressing and discard dressing and gloves
6. Wash hands and open supplies

Cleansing a non-disposable inner cannula

1. Prepare supplies prior to cleaning inner cannula, using sterile technique
2. Open tracheostomy care kit and separate basins
3. Fill one basin with hydrogen peroxide
4. Fill second basin with saline
5. Don disposable gloves
6. Remove the oxygen source if present. Rotate the lock on the inner cannula in a counter-clockwise motion to release
7. Gently remove the inner cannula and carefully drop in the basin of hydrogen peroxide.
8. Clean the inner cannula: remove from soaking solution. Moisten brush in saline and insert into tube using back-and-forth motion.
9. Agitate cannula in saline solution; tap against inner surface of basin to remove extra saline
10. Run pipe cleaner through inner cannula a few times to remove remaining saline.
11. Replace inner cannula into outer cannula. Turn clockwise to lock and make sure that inner cannula is secure. Reapply oxygen source if needed.
12. Replacing a disposable inner cannula: Release lock. Gently remove inner cannula and place in disposable bag. Replace with appropriately sized new cannula. Engage lock on inner cannula.

Applying clean dressing and tape

1. Dip cotton-tipped applicator in saline and clean stoma under faceplate. Use each applicator only once, moving from stoma site outward.
2. Pat skin gently dry with 4 X 4 gauze
3. Change tracheostomy ties (kit comes with cotton ties i.e. umbilical tape or obtain foam trach tie that Velcro)
4. Leave soiled ties in place until new one is applied.
5. Cut piece of tie that is twice the neck circumference plus 4 inches (10 cm). trim ends on the diagonal
6. Insert one end of tie through faceplate opening alongside old tie. Pull through until both ends are even
7. Slide both ties under patient's neck and insert one end through remaining opening on other side of faceplate. Pull snugly and tie ends in double square knot on the side, alternating sides. Check that patient can flex neck comfortably and tie allows one finger breath.
8. Carefully remove old tie.Slide prepared tracheostomy (drain sponge or foam dressing) dressing or prefolded non-cotton filled 4 X 4 dressing under faceplate. DO NOT CUT SLIT IN 4x4
9. Remove gloves and other PPE and discard. Wash hands. Assess patient's respirations.
10. Document assessments and completion of procedure.

Suctioning using Suction Catheter Kit

1. Obtain suction catheter kit
2. Wash hands
3. Explain procedure to patient
4. Turn on wall suction pressure to -80 to -120 mm Hg pressure
5. Open sterile suction kit and put on gloves
6. Pick up suction catheter and remove outer wrapper
7. Maintain sterile technique with the hand holding the catheter (dominant hand)
8. Pick up suction tubing with other hand and attach it to the catheter
9. Pre-oxygenate patient using 100% oxygen
10. Insert catheter to correct level without applying suction
11. Apply suction as the catheter is removed in a rotating motion. Limit suction to 10 seconds and three passes
12. Monitor for cardiac dysrhythmias or desaturation, stopping suctioning and oxygenate if occurs
13. Place patient back on oxygen source and allow 3-6 breaths before reinserting catheter
14. When suctioning is complete, rinse suction tubing with water. Discard catheter
15. Wash hands
16. Throughout procedure, assess patient's heart rate, rhythm, color and SpO2

Suctioning using In-line Suction Apparatus

1. Wash hands and put on non-sterile gloves
2. Explain procedure to patient
3. Unlock suction port
4. Turn on wall suction pressure to -80 to -120 mm Hg pressure
5. Pre-oxygenate patient using 100% oxygen
6. Insert catheter to correct level without applying suction
7. While securing ETT with non-dominant hand, withdraw catheter, applying suction as the catheter is removed
8. Limit suction to 10 seconds and three passes – allow 3-6 breaths between passes
9. Pull catheter back to black marking and lock suction port

Indications that patient needs suctioning – assess every 2 hours

1. Coarse crackles or rhonchi over large airways; moist cough
2. Increase in peak inspiratory pressure on mechanical ventilation
3. Restlessness or agitation if accompanied by a decrease in SpO2

Suctioning Checklist

Skill	completed
Suctioning using Suction Catheter Kit	
Obtain suction catheter kit	
Wash hands	
Explain procedure to patient	
Turn on wall suction pressure to -80 to -120 mm Hg pressure	
Open sterile suction kit and put on gloves	
Pick up suction catheter and remove outer wrapper	
Maintain sterile technique with the hand holding the catheter (dominant hand)	
Pick up suction tubing with other hand and attach it to the catheter	
Pre-oxygenate patient using 100% oxygen	
Insert catheter to correct level without applying suction	
Apply suction as the catheter is removed in a rotating motion. Limit suction to 10 seconds and three passes	
Monitor for cardiac dysrhythmias or desaturation, stopping suctioning and oxygenate if occurs	
Place patient back on oxygen source and allow 3-6 breaths before reinserting catheter	
When suctioning is complete, rinse suction tubing with water. Discard catheter	
Wash hands	
Throughout procedure, assess patient's heart rate, rhythm, color and SpO2	
Suctioning using In-line Suction Apparatus	
Wash hands and put on non-sterile gloves	
Explain procedure to patient	
Unlock suction port	
Turn on wall suction pressure to -80 to -120 mm Hg pressure	
Pre-oxygenate patient using 100% oxygen	
Insert catheter to correct level without applying suction	
While securing ETT with non-dominant hand, withdraw catheter, applying suction as the catheter is removed	
Limit suction to 10 seconds and three passes – allow 3-6 breaths between passes	
When suctioning is completed, instill NS and simultaneously apply suction to rinse catheter and tubing	
Pull catheter back to black marking and lock suction port	
While securing ETT with non-dominant hand, withdraw catheter, applying suction as the catheter is removed	
Limit suction to 10 seconds and three passes – allow 3-6 breaths between passes	
Pull catheter back to black marking and lock suction port	

APPENDIX I

Demographic Questionnaire

INSTRUCTIONS: Answer each question by filling in your appropriate response:

1. What is your classification in nursing school?
   ◯ Senior 1
   ◯ Senior 2

2. Which BSN program are you enrolled in?
   ◯ Accelerated online BSN program
   ◯ Campus-based BSN program

3. What was your gender at birth?
   ◯ Female
   ◯ Male

4. What is your age? ____________

5. What is your ethnicity/race?
   ◯ African American or Black
   ◯ Asian
   ◯ Hawaiian Native or Pacific Islander
   ◯ Hispanic or Latino
   ◯ Native American or Alaska Native
   ◯ Other race or ethnicity
   ◯ White

6. Is English your second language?
   ◯ Yes
   ◯ No

7. Do you have previous healthcare experience? [select all that apply]
   ◯ None
   ◯ Nurse Tech or Patient Care Technician (PCT)
   ◯ Certified Nursing Assistant (CNA)
   ◯ Licensed Vocational/Practical Nurse (LVN/LPN)
   ◯ Medical Assistant
   ◯ Paramedic/EMT
   ◯ Pharmacy Technician
   ◯ Respiratory Therapist
   ◯ Speech Therapist

◯ Other ______________________

8. What is the highest college degree you have completed? [select all that apply]
   ◯ None
   ◯ Associate Degree
   ◯ Baccalaureate Degree
   ◯ Master's Degree
   ◯ Doctoral degree

9. If you have completed a previous college degree, what is the name of the degree?
   ◯ __________________
   ◯ N/A

10. Have you had a patient with a tracheostomy airway during your clinical experiences in nursing school?
    ◯ Yes
    ◯ No

11. Have you performed tracheostomy care (stoma care, stoma dressing change, inner cannula care [cleaning or replacing], or tracheostomy suctioning) on a patient in the clinical setting (hospital, home health, nursing home etc.)?
    ◯ Yes
    ◯ No

12. Have you practiced tracheostomy care (stoma care, stoma dressing change, inner cannula care [cleaning or replacing], or tracheostomy suctioning) on a manikin or simulated (standardized) patient [select all that apply]?
    ◯ Manikin
    ◯ Simulated (standardized) patient (SP)
    ◯ None

13. What tracheostomy care procedures have you performed? [select all that apply]
    ◯ Stoma care
    ◯ Stoma dressing change
    ◯ Changing of tracheostomy tube ties
    ◯ Inner cannula care (cleaning or replacing)
    ◯ Tracheostomy suctioning
    ◯ None

14. Do you plan to work in a place where there will be tracheostomy patients?
    ◯ Yes
    ◯ No

APPENDIX J

Prebriefing Video Content and Script

- *Note: The video will be recorded in Microsoft Teams, then deleted and moved to a university OneDrive folder shared with the dissertation Chair). It will then be imported into QuestionPro for viewing by participants.*
- Introduce self; state that I'm a PhD in Nursing student.
- Thank you for completing the two questionnaires. You are now ready to begin the simulation-based, e-learning activities.
- I'd like to reinforce that participation is voluntary & anonymous; will not affect your grade, academic standing, or graduation. You may quit the study at any time.
- Your answers are confidential: Questionnaire and survey data housed in UTA secure OneDrive folder that only I and the dissertation Chair and statistician can access. Your faculty will not know if you participate in the study.
- Everything you need to participate in the study is housed here in the QuestionPro platform.
- Tracheostomy preparation material is from your N4581 clinical packet. You will be able to download the document from QuestionPro.
- 3 tracheostomy modules. You will see links to each module. Please complete the modules in order: 1, 2, 3. Approximate time for completion of the 3 modules is 90 minutes. You can view the modules unlimited times and at your own pace.
- Optional videos will be identified in QP: Stay suture, Passy Muir valve, some cuff deflation videos
- Videos/animations will show various trach & inner cannula brands. Shiley most common in U. S. (see picture on your preparation material).
- Policy for cleaning trach inner cannula, suctioning, & stoma care will vary by institution. E.g. sterile vs. clean. Dressing brands/types and trach tie (velcro or cotton ties) products may also differ from institution to institution. When you enter practice you will learn and follow the policy and procedure of your facility.
- The modules were created by an Australian tracheostomy safety health organization. Some of the terms in used in the modules are different than what we use in the U. S. For example, *Respond Blue* is what we call a *Code Blue* and the word esophagus uses the British spelling (oesophagus).
- Please don't use the preparation material or other resources to fill out the tracheostomy survey. Mark your level of agreement or disagreement with each statement on the survey.
- Please keep the contents of the learning modules confidential, as you would if you were taking care of a patient in the simulation center or hospital clinical setting.
- Debriefing will be in the form of self-guided questions you will answer after you finish the 3 modules. If you have any concerns or need assistance please contact me (325) 668-7566 or ruth.bargainer@mavs.uta.edu

- Certificate of completion: Download and fill in your name.
- Thank you for your participation and helping to promote the safety of tracheostomy patients!

APPENDIX K

Debriefing Questions

The following debriefing questions give you an opportunity to voice your thoughts and feelings about the tracheostomy learning modules. Answering the questions will assist you in processing your thoughts and feelings and transforming the experience into learning. If you have any questions, concerns, or distress please contact the researcher (PhD student):

PhD Student: Ruth Bargainer Tobin: 325-668-7566 ruth.bargainer@mavs.uta.edu
Dissertation Chair: Dr. Deborah Behan: dgreen@uta.edu

1. What is the first thing that comes to mind about the tracheostomy modules you just completed?
2. How did the care of the patients you saw in the tracheostomy learning modules make you feel?
3. What did you learn about providing nursing care to a tracheostomy patient?
4. How will you apply the knowledge and skills you obtained in the tracheostomy modules to a future patient care situation?
5. What other feelings or thoughts do you have?