5-2016

Interprofessional Patient Simulation Training Compared to Online Training for learning to use In-Line Speaking Valves

Kristi A. Moore
East Tennessee State University

Follow this and additional works at: http://dc.etsu.edu/etd

Part of the Speech Pathology and Audiology Commons

Recommended Citation

This Thesis - Open Access is brought to you for free and open access by Digital Commons @ East Tennessee State University. It has been accepted for inclusion in Electronic Theses and Dissertations by an authorized administrator of Digital Commons @ East Tennessee State University. For more information, please contact dadmin@etsu.edu.

This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.
Interprofessional Patient Simulation Training Compared to Online Training for learning to use
In-Line Speaking Valves

A thesis
presented to
the faculty of the Department of Audiology and Speech Language Pathology of
East Tennessee State University
In partial fulfillment
of the requirements for the degree of
Master of Science in Speech Language Pathology

by
Kristi Ann Moore
May 2016

Neina Ferguson, Ph.D., Co-Chair
Kerry Proctor-Williams, Ph.D., Co-Chair
Chaya Nanjundeswaran, Ph.D.

Keywords: Simulation training, Tracheostomy, Ventilator, Speaking Valve
ABSTRACT

Interprofessional Patient Simulation Training Compared to Online Training for learning to use In-Line Speaking Valves

by

Kristi Ann Moore

Restoring speech in persons who are tracheostomy and ventilator dependent, through the use of a Passy-Muir Speaking Valve (PMSV), requires specific training. Methods of training interprofessional team members to assess in-line PMSVs are unclear. This study used a pre-test/post-test design to compare effects of online training and online training plus simulation training on knowledge acquisition, skills performance, and comfort levels when working with persons who are tracheostomy and ventilator dependent. Twenty-six students studying either respiratory therapy (N=13) or speech-language pathology (N=13) were assigned to the control group or experimental group. Results revealed that online training proved beneficial for increasing tracheostomy and ventilator knowledge. Participants who underwent simulation training reported greater levels of comfort and demonstrated more efficient skills performance during simulation post-testing. Simulation training is efficacious to train interprofessional teams how to properly assess this population for use of in-line PMSVs.
DEDICATION

I dedicate this thesis to my loving parents: Shelley and Tim Moore. I would not be who I am today if it was not for your endless love and support. Thank you for instilling good morals and perseverance in me. Thank you for your patience while simultaneously giving me the independence I needed to determine the path I wanted to take in life. You have laid the foundation to my success. You are the wind beneath my wings. I am proud to be your daughter, always and forever.
ACKNOWLEDGEMENTS

I would like to extend my sincerest gratitude to my co-chair of this thesis committee, Dr. Neina Ferguson. Her guidance, support, and patience was unending throughout this whole process. Dr. Ferguson fosters a warm, passionate, and lively personality which makes working and learning from her an invaluable opportunity. I deeply appreciate the extensive time and effort Dr. Ferguson took to provide me with the utmost research experience.

I would also like to offer my special thanks to my other co-chair, Dr. Kerry Proctor-Williams. Her genuine passion for research and sophisticated level of expertise provided me with a positive, well-rounded research experience.

I also wish to thank Dr. Nanjundeswaran for her insight, valuable feedback, and mentoring throughout this investigation. Her continuous support helped me see this project through.

Finally, I wish to thank my humble family: Shelley, Tim, Todd and Chad Moore. I wish to thank my loving partner, Andrew, for his faithful support and great deal of patience as I completed my studies. I would also like to acknowledge my late grandmother, Shirley Earle (Sis), for whom I provided tender care during the tragic days of her battle with ALS. I stayed at her bedside for countless hours while working on this research. I will never think of this thesis, or any of my future research, without remembering these bitter-sweet days with Sis. Her passion for life has forever inspired me. These outstanding individuals have been a constant rock in my life and have undoubtedly given me the strength to push forward when it was not always easy.
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>2</td>
</tr>
<tr>
<td>DEDICATION</td>
<td>3</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>4</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>9</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>10</td>
</tr>
<tr>
<td>Chapter 1. INTRODUCTION</td>
<td>11</td>
</tr>
<tr>
<td>Chapter 2. REVIEW OF LITERATURE</td>
<td>14</td>
</tr>
<tr>
<td>The Power of Human Communication</td>
<td>14</td>
</tr>
<tr>
<td>The Human Speech Mechanism</td>
<td>15</td>
</tr>
<tr>
<td>Respiration</td>
<td>15</td>
</tr>
<tr>
<td>Phonation</td>
<td>16</td>
</tr>
<tr>
<td>Resonance, Articulation, and Prosody</td>
<td>16</td>
</tr>
<tr>
<td>Respiratory Failure</td>
<td>17</td>
</tr>
<tr>
<td>Treatment</td>
<td>17</td>
</tr>
<tr>
<td>Tracheostomies</td>
<td>18</td>
</tr>
<tr>
<td>Anatomical and Physiological Changes</td>
<td>20</td>
</tr>
<tr>
<td>Ventilator Speech</td>
<td>20</td>
</tr>
<tr>
<td>Ventilator Speech and PMSV</td>
<td>21</td>
</tr>
<tr>
<td>Candidacy for PMSV</td>
<td>22</td>
</tr>
</tbody>
</table>
Skills Performance Assessment .................................40
Skills Performance Assessment during In Vivo Post-testing .......40
Comfort Rating Scale ..................................................41
Reliability ........................................................................42

4. RESULTS ......................................................................43
Descriptive Statistics for Control and Experimental Groups .......44
Comparison of Team Knowledge Gains .................................45
Comparison of Skills Performance .....................................46
   Ranked Analysis of Skills Performance ..............................46
   Analysis of Skills Performance: Time Duration .....................48
Comparison of Comfort Levels ...........................................51

5. DISCUSSION .............................................................53
Comparison of Knowledge Acquisition ................................53
Skills Performance ..........................................................54
Comparison of Comfort Levels ...........................................55
Clinical Implications ........................................................56
Study Limitations ............................................................58
Future Research ..............................................................59
Conclusions ......................................................................61

REFERENCES ..............................................................62
APPENDIX A: Approved IRB Script .....................................68
APPENDIX B: Control Group Video Links .............................70
APPENDIX C: Knowledge Test ............................................71
APPENDIX D: Comfort Rating Scale ........................................................................................................74
APPENDIX E: In-Line Passy-Muir Speaking Valve Skills Assessment ..................................................76
APPENDIX F: Case Study ..........................................................................................................................79
VITA .........................................................................................................................................................80
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Means and Standard Deviations for the Control and Experimental Groups Across Dependent Variables</td>
<td>44</td>
</tr>
<tr>
<td>2. Raw Data Time by Team and Scenario</td>
<td>50</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Nasal, oral, and tracheal intubation routes with an inflated cuff</td>
<td>18</td>
</tr>
<tr>
<td>2. Cuffed tracheostomy tube</td>
<td>19</td>
</tr>
<tr>
<td>3. Anatomical positioning of a cuffed tracheostomy tube</td>
<td>19</td>
</tr>
<tr>
<td>4. Participant recruitment flow chart</td>
<td>33</td>
</tr>
<tr>
<td>5. Laedral NG tube and Trach Care Trainer®</td>
<td>34</td>
</tr>
<tr>
<td>6. LTV series 1200® ventilator</td>
<td>35</td>
</tr>
<tr>
<td>7. Shiley® cuffed tracheostomy tube</td>
<td>35</td>
</tr>
<tr>
<td>8. Aqua Color PMSV, 007®</td>
<td>36</td>
</tr>
<tr>
<td>9. Overview of procedures</td>
<td>37</td>
</tr>
<tr>
<td>10. Total number of correctly answered knowledge test questions by team</td>
<td>45</td>
</tr>
<tr>
<td>11. Average team skills performance scores</td>
<td>48</td>
</tr>
<tr>
<td>12. Mean time (in seconds) for skills performance</td>
<td>50</td>
</tr>
<tr>
<td>13. Mean comfort level</td>
<td>52</td>
</tr>
</tbody>
</table>
CHAPTER 1
INTRODUCTION

Without a sound source, humans are robbed of the ability to speak. Speech, along with language, is a powerful tool that sculpts interpersonal relationships and shapes our physical and psychological well-being. Speech production is a result of complex central nervous system interactions across the respiratory, phonatory, and articulatory systems. The respiratory system acts as the driving force for sound production. The articulators and resonators shape the sounds created by the phonatory system. At particular risk for loss of speech are those who experience respiratory failure. They require life-saving medical procedures which prevents phonation and disrupts verbal communication. As well as the devastating loss of the ability to speak, patients who are unable to verbally communicate with healthcare professionals are at increased risk for negative health outcomes.

Successful verbal communication begins with a properly functioning respiratory system. Respiratory failure occurs when the respiratory system fails in its function to exchange gases. Either oxygenation is prevented or carbon dioxide cannot be eliminated (Fournier, 2014). Respiratory failure results from illnesses such as, but is not limited to, chronic obstructive pulmonary disease (COPD), pneumonia, pulmonary sepsis, pulmonary contusion, and inhalation injury (Fournier, 2014; Sagiul & Fargo, 2012). In acute respiratory failure, immediate intubation may be required for life-saving measures (Fournier, 2014).

Intubation involves the placement of a tube into the trachea to achieve mechanical ventilation (MV). MV is an artificial means of moving air in and out of the lungs to facilitate breathing for patients who are unable to breathe independently (Hoit, Shea, & Banzett, 1994). It may be required for short- or long-term support. In the short-term, such as during surgical procedures or
emergent respiratory failure, intubation tubes are typically inserted through the nasal or oral cavity. Long-term MV, however, requires a stoma for a tracheostomy tube. In this case, inhaled and exhaled air moves through an endotracheal tube to the lungs. No air flows through the glottis thus preventing vocal fold vibration, which leaves patients unable to verbally communicate using their own speech mechanism. Nevertheless, restoration of phonation is possible in patients who are tracheostomy and ventilator dependent (TVD) through placement of a Passy Muir Speaking Valve (PMSV). It requires a collaborative team to determine whether a patient meets the criteria for a PMSV and would benefit.

Healthcare professionals, including respiratory therapists (RTs) and speech language pathologists (SLPs) with advanced knowledge of the indications, contraindications, and procedural techniques manage patients who are dependent on tracheostomy and/or ventilators (Grossbach, Stranberg, & Chlan, 2011). However, evidence suggests that healthcare professionals knowledge and skills for managing persons who are TVD with PMSV is lacking (Norwood, Spiers, Bailiss, & Sayers, 2004). A key contributor to this deficiency is lack of access to effective training methods that focus on knowledge acquisition, skill development, and interprofessional collaboration.

Various pedagogical approaches exist to meet the needs of healthcare providers working with persons who are TVD. One approach, online training, provides a practical alternative to the conventional face-to-face instruction and has caused a major shift in education. Online training utilizes a learner-centered focus, and offers students flexibility and a sense of autonomy for self-learning (Artino, 2008). Online training is cost effective because the format allows educators to train large numbers of students in brief periods. The down side to online educational models in healthcare is that students do not practice clinical skills until they encounter live patients.
Persons who are TVD are then at increased risk for life-threatening, harmful events at the hands of unskilled practitioners.

In contrast, simulation training is a form of learning that is based on experiential learning theories. Human patient simulators offer rich learning experiences in realistic contexts which rapidly convert knowledge into skill acquisition (Corbridge, Robinson, Tiffen, & Corbridge, 2010). However, simulation mannequins are expensive and regular availability to laboratory space is required. These restrictions may limit healthcare provider access. Despite limitations, pros of simulation training may outweigh cons when considering patient safety. The purpose of this study is to examine a pedagogical approach, called Experiential Learning Theory, which incorporates the strengths and minimizes the weakness of both of these forms of learning.

The following sections will review the literature of persons who are TVD. Then the participants of the present study and methods are described in detail. Next, the results from this study are presented, including statistical analysis and interpretation of the data. Finally, a discussion of the implications of the results concludes this thesis.
CHAPTER 2

REVIEW OF THE LITERATURE

The Power of Human Communication

In the words of Daniel Webster, “If all my possessions were taken from me with one exception, I would choose to keep the power of communication, for by it I would soon regain all the rest.” Communication is a fundamental human function that supports complex interactions and connection. Particularly relevant to participation in the healthcare environment, humans gain a sense of self-empowerment through effective communication. Self-empowerment arises from the ability to comment, inquire, negotiate, advocate (McCaffrey et al., 2012). Self-advocacy is the ability to argue or speak in defense, favor, or for the benefit of one’s being and is used medically, judicially, and socially.

With medical models moving toward a collaborative care paradigm, patients are treated as experts about their own lives and play a more integral role in decisions regarding their medical care (Bodenheimer, Lorig, Holman, & Grumbach, 2002). For example, hospitalized persons may argue against a life-saving procedure for religious reasons. As well, patients may provide valuable information that enables physicians to make an accurate diagnosis, which leads to effective treatment. In collaborative care paradigms, patients set their own goals and identify their own problems. However, in persons who are TVD, the function of the speech mechanism is disturbed. This prevents use of necessary verbal communication skills to self-advocate for medical management and increases the risk of adverse patient events. In addition, with the inability to speak, patients experience increased levels of anxiety and poor interactions with family and friends.
The Human Speech Mechanism

Successful communication is accomplished through complex physiologic interactions within the human speech mechanism. Components of the human speech mechanism include respiration, phonation, resonance, articulation, and prosody.

Respiration

The respiratory system supports life through the exchange of gas at the cellular level. The respiratory system provides the means for this gas exchange system and has two functions: to inhale oxygen and exhale carbon dioxide (Carhart, 2012). Respiration occurs in repeated cycles of inhalation and exhalation. During inhalation, air flows through the nose, mouth, glottis, and into the trachea (Peracchia & Anaizi, 2014). The trachea then divides in the lungs into twenty-three individual tree-like airways ending in air sacs, known as the alveoli. Respiration or gas exchange occurs at the level of the alveoli. The diaphragm, below the lungs, is the primary inspiratory muscle during quiet respiration. It contracts to expand the thorax vertically, thereby increasing lung volumes (Peracchia & Anaizi, 2014). Boyle’s Law states that due to the inverse relationship that exists between volume and pressure, as lungs expand, lung volumes increase and pressures decrease, which facilitates inhalation (Carhart, 2012). Once the chest and lungs reach full expansion (or close to it), sensory receptors signal the brain to stop inhalation and begin exhalation (Carhart, 2012). As a result of the gravity, elasticity, and elastic recoil force in the lungs, gases are released, lung volume decreases, pressures increase in the thoracic cavity and air moves out of the lungs (Carhart, 2012; Peracchia & Anaizi, 2014). Exhaled air travels upward through the trachea, vocal folds, pharynx, and out the nasal/oral cavities.
**Phonation**

The respiratory system works in conjunction with the phonatory system to produce sound. The respiratory system provides a stream of air, building subglottic pressure, which flows past the vocal folds. Prior to sound production, the vocal folds come to midline at the level of the glottis, thereby increasing subglottic pressure. Increased pressure causes the vocal folds to abduct and subglottic pressure reduces as the rate of airflow increases through the glottis, completing one vibratory cycle (Stemple, Glaze, & Klaben, 2010). The Bernoulli Effect causes decreased pressure and elastic tissue recoil forces to bring the vocal folds back to midline, completing one full cycle of vibration. As a result of subglottic air pressure, sound is produced as the vocal folds vibrate with repeated opening and closing motion (Stemple et al., 2010).

**Resonance, Articulation, and Prosody**

Sound produced at the level of the vocal folds is shaped at various levels along the vocal tract into combinations of phonemes to produce recognizable words and intonation patterns to supplement meaning (Stemple et al., 2010). Resonators enhance sound, creating a voice unique to every individual. The tongue, teeth, and lips further shape sound into individually precise phonemes. Phonemes are combined to form words; words combined to form sentences; sentences combined to form language and communication. Prosody adds meaning through the tune and loudness, also controlled at the level of the vocal folds, and rhythm of speech (Stemple et al., 2010).

In healthy individuals, these complex physiologic processes work together to achieve speech. However, when one or more of these mechanisms are debilitated, speech is directly impaired. When the respiratory system is impaired, phonation is compromised which diminishes or prevents word and prosody production.
Respiratory Failure

Respiratory failure is a life threatening medical condition that interferes with either oxygen or carbon dioxide exchange at the cellular level (Fournier, 2014). Among the most common causes of respiratory failure are chronic obstructive pulmonary disease (COPD), pneumonia, pulmonary sepsis, pulmonary contusion, and inhalation injury to name a few (Fournier, 2014; Saguil & Fargo, 2012). In-hospital mortality rates for patients with respiratory failure are approximately 33-55% (Saguil & Fargo, 2012). To reduce mortality rates, intubation with or without MV is needed to sustain life and prevent deaths.

Treatment

Treatment options for respiratory failure can include nasal, oral or tracheal intubation with or without mechanical ventilation (Saguil & Fargo, 2012). Regardless of the intubation route, a balloon occludes the trachea to prevent air from escaping into the upper airway. See Figure 1 for an illustration. Intubation tubes are unsecured, which allows the tube to move around and, if unsecured, cause damage to the glottis; thus, a tracheostomy is secured to the neck preventing repeated injury (Silbergleit, Gardner, & Iannuzzi, 2000).

Figure 1. Nasal, oral, and tracheal intubation routes with an inflated cuff
In patients who require long-term MV to sustain life, a tracheostomy is performed. A tracheostomy is the surgical placement of a stoma into the trachea that supports ventilation (Hess, 2005a; Norwood et al., 2004). It is positioned below the vocal folds, which seals off the lower airway from the upper airway, facilitating MV. After a tracheostomy is placed, the intubation tube is removed and airflow is redirected through a tracheostomy tube. When the intubation tube is removed from the glottis, the primary airflow is now through the tracheostomy tube. This results in a lack of subglottic air pressure which prevents vocal fold vibration and phonation.

**Tracheostomies**

Tracheostomy tubes vary in sizes, designs, materials, and functions. Surgeons determine the type and size of tube to insert into the stoma. Plastic tracheostomy tubes are disposable, whereas, metal tubes are reusable. Cuffed tracheostomy tubes are most commonly used with MV because they allow for more effective positive-pressure ventilation (Hess, 2005b). See Figure 2 for an illustration. A cuff seals the airway to control mechanical ventilation (Dean, 2011). A cuffed tube blocks air from leaking into the upper airway and reduces aspirated saliva and food from traveling deeper into the pulmonary system (Hess, 2005b). See Figure 3 for an illustration. Size and design are taken into careful consideration when selecting tracheostomy tubes. Selecting a wrong tube for an individual can increase resistance in the tube, or reduce airway clearance with cuff deflation, which affects upper airway patency when attempting to re-establish speech (Hess, 2005b).
Figure 2. Cuffed tracheostomy tube

Figure 3. Anatomical positioning of a cuffed tracheostomy tube
Anatomical and Physiological Changes

The presence of a tracheostomy tube changes the normal flow of air through the upper airway. When the cuff of the tracheostomy tube is inflated the cuff blocks airflow that normally flows through the larynx, vocal folds, mouth, and nasal passage preventing phonation (Tippett & Vogelman, 2000). At this point, the respiratory system has become an open system. Air is no longer inhaled and exhaled through the upper airway; rather it occurs at the level of the stoma. Phonation is difficult, or impossible, secondary to insufficient subglottic pressure that is needed for vocal fold vibration. This results in ineffective voice and speech production, unless the upper respiratory system is closed (Tippett & Vogelman, 2000). In a closed respiratory system air is released through the upper airway and subglottic air pressure is present, making speech possible. With either treatment option, whether it be intubation or a tracheostomy, a ventilator can be attached to the tube to achieve MV.

Ventilator Speech

Persons, who are TVD and require low minute ventilations, may achieve whispered speech if the cuff of the tracheostomy tube is partially deflated. To achieve whispered speech, the cuff is slowly deflated until a stream of air leaks around the cuff and travels upward through the vocal folds (Heffner & Hess, 2001). Positive end-expiratory pressure (PEEP) is the pressure in the lungs at the end of exhalation that exceeds atmospheric pressure (Acosta, Santisbon, & Varon, 2007). An increased amount of PEEP will create a continuous flow of air around the tracheostomy tube upward through the vocal tract. Patients who tolerate increased PEEP, may achieve whispered speech throughout the entire respiratory cycle (Heffner & Hess, 2001). Hoit et al. (1994) also reported that longer durations of phonation were possible when PEEP and
length of inspiratory flow were increased. While ventilator supported speech is possible, effective speech production is limited because of poor speech quality and reduced intensity.

In normal speech production, stable tracheal pressure allows the larynx to function (Hoit & Banzett, 1997). Contrarily, in ventilated speech production, tracheal pressure continuously changes throughout the inspiration and expiration cycles. When pressure is high at the beginning of a cycle patients also experience disruptive, explosive bursts of loudness with a decrease in vocal intensity at the end of phrases. When tracheal pressures drop below the level needed to produce voice, silence ensues. As a result, brief rushes of speech followed by long periods of silence characterize speech production. These constant changes in vocal quality negatively impact speech. However, effective speech is possible with the use of a PMSV that is placed inline with ventilator circuitry.

**Ventilator Speech and PMSV**

Effective voice and communication may be restored for persons who are TVD if they have a patent upper airway and can tolerate cuff deflation. Voice is restored when a closed respiratory system is re-established and there is adequate subglottic pressure. A PMSV is a piece of medical grade equipment that attaches to the hub of the tracheostomy tube (Bier, Hazarian, McCabe, & Perez, 2004). A PMSV is one-way speaking valve that opens to allow air in through the tracheostomy during inhalation and closes during exhalation, directing air through the glottis and upper airway (Bier et al., 2004). The patented, closed position-no leak design allows the PMSV to open only during inspiration and automatically close before the end of the inspiratory cycle/beginning of the expiratory cycle (Kobak, 2000). A PMSV also allows for subglottic air pressure to be restored. Air is unable to leak from the tracheostomy tube during exhalation due to a column of trapped air in the tracheostomy tube and PMSV. Trapped air prevents secretions
from entering the tube and/or occluding the PMSV while in use (Kobak, 2000). With a PMSV, speech is attainable; however, before the use of a PMSV, candidacy must be established.

**Candidacy for PMSV**

The primary criteria for candidacy for PMSV use includes the ability to attain sufficient respiratory muscle control, oxygenation, and secretion management (Happ, 2001). PMSV is contraindicated in patients with an obstructed upper airway and those who do not tolerate cuff deflation (Hess, 2005a). An inflated cuff or an obstructed airway blocks exhalation through the upper airway and the PMSV blocks exhalation through the tracheostomy tube. These conditions cause acute respiratory failure or barotrauma; that is, damage to tissue secondary to unequal pressure in an air contained space (Grossbach et al., 2011).

While restored speech is desired for persons who are TVD, breathing is the primary function of the pulmonary system. Therefore, to protect ventilation and respiration, a physician’s order and a comprehensive assessment are required to determine if a PMSV can be safely donned. Professionals that care for persons who are TVD require detailed knowledge to maximize patient outcomes.

**Need for Knowledgeable and Proficient Healthcare Providers**

Hospitals are experiencing increasingly higher numbers of persons who are TVD on their caseload (Dikeman & Kazandjian, 2004). Historically, persons who were TVD were permanently housed in acute care facilities (Dikeman & Kazandjian, 2004). Currently, these patients live in a much wider variety of settings, including long-term acute care units, subacute care units, and at home. As a result, healthcare providers across a broader range of healthcare settings are responsible for assessing and treating persons who are TVD (Dikeman & Kazandjian, 2004).
The potential for restoring speech for persons who are TVD relies on skilled healthcare providers. Healthcare providers who care for this population must be particularly skilled in head and neck anatomy and airway management. Advanced knowledge is required for managing a complex airway with a PMSV placed in-line with ventilator circuitry or may result in potential harm to the patient. Given the potential dangers, a team approach is the safest and most effective method for administering a PMSV assessment (Grossbach et al., 2011).

Because of the increasing use and prevalence of tracheostomy as a treatment for respiratory failure, effective interprofessional training methods are needed. Initial training goals for students should increase basic knowledge and develop competent clinical skills performance to maximize patient benefits and safety. Then clinical application with skilled mentors is needed to further praxis knowledge. Praxis is skilled and purposeful motor acts that are part of an overall plan. Unfortunately persons who are TVD are frequently exposed to sentinel events, which are deaths secondary to avoidable medical errors (Valentin et al., 2006). Highly knowledgeable healthcare professionals who interact with persons who are TVD play a critical role in working with this high-risk population.

**Interprofessional Collaboration**

Management of tracheostomies requires an interprofessional team with specific expertise and training (Tobin, 2009). Team members typically include physicians, respiratory therapists, nurses, dieticians, social workers, speech-language pathologists, families, and patients (Dikeman & Kazandjan, 2004; Grossbach et al., 2011). All team members must understand the indications, contraindications, and procedural techniques to properly manage persons who are TVD (Grossbach et al., 2011). Implementing a team approach to manage the care of persons who are TVD reduces the length of time to decannulation, and shortens length of ICU care and stay in
the hospital (Mitchell, Parker, & Giles, 2013). However, team members must be trained with an emphasis on interprofessional collaboration in order to maximize patient care.

Evaluations of tracheostomy team performances that include an intensivist, an intensive care unit liaison nurse, a physiotherapist, a speech pathologist, and a dietician suggest that inadequate management negatively impacts patient outcomes (Tobin & Santamaria, 2008). This lack of knowledge and deficient performance may be addressed through interprofessional training that develops competent clinical skills, maximizes patient benefits, increases positive health outcomes, and reduces the occurrence of sentinel events (Mitchell et al., 2013). To implement interprofessional training and education, relevant pedagogical techniques have to be utilized, which is the focus of the current investigation. Two specific team members that heavily collaborate with each other is the respiratory therapist and speech-language pathologist.

**Roles and Responsibilities of Respiratory Therapists and Speech-Language Pathologists**

Two of the critical team members involved in assessment and management include RTs and SLPs. RTs are trained to manage medical equipment that maintains ventilation. SLPs are trained to assess and manage communication and voice disorders. Criteria for using speaking valves and skilled techniques for in-line application are within the scopes of practice for both disciplines.

The overall objective of SLP services is to optimize patients’ ability to communicate, which also improves their quality of life (ASHA, 2007). Training and experience for managing persons who are TVD vary across SLPs. However, all SLPs are ethically and professionally responsible for obtaining the knowledge and skills needed to competently perform specialized services. SLPs who work with persons who are TVD must be knowledgeable about normal and disordered anatomy and physiology of the respiratory and phonatory systems, airway
management techniques, mechanical ventilators, typical respiratory and metabolic values (Dikeman & Kazandjian, 2004). SLPs require knowledge of tracheostomy tubes and the criteria for candidacy for PMSV. SLPs are also responsible in managing voice with the use of PMSV. They must have knowledge of the pulmonary system and MV in order to effectively evaluate speech and swallow function for persons who are TVD (Dikeman & Kazandjian, 2004). SLPs should be comfortable working with a team of professionals to evaluate the possibility of establishing phonation through use of a PMSV.

RTs play critical role in team management of persons who are TVD. RTs assess patent airways and adjust and monitor medical grade ventilator equipment to maintain ventilation and respiration. RTs are responsible for technical troubleshooting, monitoring the status of the patient, and providing pulmonary treatments (Riley, 2013). MV is implemented and managed by RTs under the direction of a physician. RTs manage pulmonary rehabilitation, breathing techniques, airway management, intubation, and extubation. RTs and SLPs require skilled training to assess potential for tolerating PMSV. Interprofessional collaboration and effective training programs for SLPs and RTs will optimize the care provided to the rising number of persons who are TVD. Online training combined with a simulation-based training can be utilized to optimize interprofessional collaboration.

**Online Training**

Recently, online training has caused a major shift in education by providing practical alternatives to the conventional, face-to-face instruction. Online training results in a learner-centered focus, offering students a sense of autonomy for their own learning. Online training offers autonomy because it encompasses self-regulated learning (SRL) where students set their own goals. To achieve these goals, students take control of their own cognition, motivation,
behavior, and enact their personal learning styles. Online training allows individuality in the process of learning (Artino, 2008; Taylor & Hamdy, 2013).

Online training provides easy access, great personal flexibility in the timing of participation, and provides the opportunity for individualized learning. A benefit of online training is that educators can train large numbers of students simultaneously, using consistent structure and content (Ballew et al., 2013). Although online training is gaining popularity, there are barriers and concerns, such as the lack of hands-on activity, especially within the medical professions.

Some educators tend to resist online training formats and prefer traditional training methods (Ballew et al., 2013). Online training risks isolating students, and reducing the educational standards that are typically in place (Johnson, Aragon, & Shaik, 2000). Online training for healthcare professionals does not offer opportunities for skilled practice in realistic contexts. Because of this, learning becomes more passive than active. This investigation used online training by itself in the control group to test these claims for persons who are TVD. However, there is an alternate form of training, simulation-based training, that supports a more concrete, hands-on approach in learning how to care for persons who are TVD.

**Simulation Based Training**

Simulation training is a form of learning that is supported by experiential learning theories. Patient simulation is a rich learning experience that provides a context for the information to be rapidly converted into knowledge and skill acquisition (Corbridge et al., 2010). Over the last century, clinical education focused on learning through observation (Heinrichs, Youngblood, Harter, & Dev, 2008). However, with advances in technology, patient simulators offer realistic and safe opportunities for hands-on practice (Heinrichs et al., 2008). With today’s technology,
students and clinicians are better equipped to perform in clinical situations because they are offered the opportunity to learn interactively.

Well thought-out simulation experiences can be used to encourage higher level, critical thinking skills which aid problem solving and further develop communication skills (Burns, O’Donnell, & Artman, 2010). An advantage to simulation based training is that it allows for a risk-free learning environment where clinicians can successfully achieve the skills required for effective clinical practice (Maran & Glavin, 2003). Corbridge et al. (2010) conducted a study that investigated the learning differences between online and simulation training when caring for patients who are MV. The study concluded that participants in the simulation group were more satisfied with their method of training and that they demonstrated better understanding of the material when compared to participants in the online group.

Problem solving skills are imperative for successful clinical practice. Simulation training facilitates skilled based learning through an interactive approach. Interactive learning can take many forms, but the most popular is hands-on simulation training (Burns et al., 2010). In simulation based training, training scenarios simultaneously include learning opportunities and development of performance-based measures, which are directly linked to learning opportunities (MacMillan, Entin, Morley, & Bennett, 2013). Kuduvalli, Jervis, Tighe, and Robin (2008) found that simulation based airway training significantly improved skills performance for 6-8 weeks post training and suggested that training should be repeated every six months or less. Vadnais et al. (2012) found that knowledge and comfort increased after simulation training, but knowledge tended to decrease slightly over time. This investigation used simulation-based training with a mannequin in the experimental group to test these claims for persons who are TVD and to compare to the learning effects of online training.
Purpose of the Present Investigation

The purpose of this study was to compare knowledge acquisition, skills performance, and student comfort levels for in-line PMSV management in persons who are TVD after two types of training: Online or Online + Simulation. The participants included RT students from the undergraduate cardiopulmonary science and SLP students from the graduate speech-language pathology program at East Tennessee State University. Participants in both groups received online training to learn basic tracheostomy and ventilator mechanics, anatomical and physiological differences, and assessment protocols for in-line PMSV use in persons who are TVD. Participants in the online group (control group) watched a 90-minute video covering universal healthcare precautions to control for engagement time in task-related activity. Participants in the simulation group (experimental group) completed a 90-minute, simulated clinical experience (SCE). Knowledge change was measured using a multiple-choice test to ensure that all participants gained the same basic tracheostomy and ventilator knowledge before entering laboratory experiences. Comfort levels regarding interprofessional collaboration, discussions with families, and understanding of anatomical changes that occur with tracheostomies, were measured using a six-point Likert scale to compare pre- and post-intervention comfort when working with persons who are TVD, their families, and other related professionals. Clinical skills performance was measured using a skills performance checklist protocol to monitor for specific skills demonstrated when working with the simulator mannequin. A pre-test-post-test within and between subjects design was used to compare training efficacy for OLT and OLT plus an SCE laboratory.
Research Questions and Hypotheses

The following research questions were posed:

1. Do team test scores reflecting tracheostomy and ventilator knowledge change as a result of participation in an online training?
2. Do participants who receive SCE plus online training (experimental group) differ in their clinical skills performance scores than participants who receive online training alone (control group)?
3. Do participants who receive an SCE plus online training (experimental group) differ in their comfort levels while placing in-line PMSV than participants who receive online training alone (control group)?

The following research hypotheses were proposed:

1. It was hypothesized that participants in both groups will gain knowledge from pre- to post-testing without group differences. Corbridge and colleagues (2010) found that some level of knowledge was gained regardless of the teaching method (online or simulation). However, the extent of knowledge and application was dependent on teaching methods.
2. It was hypothesized that participants in the experimental group will have higher performance skills than participants in the control group. This hypothesis is based on Corbridge et al. (2010), who found that participants who received simulation training had better understanding of the material and a greater ability to apply their knowledge to a patient who required MV.
3. It was hypothesized that participants in both groups will feel more comfortable working with persons who are TVD after training. The experimental group will report greater comfort levels than the control group. This hypothesis is based on Vadnais et al. (2012),
who found that after one day of simulation training, there was an immediate increase in comfort levels across four different simulated scenarios.
CHAPTER 3

METHODS

This study examined the effectiveness of an interprofessional simulation pedagogical approach for educating students in the care of persons who are TVD. The purpose was to determine learning effects using a low fidelity respiratory mannequin (VITO) to increase knowledge acquisition, comfort levels, and skills performance when providing in-line Passy-Muir Speaking Valve (PMSV) care. This chapter describes the methods employed in the completion of this study.

Research Design

A 2x2 mixed-model design was used with Group as the between subjects variable and Time as the within subjects variable. Effects of online training (OLT) to online training plus a simulated clinical experience (SCE) for knowledge gained, comfort levels, and skills performance were compared. All participants completed pre-testing, viewed a prerecorded PowerPoint® OLT lecture, and completed post-testing. The OLT module was designed to increase participants’ knowledge of tracheostomy procedures, tracheostomy tubes, ventilator management, and use of in-line PMSV. The SCE laboratory was designed to offer participants the opportunity to safely perform skills on a patient simulator as members of an interprofessional team.

Setting

This study was conducted at East Tennessee State University’s cardiopulmonary science laboratory located at the Nave Center in Elizabethton, TN. Inclusion criteria required students to be enrolled during the Fall 2015 semester at ETSU as an undergraduate student in cardiopulmonary science program or second year graduate student in speech-language
pathology. Faculty members from Cardiopulmonary Science (KM1) and Speech-Language Pathology (NF) conducted the SCE with the researcher (KM2). Passy-Muir, Inc. provided equipment support and a representative with specific expertise in managing persons who are TVD with PMSVs. The Passy-Muir, Inc. representative, GS, assisted with in vivo post-testing and debriefing.

Participants

Ethics

Approval was obtained from the Institutional Review Board (IRB) at East Tennessee State University. See approved script in Appendix A. IRB guidelines did not require written consent. After the script was read and a question and answer session was completed, interested participants provided their names and email addresses on a sign-up sheet. Participants received a certificate of completion for participating in this research experience.

Sampling Method

A convenience sample of 26 participants was recruited from East Tennessee State University’s College of Clinical and Rehabilitative Health Sciences. KM1 and NF presented this research opportunity to graduate level SLP students and undergraduate RT students at the beginning of the Fall 2015 semester. RT and SLP students were selected because both disciplines are critical members of the healthcare team who typically work together with persons who are TVD and have a PMSV.

Participant Description

Thirteen of the 20 RT students consented to participate. All of the 24 SLP students consented to participate. All of the RT students who consented were selected for participation in the study. All RT students were seniors with the exception of one. Thirteen of the 27 SLP

32
students who consented to participate were randomly chosen using a lottery method. All SLP students were in their second year of study. Five of the RT participants were male and one of the SLP participants was a male. The rest of the participants were females. The average age of RT students was 27 years and average age for SLP students was 26 years. None of the selected participants had any previous exposure to using a PMSV in-line; however, twenty-five of the 26 participants had general content exposure to PMSV. Twenty-five of the 26 participants had previous course content that included information on artificial airways.

**Group Assignment**

Selected participants were randomly assigned, with the exception of meeting the planned group size, to either the control or experimental group. See figure 4 for details.

*Figure 4. Participant recruitment flow chart*

**Equipment**

Medical grade equipment and a low-fidelity mannequin were used to complete this investigation. Equipment included: an LTV series 1200 ventilator, Shiley® size 6 and size 8
cuffed tracheostomy tubes with an inner cannula, size 15mm x 22mm Kimberly Clark® adaptor, corrugated ventilator circuitry, Aqua 007 Passy-Muir Speaking Valve®, and a low-fidelity NG tube and Trach Care Trainer created by Laedral® model 375-10001 (VITO). See Figure 5 below for a model of VITO. Public YouTube® videos were compiled to create a 90-minute sham laboratory experience. Videos were selected that reviewed universal healthcare precautions. See Appendix B for a list of links to videos. Participants accessed pre-testing, the self-paced OLT, and post-testing through an online university platform, Desire to Learn® (D2L).

![Laedral NG tube and Trach Care Trainer® (VITO)](image)

*Figure 5. Laedral NG tube and Trach Care Trainer® (VITO)*

VITO was used to create the OLT module, the SCE laboratory, and in vivo post-testing scenarios. Using VITO provided visual and kinesthetic feedback to participants via his open chest design. Participants were able to watch the lungs on VITO while respiratory support was provided through mechanical ventilation. An LTV 1200 series ventilator was used to mechanically ventilate VITO during the recorded OLT, SCE laboratory training, and in vivo post-testing. See Figure 6 for a model of the LTV ventilator. LTV ventilators are frequently
used for patients who require long-term home ventilation; they are portable, compact, and appropriate for use across the lifespan.

![LTV series 1200® ventilator](image)

**Figure 6.** LTV series 1200® ventilator

Shiley®, size 6 and size 8 cuffed tracheostomy tubes were used during simulation scenarios. A size 8 tube was used to simulate an obstructed upper airway because the diameter did not permit a sufficient air leak. A size 6 tracheostomy tube was used to simulate a patent airway scenario. **Figure 7** shows a picture of a Shiley® disposable cuffed tracheostomy tube. An Aqua Color PMSV 007® was used during training videos, SCE laboratory, and in vivo post-testing. **Figure 8** depicts the PMSV 007®. The aqua PMSV is designed for in-line placement with corrugated ventilator tubing.

![Shiley® cuffed tracheostomy tube](image)

**Figure 7.** Shiley® cuffed tracheostomy tube
Procedures

All participants in this study were enrolled into a D2L® course to access to pre- and post-testing and the OTL module. Pre-tests were proctored and completed prior to OTL access. Participants completed the OLT module between 48 to 72 hours prior to their laboratory experience. After laboratory experiences, all participants completed in vivo post-testing and a team debriefing session. Participants completed laboratory experiences and post-testing at ETSU’s cardiopulmonary science lab, which is located at the Nave.

Upon arrival, participants entered a computer laboratory to complete the proctored post-knowledge test. Due to the extent of material covered in the OLT, participants were permitted to use notes from the OLT during knowledge post-testing. After completing knowledge post-testing, participants assigned to the video laboratory entered a classroom to watch 90 minutes of universal healthcare precaution videos; students in the experimental group entered the simulated clinical experience laboratory.

Skills performance post-testing was completed in the simulated clinical experience laboratory for both groups. Participants completed post-comfort surveys (description follows) in
the computer laboratory after skills performance-post-testing. Finally, participants completed debriefing with faculty. See Figure 9 for an illustration of procedures.

<table>
<thead>
<tr>
<th>Pretest</th>
<th>Training</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Knowledge Test • Comfort Scale</td>
<td>• OLT • OLT + SCE</td>
<td>• Knowledge Test • Clinical Skills Performance • Comfort Scale • Debriefing</td>
</tr>
</tbody>
</table>

Figure 9. Overview of procedures

**Training**

**Online Training**

Participants in both groups accessed a forty-five minute, self-paced voice-over OLT module from ETSU’s D2L® platform. The OLT addressed the following topics: explanation of tracheostomies and ventilators; cuff inflation and deflation; in-line PMSV placement; and live instruction videos.

The explanation portion of the OLT included indications for a tracheostomy; anatomical changes that occur after a tracheostomy; indications for mechanical ventilation; the mechanics of ventilator operations and connections for circuitry; and indications, contraindications, and application of an in-line PMSV. The OLT module demonstrated the components of a tracheostomy tube and insertion.

The OLT explained how to inflate and deflate the cuff, airflow change as a result of cuff inflation/deflation, and the mechanics of operating an LTV ventilator. Finally, the OLT module included placement of an in-line PMSV using a 15 x 22 mm adaptor. Participants observed two
live instruction scenarios in the OLT: an obstructed and a patent upper airway. Scenarios were included to introduce students to the clinical decision process for using an in-line PMSV.

Each scenario focused participants on the necessary critical problem solving skills for working with persons who are TVD. The first scenario introduced the contraindications for PMSV use. A patient with a tracheostomy tube that was too large to permit an adequate air leak (obstruction) resulted in an insufficient drop in exhaled tidal volume and positive inspiratory pressure after cuff deflation. In this case the OLT module instructed participants to return the ventilator to baseline settings without attempting to place the PMSV in-line with ventilator circuitry.

The second scenario presented a patient with a patent upper airway. After cuff deflation, a 40-50% drop in exhaled tidal volume and positive inspiratory pressure indicated an adequate air leak, suggestive of airway patency for PMSV use. The OLT module instructed participants to proceed with in-line placement of a PMSV. They received step-by-step instructions for accurate placement for a PMSV. After donning the PMSV, participants reviewed instructions for achieving patients’ pre-cuff deflation PIP levels. Finally, they were educated on how to doff the PMSV and return the ventilator to the original settings.

**Alternative Experience (Control Group)**

In addition to the OLT, participants in the control group watched a 90-minute video series that reviewed healthcare precautions. This alternate experience was designed to control for participant time invested in training. Therefore, both groups engaged in a 90-minute educational experience.
**Simulated Clinical Experience Laboratory (Experimental Group)**

The SCE was designed to allow participants opportunities for realistic, hands-on interprofessional practice. In the 90-minute interprofessional practice experience, participants practiced in teams of two (one RT and one SLP). Participants were encouraged to use the information learned from the OLT to place in-line PMSVs on a patient simulator. For example, when participants entered the laboratory, they were told to practice determining candidacy for PMSV and how to place a PMSV in-line with corrugated ventilator tubing, if clinically appropriate. Participants were allowed to repeat practice of these skills as many times as they liked within the time allotted. Although the frequency of repeated practice was not measured, it was estimated that interprofessional teams practiced a minimum of five times throughout the SCE. KM1, NF, KM2, and GS oversaw these experiences but did not offer additional instruction, except in response to direct questions. Participants were told to refer to their notes and ask questions throughout the process.

**Assessment Measurements**

Three outcome measurements were used in this investigation: an online knowledge test, an online comfort scale, and an in vivo clinical skills performance assessment. The knowledge test and comfort scale were adapted with permission for entry-level students from Dorton, Lintzenich, and Evans (2014). See Appendix C for the knowledge test and Appendix D for the comfort scale.

**Knowledge Test**

The knowledge test included fifteen multiple-choice questions designed to assess participants’ understanding of: indications for a tracheostomy; anatomical changes that occur after a tracheostomy; indications for mechanical ventilation; the mechanics of ventilator
operations and connections for circuitry; and indications, contraindications, and application of an in-line PMSV for persons who are TVD. The same set of questions and answers were used in the pre- and post-test. They were reordered from pre- to post-test to increase test-retest reliability. Knowledge test scores were analyzed by teams (1 RT, 1 SLP). Total team scores were used when comparing pre and post-test differences for knowledge gained during the OLT. Team scores were used to ensure that all interprofessional teams had adequate knowledge before entering in vivo post-testing as teams.

**Skills Performance Assessment**

A clinical skills performance checklist was adapted from one developed at the Middle Tennessee State University School of Nursing (S. Moore, personal communication, July 19, 2015). The adapted clinical skills checklist entitled *In-Line Passy Muir Speaking Valve Skills Assessment* assessed each team’s in vivo skills performance across fifteen tasks. The skills were initially coded on a dichotomized scale as “completed” or “not completed”. Then, a three-point scale was applied to rate the level of skill competence using the following criteria:

1. The skill was not completed or the performance was unsatisfactory.
2. The team performed the skill satisfactorily in a safe and accurate manner.
3. The team completed an in-depth, safe, and accurate performance.

Last, each skill component demonstrated in each scenario was time coded to determine efficiency in skills performance for each team. KM2 initially coded all data; then, re-coded 20% of the data in order to determine intra-rater reliability. NF independently coded 20% of the data to determine inter-rater reliability.

**Skills Performance Assessment during In Vivo Post-testing.** During skills performance post-testing, each team (1 RT and 1 SLP) evaluated a TVD patient simulator
(VITO) for in-line PMSV use. Each team received a medical history and a physician’s order to evaluate for PMSV use. In the first part of the total scenario, VITO had a size 8 Shiley® cuffed tracheostomy tube, which obstructed airflow through the upper airway. In the second part of the total scenario, VITO’s tracheostomy tube was changed to a size 6 Shiley® to facilitate sufficient airflow through the upper airway. After the tracheostomy tube change, the team was ordered to re-evaluate VITO for an in-line PMSV. Team performance was scored on the following: ability to adjust ventilator alarms; accurate judgment of airway patency; ability to deflate the cuff and calculate changes in exhaled tidal volume and positive inspiratory pressure; ability to accurately judge safety for donning PMSV; and ability to perform a voice evaluation and teach VITO to coordinate phonation with ventilator controlled inhalations and exhalations. During each scenario, team performances were video-recorded to allow for coding of skills across criteria by multiple raters. See performance skills checklist in Appendix E. VITO’s case history is provided in Appendix F. Skills performance was judged as a team; therefore, each team of two participants (1 RT, 1 SLP) had one skills checklist for each scenario.

**Comfort Rating Scale**

A 6-point Likert scale was used across 15 statements to assess participants’ comfort levels before and after the combined OTL training, laboratory experiences, and in vivo post-testing (see Appendix D). This adapted scale added five additional comfort statements to the original to measure participants’ comfort levels when working with persons who are TVD. This scale was used to assess participants’ comfort level with tracheostomies/ventilators, working with other related professionals, anatomical changes, and working with families of persons who are TVD. Higher scores on the comfort rating indicated greater agreement with statements. For example, it included statements such as: “I feel comfortable talking to families and patients about
tracheostomies”; “I feel comfortable assessing for an in-line PMSV in persons who are TVD”; and “I feel comfortable working with persons who are TVD”. Participants rated each statement on a 1-6 scale: I don’t know, strongly disagree, disagree, neutral, agree, and strongly agree. Pre and post-test comfort levels were analyzed by group (control and experimental).

**Reliability**

Intra- and inter-rater reliability were calculated for 20% of participants’ performances, and comfort levels. The classic standard for using reliability is considered to be $r = 0.80$; however, a higher value such as 0.90 is preferred as it is sufficiently reliable to make decisions about individuals regarding their scores (Rao & Sinharay, 2006). To determine the intra-rater reliability, KM2 coded 100% of the responses and then re-coded 20%. Intra-rater reliability was calculated for: knowledge pre-test scores ($r = 1.0$); knowledge post-test scores ($r = 1.0$); and skills performance post-test scores ($r = 1.0$). Hence, there is evidence for the repeatability of measurements for KM2. To determine inter-rater reliability, NF coded 20% of the responses. Inter-rater reliability was calculated for: the knowledge pre-test scores ($r = 1.0$); knowledge post-test scores ($r = 1.0$); and skills performance post-test scores ($r = .953$). Overall, KM2 and NF scored measures similarly across all assessment measures, suggesting strong reliability. Discrepancies were resolved between coders/rater by an in-person discussion to arrive at a consensus.
CHAPTER 4

RESULTS

This study first sought to determine if a difference in learning existed between the OLT and SCE groups when assessing in-line PMSV use. Learning differences were measured by knowledge gains, participants’ comfort levels in working with patients who are TVD, and skill performance during an SCE. To further investigate effectiveness of training modalities, the data was used to test efficiency of learning methods.

A mixed-model design was used to compare the effects of an OLT and SCE on participants’ knowledge gains and comfort levels across time. Knowledge test scores reflected understanding the use of in-line PMSV use; comfort levels reflected participants’ perceived ease of working interprofessionally with in-line PMSVs. The between subject variable was Group with two levels (control and experimental). The within subjects variable was Time with two levels (pre-test and post-test). Independent variables included Time (pre- and post-test) and Group (control and experimental). Dependent variables included scores on team knowledge test and individual participant comfort levels. An alpha level of .05 was used to test significance for repeated measures mixed model analyses.

Skills performance measures compared the control and experimental groups on skill accuracy and efficiency using a post-test only analysis. Independent variables included Group (control and experimental). Dependent variables included team clinical skills performance scores and efficiency. An alpha of .01 was used to test significance for the one-way ANOVAs to reduce the risk of a Type I error.

Effect sizes were calculated using partial eta squared ($\eta^2$) in the repeated measures and mixed model Analysis of Variance (ANOVA) for knowledge gains and comfort levels. Effect
sizes were calculated using Cohen’s $d$ in the one-way ANOVAs for ranked analysis of skills performance scores and efficiency analyses. Effect size is a measure of the strength, magnitude, or importance of the relationship between variables. Partial $\eta^2$ values were judged small (.01), medium (.06), or large (.14); Cohen’s $d$ values were judged small (.20), medium (.50), or large (.80) (Tabachnick & Fidell, 2007).

**Descriptive Statistics for Control and Experimental Groups**

Dependent variables as a function of Group were used to measure outcomes for all research questions. Table 1 illustrates the means and standard deviations for the control and experimental groups across all dependent variables.

Table 1

*Means and Standard Deviations for the Control and Experimental Groups Across Dependent Variables (N = 26)*

<table>
<thead>
<tr>
<th>Outcome Measure</th>
<th>Control Group</th>
<th></th>
<th>Experimental Group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Team (N = 6)</td>
<td>Individual (N = 12)</td>
<td>Team (N = 7)</td>
<td>Individual (N = 14)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Knowledge Test Max Score = 30</td>
<td>Pre Post</td>
<td>15.50 2.950</td>
<td>17.29 3.946</td>
<td></td>
</tr>
<tr>
<td>Clinical Skill Obstructed Airway Max Score = 42</td>
<td>Post</td>
<td>20.50 7.89</td>
<td>37.14 4.67</td>
<td></td>
</tr>
<tr>
<td>Clinical Skill Patent Airway Max Score = 45</td>
<td>Post</td>
<td>12.66 15.25</td>
<td>40.57 4.64</td>
<td></td>
</tr>
<tr>
<td>Comfort Level Max Rating = 6</td>
<td>Pre Post</td>
<td>3.68 0.450</td>
<td>4.16 0.628</td>
<td></td>
</tr>
</tbody>
</table>

*Note. M = Mean, SD = Standard Deviation.*
Comparison of Team Knowledge Gains

Research question 1: Do team test scores reflecting tracheostomy and ventilator knowledge change as a result of participation in an online training? This question was tested using a repeated measures and mixed model ANOVA to determine if team knowledge test scores differed between groups. The maximum score for each individual on the knowledge test was 15. Therefore, the maximum score for each team was 30 points (15 points per team member). Group was the between subject variable with two levels (control and experimental). Time was the within subjects variable with two levels (pre- and post-testing). The ANOVA revealed no significant main effect for Group, $F(1,11) = 1.843, p = .202$. A main effect of Time was significant with a large effect size $F(1, 11) = 150.104, p < .001$, partial $\eta^2 = .932$. No significant Group by Time interaction was found and the effect size was small, $F(1, 11) = .030, p = .866$, $\eta^2 = .003$. Figure 10 depicts the means and standard deviations across time between groups.

![Figure 10](image)

*Figure 10.* Total number of correctly answered knowledge test questions by team. Error bars represent standard deviation
Comparison of Skills Performance

Research question 2: Do participants in the control and experimental groups differ in their post-test clinical skills performance scores? Neither group had previous knowledge of in-line PMSV use. Therefore, this question was analyzed for skills accuracy and efficiency using post-test data only. Total skills performance data was further analyzed to determine how participants’ performance skills differed for each part of the total scenario (obstructed versus patent upper airway).

Ranked Analysis of Skills Performance

One-way ANOVAs were used to analyze team clinical skills performance for: (1) total scenario scores, (2) obstructed airway part of the total scenario scores, and (3) patent airway part of the total scenario scores. Skills performance was coded on a ranked scale from one to three:

1. The skill was not completed or the performance was unsatisfactory
2. The team performed the skill satisfactorily in a safe and accurate manner
3. The team completed an in-depth, safe, and accurate performance

The maximum total scenario score was 87; the minimum was 29. The maximum score for the obstructed upper airway part of the total scenario was 42; the minimum was 14. The maximum score for the patent upper airway part of the total scenario was 45; the minimum was 15.

A one-way ANOVA was calculated for the total scenario score with Group as the between subjects variable and the in vivo post-test total scenario scores as the dependent variable. A significant effect of Group was found with a large effect size $F(1,12) = 24.520, p = <.001, d = 2.664$. Results indicate a significant learning difference between groups. Participants who completed the SCE (experimental group) demonstrated significantly higher total skills
performance scores. Skills performance scores were further analyzed to determine which part of the total scenario drove group differences.

A one-way ANOVA was calculated for the obstructed upper airway part of the total scenario with Group as the between subjects variable and in vivo post-test scores as the dependent variable. A significant effect of Group was found with a large effect size $F(1, 12) = 22.253, p = .001, d = 2.566$. Results indicate a significant learning difference between groups. Participants who completed the SCE demonstrated significantly greater abilities for recognizing airway obstruction.

A one-way ANOVA was calculated for the patent upper airway part of the total scenario with Group as the between subjects variable and in vivo post-test scores as the dependent variable. Results showed a significant effect of Group with a large effect size $F(1, 12) = 21.401, p = .001, d = 2.475$. Results indicate that a significant learning difference between groups. Participants who completed an SCE demonstrated better praxis skills for donning an in-line PMSV. Average skills performances scores of participants between groups and across scenarios parts are plotted in Figure 11. Overall, results indicate that SCE training resulted in superior learning effects when compared to OLT alone.
Analysis of Skills Performance: Time Duration

Team efficiency was analyzed using three one-way ANOVAs with Group as the independent variable with two levels (control and experimental) and averaged post-test scenario time (measured in seconds; efficiency) as the dependent variable. Efficiency was measured for: (1) total scenario, (2) obstructed airway part of the total scenario, and (3) patent airway part of the total scenario. Efficiency was measured by calculating the time required to complete each part of the total scenario (obstructed and patent). The maximum total time it took for any one team to complete the entire scenario was 1118 seconds (900 seconds-patent airway; 218 seconds-obstructed airway).

For the obstructed airway part of the scenario, time ended once the team determined the upper airway was obstructed and the PMSV was contraindicated, the team did not recognize airway obstruction and donned the PMSV, or the team was unable to complete the task. The
maximum time it took for any one team to complete the obstructed upper airway part of the scenario was 633 seconds (10.5 minutes).

The patent airway scenario time ended once the team successfully placed the PMSV in-line with ventilator circuitry or the team was unable to complete the task. A ceiling of 900 seconds (15 minutes) was implemented for the patent upper airway part of the scenario due to excessive participant frustration levels during in vivo post-testing. Table 2 shows raw time data by team and scenario sections.

A one-way ANOVA was calculated for the total scenario with Group as the between subjects variable and efficiency as the dependent variable. A significant effect of Group was found with a large effect size $F(1,12) = 52.699, p = .001, d = 9.498$. Results indicate that participants who engaged in the SCE completed the total scenario more efficiently than participants who completed an OLT alone. The magnitude of group differences can be attributed to the SCE as evidenced by the large effect size. Efficiency was further analyzed to determine which part of the total scenario drove group differences.

A one-way ANOVA was calculated for the obstructed airway part of the scenario with Group as the between subjects variable and efficiency as the dependent variable. No effect of Group was found but there was a medium effect size, $F(1,12) = 2.074, p = .178, d = 0.768$. Results indicate that while there was no statistically significant difference in efficiency for identifying airway obstruction between groups, there may be a clinically important advantage in efficiency for the SCE group.

A one-way ANOVA was calculated for the patent airway part of the total scenario with Group as the between subject variable and efficiency as the dependent variable. A significant effect of Group was found with a large effect size $F(1,12) = 19.781, p = .001, d = 2.358$. Results
indicate that the experimental group was more efficient during the patent part of the total scenario than the control group. The magnitude of group differences can be attributed to the SCE as evidenced by the large effect size. Overall, group differences in efficiency were primarily driven by the patent airway part of the total scenario. Figure 12 represents the learning differences as measured by efficiency between groups during in vivo post-testing scenarios.

Table 2

*Raw Data Time by Team and Scenario*

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th></th>
<th>Experimental Group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Obstructed</td>
<td>Patent</td>
<td>Obstructed</td>
<td>Patent</td>
</tr>
<tr>
<td></td>
<td>Scenario</td>
<td>Scenario</td>
<td>Scenario</td>
<td>Scenario</td>
</tr>
<tr>
<td>Seconds</td>
<td>78</td>
<td>900</td>
<td>76</td>
<td>64</td>
</tr>
<tr>
<td>Minutes</td>
<td>1.3</td>
<td>15</td>
<td>1.26</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>148</td>
<td>284</td>
<td>111</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>2.46</td>
<td>4.73</td>
<td>1.85</td>
<td>0.63</td>
</tr>
<tr>
<td></td>
<td>633</td>
<td>106</td>
<td>171</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>10.55</td>
<td>1.76</td>
<td>2.85</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>900</td>
<td>15</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>3.33</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>218</td>
<td>900</td>
<td>15</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>3.63</td>
<td>15</td>
<td>2.65</td>
<td>1.11</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>900</td>
<td>15</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>1.25</td>
<td></td>
<td>0.53</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>114</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.9</td>
<td>0.33</td>
</tr>
</tbody>
</table>

*Figure 12.* Mean time (in seconds) for skills performance. Error bars represent standard deviation.
Comparison of Comfort Levels

Research question 3: Do participants who receive an SCE plus OLT (experimental group) differ in their comfort levels while placing in-line PMSV from participants who receive OLT alone (control group)? The dependent variable, individual participant comfort ratings were averaged across Time and between Groups. Participants ranked their perceived comfort using a six-point Likert Scale, which included the options: I don’t know, strongly disagree, disagree, neutral, agree, and strongly agree. The lowest comfort selection, “I don’t know”, was ranked one. The highest level of comfort, “Strongly Agree”, was ranked six. Higher scores indicate greater perceived comfort levels. To investigate this question, a total comfort score was calculated across 15 questions. Cronbach’s alpha was used to demonstrate that there was internal reliability for the comfort rating scale ($r = .835, p < .05$).

A repeated measure, mixed-model ANOVA was conducted to determine if comfort levels for working with persons who are TVD and use in-line PMSVs differed across Time and between Groups. Group was the between subjects variable with two levels (control and experimental). Time was the within subjects variable (pre- and post-test). Sample sizes were unequal. The assumption of equal covariance matrices was violated as evidenced by a significant Box’s Test. To account for this violation, Pillai’s Trace was used to test for significance, and the alpha was changed from .05 to .01 to decrease the risk of a Type I error. The assumptions of normality and sphericity and error variances were tested and met. Analyses revealed main effects for Group, $F(1, 24) = 34.162, p = <.001, \eta^2 = .587$, and Time, $F(1, 24) = 51.179, p = <.001, \eta^2 = .681$, with large effect sizes. Results were further explained by a Group by Time interaction with a large effect size $F(1, 24) = 10.498, p = .003, \eta^2 = .304$. Participants’ comfort levels changed over time but in different ways. Additional post hoc one-way ANOVAs
were used to further examine the interaction. While comfort levels in both groups increased numerically across Time, the increase was only significant for the experimental group $F(1,25) = 51.709, p = <.001, d = 2.797$. There were no statistical differences at pre-test between groups $F(1,25) = 4.868, p = .037$. Figure 13 illustrates the effect of training on comfort levels across Time and between Groups.

![Figure 13](image_url)

*Figure 13.* Mean comfort level. Error bars represent standard deviation
CHAPTER 5
DISCUSSION

The purpose of this study is to compare the effectiveness of two types of training: OLT and OLT + SCE. Knowledge acquisition, skills performance, and participant comfort levels for in-line PMSV management in persons who are TVD were compared across the two types of training.

Comparison of Knowledge Acquisition

The results of this investigation support the use of OLT to increase tracheostomy and ventilator knowledge in RT and SLP students. The findings show that interprofessional teams in both groups (control and experimental) gained equivalent knowledge across time without group differences. Pre-knowledge test scores indicated limited knowledge of salient concepts for in-line PMSV use between groups. The control group scores averaged 15 out of 30; the experimental group averaged 17 out of 30. When examining post-test scores, knowledge of salient concepts nearly doubled for the control group (26 out of 30) and for the experimental group (28 out of 30). Given that participants were able to refer to their notes from the OLT, theoretically, scores should have been higher for both groups. Nevertheless, results revealed that participation in an OLT increased participants’ ability to recall knowledge of salient concepts for using in-line PMSV with ventilators. This is consistent with the outcomes of Corbridge et al. (2010). They studied pre-post-test knowledge gains using an online training in nursing students and reported that knowledge increased with online training.

Regardless of participants’ increased ability to recall facts, without a hands-on SCE practice, participants in the current study had great difficulty applying the knowledge they gained via OLT alone to a clinical case scenario during in vivo post-testing. This finding was similar to
that of Wagner (2016). Wagner’s examination of novice graduate level speech-language pathology students who trained using video simulation made fewer correct clinical judgments during in vivo simulation case study post-testing when compared to students with salient concept knowledge. This suggests that for novice learners, foundational recall knowledge of salient concepts was critical for learning during in vivo simulation. In the current study, knowledge gains from OLT alone did not translate into clinical application during in vivo simulation post-testing. However, OLT accomplished a critical initial step in the learning process. Salient concepts were learned as a precursor to accurate praxis application in the SCE, which in turn translated into competent efficient case management during in vivo simulation post-testing.

Skills Performance

An SCE in addition to OLT improved skills performance and efficiency for students with fundamental knowledge of artificial airways. Prior to the current investigation, RT students were proficient with managing patients on ventilators but not with managing patients using in-line PMSV; SLP students were already proficient in managing PMSVs in simulated patients without ventilators. After OLT alone, neither group of interprofessional team members acquired the clinical competence to place an in-line PMSV in a simulated patient.

Given the opportunity to repeatedly practice salient skills in interprofessional teams during an SCE, participants in the experimental group developed proficiency that superseded OLT alone. All teams in the control group demonstrated the ability to deflate the cuff prior to donning the PMSV; only one of the six teams correctly identified airway obstruction and correctly judged that donning the PMSV was contraindicated. The same team was able to recognize a patent upper airway and safely don the PMSV; it took them longer to complete salient skills than teams in the experimental group. The experimental group not only increased proficiency but also efficiency for identifying an obstructed airway, a patent airway, and safely
donning the PMSV in-line. In the current study, efficiency appears to be linked to the frequency and dosage of hands-on practice during an SCE.

Current evidence suggests that efficiency increases with experience. Accurate use of a praxis skill affects the speed of its use when performing the same task clinically. Girzdas and colleagues (2007) studied clinical skills of first year and third year medical residents for surgically placing an artificial airway in a simulated patient. While all medical residents in the study were accurate and proficient in the salient skills, third year residents were significantly more efficient. Authors reported that first year residents took longer to start the procedure (8.9 minutes) than third year residents (7.36 minutes). First year residents took longer to complete the case (10.8 minutes) when compare to third year residents (8.55 minutes). Overall, findings from this study are congruent with recent research, in that more knowledge and hands-on experience contributes to skills proficiency and efficiency during a simulation experience.

Comparison of Comfort Levels

The results of this investigation confirm that simulation training improves the comfort levels of students who work with a simulated patient. Comfort levels for participants in the experimental group demonstrated significant gains in their comfort across time. Examination of comfort levels changes as a result of OLT or SCE is relatively recent. Vadnais et al. (2012) included residents and attending physicians who participated in a one day, multiple-task simulation training. Prior to simulation training, all participants attended a one-hour didactic session that dedicated approximately 15 minutes to each of the four clinical scenarios. Pre- and post-comfort scales were completed before and after simulation training. Immediately after simulation training, Vadnais et al. (2012) found that there was a statistically significant improvement in overall comfort with each subsequent simulated scenario. This improvement in
comfort may contribute to nursing students’ reports of greater satisfaction after SCE than OLT found by Corbridge et al. (2010).

In the current investigation, comfort levels also improved with SCE. In contrast to Vadnais et al. (2012) the current investigation offered only one simulated situation for participants to practice. It is possible that if participants were offered more cross training simulated scenarios, there would have been an even further increase in comfort levels for participants in the experimental group. This study offers unique evidence about the impact and effect of simulation training on comfort levels across participants who received a simulation experience and those who do not.

**Clinical Implications**

The current investigation found that OLT is an efficient and effective way to improve knowledge. Additionally, inclusion of an SCE in training proved more effective in improving skills performance, efficiency, and increasing comfort levels for managing persons who are TVD. For students who may work in a setting with persons who are TVD, this investigation contributes valuable information for future training programs. This study adds to what Ferguson (2013) found: simulation training is more effective than a more traditional form of learning.

Although the results of this study contribute greatly to simulation training, they do not suggest that participants, even in the SCE group, are competent to effectively manage live patients in a clinical setting. This is because the simulation training in the current study did not include experiences of patient anxiety and feedback or patient vitals (oxygen saturation, heart rate, and blood pressure). The SCE offered in this study was a very basic experience that gave participants practice at praxis application, but not at the sophisticated level required for adequate and safe care of live patients. The next step in following a learning hierarchy, would be to
include a higher level fidelity simulation training with a greater ability to practice praxis skills, and evaluate and analyze information from a simulation mannequin.

As persons who are TVD continue to be cared for in various medical settings, healthcare workers need to have the knowledge, expertise, and interprofessional collaboration skills to adequately care for the population. Given that RTs and SLPs represent two professions that commonly work with this population, their collaboration is critical to delivering effective patient care and success. Simulation training offers an innovative pedagogical means to accomplish this goal. It was observed during in vivo post-testing that interprofessional teams in the control group had limited communication with each other when compared to interprofessional teams in the experimental group. It was observed that teams in the experimental group more thoroughly and confidently discussed their actions with each other when compared to the control group. Being more comfortable with each other’s roles, RTs and SLPs were able to more effectively apply the skills within each of their unique professional roles to contribute to the well-being of the patient simulator. This suggests that the SCE improved interprofessional collaborative skills and awareness of cross professional roles in the management of persons who are TVD.

Currently, educators across healthcare professions struggle to provide students access to medically complex patients for training clinical skills (Polovy, 2015; Sia, Halan, Lok, & Crary, 2016). Professionals are often initially exposed to complex clinical cases after graduating from higher education programs. This study provides support for the use of simulation training to educate students on the strategies of how to manage the complex TVD population who may benefit from in-line speaking valves.
Study Limitations

There were three important limitations to the current investigation that may be used to direct future research.

1. Possible inflation of test scores.
2. Counterbalancing in vivo post-testing scenarios.
3. Impact of clinical debriefing.

The first limitation was allowing participants to use notes during knowledge and in vivo post-testing. Use of notes may have caused possible inflation of knowledge test scores and in vivo skills performance during post-testing. In contrast, comfort scale scores were not susceptible to inflation because personal comfort decisions required participants to rate their own levels of comfort prior to the investigation and after laboratory experiences and in vivo post-testing.

Second, counterbalancing of in vivo post-testing scenarios was not implemented. Perhaps if the scenarios were counterbalanced, then participants who completed the patent upper airway scenario first would have performed better on the obstructed upper airway scenario.

A third limitation to the current investigation is that the role of debriefing was not measured. It is unknown whether clinical debriefing would have further improved comfort levels and skills performance across participants. The current investigation also does not investigate the long term effects of simulation training, and the extent of generalizability to the clinical setting.
Future Research

Results of the current investigation are promising to future research and should be extended to strengthen examination the use of OLT and simulation training. Continued efforts to determine the best way to use simulation mannequins in training are needed, including measures of fidelity and number of exposures to hands-on practice. Investigating the optimal number of exposures to procedures and simulation training is needed to maximize learning and decrease stress. Schwabe, Bohringer, and Wolf (2009) concluded that stress levels can negatively impact learning and performance, which in turn impede knowledge and skills acquisition. Measurement of stress levels and anxiety may contribute to observation of the impact they have on each form of training when working with persons who are TVD. Methods for controlling for variations in testing and learning environments need to be developed in future research designs. It was observed that participants in the control group appeared to be more frustrated during in vivo post-testing. Therefore, future research should include a measurement for frustration levels and emotions between two forms of training (OLT and SCE). These measures would add to the unique findings of comfort levels in the current experiment, rounding out study of emotional impacts of learning approaches.

An additional benefit to repeated practice on patient simulators was increased efficiency secondary to praxis motor learning. Although the current investigation did not objectively track the specific number of hands-on trials it took to increase skills performance and efficiency, it appears that the repetitive practice was critical for participants to learn how, where, and when to safely don in-line speaking valves. Therefore, future research needs to monitor the frequency of practice during an SCE to determine to effects that repeated hands-on practice offers.
Future research should include a high fidelity mannequin, because it may expand learning opportunities. Use of a high-fidelity simulation mannequin offers verbal and non-verbal patient feedback and may introduce more voice associated impairments, such as voice quality as a result of intubation. However, it is recognized the use of simulation mannequins is an expensive method of training professionals. Future research may benefit most by introducing high-fidelity simulation training after participants have demonstrated competent praxis skills with a low-fidelity mannequin to follow a step-wise progression of skill development, while also controlling the emotional load for learners.

Future research needs to examine the impact that interprofessional team interaction has on skills performance. Interprofessional teams in the experimental group had additional interactions with each other during the SCE, which could have also increased skills performance and efficiency. Teams in the control group did not have the opportunity to become more comfortable with each other, which could have potentially contributed to their lower performance and comfort scores.

Future research should also include participants’ preference of training method, level of satisfaction with each form of training, and level of motivation. Additionally, future research should look into retention of skills performance gained during an SCE, knowledge retention from an OLT, and comfort levels during simulated scenarios in specific time intervals following training. Kuduvalli et al. (2008) found that simulation training significantly improved skills performance for at least 6-8 weeks following training. However, they also found that skills had diminished at 6-8 months post training, suggesting that simulation training should be repeated at 6-month intervals, or less. Skill retention is likely to diminish over time, particularly if skills are infrequently used.
Conclusions

This study confirms that OLT combined with SCE provides an effective means for initial knowledge acquisition, in vivo skills performance, and comfort levels when working with persons who are TVD. Through investigating effects of OLT and SCE, this study sheds light on effective training methodologies in several ways, which contributes to the emerging simulation training literature. This study revealed a successful training methodology for future researchers to investigate the effects of simulation training. Although the trends and findings of this study provide an initial indication of how to use training methodologies effectively, the information gained established a foundation upon which future research can build. Based on this study, simulation training is beneficial for training novel learners to manage the complex population of persons who are TVD and can benefit from in-line PMSV use.
REFERENCES


APPENDICES

APPENDIX A

APPROVED IRB SCRIPT

Dear Student,

You are being asked to take part in a research study. The purpose of the study is to develop the pedagogical approach and methodology for measuring learning outcomes for interdisciplinary simulation scenario training involving medical, nursing, respiratory, and speech-language pathology students. We hypothesize students will demonstrate performance-based mastery of technical management of mechanical airways using speaking valves. As well, they will improve their problem-based decision-making skills through development of interpersonal collaborative skills and team performance.

Before you agree, we want to share the following information with you regarding your participation:

1. The study will require you to complete pre-course testing, training, an interprofessional simulated clinical experience, a debriefing and post-course testing. Total time for these five components will take between five and nine hours. Pre-course testing prior to training will take approximately one hour. Training, your simulated clinical experience, debriefing, and post-course testing will be conducted in one day and take between four and eight hours.
2. You may experience anxiety or fatigue during this course. Levels of anxiety and fatigue are no greater than you experience with other courses.
3. As participants you will benefit from the knowledge gained in managing ventilator-dependent persons with speaking valves. Simulation clinical experience training will allow you to experience, in real-time, the consequences of your decisions and actions without risking patients’ health statuses.
4. Results from this investigation will add to the knowledge base for optimizing training for future healthcare providers who manage ventilator-dependent persons. As health care professionals increase their knowledge safe ventilator management and speaking valve use, patient safety is optimized. Effective training is critical in the process of changing health care practices. Your participation will help make improve current practices.
5. Your participation is voluntary and you may refuse or choose to stop at any time without any consequence.
6. Your identifying information will not be collected but your simulated clinical experience will be video recorded.
7. There is no cost to participate.
8. We are expecting a total of 40 participants. Ten from each discipline: medicine, nursing, cardiopulmonary rehabilitation, and speech-language pathology.

9. You must be 18 years of age to participate.

10. Overall findings will be used for publication in a peer-reviewed journal and at conference presentations but your individual scores will not be linked with your name in any way.

11. Although your rights and privacy will be maintained, the Secretary of the Department of Health and Human Services, the ETSU IRB, and the study investigators and department research staff will have access to records and video recordings.

If you agree to be in the study, the researcher must give you a copy of this form.

If you have any questions about this research study or if you feel you have been hurt because of this study, please contact Dr. Neina F. Ferguson at 423-439-4712 or Dr. Martin Eason at 423-439-8019.

If you have any questions or concerns about the research and want to talk to someone independent of the research team or you can’t reach the study staff, you may call the IRB Coordinator at the East Tennessee State University Institutional Review Board Office at 423-439-6055 or 423-439-6002.

IRB approval for this research study is on file.

By providing your name and contact information to Dr. Neina F. Ferguson, you are consenting to participate. Study staff will be in touch with you soon regarding the schedule for both sessions. Thank you.
APPENDIX B

CONTROL GROUP VIDEO LINKS

Advanced Directives:
  • https://www.youtube.com/watch?v=WUv3a3V6Rf8&feature=youtu.be

Fall Prevention:
  • https://www.youtube.com/watch?v=i2udK9Hte34&feature=youtu.be

Handwashing:
  • https://www.youtube.com/watch?v=mWe51EKbewk&feature=youtu.be

Patient Lifting Techniques:
  • https://www.youtube.com/watch?v=VaUTYwC5how&feature=youtu.be

Professionalism I:
  • https://www.youtube.com/watch?v=2PIp1MOlINg&feature=youtu.be

Professionalism II:
  • https://www.youtube.com/watch?v=G7A8Mu9-26Y&feature=youtu.be

Sterile Gloving:
  • https://www.youtube.com/watch?v=aq45N-4ozE4&feature=youtu.be

Universal Precautions:
  • https://www.youtube.com/watch?v=tUHLGwDtkmE&feature=youtu.be
APPENDIX C

KNOWLEDGE TEST

1. An advantage of tracheotomy over transoral intubation is:
   a. Easier for patient to be taken on and off the ventilator
   b. Increased patient comfort, decreased need for sedative/pain medications
   c. Decreased damage to the larynx (voice box)
   d. Decreased damage to subglottis
   e. All of the above
   f. I don’t know

2. Criteria for in-line Passy-Muir Speaking Valve is:
   a. Patient’s ventilator settings: FiO2 >60%, PEEP >10
   b. Patient's ventilator settings: FiO2 <50%, PEEP <10
   c. Both A and B are sufficient criteria
   d. I don’t know

3. A tracheotomy tube is usually inserted:
   a. Through the thyrohyoid membrane
   b. Through the cricothyroid membrane
   c. Between the vocal cords in the upper trachea
   d. Between 2nd and 3rd tracheal rings
   e. Between 4th and 5th tracheal rings
   f. I don’t know

4. An advantage of a **cuffed** tracheotomy tube over a **cuffless** tracheotomy tube is it:
   a. Permits better delivery of positive pressure ventilation
   b. Allows for better swallowing function
   c. Causes lower risk of damage to tracheal wall mucosa
   d. Allows for better voice, as patient can produce more subglottic pressure
   e. Has a lower risk of mucus plugging
   f. I don’t know

5. A female patient with a 6-0 cuffed double cannula tracheotomy tube has been weaned off the ventilator, but is unable to speak using a Passy-Muir Speaking Valve. To improve her voice, it may help to:
   a. Inflatable the cuff on the tracheostomy tube to get a better seal
   b. Change to a larger cuffed tracheotomy tube for a larger inner diameter
   c. Try using a cap instead of a Passy Muir Valve
   d. Change to a cuffless tracheotomy tube
   e. Remove the inner cannula and clean out the mucus plug
   f. I don’t know
6. An advantage of a double cannula tracheotomy tube over a single cannula tube is:
   a. Less damage to the tracheal wall mucosa
   b. Larger inner tube diameter
   c. Less likely to develop mucous plugs
   d. Improved voice
   e. The ease of clearing mucus plugs from the trach tube
   f. I don’t know

7. Two types of ventilation provided by the ventilator are:
   a. Volume and Pressure
   b. Volume and Oxygen
   c. Pressure and Oxygen
   d. Pressure and Temperature
   e. I don’t know

8. Benefits of restoring a closed system by using a Passy-Muir Speaking Valve include:
   a. Restoring positive subglottic air pressure
   b. Restoring Positive End Expiratory Pressure (PEEP)
   c. Facilitating oxygenation
   d. Having a stronger cough
   e. Ability to perform Valsalva maneuvers
   f. All of the above
   g. I don’t know

9. Cuff deflation reduces positive inspiratory pressure. Once a Passy-Muir Speaking Valve is placed with in-line ventilator circuitry, ventilator adjustments may include:
   a. Low volume and pressure alarms
   b. Fi02
   c. Increase in tidal volume
   d. Both A and C
   e. I don’t know

10. The function of this part of the tracheotomy tube is to:
    a. Remove mucus plugs clogging the trach tube
    b. Facilitate a better speaking voice in patients with a cuffed tube in place
    c. Plug the trach tube in anticipation of decannulation
    d. Connect the trach tube to the ventilator
    e. Facilitate insertion of trach tube into tracheal stoma
    f. I don’t know

11. A *contraindication* for using a foam filled cuff with a Passy-Muir Speaking Valve is:
    a. The foam will clog the speaking valve
b. There is a higher chance of a mucous plug occurring  
c. The cuff cannot be deflated  
d. I don’t know

12. When donning a Passy-Muir Speaking Valve the cuff should be:  
a. Inflated  
b. Deflated  
c. Slightly inflated  
d. Slightly deflated  
e. I don’t know

13. When determining candidacy for a Passy-Muir Speaking Valve, what is an indicator of a patent upper airway?  
a. Positive inspiratory pressure and exhale tidal volume increase by 40-50%  
b. Positive inspiratory pressure and exhaled tidal volume remains unchanged  
c. Positive inspiratory pressure and exhaled tidal volume decreases by 40-50%  
d. Positive inspiratory pressure and exhaled tidal volume does not matter when assessing airway patency  
e. I don’t know

14. When troubleshooting reasons for inability to phonate when using a Passy-Muir Speaking Valve, why might your patient lack the ability to phonate?  
a. Subglottic air pressure is <6 cm/H20  
b. Inadequate vocal fold approximation  
c. Increased subglottic air pressure  
d. Both A and B  
e. Cuffless tracheostomy tube  
f. I don’t know

15. To maximize patient communication effectiveness using an in-line Passy-Muir Speaking Valve:  
a. Remove the tracheostomy tube  
b. Increase PEEP on the ventilator  
c. Decrease volume and pressure settings on the ventilator  
d. Teach patient to coordinate phonation with expiratory phase of ventilation  
e. I don’t know
APPENDIX D

COMFORT RATING SCALE

1. I feel comfortable talking to patients and their families about tracheostomies.
   Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree   I don’t know

2. I feel comfortable talking to other team members (i.e., respiratory therapists, speech therapists, nurses, physicians) about tracheostomies.
   Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree   I don’t know

3. I feel comfortable talking to the surgical team about a tracheostomy.
   Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree   I don’t know

4. I feel comfortable assessing for an in-line Passy-Muir Speaking valve for a patient who has a tracheostomy.
   Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree   I don’t know

5. I feel comfortable managing an airway emergency in a patient who has a tracheostomy.
   Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree   I don’t know

6. I understand the indications for and the potential benefits of a tracheostomy.
   Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree   I don’t know

7. I understand anatomical changes that occur with airway anatomy as it relates to a tracheostomy.
   Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree   I don’t know

8. I am able to recognize different parts of tracheostomy tubes and distinguish between tube types.
   Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree   I don’t know

9. I understand how a Passy-Muir Speaking Valve works.
   Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree   I don’t know

10. I understand the changes of airflow in and out of the lungs after a tracheostomy.
    Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree   I don’t know
11. I am comfortable placing a Passy-Muir Speaking Valve in-line with ventilator circuitry.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree  I don’t know

12. I am comfortable determining a patent upper airway in patients with tracheostomies.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree  I don’t know

13. I am comfortable trouble shooting voice problems in patients who are wearing a Passy-Muir Speaking Valve.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree  I don’t know

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree  I don’t know

15. I feel comfortable working with patients who are tracheostomy and are ventilator dependent.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree  I don’t know
# APPENDIX E

## IN-LINE PASSY-MUIR SPEAKING VALVE SKILLS ASSESSMENT

### Video Coding: Obstructed Airway

<table>
<thead>
<tr>
<th>#</th>
<th>Y/N</th>
<th>Skills Performance</th>
<th>Timer</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td>Did the team introduce themselves?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>Did a team member state purpose for visit?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>Did a team member explain the procedure to the patient?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>Did a team member record or state baseline measurements? (Vte and PIP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>Did a team member turn off alarms? (Low pressure and low minute volume)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Was PEEP removed prior to cuff deflation?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td>Was the cuff deflated prior to donning the PMSV?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td>Did the team check for decrease in both Vte and PIP prior to donning the PMSV?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td>Did the team state whether there was airway patency or an obstruction?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td>Did the team correctly don valve or discontinue placement?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td>Did the team return vent setting back to baseline measurements before doffing PMSV?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td></td>
<td>Did team re-inflate the cuff after doffing PMSV?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td>Did the team ask the patient after donning PMSV?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td>Did team double check that volumes and pressures returned to baseline after doffing the PMSV?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>N/A</td>
<td>Did a team member accurately assess voice function accurately?</td>
<td></td>
<td>N/A</td>
</tr>
</tbody>
</table>

Total Skills Performance Score Time/Score *seconds

**Coding Instructions:**

1. Watch each video and answer yes or no to each skill numbered 1-15. Note: if the airway is obstructed, no voice assessment is possible. If answer is No, time is coded N/A.
2. Watch each video a second time and code a score using the description below.
3. Watch each video a third time and code the time in seconds for the team to initiate each skill. **Except number 10,** Code the duration time from initial touch on tubing to final release with the valve in place. **Total time: record total seconds.**

76
Score:

1 = Incomplete performance; unable to demonstrate behavior: Unsatisfactory/Fail
2 = Safe, accurate performance: Satisfactory/Pass
3 = Thorough, complete, and in-depth performance: Satisfactory/Pass

Comments/Rater:
# Video Coding: Patent Airway

<table>
<thead>
<tr>
<th>#</th>
<th>Y/N</th>
<th>Skills Performance</th>
<th>Timer</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td>Did the team introduce themselves?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>Did a team member state purpose for visit?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>Did a team member explain the procedure to the patient?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>Did a team member record or state baseline measurements? (Vte and PIP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>Did a team member turn off alarms? (Low pressure and low minute volume)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Was PEEP removed prior to cuff deflation?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td>Was the cuff deflated prior to donning the PMSV?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td>Did the team check for decrease in both Vte and PIP prior to donning the PMSV?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td>Did team state whether there was airway patency or an obstruction?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td>Did the team correctly don valve or discontinue placement?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td>Did the team return vent setting back to baseline measurements before doffing PMSV?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td></td>
<td>Did team re-inflate the cuff after doffing PMSV?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td>Did the team ask the patient how he’s feeling?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td>Did team double check that volumes and pressures returned to baseline after doffing the PMSV?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td></td>
<td>Did a team member accurately assess voice function accurately?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Skills Performance Score Time/Score** *seconds*

**Coding Instructions:**

1. Watch each video and answer yes or no to each skill numbered 1-15. Note: if the airway is obstructed, no voice assessment is possible. If answer is No, time is coded N/A.
2. Watch each video a second time and code a score using the description below.
3. Watch each video a third time and code the time in seconds for the team to initiate each skill. **Except number 10,** Code the duration time from initial touch on tubing to final release with the valve in place. **Total time: record total seconds.**

**Score:**

1 = Incomplete performance; unable to demonstrate behavior: Unsatisfactory/Fail
2 = Safe, accurate performance: Satisfactory/Pass
3 = Thorough, complete, and in-depth performance: Satisfactory/Pass

**Comments/Rater:**
APPENDIX F

CASE STUDY

Patient History:

Patient is a 28 year-old male who was involved in a motor vehicle crash 26 days ago. He was emergently intubated in the field. Injuries are significant for head trauma, multiple rib fractures, pulmonary contusion, broken right femur of the leg, broken left ulna and radius of the arm, fractured pelvis, and C-4 and C5 spinal fractures. Patient underwent multiple surgeries requiring prolonged intubation (18 days). On day 19, he received a tracheostomy. Patient currently has a Shiley, size 8 double lumen cuffed tracheostomy tube. Patient is awake and alert. He is clinically managing his secretions with minimal serous mucous production. He is able to follow simple commands and has indicated he wants to talk. He is ventilator dependent on assist control. Ventilator settings are:

RR – 14 bpm
Inspiratory Tidal Volume = 450ml
Inspiratory time 1 second
FI02 = 21%
Sensitivity – 2
PEEP = 5

His physician ordered a Passy Muir Speaking valve assessment, which includes orders to deflate the cuff on his tracheostomy tube.

Proceed with your interprofessional team assessment.
VITA

KRISTI ANN MOORE

Education:

M.S. Speech Language Pathology, East Tennessee State University, Johnson City, Tennessee 2016

B.S. Communication Disorders, Middle Tennessee State University, Murfreesboro, Tennessee 2014

Mount Juliet High School, Mount Juliet, Tennessee

Professional Experience:

Graduate Assistant, East Tennessee State University, 2014-2016

Graduate Clinician, East Tennessee State University, 2014-2016

Honors and Awards:

Inaugural College of Clinical and Rehabilitative Health Sciences Outstanding Graduate Student Award, East Tennessee State University, 2016

James H. Quillen Scholarship Recipient, East Tennessee State University, 2015-2017

Outstanding ASHA Application Funding Award, East Tennessee State University, 2015

State Knowledge Bowl Winner, Tennessee Association of Audiologists and Speech Language Pathologists, 2015

Dr. Kay Garrard Academic Leadership Award, Middle Tennessee State University, 2014