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SURVEY OF RESPIRATORY THERAPY STUDENTS' PERCEPTIONS OF APPROPRIATE VIBRATING MESH NEBULIZER PLACEMENT FOR INLINE MECHANICAL VENTILATOR CIRCUITS

Jordan Kenney

ACCEPTANCE

This thesis, SURVEY OF RESPIRATORY THERAPY STUDENTS' PERCEPTIONS OF APPROPRIATE VIBRATING MESH NEBULIZER PLACEMENT FOR INLINE MECHANICAL VENTILATOR CIRCUITS, by Jordan Kenney, BSHS, was prepared under the direction of the Master Thesis Advisory Committee of the Respiratory Therapy department at Georgia State University. It is accepted by the committee in partial fulfillment of requirements for the Master of Science degree with a concentration in Respiratory Therapy at Byrdine F. Lewis College of Nursing and Health Professions, Georgia State University.

The Master Thesis Advisory Committee, as representatives of the faculty, certifies that this thesis has met all standards of excellence and scholarship as determined by the faculty.

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DEDICATION

I would like to thank those that have supported me while I strive to accomplish higher education. I thank my parents who not only inspired my effort to become a respiratory therapist but also provided for me all the while. They have been there for me, encouraging me, supporting me, every step of the way. I am grateful for my sister, who has assured my emotional wellness and provided the space to feel rested. I have been guided by my professors, who have been endlessly patient and kind throughout this process. Thank you to all who have had a piece in supporting me all this way.

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By

Jordan Kenney, BSHS

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Under the supervision of Dr. Douglas S. Gardenhire

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(Under the supervision of Dr. Douglas S. Gardenhire)

ABSTRACT

BACKGROUND: Perceptions of Respiratory Therapists (RTs) pertaining to the appropriate location of vibrating mesh nebulizer placement are an understudied subject that has the potential to shape training methods and improve the execution of research-based practice methods.

METHODS: This study consisted of a convenience sample and an online survey that was electronically distributed to all students currently enrolled in the respiratory therapy program at Georgia State University. The questionnaire consisted of demographic factors, perception of nebulizer placement questions, and a rating question to determine how students gained their knowledge.

RESULTS: The sample included 34 (47.9%) 1st year Baccalaureate students, 15 (21.1%) 2nd year Baccalaureate students, 8 (11.3%) 1st year integrated Masters students, 4 (5.6%) 2nd year integrated Masters students, 2 (2.8%) 1st year traditional Masters students, and 7 (9.9%) 2nd year traditional Masters students, totaling 71 participants (n=1 survey incomplete). Among those who completed the study 62.0% were female, 59.2% were first-year students, 26.8% were second-year students, and

12.7% were traditional Master students. Of all the participants, 71.8% have no work experience, 16.9% have experience as a paid RT technician, and 9.9% have experience as a Certified Respiratory Therapist (CRT) or Registered Respiratory Therapist (RRT). The responses to the nebulizer placement questions were categorized into 3 categories: correct according to research, somewhat correct, and incorrect. Total scores were computed for each individual according to their responses (2 points for correct responses, 1 point for partially correct, and 0 points for incorrect). The total mean score is 3.25 (standard deviation=1.26), with only 2.8% of students receiving a perfect score. Statistically significant differences were found between student position and total scores, with 2nd year students scoring the highest (mean= 3.83, standard deviation= 1.20, F= 4.94, p= 0.010).

CONCLUSIONS: This study suggests that 2nd year students will most appropriately place a vibrating mesh nebulizer in a mechanical ventilation circuit when compared to 1st year students and traditional Master students. This finding supports the idea that 2nd year students are the most up-to-date with current research involving vibrating mesh nebulizer placement. This can be explained by the limited knowledge of first-year students, and outmoded knowledge of traditional master students.

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CHAPTER I

INTRODUCTION

The field of respiratory therapy is a relatively new platform in the healthcare industry. For a frame of reference, the first foundation for nursing was in 1911 by the American nursing foundation. Respiratory therapy (RT) was officially founded many years later as the Inhalation Therapy Association in 1947 (*Timeline and History of Respiratory Therapy*, n.d.). At this time therapists had different qualifications and job descriptions as compared to today. RTs were responsible for distributing oxygen tanks and setting up oxygen tents, masks, and nasal catheters (Dunne, 2017). As treatment techniques developed into modern practice, RT qualifications also became more profound and specialized. By 1960, the American Registry of Inhalation Therapists, which is now the American Association for Respiratory Care (AARC), distributed the first registry exam (*Timeline and History of Respiratory Therapy*, n.d.). The National Board for Respiratory Care (NBRC) was founded in 1974 after the merge of the certification board and the American Registry of Inhalation Therapists (Dunne, 2017). The education and training requirements of the profession continue to expand along with the initiation of more advanced equipment and procedures.

The methods of education have respectively matured along with the establishment of the AARC, the NBRC, and the Committee on Accreditation for Respiratory Care (CoARC) (Dunne, 2017). What began as on the job training has now developed into professional associates, baccalaureate, and masters degrees. According to the 2017 Report on Accreditation in Respiratory Care, there are 370 associate programs, 67 baccalaureate programs, and 6 graduate-level programs in the United

States (*2017 Report on Accreditation in Respiratory Care Education*, 2018). These programs show that education for respiratory care is still growing. With that in mind, it is vital to the functional practice of RTs to continue the educational opportunities beyond the collegiate setting and into conductive research (Dunne, 2017). While it is also a requirement of the NBRC and AARC to maintain licensure, certified continuing education units (CEU) are helpful for therapists to stay up to date with the latest research and newest technology (*FAQs for Earning and Reporting CRCEs*, n.d.). In regards to the performing research, respiratory therapy still has progress to make.

Vibrating mesh nebulizer are growing in popularity enough so that the mechanical ventilator manufacturers are including vibrating mesh nebulizer technology in the machine (Dhand, 2002). Some examples are Hamilton SI and GI as well as the Maquet Servo-i. Some facilities still use the jet nebulizer due to its low cost and familiarity. The vibrating mesh nebulizer is a better choice in regard to drug delivery mainly due to the small particle size achieved and the minimal residual volume after a nebulization period ends (Dhand, 2002). Pressurized metered dose inhalers (pMDI) are falling out of popularity as a common method of aerosol treatment delivery as a larger variety of drugs can be delivered through a vibrating mesh nebulizer (Ehrmann et al., 2016). Some examples include bronchodilators, prostaglandins, surfactants, and antibiotics. The impact that efficient drug delivery has for mechanically ventilated patients include the ability to decrease the work of breathing, enhance mucociliary clearance, and quicken the recovery of acute respiratory distress syndrome (McAuley et al., 2004). It is still unclear whether aerosol therapy has an impact on ventilator days, days in the intensive care unit, or reducing mortality for all patients as a whole. For

patients with chronic obstructive pulmonary disorder, research shows that clinical outcomes are improved with the use of aerosol therapy (Dhand, 2017).

Respiratory therapy research involves general bench research (i.e., for aerosol therapy), efficacy studies for various respiratory therapies and critical care therapeutics, and evaluation of the implementation of evidence-based practices by RTs. There is a particular research gap in evaluating RTs' implementation of best practices and the latest research, especially about aerosol therapy placement in mechanical ventilation. There is a particular deficit in survey studies relating to RT perceptions (Armaghan et al., 2020). The most common survey studies are those that focus on medical errors or job satisfaction for nurses and other healthcare workers (Abbasi et al., 2019; Baldwin DC Jr. & Daugherty SR, 2008). The literature is limited when it comes to RT perceptions concerning common practices (Armaghan et al., 2020). Studies demonstrated no measure of whether the discoveries made in vitro and in vivo studies are being adopted by RTs. A survey study of RT perceptions regarding the application of evidence-based practices dealing with inline nebulizer placement on a mechanical ventilator circuit could provide insight into the strengths and weaknesses in the execution of common practices.

Statement of Problem

There is a lack of research on whether RTs understand the purpose and mechanism of proper placement of an inline nebulizer for a patient receiving invasive mechanical ventilation.

Purpose of Study

The purpose of this study is to assess the perceptions of RT students, including Baccalaureate and Masters students, on topics concerning the placement of an inline nebulizer on an invasive mechanical ventilation circuit.

Research Questions

1. Where do RTs perceive is the most appropriate placement of a vibrating mesh nebulizer on an invasive mechanical ventilation circuit?
2. Is there an association between accurate knowledge of proper nebulizer placement and individual research, required CEUs, and/or on the job training?
3. Are RT perceptions of inline nebulizer placement consistent with studies and evidence-based practice recommendations?
4. What demographic factors (i.e., level of education, employment history) impact the RTs perceptions and how they perceive current practice for nebulizer placement?

Significance

There is limited literature regarding RTs perceptions in this area of research. This study may demonstrate the need for increased instruction post-graduation (Martins, 2013).

Definition of Terms

RT	Respiratory Therapist
AARC	American Association for Respiratory Care
NBRC	National Board for Respiratory Care
CoARC	Committee on Accreditation for Respiratory Care
CEU	Continued Education Units
IMV	Invasive Mechanical Ventilation
FiO2	Fraction of Inspire Oxygen
HME	Heat and Moisture Exchanger
HH	Heat and Humidifier
VMN	Vibrating Mesh Nebulizer

Assumptions

1. RT students are familiar with basic mechanical ventilator set up.
2. RT students are familiar with basic aerosol set up.

Summary

The respiratory care profession continues to evolve. Ongoing research is necessary to grow any occupation in the medical field. The evidence-based practice could impact current practices positively. The review of RT perceptions could provide insight into what limitations may be present in the scope of practice in respiratory therapy.

CHAPTER II

REVIEW OF LITERATURE

The review of the literature provides a comprehensive knowledge of all data involved in the studies conducted by other researchers to establish an evident, solid foundation regarding the mechanical ventilation, effect and set up of aerosol attachments, and healthcare perceptions. The literature review's ultimate purpose is to clarify the topic from different aspects, show the conflicting viewpoints on the topic, and find the gap of evidence that indicates the necessity of the current study. The databases used to review the literature include Google Scholar, PubMed, EBSCOhost, and CINHALL.

Mechanical Ventilation

Many patients may require ventilatory support at varying levels. Invasive Mechanical Ventilation (IMV) is an intervention that consists of using positive pressure ventilation to inflate the lungs through an artificial airway. IMV for non-spontaneously breathing patients is primarily provided in volume control mode or pressure control mode. Volume control ensures that a certain amount of volume will be delivered with each breath at a certain respiratory rate. Pressure control ensures that a certain pressure will be reached on each inspiration at a set respiratory rate. One mode called pressure regulated volume control is considered a blend of volume control and pressure control. Here, one would set a target tidal volume which may fluctuate from breath to breath depending on the lung compliance and resistance all while assuring safe pressures in the lung tissue. Other modes such as synchronized intermittent mandatory

ventilation and pressure support are weaning modes meant for spontaneously breathing patients. All devices provide a certain fraction of inspired oxygen (FiO2) and a specific amount of flow which can be catered to the patient's needs.

The focus of this paper will involve IMV and the modalities and adjunct therapies associated with its' use. The indications for invasive ventilation include acute respiratory failure, inability to protect the airway, and hemodynamic instability. The table below displays measures of ventilatory efficiency and oxygenation parameters. A critical value for ventilation determines the need for ventilatory support whereas a critical value determines the need for oxygen therapy. The ventilatory mechanics portion indicates where a patient may need ventilatory support.

Table 1: Indications for Ventilatory Support

Measurement	Normal	Critical Value
Ventilation		
pH	7.35 – 7.45	< 7.25
P_aCO_2 (mm Hg)	35 – 45	> 55 and rising
V_D / V_T	0.3 – 0.4	> 0.6
Oxygenation		
P_aO_2 (mm Hg)	80 – 100	< 70
$P_{(A-a)}O_2$ (mm Hg)	5 – 20	> 450
P_aO_2 / P_AO_2	0.75	< 0.15
P_aO_2 / F_iO_2	475	< 200
Ventilatory Mechanics		

Maximum Inspiratory Pressure (cm H_2O)	-100 to -5	-20 to 0
Maximum Expiratory Pressure (cm H_2O)	100	< 40
Vital Capacity (mL/kg)	65 – 75	< 10 – 5
Tidal Volume (mL/kg)	5 – 8	< 5
Respiratory Frequency (breaths/min)	12 – 20	> 35
Forced expired Volume at 1 sec (mL/kg)	50 – 60	< 10
Peak Expiratory Flow (L/min)	350 – 600	75 – 100

Heat and Humidification

The respiratory therapist is responsible for maintenance of the airway. This entails delivering aerosolized medication, airway clearance, assurance of acceptable heat and humidity, and manipulation of the ventilator settings to assist with overall care and recovery. Normal spontaneous inspiration through the nares will accomplish a certain level of filtration, warming, and humidification of the air before it reaches the lower respiratory tract. The upper airway consists of the nostrils, conchae, oral cavity, and pharynx. In normal healthy conditions the upper airway, specifically, the nose can heat inspired gases to body temperature and humidify inspired gases to approximately 80% relative humidity (Restropo, 2012). While a patient is receiving IMV, the upper airway is bypassed meaning that they cannot heat and humidify each breath on

inspiration. Supplying sufficient heat and humidification is essential for proper care of the lung tissue. There are two central methods of supplying heat and humification: heat-moisture exchanger (HME) and active humidification via a wick style or pass-over device called heated humidification (HH). The correct placement for a small volume nebulizer on these two systems is very different.

Placement of Small Volume Nebulizer

It is known that aerosol delivery is affected by the aerodynamic, pharmacokinetic, and pharmacodynamic properties of a drug, and the nebulizer type as well as other factors regarding ventilator set up (Miller et al., 2003; Hughes, 1987; O'doherty et al., 1992). These factors include but are not limited to the presence of a heat and humidification device, nebulizer placement in the circuit, and ventilator settings (Ari, 2016). For this study, we will be focused on the placement of vibrating mesh nebulizers (VMN) in the two circuits.

HME's are known good alternatives to heater and humidifier devices when the upper airway is being bypassed if it is not contraindicated for use (Restrepo, 2012). Studies recommend a practitioner should not place the HME between the ETT and the nebulizer (excluding the ThermoFlo non-filter HME) (Ari et al., 2018). When the HME is improperly placed, low drug delivery will result (absorbed by the HME) which will increase the resistance to flow and aerosol in the HME. The use of an HME inline on a ventilator circuit adds more weight to the end of the ETT tube, but the emphasis remains on drug delivery for this circuit setup. Some commercially available HMEs (Airlife HME) have an aerosol setting and an HME setting. These devices are intended

to decrease resistance from the exhaled aerosol as opposed to traditional HMEs. HMEs with aerosol adaptors should be placed between the ETT and the wye-piece and the VMN should be placed on the inspiratory limb. This will keep dead space minimal and deliver aerosolized medication on inspiration which will increase drug delivery. Studies suggest practitioners should be cautious when using this device to ensure that the device is in the proper setting for aerosol delivery and promptly changed to HME when the aerosol treatment is over (Ari et al., 2018).

When using a heat and humidifying system, the vibrating mesh nebulizer is shown to increase drug delivery when the nebulizer is placed before the heater (proximal to the ventilator). Studies suggest the inspiratory limb served as a reservoir for aerosolized medication, and the placement of the VMN closer to the heater removed bulk weight from the endotracheal tube. This is more concerning for pediatric patients, but also valid for adult patients where a kink in the tube is a possible complication. The aerosol generator was removed from any possible contamination from the endotracheal tube or the patient when placed proximal to the ventilator, and rainout deposited in the tubing was reduced (deposited in the heater and humidifier). This drastically reduced the risk of occlusion (Ari et al. 2010).

Healthcare Professionals' Perceptions

There is an overall lack of research involving respiratory therapists' perceptions regarding aerosolized medication placement during mechanical ventilation. This alone suggests that there is a need for more studies incorporating the opinions, ideas, and understandings of the daily practices of respiratory therapists. While this study focuses

on assessing student perceptions, the researcher can still apply some of the findings to the clinical setting. The overall findings report that evidence-based practices and perception of practices do not coincide.

A study conducted by Martins and Kenaszchuk aimed to quantify RTs attitudes towards research and possible barriers to performing research. The survey found that the majority of respondents would participate in conducting research if the most common barriers were removed. RTs claimed that lack of time was their most impendent barrier. Many therapists reported requiring increased exposure to research while in training and increased support from mentors and research staff (Martins & Kenaszchuk, 2013). One other survey study conducted in North Carolina took into consideration RTs perceptions on intubation practices. This study encouraged RT participation and was clinically relevant to the field. (Miller et al., 2020). There is relatively no research conducted regarding RT or RT students' perceptions and practices on nebulizer placement in conjunction with IMV.

CHAPTER III

METHODOLOGY

In this study, the researcher investigated respiratory therapy students' perceptions of nebulizer placement for invasive mechanical ventilation and their understanding of appropriate nebulizer placement. This study was accomplished through the use of a convenience sample and an online survey that was emailed to all students currently enrolled in the respiratory therapy. Members of the thesis committee have met and approved all elements of the survey tool. The researcher has utilized an online survey platform called Qualtrics to deliver the survey to prospective participants. This chapter illustrates the methods and procedures to be used in the conduction of this study.

Research Questions

1. Where do RT students perceive is the most appropriate placement of a vibrating mesh nebulizer on an invasive mechanical ventilation circuit?
2. Is there an association between accurate knowledge of proper nebulizer placement and individual research, required CEUs, and/or on the job training?
3. Are RT student perceptions of inline nebulizer placement consistent with studies and evidence-based practice recommendations?
4. What demographic factors (i.e., level of education, employment history) impact the RT student perceptions and how they perceive current practice for nebulizer placement?

Instrumentation

This study will create a survey to assess RT perceptions. The survey was reviewed by the committee to be valid and reliable. The survey contains multiple-choice questions and scale questions.

To test the tool's content validity, a group of respiratory therapy education specialists composed of the director of clinical education, one assistant clinical professor, and one clinical associate professor tested the validity to ensure the degree the instrument was able to measure what it purported to measure. Likewise, the researcher cautiously evaluated the study's instrument and recommended any need for modifications regarding the words, format, and content used. Meanwhile, the committee members also evaluated and discussed all survey questions. A copy of the survey can be found in appendix A.

Study Design

The most popular type of descriptive study is delivered via survey. Surveys can be distributed in a variety of methods: postal, telephone, personal, or electronic. Common disadvantages of the electronic survey method are non-response and limited accessibility for some participants. On the other hand, electronic surveys tend to reach a larger target population, may contain visual aids, may result in a faster response time, and streamlined data compilation (Jones et al., 2013). The benefits and structure of the online survey is the best option for the distribution and the design of this study.

Data Collection and Analysis

Georgia State University Institutional Review Board approved this study. The questionnaire was written by the researcher with the aid and approval of the committee. It was used to gather data and to serve as this study's research instrument. The survey was then disseminated to students currently enrolled in the respiratory therapy program at Georgia State University.

The latest version of *Statistical Package for the Social Sciences* (SPSS version 27) was used to analyze descriptive statistics of the collected data. The frequency, percentage, and standard deviation were analyzed to help determine the differences in the ranking perceptions of the participants' responses. Scores were categorized into incorrect responses, partially incorrext responses, and correct responses. Correct responses received a score of 2, partially incorrect responses received a score of 1, and incorrect responses received a score of 0. One was ANOVA's were used to assess differences un the score between the RT students enrolled in different programs and experience level.

Sample

The study sample consisted of a convenience sample of RT students currently enrolled in the respiratory therapy program at Georgia State University. Subjects were selected based on their availability. More importantly, all participants were given a cover letter that had informed them about the specifics and purpose of the present study, as well as ensured their confidentiality. A list of all the students currently enrolled in the RT

program at Georgia State University and their emails was compiled by the thesis committee chairperson and utilized for the distribution of the survey.

Development of Cover Letter

The researcher developed the cover letter after examining different styles and examples of similar surveys published previously. The final cover letter and a follow-up email can be found in Appendixes B and C.

CHAPTER IV

DATA ANALYSIS

The goal of this study was to identify RT students' perceptions and what influences exist for correct nebulizer placement. The results of the data analysis are presented in this chapter alongside demographic information of the participants. The latest version of *Statistical Package for the Social Sciences* (SPSS) was used to analyze descriptive statistics of the collected data.

Demographic Data

The electronic questionnaire was distributed to 110 participants. 71 participant responded by completing the survey resulting in a 64.5% response rate. The sample included 34 (47.9%) 1st year Baccalaureate students, 15 (21.1%) 2nd year Baccalaureate students, 8 (11.3%) 1st year integrated Masters students, 4 (5.6%) 2nd year integrated Masters students, 2 (2.8%) 1st year traditional Masters students, and 7 (9.9%) 2nd year traditional Masters students, totaling 71 participants (n=1 survey incomplete). Among those who completed the study 62.0% were female, 59.2% were first-year students, 26.8% were second-year students, and 12.7% were traditional Masters students. Of the 23 masters students who completed the survey, 20 (87%) completed their undergraduate degree in the United States of America, while 3 (13%) completed their undergraduate degree in a country other than the United States. Of all the participants, 71.8% have no work experience, 16.9% have experience as a paid RT technician, and 9.9% have experience as a Certified Respiratory Therapist (CRT) or

Registered Respiratory Therapist (RRT). Utilize Table 2: Demographic Data as a visual aid.

Table 2: Demographic Data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1st year Baccalaureate student	34	47.9	48.6	48.6
	2nd year Baccalaureate student	15	21.1	21.4	70.0
	1st year Integrated Masters student	8	11.3	11.4	81.4
	2nd year Integrated Masters student	4	5.6	5.7	87.1
	1st year Traditional Masters student	2	2.8	2.9	90.0
	2nd year Traditional Masters student	7	9.9	10.0	100.0
	Total	70	98.6	100.0	
Missing	System	1	1.4		
Total		71	100.0		

Perception Questions

Due to the limitation that our sample size was small, the groups of students had to be collapsed into three groups. The 1st year Baccalaureate and 1st year Masters students were combined to make up a group of 1st year students. The 2nd year Baccalaureate and 2nd year Masters students were combined to make up a group of 2nd year students. The 1st year traditional Masters students and 2nd year Masters students were combined to make up a group of traditional masters students. This helped achieve the ability to run a larger variety of statistical analyses such as the one way ANOVA. The responses to the nebulizer placement questions were categorized into 3 categories:

correct according to research, somewhat correct, and incorrect. Total scores were computed for each individual according to their responses (2 points for correct responses, 1 point for partially correct, and 0 points for incorrect). The total mean score is 3.25 (standard deviation=1.26), with only 2.8% of students receiving a perfect score. Statistically significant differences were found between student position and total scores, with 2nd year students scoring the highest (mean= 3.83, standard deviation= 1.20, F= 4.94, p= 0.010).

Traditional HME

Reference Table 2: Traditional HME Question Results as a visual aid for the following analyses. Beginning with first-year students, 14 (34.1%) answered the question with an incorrect response, 5 (12.2%) with a partially incorrect response, and 22 (53.7%) with a correct response. Of the second-year students, 7 (36.8%) answered the question with an incorrect response, 0 (0.0%) with a partially incorrect response, and 12 (63.2%) with a correct response. Of the traditional masters students, 1 (11.1%) answered the question with an incorrect response, 1 (11.1%) with a partially incorrect response, and 7 (77.8%) with a correct response. Comprehensibly, 31% responded to the Traditional HME question incorrectly, 8.5% got it partially correct, 59.2% responded with the correct answer.

Table 3: Traditional HME Question Results

		StudentPosition			
		1st year students	2nd year students	traditional students	Total
RegularHME	incorrect	14	7	1	22
	partially correct	5	0	1	6
	correct	22	12	7	41
Total		41	19	9	69

Converting HME

Reference Table 3: Converting HME Question Results as a visual aid for the following analyses. Beginning with first-year students, 15 (35.7%) answered the question with an incorrect response, 22 (52.4%) with a partially incorrect response, and 5 (11.9%) with a correct response. Of the second-year students, 1 (5.6%) answered the question with an incorrect response, 13 (72.2%) with a partially incorrect response, and 4 (22.2%) with a correct response. Of the traditional masters students, 4 (44.4%) answered the question with an incorrect response, 3 (33.3%) with a partially incorrect response, and 2 (22.2%) with a correct response. Of the participants that completed the survey, 29.6% responded to the Converting HME question incorrectly, 53.5% got it partially correct, 15.5% responded with the correct answer.

Table 4: Converting HME Question Results

		StudentPosition			
		1st year students	2nd year students	traditional students	Total
ConvertingHME	incorrect	15	1	4	20
	partial incorrect	22	13	3	38
	correct	5	4	2	11
Total		42	18	9	69

Heater And Humidifier System

Reference Table 4: Heater and Humidifier System Question Results as a visual aid for the following analyses. Beginning with first-year students, 9 (22.0%) answered the question with an incorrect response, 28 (68.3%) with a partially incorrect response, and 4 (9.7%) with a correct response. Of the second-year students, 0 (0.0%) answered the question with an incorrect response, 13 (68.4%) with a partially incorrect response, and 6 (31.6%) with a correct response. Of the traditional masters students, 4 (44.4%) answered the question with an incorrect response, 3 (33.3%) with a partially incorrect response, and 2 (22.2%) with a correct response. Of the participants that completed the survey, 14.1% responded to the Heater and Humidifier System question incorrectly, 64.8% got it partially correct, 19.7% responded with the correct answer. Using the Fisher test, there is a significant difference between student position and responses with the heater/humidifier system.

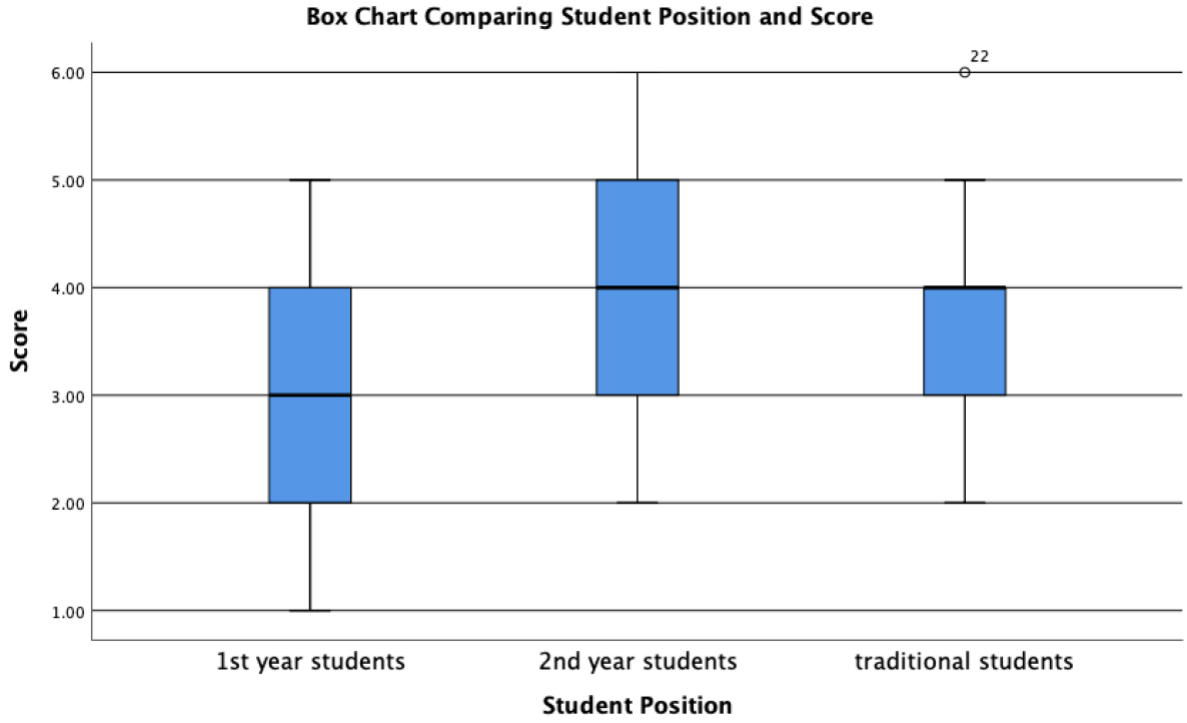
Table 5: Heater and Humidifier System Question Results

		StudentPosition			
		1st year students	2nd year students	traditional students	Total
Heater	incorrect	9	0	1	10
	partially incorrect	28	13	4	45
	correct	4	6	4	14
Total		41	19	9	69

Comparison of Student Position and Score

The responses to the nebulizer placement questions were categorized into 3 categories: correct according to research, somewhat correct, and incorrect. Total scores were computed for each individual according to their responses (2 points for correct responses, 1 point for partially correct, and 0 points for incorrect). The total mean score is 3.25 (standard deviation=1.26), with only 2.8% of students receiving a perfect score. Statistically significant differences were found between student position and total scores, with 2nd year students scoring the highest (mean= 3.83, standard deviation= 1.20, F= 4.94, p= 0.010). Please reference Figure 4: Comparison of Student Position and Score.

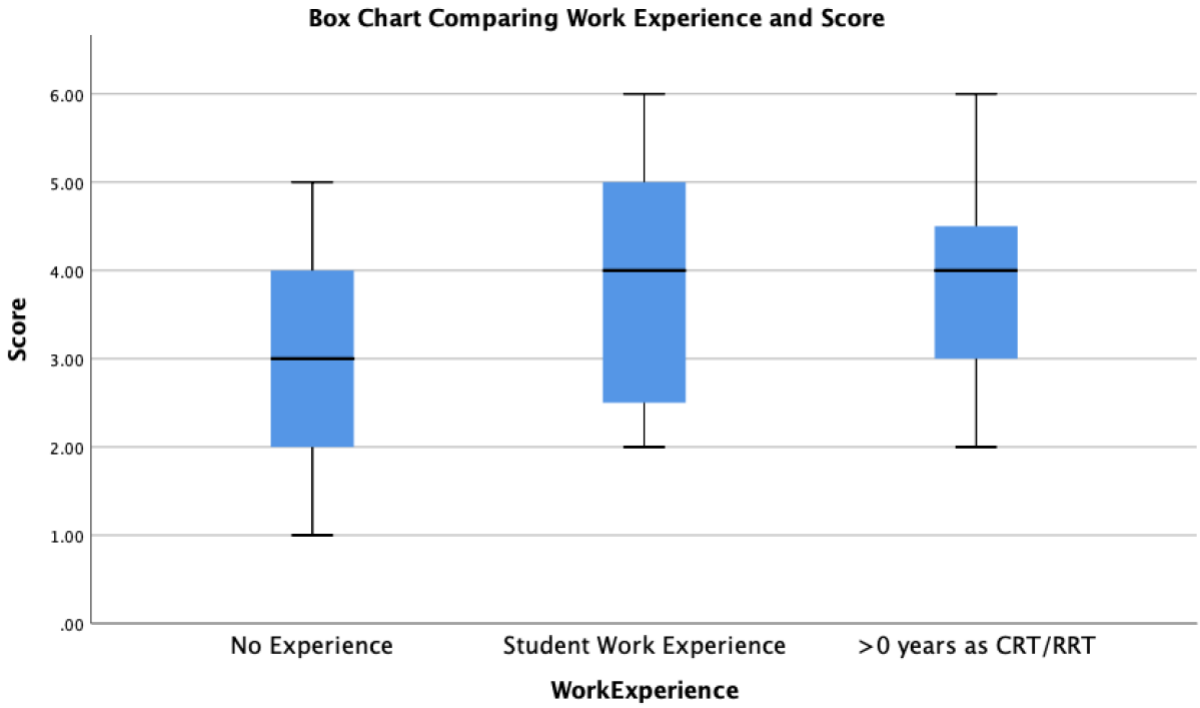
Figure 4: Comparison of Student Position and Score



Comparison of Work Experience and Score

It is notable to look at the differences found between work experience and score. A total of 48 participants responded having no paid experience in a student or certified/registered RT position and scored the lowest of the three groups (mean= 3.02, standard deviation= 1.19). 12 respondents who had experience in a student position scored higher than those with no experience but very similar to students with certified/registered RT experience (mean= 3.75, standard deviation= 1.36). Of the participants, 7 students had experience in a certified/registered RT position, and score the highest of the three groups (mean= 3.86, standard deviation= 1.34). Utilize Figure 5: Comparison of Work Experience and Score as a visual aid.

Figure 5: Comparison of Work Experience and Score



CHAPTER V

DISCUSSION

This study suggests that 2nd year students will most appropriately place a vibrating mesh nebulizer in a mechanical ventilation circuit when compared to 1st year students and traditional master students. This finding supports the idea that 2nd year students are the most up-to-date with current research involving vibrating mesh nebulizer placement. This can be explained by the limited knowledge of first-year students, and outmoded knowledge of traditional master students.

When comparing work experience and score, the study suggests that students who have experience as a paid student RT technician or as a certified/registered RT have a higher likelihood to appropriately place a vibrating mesh nebulizer in a mechanical ventilator circuit. The finding supports the idea that work experience increases the knowledge obtained and retained by RT students.

The responses to the nebulizer placement questions were categorized into 3 categories: correct according to research, somewhat correct, and incorrect. Total scores were computed for each individual according to their responses (2 points for correct responses, 1 point for partially correct, and 0 points for incorrect). For the question pertaining to a traditional HME, Position 2 (between the Suction Ballard and the HME) was coded to award two points. Any point proximal to the ventilator on this circuit would have caused the HME to become saturated with aerosol thus diminishing drug deposition (Ari et al., 2010). For the question pertaining to a converting HME, Position 4 (30 cm distal from the Wye-piece on the Inspiratory Limb) was coded to award two points. This is the ideal position with the converting HME because the reservoir is

maximized and rainout is limited (Ari et al., 2010). For the question pertaining to a heated and humidified system Position 6 (at the Heater/Humidifier proximal to the Ventilator) is the best location for a vibrating mesh nebulizer. This response was coded to award two points. This position is ideal for vibrating mesh nebulizer placement as studies show it will not contribute to rainout and one has the most reservoir while maintain optimal drug delivery to the lungs (Ari et al., 2010).

Respondents reported that they slightly agreed to their knowledge originating from school work. Respondents reported that they did not agree nor disagree (neutral) to their knowledge originating from reading research material. Respondents reported that they agreed to their knowledge originating from on-the-job training.

Limitations

Limitations existed for this study. One limitation was our small sample size. As previously mentioned, groups had to be combined and collapsed in order to qualify for certain statistical analyses. Another limitation is that the duration of the study was short. Students had two weeks to complete the survey. It is likely that a larger participation rate would have been achieved if the duration was longer.

Recommendations

In regards to future research on this topic, the recommendation is to seek a larger sample of participants. One can send the survey to multiple schools or expand the survey to include practicing respiratory therapists from the clinical setting.

Conclusion

With the findings from this study and other studies as a whole, there is still quite a disconnect between perceived knowledge and actual evidence-based practice. In a survey study conducted by Melnyk et al., respondents believed that clinical outcomes were improved by evidence-based practice, but that their knowledge of such practices did not correspond (Melnyk et al., 2004). This study made attempts to identify barriers which prevented healthcare providers from adopting evidence-based practice. The most common barriers were lack of time and lack of resources. Certain barriers were identified specifically for collecting date and performing research in the clinical setting. The most common barrier was lack of resources and the second most common was lack of support or resistance from nursing and clinical staff. The need for intervention to increase evidence-based practice exists in many branches of healthcare. Some suggestions to improve the use of evidence-based practices include increasing the number of mentors and increasing the requirement for continuing education courses.

APPENDIX A: SURVEY QUESTIONNAIRE

Select the best answer.

1. How old are you in years?
2. How do you identify?
    a. Female
    b. Male
3. What is your current position in the Respiratory Therapy Program at GSU?
    a. 1st year Baccalaureate student
    b. 2nd year Baccalaureate student
    c. 1st year Integrated Masters student
    d. 2nd year Integrated Masters student
    e. 1st year Traditional Masters student
    f. 2nd year Traditional Masters student
4. If you are a Master degree-seeking student, where did you earn your Baccalaureate degree?
    a. USA
    b. Other country outside the USA
5. Do you hold one of the following National Board of Respiratory Care Credentials? Select all that apply.
    a. CRT
    b. RRT
    c. NPS
    d. ACCS

e. CPFT

f. RPFT

6. Select the statement that best describes your work experience in respiratory therapy.

    a. I have no experience in a paid certified/registered respiratory therapist position

    b. I have experience as a paid student respiratory therapy technician

    c. I have 0-1 years of experience as a certified/registered respiratory therapist

    d. I have 2-3 years of experience as a certified/registered respiratory therapist

    e. I have 3 or more years of experience as a certified/registered respiratory therapist

7. How many semesters of respiratory therapy clinical practice in a hospital setting have you participated in as a student?

    a. 1 semester

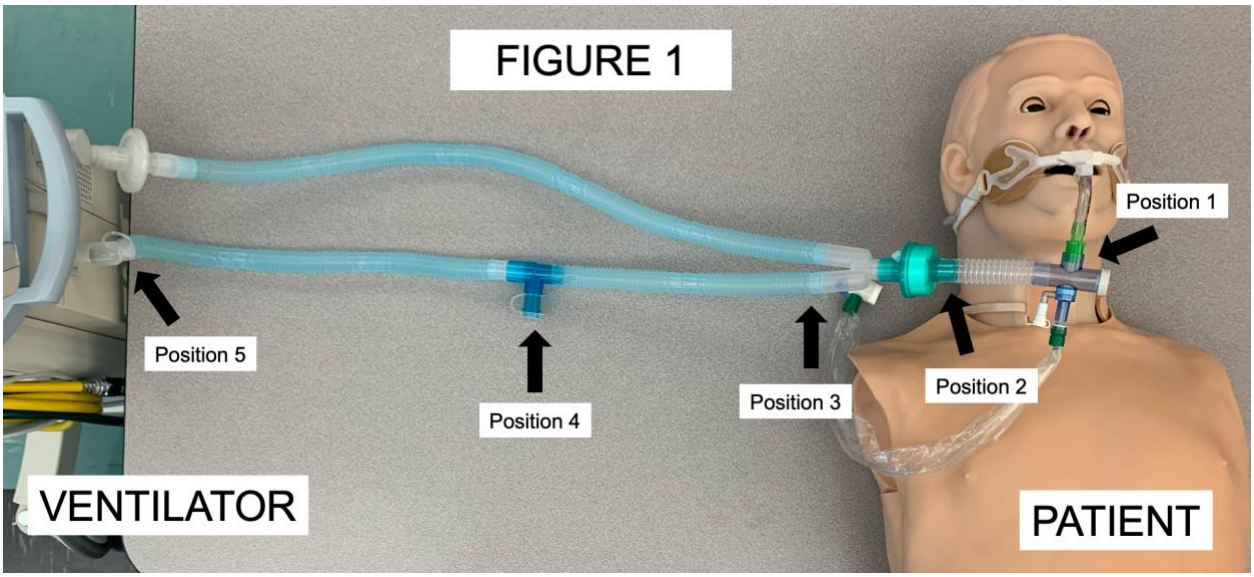
    b. 2 semesters

    c. 3 semesters

    d. 4 semesters

    e. 5 semesters or more

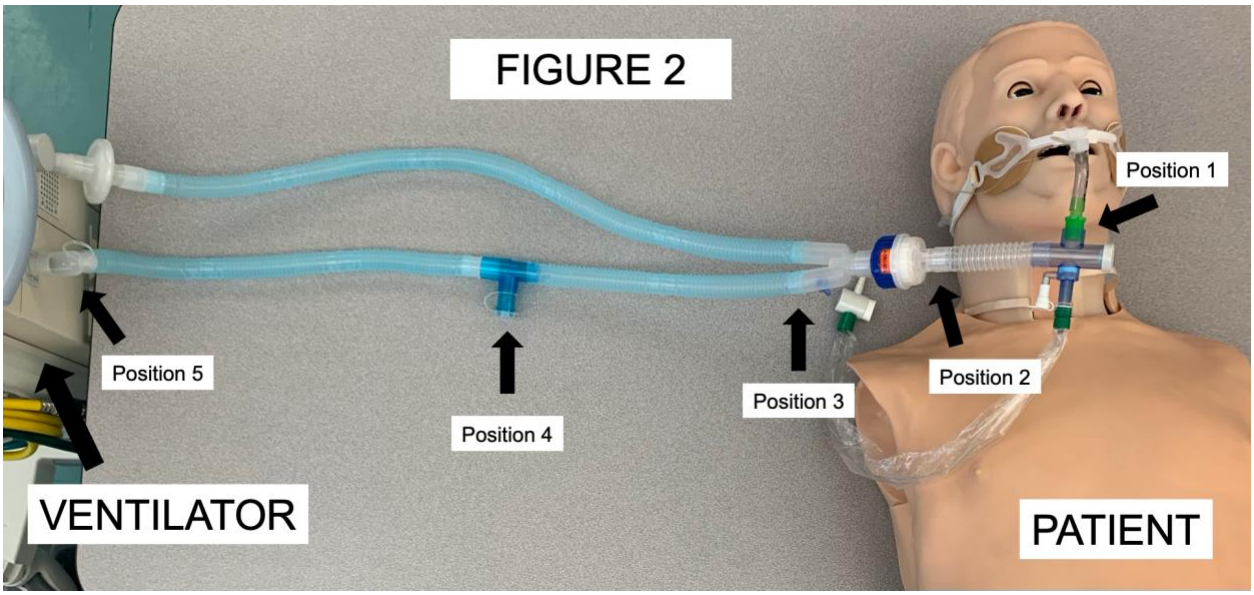
8. From your experience, where would you place a vibrating mesh nebulizer on an invasive mechanical ventilation circuit utilizing a traditional HME? Please reference Figure 1: Invasive Mechanical Ventilation Circuit with traditional HME.



Kenney, Jordan (Photographer). (2021, February 10). *Figure 1: Invasive Mechanical Ventilation Circuit with traditional HME.*

a. Position 1 (between the ETT and the Suction Ballard)
b. Position 2 (between the Suction Ballard and the HME)
c. Position 3 (between the Wye-piece and the Inspiratory Limb)
d. Position 4 (30 cm distal from the Wye-piece on the Inspiratory Limb)
e. Position 5 (at the ventilator)

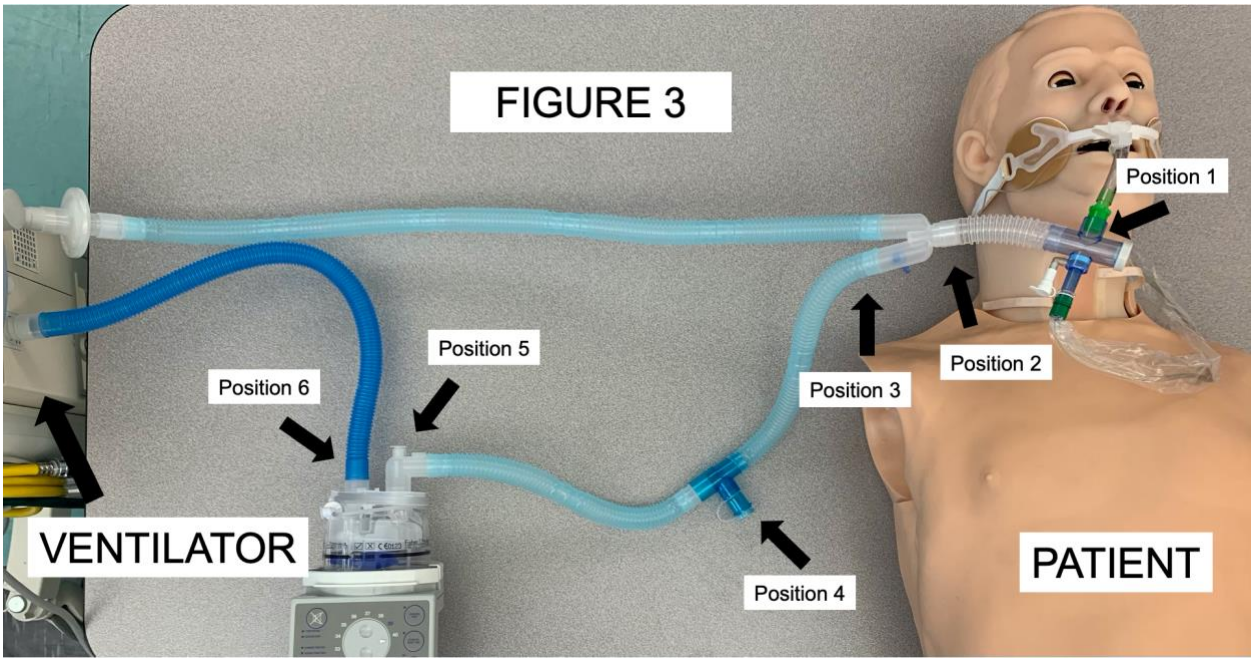
9. From your experience, where would you place the vibrating mesh nebulizer on an invasive mechanical ventilation circuit utilizing a converting HME? Please reference Figure 2: Invasive Mechanical Ventilation Circuit with converting HME.



Kenney, Jordan (Photographer). (2021, February 10). *Figure 2: Invasive Mechanical Ventilation Circuit with converting HME.*

a. Position 1 (between the ETT and the Suction Ballard)
b. Position 2 (between the Suction Ballard and the HME)
c. Position 3 (between the Wye-piece and the Inspiratory Limb)
d. Position 4 (30 cm distal from the Wye-piece on the Inspiratory Limb)
e. Position 5 (at the Ventilator)

10. From your experience, where would you place the vibrating mesh nebulizer on an invasive mechanical ventilation circuit utilizing a heater and humidifier system? Please reference Figure 3: Invasive Mechanical Ventilation Circuit with Heater/Humidifier.



Kenney, Jordan (Photographer). (2021, February 10). *Figure 3: Invasive Mechanical Ventilation Circuit with Heater/Humidifier.*

a. Position 1 (between the ETT and the Suction Ballard)
b. Position 2 (between the Suction Ballard and the Wye-Piece)
c. Position 3 (between the Wye-piece and the Inspiratory Limb)
d. Position 4 (30 cm distal from the Wye-piece on the Inspiratory Limb)
e. Position 5 (at the Heater/Humidifier distal to the Ventilator)
f. Position 6 (at the Heater/Humidifier proximal to the Ventilator)

11. Please select whether you strongly agree or strongly disagree for the following statements based on a scale of 1-7.
    a. I learned where to place the nebulizer while in Respiratory Therapy School

       Strongly Disagree 1…..2…..3…..4…..5…..6…..7 Strongly Agree
    b. I learned where to place the nebulizer by reading up-to-date research.

       Strongly Disagree 1…..2…..3…..4…..5…..6…..7 Strongly Agree
    c. I learned where to place the nebulizer from my hospital/work training.

       Strongly Disagree 1…..2…..3…..4…..5…..6…..7 Strongly Agree

Thank you for your time.

APPENDIX B: COVER LETTER

Greetings Scholars,

You are invited to participate in an electronic survey study called “Respiratory Therapy Students’ Perceptions of Appropriate Vibrating Mesh Nebulizer Placement for Inline Mechanical Ventilator Circuits.” The goal of this study is to identify RT students’ perceptions and what influences exist for correct nebulizer placement. Jordan Kenney, a Master’s Degree student from Georgia State University, Department of Respiratory Therapy, leads this study. She is guided and supervised by the chair of the Department of Respiratory Therapy at Georgia State University, Dr. Douglas Gardenhire. The information you provide will be used in a thesis prepared by Jordan Kenney.

Participation in this study is completely voluntary and anonymous. Your answers will be kept confidential and only codes will be used to identify participants. If you decide to partake, utilize the link at the end of this email. This survey should take less than 10 minutes to complete. Since this is voluntary, you may cease in completing the survey at any time you wish without loss of benefits or penalty.

If you experience any difficulties with the online survey process please contact Jordan Kenney at jkenney2@student.gsu.edu or Dr. Gardenhire at dgardenhire@gsu.edu. To access the survey please click the following link: (insert link here)

Thank you in advance for participating in this important survey.

Jordan Kenney

Department of Respiratory Therapy

Georgia State University

APPENDIX C: FOLLOW UP LETTER

I am reaching out to remind you that you are invited to participate in an electronic survey study called “Respiratory Therapy Students’ Perceptions of Appropriate Vibrating Mesh Nebulizer Placement for Inline Mechanical Ventilator Circuits.” The goal of this study is to identify RT students’ perceptions and what influences exist for correct nebulizer placement. If you have already finished taking the survey, I would like to thank you for your participation. Your information will be of great value and contribution to the research and development in respiratory therapy clinical education. On the other hand, if you have not completed the survey, please do so by clicking the link below. Your participation would greatly be appreciated.

To access the survey please click the following link: (insert link here)

Thank you for your time and consideration in completing this survey.

Jordan Kenney

Department of Respiratory Therapy

Georgia State University

APPENDIX D: INFORMED CONSENT

Title: Respiratory Therapy Students Perceptions Of Appropriate Vibrating Mesh Nebulizer Placement For Inline Mechanical Ventilator Circuits

Principal Investigator: Doug Gardenhire

Student Principal Investigator: Jordan Kenney

Procedures

You are being asked to take part in a research study. If you decide to take part, you will complete a brief one-time online survey that will take 20 minutes of your time.

Voluntary Participation and Withdrawal

You do not have to be in this study. You may skip questions or stop participating at any time.

Contact Information

Contact Doug Gardenhire at (404) 413-1270 or dgardenhire@gsu.edu. You may also contact Jordan Kenney at (470) 899-1110 or jkenney2@student.gsu.edu.

Consent

If you are willing to volunteer for this research, please start the survey.

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