Marian University

Leighton School of Nursing

Doctor of Nursing Practice

Final Project Report for Students Graduating in May 2024

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Evidence-Based Bag Mask Ventilation Education in the Simulation Setting

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Table of Contents

Abstract

Background and Review of Literature: Bag-mask ventilation (BMV) is a critical skill in the peri-operative setting and is difficult to master for student registered nurse anesthetists (SRNAs). BMV has been shown to be the superior method of adequately pre-oxygenating patients prior to securing an airway. There is a growing body of evidence that all anesthesia providers including CRNAs, resident physicians, and attending physicians have lower levels of confidence with this skill in comparison to other, more invasive skills. Additionally, most providers prefer having access to annual BMV courses to refresh themselves on the latest BMV guidelines.

Purpose: This study assessed changes in first year SRNA competence, knowledge, satisfaction, and confidence levels with BMV after implementing a BMV refresher simulation session prior to beginning clinical rotations.

Methods: A systematic review of the literature was conducted using "*bag mask ventilation*" or "*bag valve mask*". Inclusion criteria included text available in English, articles less than 5 years old, BMV as an intervention, and ventilation as an assessment. Exclusion criteria were laryngeal mask ventilation, passive oxygen insufflation, pilot studies, and unrelated research purposes. This resulted in 14 articles. The Marian University Internal Review Board (IRB) approval was obtained prior to initiating the DNP Project. First year SRNAs at Marian University Leighton School of Nursing were given a survey to assess their knowledge and confidence surrounding BMV prior to, and after attending a simulation session hosted by upper level SRNAs. The simulation session focused on the latest evidence based BMV techniques as well as indications to perform BMV and troubleshooting for patients who are difficult to ventilate. Paired t-tests were employed to compare pre and posttest scores.

Implementation Plan/Procedure: This prospective cohort study and systematic review assesses whether implementation of a hands on, evidence based BMV refresher course, in the simulation setting, improves first-year SRNA knowledge, satisfaction, confidence, and competence regarding BMV. The International Nursing Association of Clinical Simulation Learning (INASCL) standards of simulation education were upheld. Surveys were given prior to and after the simulation sessions on Qualtrics. Data was exported to Excel where statistical analysis was done.

Implications/Conclusions: Eight first year SRNAs participated in the BMV simulation and completed the pre and posttests. There was a statistically significant improvement in SRNA confidence ($p = 0.0084$) and knowledge ($p = 0.00058$). This study underscores the importance of implementing BMV refresher courses to SRNAs. Additionally, this intervention should be considered by other anesthesia providers to increase confidence, knowledge, and competence surrounding BMV.

Evidence-Based Bag Mask Ventilation Education in the Simulation Setting

Introduction

This project is submitted to the faculty of Marian University Leighton School of Nursing as partial fulfillment of degree requirements for the Doctor of Nursing Practice, Nurse Anesthesia track.

Effective bag-mask ventilation (BMV) is a critical skill in the peri-operative setting, providing adequate oxygenation upon induction for intubation, as well as providing adequate ventilation and airway management during times of crises. BMV is often a difficult skill to master among student registered nurse anesthetists (SRNAs) and novice anesthesia providers, accentuating the crucial need for proficient BMV education and mastery. Anesthesia providers provide BMV among individuals undergoing tracheal intubation to prevent severe hypoxemia and provide stability for ventilation in times of crises and implementing the latest evidence-based practice in BMV simulation can improve SRNA knowledge base and clinical skills.

The purpose of this project was to implement the latest evidence based BMV practice in the simulation setting prior to first years entering the clinical environment, and then assess SRNA knowledge, satisfaction, and confidence levels pre and post-simulation. By implementing a BMV refresher course prior to clinical, we measured SRNA knowledge improvement and satisfaction due to said intervention. Not only did this intervention measure the effectiveness of evidence based BMV simulation as a refresher course, but this project also educated and prepared SRNAs for airway management success in the clinical setting.

Background

BMV is a crucial skill in multiple facets of anesthesia care including preventing severe hypoxemia, establishing adequate ventilation when intubation is unsuccessful, and providing resuscitation due to adverse events. The relevance to patient safety illustrates the undeniable need for evidence based BMV education and anesthesia provider proficiency.

Establishing effective ventilation in patients prevents severe hypoxemia upon induction. Severe hypoxemia can be defined as oxygen saturations less than 80% (Casey et al., 2019). Studies comparing BMV versus alternative methods upon induction incessantly prove BMV to be superior at providing adequate oxygenation in the perioperative setting (Casey et al., 2019; Semler et al., 2021). In fact, Casey et al. (2019) studied the differences in oxygen saturations among patients receiving BMV between induction and laryngoscopy and those not receiving BMV between induction and laryngoscopy. This study found patients receiving BMV during induction and laryngoscopy had higher oxygen saturations and lower rates of severe hypoxemia (oxygen saturation less than 80%) than those receiving no ventilation (Casey et al., 2019). Hypoxemia not only causes short-term ischemia to the body, but can also lead to cardiac arrest and death (Casey et al., 2019). Benditt (2019) further illustrates the necessity of effective BMV, especially among individuals with neuromuscular disorders as their decreased muscle strength predisposes them to severe hypoxemia and respiratory failure peri-operatively. More specifically, examples of at-risk populations include those with sleep apnea, hypoventilation disorders, muscular dystrophy, kyphoscoliosis, myasthenia gravis, Guillain Barre syndrome, sialorrhea, and ALS (Benditt, 2019). Not only are patients with neuromuscular diseases at risk, but other populations such as cigarette smokers, pediatrics, and obese patients (Dai et al., 2021). Similar to previous studies, Semler et al. (2019) studied the differences in oxygen saturation among patients receiving BMV between induction and laryngoscopy and those receiving apneic oxygenation between induction and therapy. The patients receiving apneic oxygenation (receiving 100% oxygen at 15 L/min via nasal cannula) demonstrated lower oxygenation peri-operatively than those receiving BMV (Semler et al., 2019). Multiple studies conclude the ample benefits of effective BMV when utilized during the induction phase of anesthesia.

BMV is a fundamental skill learned in anesthesia school and effective ventilation continues to be a difficult skill to master in the field of anesthesia. Despite many educational efforts, this essential airway skill can be difficult to perform effectively, especially among inexperienced providers (Hart et al., 2020). The incidence of cannot intubate cannot ventilate (CICV) is estimated to be 1 in 10,000 cases (Fayed et al., 2022), and sufficient BMV can reduce the incidence of this dire complication. Fayed et al. (2022) assessed confidence levels among anesthesia providers regarding CICV management and found a high lack of experience and confidence in all provider roles (CRNAs, residents, and attendings). This highlights a need for more emergency airway teaching and training. In addition, results from Fayed et al. (2022) survey regarding preferred method of CICV teaching indicate the majority of respondents prefer an annual simulation training as an optimal teaching method.

In recent years, new BMV research provides improved methods to adequately ventilate peri-operative patients. For instance, numerous studies have illustrated advantages of E-O hand technique over the E-C technique (Soleimanpour et al., 2018), and other studies have demonstrated the weight of utilizing STOP-bang questionnaire to identify risk factors for difficult BMV (Khan & Ahmed, 2021). The traditional E-C BMV technique includes forming a ”C” with the index finger and thumb and applying downward pressure, while simultaneously creating an “E” with the third, fourth and fifth fingers, lifting the mandible upwards (Soleimannpour et al., 2018). The E-O technique involves placing the first and second fingers in an “O” position around the mask entrance hole and the third, fourth, and fifth fingers placed surrounding the chin and mandible while simulating the same downward pressure and lifting of the jaw (Soleimanpour et al., 2018). The two-handed thenar eminence technique—in which the thenar eminences at the base of the thumbs press the mask to the face, while the other four fingers surround the mandible to lift the jaw—has also shown to be more effective than E-C technique. However, data supports E-O technique to be superior compared to the other two (Soleimanpour et al., 2018). Furthermore, latest research has provided techniques for managing these difficult to ventilate patients, such as utilizing gel among bearded patients (Saqer et al., 2020). BMV research within the past five years guides practitioners to implement safe evidence-based practice.

Problem Statement

Despite efforts to teach proper BMV technique, new providers still require more robust teaching, as evidenced by (Fayed et al., 2022). Fayed et al. also shows that anesthesia providers are most receptive to in-person simulation workshops to learn and reinforce skills. The problem statement in PICOT format is: Does implementation of an evidence-based bag mask ventilation refresher course, in the simulation setting, improve SRNA knowledge, satisfaction, and self-confidence, from pretest to posttest? Therefore, first-year Marian University SRNAs participated in a hands-on simulation workshop demonstrating the newest evidence-based techniques for providing effective bag-mask ventilation.

Needs Assessment & Gap Analysis

There is a need for more robust education in terms of BMV administration especially among new anesthesia providers, as evidenced by Fayed et al. 2022. Since this study took place at Henry Ford Hospital in Detroit Michigan, a large Midwest hospital, its findings are likely generalizable to Marian University affiliate hospitals. This study showed that young anesthesia providers need more education when it comes to ventilation of difficult airways. Additionally, this study found that providers are most amenable to annual in-person simulation workshops. By instituting this adjunct pre-clinical workshop at Marian University, it will close the gap in knowledge, experience, and confidence among new anesthesia providers. Furthermore, recent evaluation has shown that Marian University offers a limited scope when teaching BMV techniques. Deficits include the evidence based, most effective BMV technique for inexperienced anesthesia providers, the E-O technique (Soleimanpour et al., 2018). Currently, at Marian University, educational standards of the bag mask ventilation skill include a shared simulation session among a small group of learners. About a week later, the skill is then checked by the simulation instructor, ensuring hand placement and adequate tidal volumes delivered for the manikin. This is helpful for foundational knowledge, and one can anticipate that fine-tuning techniques for application to real patient scenarios will be beneficial for students entering the clinical environment. The goal is for first year SRNAs to gain competency at all hand placements, including the E-O technique, two-handed thenar eminence technique, and mastery of STOP-bang under the close guidance of more experienced SRNAs.

Project Aims and Objectives

- This project's aim was to educate pre-clinical Marian SRNAs how to effectively bag-mask ventilate utilizing the latest evidence-based practice
- The hope was to improve SRNA knowledge, satisfaction, and confidence scores from pretest to posttest

Theoretical Framework

Jeffries Simulation Theory

The theoretical framework utilized to guide our project includes the Jeffries Simulation Theory developed by Pamela R. Jeffries, as displayed in Appendix A (Jeffries et al., 2015). This theory recognizes the significant research available supporting the efficacy of simulation-based education. The six core elements in this theory include context, background, design, educational practices, simulation experience, and outcomes (Jeffries et al., 2015). The background especially highlights the need for identifying learning expectation, overarching goals for the simulation, needed resources for simulation, and how this simulation supports the curriculum (Jeffries et al., 2015). In fact, implementing these strategies leads to improved patient outcomes, reduced cost, and improved processes within systems (Jeffries et al., 2015).

Theory Guidance

Jeffries Simulation Theory guided our project by identifying successful strategies to implement education in the clinical setting as well as methods to evaluate learned skills. For instance, Jeffries' theory states commencing from an environment of trust on parts of both the facilitator and learner translates to being interactive, learner centric, experiential, and collaborative (Jeffries et al., 2015). In addition, steps of the simulation experience include having a pre-brief, simulation progression, cues, and debriefing (Jeffries et al., 2015). This theory is designed to promote favorable educational interventions by understanding factors influencing SRNA clinical behavior. For example, Jeffries theory provides guidance to promote a favorable bag mask ventilation simulation by including the following simulation design: Simulation should include specific learning objectives, desired fidelity, learner role assignments, simulation flow, and strategies for pre-briefing/debriefing (Jeffries et al., 2015). Creating, implementing, and evaluating interventions influenced by Jeffries Simulation Theory provided insightful information regarding effectiveness of simulation and evidence-based bag mask ventilation education.

SWOT Analysis

SWOT stands for strengths, weaknesses, opportunities, and threats (Moran et al., 2019). See APPENDIX C for SWOT Analysis graphic. Strengths and weaknesses are intrinsic factors. The intrinsic strengths related to this project include having a reliable and valued team member to co-navigate this project, as well as being able to carry out this intervention in a familiar environment—in the simulated OR at Marian University. Technology and ease of data collection can be seen as a strength. However, technology can potentially land in the *threats* category as well, since all data stored in technology is at risk for being hacked, altered, and inaccessible. Anticipated intrinsic weaknesses involving this study are related to participation and ensuring adequate student involvement. Since there will likely not be a monetary or grade incentive to participate, busy students may not want to involve themselves in a time-consuming task. Unfamiliarity with Qualtrics could perhaps be a weakness as well. Opportunities to benefit the project would be if the teachers granted incentive to students for taking time to participate in the DNP projects. Additionally, there could be a change to the clinical environment to benefit the project and outcomes of patients. Threats, like opportunities, are external factors. The processes of the study, regarding a comparison of pretest vs. posttest knowledge results, requires the student to have internet and device access, which all these students have. However, a future change in access to devices and internet could truncate opportunity and threaten students' ability to participate in the data collection. This external factor, along with environmental changes related to school simulation access, are situations in which there would be a negative impact on project data and implementation. Potential threats to our project could have been a lack of participation from students, students not receiving the survey, or an issue with the Qualtrics website; if there is an update that wipes all the data and surveys. A contingency plan is in play: all surveys and resulting data will be saved on an alternative medium so that a crash or wipe of Qualtrics software would not be detrimental or cause us data loss. Additionally, encouragement of checking “spam” and “junk” email folders could fix the issue of students not receiving the survey. If necessary, the surveys will be filled out on paper. Another potential threat to the project was if the new methods of bag masking become standard in sim education, prior to conducting the project. In addition, the equipment must be readily available and in working function for proper project implementation. Lastly, a threat to the project could have been related to our school stakeholder no longer approving the conduction of this project or granting us simulation lab access.

Search Methodology

The search for pertinent sources regarding effective bag-mask ventilation was conducted September and October of 2022 utilizing PubMed database. The keywords and BOOLEAN phrases that were entered into PubMed include “*bag mask ventilation”* OR “*bag valve mask ventilation.”* The initial search resulted in 129 articles. Results older than five years old and not available in English language were filtered, as shown in a PRISMA flow chart (Appendix D). Duplicate articles were removed as well, resulted in 94 identified sources. Inclusion criteria for selected articles included text available in English articles less than 5 years old, bag mask ventilation as an intervention, and ventilation as an assessment. Upon screening the 94 identified articles, 62 results with the following criteria were excluded: laryngeal mask ventilation, passive oxygen insufflation, pilot studies, and unrelated research purposes. Final screening of sources resulted in 13 articles. Additional review of reference lists from one systematic review did identify one additional relevant source, totaling the sources utilized in this literature review to 14.

Literature Review Results

The literature review search resulted in a final count of 14 relevant articles illustrating main points regarding effective bag mask ventilation. Multiple topics were covered among these articles including the relevance and dire need for effective BMV, key predictors for difficult BMV, and effective BMV strategies. Appendix F exhibits a literature review matrix detailing key points of each article.

Relevance of Effective Bag Mask Ventilation

Multiple articles accentuate the clinical significance and dire need to implement effective BMV among patients receiving anesthesia (Benditt, 2019; Casey et al., 2019; Fayed et al., 2022; Semler et al., 2021). Casey et al. (2019) especially emphasizes the clinical difference between patients undergoing tracheal intubation receiving bag mask ventilation and patients undergoing tracheal intubation receiving no bag mask ventilation between induction and laryngoscopy. In fact, this randomized controlled study found the difference in lowest oxygen saturation between the bag mask ventilation group and no bag mask ventilation group was an average of 8% (Casey et al., 2019). They also found more participants exhibiting an oxygen saturation of less than 70% in the no bag mask ventilation group (Casey et al., 2019). Similarly, Semler et al. (2019) studied the difference in oxygen saturations among patients receiving apneic oxygenation and patients receiving bag mask ventilation. This study found apneic oxygenation prior to intubation does not produce the same results as bag mask ventilation prior to intubation (Semler et al., 2019). More specifically, patients receiving apneic preoxygenation had lower arterial oxygen saturations compared to those receiving bag mask ventilation prior to laryngoscopy (Semler et al., 2019). Not only is effective bag mask ventilation essential for patients undergoing surgery, but effective BMV is especially critical for those with neuromuscular diseases (Benditt, 2019). Benditt (2019) illustrates patients with neuromuscular diseases have decreased ventilatory muscle strength, a reduced vital capacity, as well as forced vital capacity (FVC) leading to rapid desaturations upon induction of anesthesia.

Fayed et al., (2022) further illustrates the need for effective bag mask ventilation as well as effective bag mask ventilation education, according to his latest research. In Fayed's quasi-experimental study, anesthesia providers (CRNAs, anesthesia residents, and anesthesia attendings) participated in a cannot intubate cannot ventilate scenario (Fayed et al., 2022). Following the scenario, the participants reported a lack of experience and confidence in managing cannot intubate cannot ventilate scenarios (Fayed et al., 2022). This critical piece of information indicates the urgent need for additional training in cannot intubate cannot ventilate scenarios.

Key Predictors for Difficult Bag Mask Ventilation

Numerous articles highlighted key predictors for effective bag mask ventilation among patients in the surgical setting, citing both pathological indicators as well as physical indicators (Farid & Taman, 2020; Khan & Ahmed, 2021; Sager et al., 2020; Mouri et al., 2022). Regarding physical characteristics, Farid & Taman (2020) mention several physical characteristics predictive of difficult bag mask ventilation and these include: a short thyromental distance, macroglossia, presence of a beard, lack of teeth, and snoring. Sager et al. (2022) also lists beard and lack of teeth as predictors, as well as obese body habitus, and an increased neck circumference. Two other studies mention disease states associated with difficult bag mask ventilation and those include asthma, pneumonia, chronic obstructive pulmonary disease (COPD), and obstructive sleep apnea (OSA) (Farid & Taman, 2020; Khan & Ahmed, 2021).

Effective Bag Mask Ventilation Strategies

Numerous studies have been conducted illustrating effective bag mask ventilation strategies including specific hand positioning, addition of positive end expiratory pressure (PEEP), medications, and supplemental devices (Farid & Taman, 2020; Sager et al., 2020; Soleimanpour et al., 2018; Otten et al., 2019; Zweiker et al., 2018; Dai et al., 2021; Uhm & Kim, 2021; Benditt, 2019). Soleimanpour et al. (2019) compared the difference between E-C technique and O-C technique during bag mask ventilation. This study found that among novice providers, there was a significant difference in tidal volume between the E-C and O-C technique ($P < 0.0001$), meaning novices provided better bag mask ventilation utilizing the O-C technique compared to the traditional E-C technique (Soleimanpour et al., 2019). Also addressing hand placement, Otten et al., (2019) compared the two hand ventilation to one hand ventilation technique and found the two handed technique produced the greatest tidal volume among patients. Applying hand placement among pediatrics, Zweiker et al. (2018) also found the use of five fingers produced greater tidal volume delivery than the tradition two finger hold during bag mask ventilation.

Three studies emphasized the implementation of PEEP to provide adequate bag mask ventilation (Farid & Taman, 2020; Dai et al., 2021; Uhm & Kim, 2021). In Dai et al.'s randomized double-blind trial, the addition of PEEP during bag mask ventilation improved oxygen reserve and enhanced oxygenation among patients with hypoxia compared to patients receiving bag mask ventilation alone. Uhm & Kim (2021) found similar results stating positive pressure during bag mask ventilation is directly proportional to administered tidal volumes. In fact, low positive pressures were associated with suboptimal tidal volumes (321 mL) and an average between 10-20 cm H2O resulted in adequate tidal volumes. On the contrary, positive pressures greater than 20 cm H2O resulted in adverse effects such as gastric insufflation and positive pressures greater than 40 cm H2O are associated with higher hospital mortality (Uhm & Kim, 2021).

Finally, numerous studies found additional medical adjuncts to improve bag mask ventilation among patients. For example, Farid & Taman (2020) found sevoflurane to facilitate bag mask ventilation and provide better intubation conditions in comparison to propofol inductions. Additionally, among patients with beards, Sager et al. (2020) found gel applied to masks to significantly improve tidal volumes during bag mask ventilation. More specifically, mean tidal volumes during bag mask ventilation with gel was an average 467 mL, and mean tidal volumes during bag mask ventilation without gel was an average 283 mL (Sager et al., 2020). Sager et al. (2020) also mentions the implementation of airway devices (lubricated nasal airway for example) is advantageous among difficult bag mask ventilation. Lastly, Benditt (2019) mentions the application of a chin strap to provide the most effective seal during bag mask ventilation.

Project Design/Methods

Project Design

The project design we implemented was an educational intervention among SRNAs at Marian University. This educational intervention included implementing the latest evidence-based research regarding bag mask ventilation in the simulation setting. The latest research included the E-O hand technique, two-handed thenar eminence technique, application of PEEP, application of gel among bearded patients, utilization of mask straps for providers with small hands, implementation of oral/nasal airways among OSA patients, and the use of two handed bag mask ventilation among hard to ventilate patients. In addition, students were presented with key indicators for difficult bag mask ventilation. Key indicators for difficult bag mask include both physical characteristics and pathological diseases. Physical characteristics include a short thyromental distance, macroglossia, presence of a beard, edentulousness, snoring, obesity, and increased neck circumference. Pathological diseases include asthma, pneumonia, COPD, and OSA.

Methods used to obtain data for the project included a pre-test and post test to compare knowledge before versus after the educational intervention. Knowledge questions were written, presented to committee to validate by content and face, and delivered to participants via Qualtrics surveying software. Quantitative methods were analyzed by way of descriptive statistics: mean, standard deviation, and frequency tables. Measurement methods from the National League for Nursing (NLN) tools for simulation activity, have two subsets for evaluation: satisfaction and self-confidence (Jeffries et al., 2015). These categories were assessed via Likert scale. This assessed the SRNA's confidence and satisfaction level of BMV pre-simulation and post-simulation. NLN tools are reliable and valid evaluation techniques. Reliability of the tools were tested using Cronbach's alpha, a measurement of reliability of a research instrument (Taber, 2018). Reliability of the satisfaction tool is 0.94, and reliability of the self-confidence tool is 0.87. See evaluation tool in Appendix E.

Implementation of surveying and educating first-year students on BMV techniques occurred prior to their first clinical rotation. Moreover, the International Nursing Association of Clinical Simulation Learning (INASCL) standards of simulation education were upheld as they fostered development and assisted in progression towards achieving objectives (McMahon et al., 2021).

After the academic year of 2023 to 2024 concludes, the students manning this project will have graduated. The hope was for students and faculty to continue this educational simulation during the pre-clinical orientation week, prior to students embarking on their clinical component of the curriculum. As new evidence-based techniques come to light, this educational intervention may be adjusted.

Population and Setting

The setting of the project took place at Marian University in the simulation center. The necessary resources for the project included the simulation manikin and a bag masking device. The adjunct resources for the project included an oral and nasal airway, chin strap, and gel. The university stakeholder, represented by faculty, played a role requiring us to coordinate accordingly to use school resources. The student participants played the role of providing data to conduct the project; participation in the pretest, posttest, and education, were all required of the student participants. Inclusion criteria were as follows: first-year student of Marian University's CRNA program and in the didactic segment of the curriculum prior to clinical. Exclusion criteria: second or third-year student of Marian University's CRNA program, has experienced the clinical environment, and Marian University student outside the CRNA program.

The project site was organized as the simulation center is already functioning prior to the start of this study. The simulation area of the school was located on the second floor of the health sciences building and the simulation chair was our contact for site personnel. If need be, other faculty had the ability to unlock the simulation center door and provide access. The hope was to integrate this skill seamlessly into the first-year curriculum so that it's maximally beneficial for the students, as well as for the project data collection.

Resources and facilitators of this project were as mentioned above. Constraints and barriers that could have influenced the implementation of this DNP project were potential difficulty coordinating time in the simulation lab, technology and access to the pretest and posttest, as well as participation turn out of the first-year student body. The plan to overcome these barriers was to assist those needing help with the technology, utilize a surveying method that students are comfortable with, be well-organized and accessible in planning simulation, and communicate with first-year students to learn how to best supplement their curriculum.

The plan of the project was to have the first-year participants fill out a qualitative pre-test about effective bag-mask ventilation strategies, to assess baseline knowledge. The educational intervention component was conducted after the pre-test. This educational intervention included implementing the latest evidence-based research regarding bag mask ventilation in the simulation setting. This included the E-O hand technique, two-handed thenar eminence technique, utilizing PEEP, gel among bearded patients, mask straps for providers with small hands, oral/nasal airways among OSA patients, and the use of two-handed bag mask ventilation among hard to ventilate patients. These methods were demonstrated and practiced. Additionally, students were presented with key indicators for difficult bag mask ventilation. After the educational intervention, the posttest was conducted. Results of pretest and posttest were compared and analyzed. The hypothesis and hope was that posttest results showed improved results compared to pretest results.

Measurement Instruments

In order to measure and evaluate the outcomes and educational efficacy of this DNP project, a comparison of pretest and posttest results were conducted on the same day. The pre-test results were obtained prior to the educational intervention, and the posttest results were obtained immediately following the educational intervention. These pretests and posttests were delivered via Qualtrics software online. Data will be saved for a minimum of two years, and a maximum of five years. To compare the pretest and posttest systematically, students were instructed to list the last four digits of their student ID number on the pretest and posttest. To maintain confidentiality, the surveyors had no way of identifying students with pre and post tests.

Data Collection Procedures

All steps of the project were planned, completed, checked, and acted upon, as is noted in the PDCA (Plan Do Check Act) framework (Isniah et al., 2020). The chronology of events were as listed above: the first-year participants fill out a qualitative pre-test about effective bag-mask ventilation strategies, to assess baseline knowledge. The educational intervention component was conducted after the pre-test. This educational intervention included implementing the latest evidence-based research regarding bag mask ventilation in the simulation setting. This included the E-O hand technique, two-handed thenar eminence technique, utilizing PEEP, gel among bearded patients, chin straps for providers with small hands, oral/nasal airways among OSA patients, and the use of two-handed bag mask ventilation among hard to ventilate patients. These methods were demonstrated and practiced. After the educational intervention, the qualitative posttest was then be conducted. NLN self-confidence and satisfaction surveys were also conducted by the student participants. The projected recruitment was done by the two students conducting the project by way of emailing and reaching out to first-years in a multimodal fashion. The data was then synthesized. The steps in actualizing the intervention was as mentioned, in a pre-clinical seminar for first-year students, and the evaluation was a comparison of pretest and posttest surveys via Qualtrics website software.

Ethical Considerations

The Marian University Internal Review Board (IRB) approval was obtained prior to initiating the DNP Project. The official IRB Determination Form was submitted as soon as the proposal was approved. Thereafter, informed consents were drafted for participants. The Family Educational Rights and Privacy Act (FERPA) is a Federal law that protects the privacy of student education records (US Department of Education, 2021). It's ensured that participating students, along with their results, was protected. Their pretest and posttest results were not identifiable to person. A unique ID number was used, consistent with both pretest and posttest in order to compare results. However, project coordinators and anyone synthesizing data were not able to associate names and test results. All information collected as part of evaluating the impact of this project was aggregated data from the project participants and did not include student identifiers. Participant confidentiality was assured by coding the participants using their randomly assigned individual identification numbers. The results of the pretest and posttest were only accessible to the project coordinators, and was password protected. To comply with the rights and welfare of participating research subjects, our project was submitted and then approved by the Institutional Review Board (IRB) at Marian University.

Project Evaluation Plan

The ability to evaluate efficacy of the project depended on statistical tests analysis methods. This was crucial for trustworthiness, credibility, dependability, confirmability, and transferability of results. Data synthesis was carried out by way of a paired t-test, comparing the two populations of pretest versus posttest knowledge. Descriptive statistics such as mean, standard deviation, and frequency tables, was analyzed to support efficacy of project. A t-test also compared the means of two samples. The p value in a t-test indicated the statistical significance of data (Greenland et al., 2016). The Likert scale NLN questionnaire on simulation satisfaction and self-confidence of student participants also synthesized by way of descriptive statistics.

Data Analysis and Results

Surveys in the form of pretest and posttest (Appendices D and E) were made available to the DNP students participating in the BMV simulation. There were a total of 8 participants, all completing the pretest, BMV simulation, and the posttest. Results of the pre and posttest were matched using the last four digits of the students' ID number. Data was compiled and analyzed via Microsoft Excel. Confidence was analyzed via a Wilcoxon test to assess the SRNAs' confidence levels from pre to post test. After conducting the Wilcoxon test, our p-value equated to 0.0084. Because our p-value was less than 0.05, we have statistically significant evidence to reject the null hypothesis (the two data sets are equal), and we can conclude the data assessing SRNA confidence level pretest differs from the data assessing SRNA confidence level posttest.

A paired t-test (Table 1) was implemented to assess knowledge gain and to determine if knowledge improvement from pre-test to posttest was statistically significant. The mean of the SRNA's pretest was 60.9%, and the mean of the SRNA's posttest was 93.8%. After performing the paired t-test, the p-value was 0.00058, concluding the p-value was <0.05, and proving the improved test scores were statistically significant.

Table 1.

	Pre-Test	*Post-Test*
Mean	0.609375	0.9375
Variance	0.037667411	0.004464286
Observations	8	8
Pearson Correlation	0.430331483	
Hypothesized Mean Difference	0	
df	7	
t Stat	-5.273595625	
P(T<=t) one-tail	0.000578042	
t Critical one-tail	1.894578605	
P(T<=t) two-tail	0.001156085	
t Critical two-tail	2.364624252	

At the end of the posttest, an NLN student satisfaction and self-confidence survey (Appendix D) was completed by the participants, and this survey is used to assess SRNA satisfaction with the educational approach and confidence to perform effective bag mask ventilation The NLN survey reflects an agree/disagree 5-point Likert scale. The mean scores for the NLN survey fall within the range of 4.625 and 4.5, correlating with a response between 4 (agree) and 5 (strongly agree). These results indicate a strong satisfaction for the simulation and a strong confidence in bag mask ventilation skills. See table 2, represented in Appendix G, for data from the validated NLN confidence and satisfaction survey.

Conclusion

Bag mask ventilation is an essential skill as an anesthesia provider in the perioperative setting, and the skills for mastery must be taught in preparation for clinical practice. This skill of BMV is often difficult to execute among SRNAs and novice providers, further accentuating the need for sufficient education. SRNAs learn this skill first in the textbooks, and this skill can be reinforced by implementing simulation training. SRNAs partaking in the BMV simulation acknowledge they are better prepared, confident, and knowledgeable implementing safe and effective bag mask ventilation.

Improvements for this study and further needs for further project projections include a multitude of factors. Reinforcing the idea of assessing first-year SRNAs could assess the student's ability to perform BMV without any prior clinical experience. Including a larger sample size could further validate our results, and including SRNAs from other graduate schools can accomplish this larger sample size goal. Another improvement includes implementing a second posttest to assess retainment of BMV knowledge. This posttest could be given one month after the simulation. Strengths of this project includes involving SRNAs who have yet to enter the clinical setting. By educating and testing SRNAs prior to entering the clinical setting, we can limit any extraneous variables affecting SRNAs BMV skills and knowledge. Another strength includes having a strong pre-test prior to our simulation. Instead of retroactively assessing the SRNAs knowledge of BMV, we were able to assess a strong baseline prior to our intervention.

Once again, BMV is an imminent skill any anesthesia provider must master and implementing effective educational BMV scenarios propels future anesthesia providers toward this goal. BMV education in the simulation setting has proven to be effective in improving student knowledge, and in parallel, has shown favorable satisfaction and confidence scores as a result.

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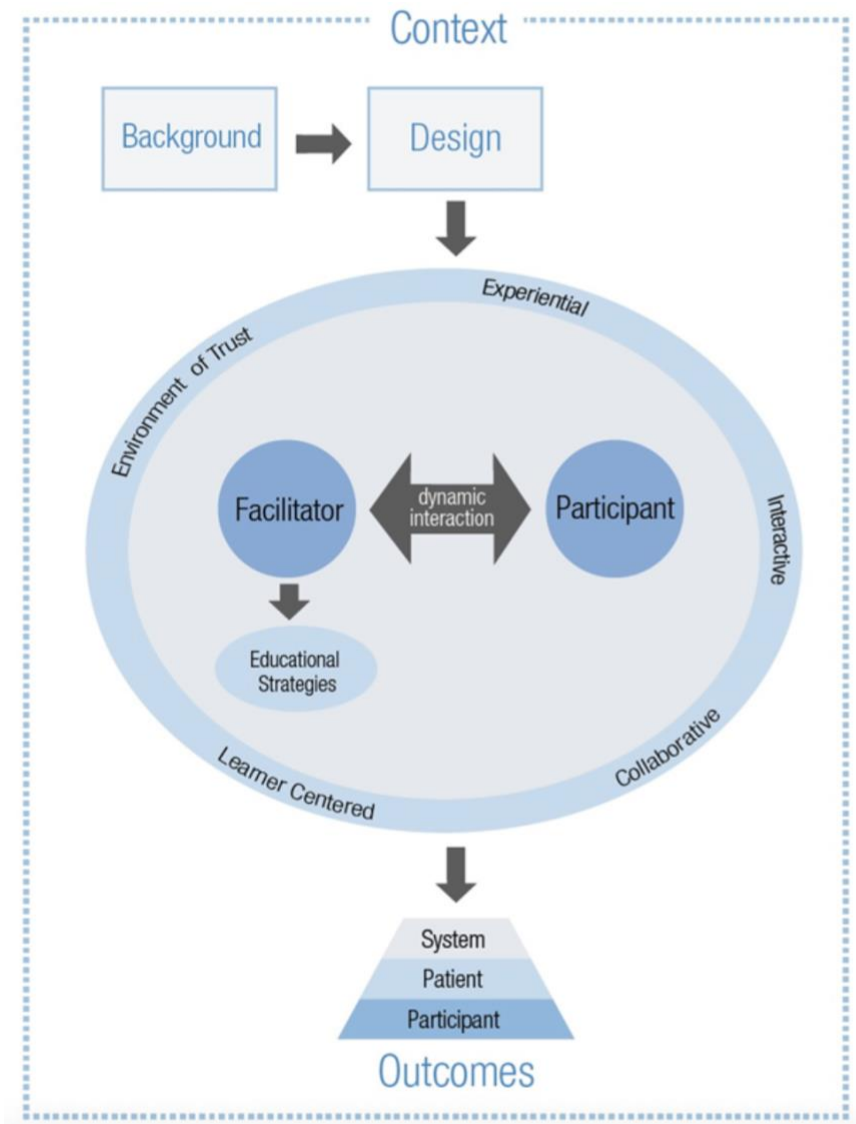
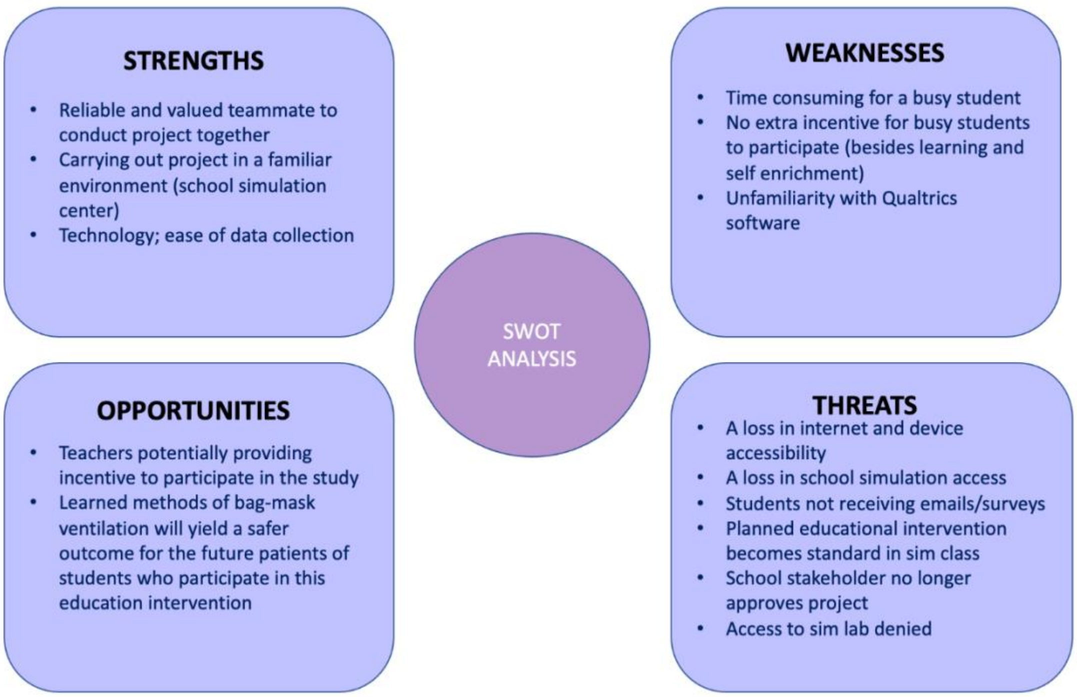
Appendix A

Jeffries Simulation Theory



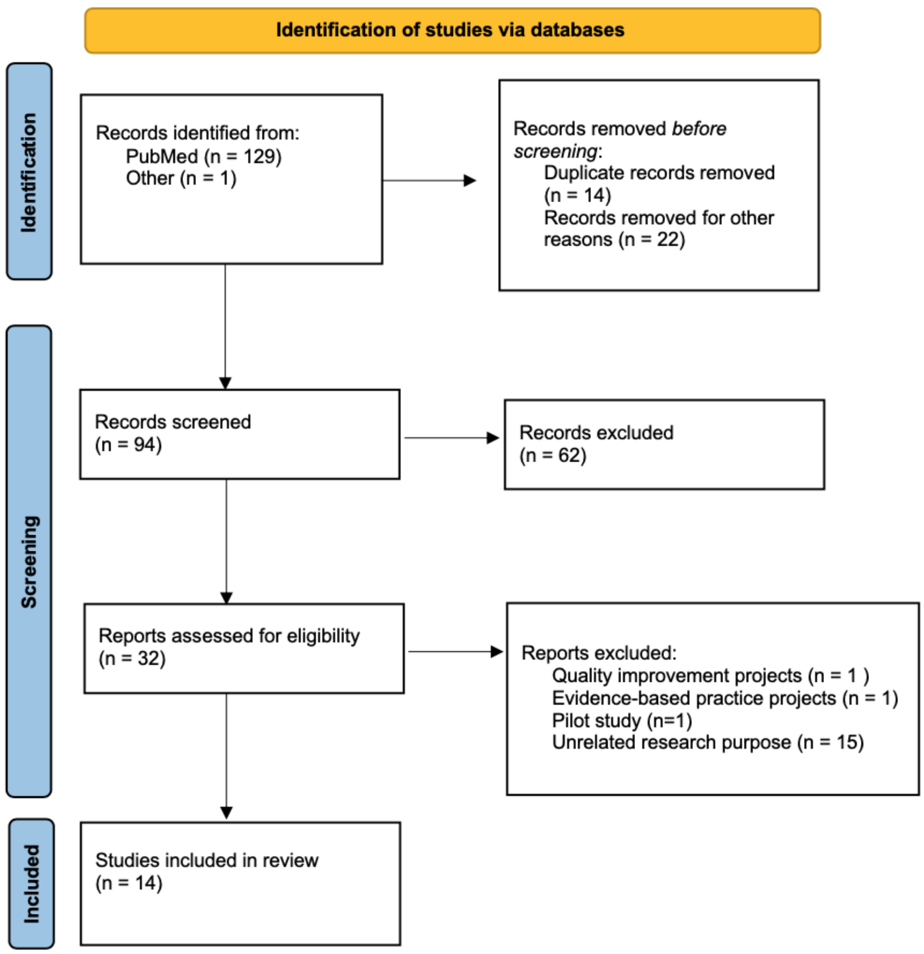
Appendix B

SWOT Analysis



Appendix C

PRISMA Flow Chart



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

For more information, visit: http://www.prisma-statement.org/

Appendix D

NLN Satisfaction & Self-Confidence Tool

Student Satisfaction and Self-Confidence in Learning

Instructions: This questionnaire is a series of statements about your personal attitudes about the instruction you receive during your simulation activity. Each item represents a statement about your attitude toward your satisfaction with learning and self-confidence in obtaining the instruction you need. There are no right or wrong answers. You will probably agree with some of the statements and disagree with others. Please indicate your own personal feelings about each statement below by marking the numbers that best describe your attitude or beliefs. Please be truthful and describe your attitude as it really is, not what you would like for it to be. This is anonymous with the results being compiled as a group, not individually.

Mark:
1 = STRONGLY DISAGREE with the statement
2 = DISAGREE with the statement
3 = UNDECIDED - you neither agree or disagree with the statement
4 = AGREE with the statement
5 = STRONGLY AGREE with the statement

Satisfaction with Current Learning	**SD**	**D**	**UN**	**A**	**SA**
1. The teaching methods used in this simulation were helpful and effective.	○ 1	○ 2	○ 3	○ 4	○ 5
2. The simulation provided me with a variety of learning materials and activities to promote my learning the medical surgical curriculum.	○ 1	○ 2	○ 3	○ 4	○ 5
3. I enjoyed how my instructor taught the simulation.	○ 1	○ 2	○ 3	○ 4	○ 5
4. The teaching materials used in this simulation were motivating and helped me to learn.	○ 1	○ 2	○ 3	○ 4	○ 5
5. The way my instructor(s) taught the simulation was suitable to the way I learn.	○ 1	○ 2	○ 3	○ 4	○ 5
Self-confidence in Learning	**SD**	**D**	**UN**	**A**	**SA**
6. I am confident that I am mastering the content of the simulation activity that my instructors presented to me.	○ 1	○ 2	○ 3	○ 4	○ 5
7. I am confident that this simulation covered critical content necessary for the mastery of medical surgical curriculum.	○ 1	○ 2	○ 3	○ 4	○ 5
8. I am confident that I am developing the skills and obtaining the required knowledge from this simulation to perform necessary tasks in a clinical setting	○ 1	○ 2	○ 3	○ 4	○ 5
9. My instructors used helpful resources to teach the simulation.	○ 1	○ 2	○ 3	○ 4	○ 5
10. It is my responsibility as the student to learn what I need to know from this simulation activity.	○ 1	○ 2	○ 3	○ 4	○ 5
11. I know how to get help when I do not understand the concepts covered in the simulation.	○ 1	○ 2	○ 3	○ 4	○ 5
12. I know how to use simulation activities to learn critical aspects of these skills.	○ 1	○ 2	○ 3	○ 4	○ 5
13. It is the instructor's responsibility to tell me what I need to learn of the simulation activity content during class time..	○ 1	○ 2	○ 3	○ 4	○ 5

 Revised December 22, 2004

APPENDIX E

Bag Mask Ventilation Knowledge Questions

1. Which evidence-based bag mask ventilation intervention is recommended among bearded patients?
    a. Apply gel to mask
    b. Shave beard for adequate mask fit
    c. Apply tape to beard
    d. Perform a rapid sequence intubation (RSI)
    Correct Answer: A

2. In a healthy patient, ventilation by mask should not exceed airway pressures greater than how many cm H2O?
    a. 5 cm H2O
    b. 10 cm H2O
    c. 15 cm H2O
    d. 20 cm H2O
    Correct Answer: D

3. Select the figure demonstrating the correct thenar-eminence technique.

a.

b.

c. 
d. None of these figures represent the thenar-eminence technique.
Correct Answer: A

4. Which interventions aid the clinician with small hands in successful bag mask ventilation? (Select 2)
   a. Utilizing a chin strap
   b. Utilizing a smaller mask
   c. Implementing two handed bag mask ventilation
   d. Applying extra force on bridge of patient's nose
   Correct Answer: A and C

5. In which pathophysiology is an oral airway indicated?
   a. Asthma
   b. COPD
   c. Cystic Fibrosis
   d. Obstructive Sleep Apnea
   Correct Answer: D

6. In which pathophysiology is a nasal airway contraindicated?
   a. Nasal congestion
   b. Ocular hypertension
   c. Basilar skull fracture and facial trauma
   d. Nasal polyp
   Correct Answer: C

7. Which physiological characteristics predict a difficult bag mask ventilation? (Select 3)
   a. Long thyromental distance
   b. Short thyromental distance
   c. Microglossia
   d. Increased neck circumference
   e. Edentulousness
   Correct Answers: B, D, and E

8. True or false. Upon implementing the "E-O" bag mask ventilation technique, the clinician's first and second fingers are placed in an "O" position around the mask entrance hole.
   a. True
   b. False
   Correct Answer: True

APPENDIX F

PROJECT TEAM MEMBERSHIP

MARIAN UNIVERSITY
Indianapolis

DNP Scholarly Project Proposal Committee Approval

Name(s): Cara Pepperman & Miriam Wallach

Project Title: Evidence-Based Bag Mask Ventilation Education in the Simulation Setting

Date of Project Proposal Defense/Meeting: 02/13/2023

I agree have reviewed this student's project proposal and verify that this this project may proceed to IRB and then project Implementation.

Yes ☑ No ☐ Chair Signature: Dr. Marie Goez, DNP, CRNA, APRN

Date: 02/13/2023

Yes ☑ No ☐ Committee Member Signature: ______ DNP, CRNA

Date: 3/8/2023

1/23

Marian University
Leighton School of Nursing
Graduate Department

Notice of DNP Project Team Membership

Name of DNP Student: Miriam Wallach & Cara Pepperman
Title of DNP Project: Evidence-Based Bag Mask Ventilation Education in the Simulation Setting

*I hereby agree to serve as the **Chairperson** of the DNP Project Committee for the above-named student.*

Signature: Marie Goez *Date:* 09/30/2022
Printed/Typed Name

*I hereby agree to serve as a **Member** of the DNP Project Committee for the above-named student.*

Signature: ______ *Date:* 10/1/2022
Printed/Typed Name Gregory Yant

***Additional Members** of the DNP Project Committee for above-named student (if needed).*
Signature: ______ *Date:*

***Approval**:*
Signature: ______ *Date:* 10/03/2022
FNP or CRNA Program Director or Ass't Program Directors or Graduate Chairperson

Please Note:

- *FNP DNP students will have a Chairperson (faculty) and an "outside the university" practice mentor (does not have to be doctorally prepared) on the committee.*
- *CRNA DNP students will have a Chairperson (faculty), PhD Project 1st Reader, and an "outside the university" practice mentor (does not have to be doctorally prepared).*

APPENDIX G

Table 2

	S1	S2	S3	S4	S5	C6	S7	C8	C9	C10	C11
Mean	4.625	4.5	4.625	4.5	4.5	4.5	4.5	4.625	4.625	4.625	4.625
Median	5	4.5	5	4.5	4.5	4.5	4.5	5	5	5	5
Mode	5	4	5	4	4	4	4	5	5	5	5
Standard Deviation	0.517	0.535	0.518	0.535	0.535	0.535	0.535	0.518	0.518	0.518	0.518
Sample Variance	0.268	0.268	0.268	0.286	0.286	0.286	0.286	0.268	0.268	0.268	0.268
Minimum	4	4	4	4	4	4	4	4	4	4	4
Maximum	5	5	5	5	5	5	5	5	5	5	5
Count	8	8	8	8	8	8	8	8	8	8	8
Confidence Level	0.433	0.447	0.433	0.447	0.447	0.447	0.447	0.433	0.433	0.433	0.433

Key: S = Satisfaction. C = Confidence.

Appendix H

Literature Review Matrix

Citation	**Research Design & Level of Evidence**	**Population / Sample size n=x**	**Major Variables**	**Instruments / Data collection**	**Results**
Benditt, J. O., (2019). Respiratory Care of Patients With Neuromuscular Disease. *Respiratory Care,* 64(6), 679-688. https://doi.org/10.4187/respcare.06827	Quasi-Experimental; Level III	Population: Patients with neuromuscular disease. Sample includes patient undergoing effective bag mask ventilation (n= 12), CPAP machines at night (n=35), and tracheostomy ventilation throughout the day (n = 20)	Independent variables include intervention such as bag mask ventilation, CPAP machines, and tracheostomy ventilation. Dependent variables include oxygen saturation, cough function, and end tidal CO2.	Vital capacity, ventilatory support, capnography, pulse oximetry.	Patients with neuromuscular disease are especially weak and need extra assistance during ventilation. Extra considerations should be given to those with neuromuscular disease while bag mask ventilating.
Casey, J. D., Janz D. R., Russel, D. W., Vonderhaar, D. J., Joffe, A. M., Dischert, K. M., Brown, R. M., Zouk, A. N., Gulati, S., Heideman, B. E., Lester, M. G., Toporek, A. H., Bentov, I., Self, W. H., Rice, T. W., & Semler, M. W., (2019). Bag-Mask Ventilation during Tracheal Intubation of Critically Ill Adults. *New England Journal of Medicine*, 380(9), 811-821. https://doi.org/10.1056/NEJMoa1812405	Randomized Controlled Trial; Level III	Population: Critically ill patients. Sample includes undergoing tracheal intubation (n=401)	Independent variables include bag mask ventilation and no bag mask ventilation intervention. Dependent variables include oxygenation saturation.	Laryngoscopy, pulse oximetry, bag mask	Patients receiving NO bag mask ventilation prior to intubation had lower oxygen saturations compared to patients receiving bag mask ventilation.
Dai, Y., Dai, J., Walline, J. H., Fu, Y., Zhu, H., Xu, J., & Xuezhong, Y., (2021). Can bag-valve mask ventilation with positive end-expiratory pressure reduce hypoxia during intubation? A	Prospective randomized double-blind trial; Level II	Population: ED patients. Sample: patients requiring endotracheal	Independent variables: bag mask ventilation without PEEP,	Ventilation device, respiratory, CO2, and O2 monitors	Additional PEEP during bag mask ventilation improves oxygen reserve and

prospective, randomized, double-blind trial. *Trials*. https:/doi.org/10.1186/s13063-021-05413-3		intubation for acute respiratory failure in the ED (n = 144)	bag mask ventilation with PEEP. Dependent variables: exhaled tidal volume, respiratory rate, exhaled oxygen concentration		enhances oxygenation in patients with hypoxia compared to patients receiving bag mask ventilation alone.
Farid, A. M. & Taman, H. I. (2020). The Impact of Sevoflurane and Propofol Anesthetic Induction on Bag Mask Ventilation in Surgical Patients with High Body Mass Index *Anesthesia: Essays and Resources*, 14(4), 594-599. https://doi.org/10.4103/aer.aer_20_21	Quasi-experimental; Level III	Population: Obese patients undergoing anesthesia Sample: pts undergoing sevoflurane induction (n = 100). Pts undergoing propofol induction (n=100)	Independent variables: sevoflurane and propofol administration. Dependent variables: ease of bag mask ventilation	Propofol, sevoflurane, bag mask, pulse oximetry	Sevo can facilitate BMV and provide better intubation conditions comparison to propofol induction.
Fayed, M., Nowak, K., Angappan, S., Patel, N, Abdulkarim, F., Penning, D. H., & China, A. K., (2022). Emergent Surgical Airway Skills: Time to Re-evaluate the Competencies. *Cureus*, 14(3). https://doi.org/10.7758/cureus.23260	Quasi-experimental; Level III	Population: Anesthesia providers. Sample: attendings (n=54), residents (n=44), CRNAs (n=21)	Independent variables: cannot intubate cannot ventilate scenario. Dependent variables: providers confidence levels	Online questionnaire	Participants reported lack of experience and confidence in managing cannot intubate cannot ventilate scenarios. Indicators of difficult bag mask ventilation
Hart, D., Driver, B., Kartha, G., Reardon, R., & Miner, J., (2020). Efficacy of Laryngeal Tube versus Bag Mask Ventilation by Inexperienced Providers. *West Journal Emergency Medicine*, 21(3), 688-693. https://doi.org/10.5811/westjem.2020.3.45844	Crossover study. Observational; Level III	Population: Inexperienced airway providers Sample: first year emergency medicine residents, third and fourth year	Independent variables: bag mask ventilation intervention and extraglottic device intervention. Dependent variables: tidal	Extraglottic devices, bag mask, mannequins	Inexperienced airway providers were able to provide higher ventilation volumes and peak pressures with extraglottic device compared to BMV in a manikin model

		medical students (n=20)	volumes and ventilation peak pressures		
Khan, M. N. & Ahmed, A., (2021). Accuracy of STOP-Bang Questionnaire in Predicting Difficult Mask Ventilation: An Observational Study. *Cureus*, 13(6). https://doi.org/10.7759/cureus.15955	Prospective cross-sectional observational study; Level III	Population: patients receiving general anesthesia for elective surgeries. Sample: patients (n=530)	Independent variables: STOP-bang score. Dependent variables: ease of BMV	STOP-bang questionnaire. Ease of mask ventilation assessment	OSA is a strong predictor of difficult bag mask ventilation
Mouri, M., Krishnan, S., & Maani, C. V., (2022). Airway Assessment. *StatPearls*.	Retrospective chart review; Level III	Population: patients receiving general anesthesia. Sample: Patients in outpatient center (n=130)	Independent variables: disease state, airway history. Dependent variables: assessment of difficult airway	Bag mask ventilation device, TV, provider assessment	Disease states such as asthma, pneumonia, and COPD have been associated with difficult ventilation and oxygenation
Otten, D., Liao, M. M., Wolken, R., Douglas, I. S., Mishra, R., Kao, A., Barrett, W., Drasler, E., Byyny, R. L., & Haukoos, J. S., (2019). Comparison of bag-valve-mask hand-sealing techniques in a simulated model. *Annual Emergency Medicine*, 63(1), https://doi.org/10.1016/j.annemergmed.2013.07.014	Prospective, crossover study; Level III	Population: Healthcare providers. Sample: healthcare providers with greater than 5 or more emergency bag-valve-mask experiences (n=52)	Independent variables: one handed BMV technique, two handed BMV technique. Dependent variable: Tidal volumes	Bag mask, inline monitor measuring tidal volume	2 handed mask ventilation technique resulted in higher tidal volumes than 1 handed technique.
Saqer, A. M., Mubarak, A. M., Alotaibi, R. N., Alharthi, M. Z., Aljanoubi, M. A., Alshabanat, & S., Mobrad, A. M., (2020). Using gel for difficult mask ventilation on the bearded patients: a simulation-based study. *Internal Emergency Medicine*, 16(4), 1043-1049. https://doi.org/10.1007/s11739-020-02547-1	Randomized crossover design; Level III	Population: respiratory therapists. Sample: male respiratory therapists (n=42) and female respiratory therapists (n=32)	Independent variables: gel application before BMV. Dependent variables: TV	Mannequin, bag mask, tidal volumes, survey	Mean tidal volume during BMV without gel application was 283 mL. Mean tidal volume during BMV with gel was 467 mL.

Semler, M. W., Janz, D. R., Lentz, R. J., Matthews, D. T., Norman, B. C., Assad, T. R., Keriwala, R. D., Ferrel, B. A., Noto, M. J., McKown, A. C., Kocurek, E. G., Warren, M. A., Huerta, L. E., & Rice, T. W., (2021). Bag-Mask Ventilation Versus Apneic Oxygenation During Tracheal Intubation of the Critically Ill. *American Journal of Respiratory and Critical Care Medicine*, 193(3), 273-280. https://doi.org/10.1164/rccm.201507-1294OC	Randomized open-label pragmatic trial; Level III	Population: medical ICU patients. Sample: 150 ICU adult patients	Independent variables: BMV, apneic oxygenation. Dependent variables: oxygen saturations	Bag mask ventilation, pulse oximetry	Apneic oxygenation does not improve lowest arterial oxygen saturation during endotracheal intubation. Findings do not support routine use of apneic oxygenation during endotracheal intubation of critically ill adults.
Soleimanpour, M., Rahmani, F., Bagi, H., Ala, A., Mahmoodpoor, A., Hassani, F., Sharifi, S., Esfanjani, R. M., & Soleimanpour, Hassan, (2018). Comparison of Three Techniques on Facility of Bag-Mask Ventilation: Thenar Eminence, E-O, and E-C. *Anesthesia and Pain Medicine*, 8(4). https://doi.org/10.5812/aapm.74226	Quasi-experimental; Level III	Population: Medical students and experienced anesthesia providers. Sample (n=100)	Independent variables: E-C technique, E-O technique. Dependent variables: chest rise, ventilation quality	Ventilation Assessment, mannequin, bag mask	Among professionals, there was no significant difference between the E-O and E-C technique. However, among the novice providers, the E-O technique was performed better than the E-C technique
Uhm, D., Kim, A., (2021). Tidal volume according to the 4-point sealing forces of a bag-valve-mask: an adult respiratory arrest simulator-based prospective, descriptive study. *BMC Emergency Medicine*, 21(1). https://doi.org/10.1186/s12873-021-00451-1	Prospective descriptive study; Level III	Population: undergraduate students Sample: undergraduate paramedic students (n=125)	Independent variables: sealing force. Dependent variables: peak pressure, tidal volume	Self-reported questionnaire	The higher the peak pressure and apex sealing force, the greater the tidal volumes.
Zweiker, D., Schwaberger, H., Urlesberger, B., Mileder, L. P., Baik-SChneditz, N., Pichler, G., Schmolzer, G. M., & Schwaberger, B., (2018). Does the Number of Fingers on the Bag Influence Volume Delivery? A Randomized Model Study of Bag-Valve-Mask Ventilation in Infants. *Children*, 5(8), 132. https://doi.org/10.3390/children5100132	Randomized crossover student; Level III	Population: Healthcare professionals. Sample: Healthcare professionals trained in neonatal/pediatric	Independent variables: 2 finger technique, 5 finger technique. Dependent variables: tidal volume	Mannequin, ventilation device, respiratory function monitor	Five-finger technique led to higher tidal volumes when compared to the two-finger technique among pediatric and neonate mannequins.

		resuscitation (n=40)				