Implementation of the A-OK Protocol for Treatment of Amniotic Fluid Emboli with Quick Reference and Education Materials

Chase Bauer, BSN, SRNA

Approved by

Chrissy Kress PhD, CRNA	Project Team Leader
Wanda Williams, PhD, MSN, RN, WHNP-BC, CNE	DNP Program Director

Table of Contents

Abstract

Background: An amniotic fluid embolism (AFE) is a rare but deadly complication that accompanies an otherwise exciting event in one's life. Without adequate knowledge of symptom presentation, pathology and treatment, anesthesia providers and labor and delivery (L&D) nurses cannot treat mothers in an emergent situation. While this pathological process is difficult to study and often is a diagnosis of exclusion, current literature discusses a protocol that has shown great success for treatment of AFE. **Purpose:** The purpose of this project is to assess the knowledge and confidence of the anesthesia providers and L&D nurses about the diagnosis, pathophysiology, presentation, and treatment of AFE and the Atropine, Ondansetron, and Ketorolac (A-OK) protocol. **Methods:** An educational session was held for anesthesia and L&D staff at a level III medical center in North Carolina that discussed AFE presentation, pathology, treatment, and the A-OK protocol. A Likert-scale self-assessment of knowledge and confidence was administered to participating staff members to assess the base levels before and after the educational session. Additionally, badge buddies highlighting the signs, symptoms, and treatment of AFE were given to staff of the participating teams. **Results:** After completion of the educational session and data collection, a statistically significant increase in provider knowledge and confidence was seen. Data was analyzed using a paired t-test to assess for statistical significance. **Conclusion:** Anesthesia providers and L&D nurses benefited from the education session and badge buddy tool regarding their knowledge and confidence. **Recommendations:** These project designers recommend the development of larger visual aids that can be placed in the L&D units and cesarean-section (c-section) suites to assist providers who may not have participated in this project. The development of an A-OK pack, including the three medications

outlined in the protocol could be used by L&D nurses as way of retrieving the medications quickly in an emergent situation.

Key Words: A-OK, knowledge and confidence, amniotic fluid emboli, pregnancy complication, AFE, maternal death, Ondansetron, Ketorolac, Atropine.

Background and Significance

Amniotic fluid embolism (AFE) can have detrimental effects for women in the obstetric population. Amniotic fluid embolism can occur during labor, or within 48 hours after the delivery of the neonate (Society for Maternal-Fetal Medicine [SMFM], Pacheco, Saade, Hankins, & Clark, 2016). The condition is thought to be caused by the entrance of material from the fetal compartment- which contains the amniotic fluid, hair, and feces- into maternal circulation (SMFM et al., 2016). An analysis of data found that 71% of AFE cases occurred during labor, 19% during cesarean section, and 11% during vaginal delivery (SMFM et al., 2016). Amniotic fluid embolism mortality rates vary, but one study shows a mortality rate between 13-26% (Dean, Rogers, Harley, & Hood, 2012) and it is the second leading cause of maternal mortality in the United States (Rezai, Hughes, Larson, Fuller, & Henderson, 2017). Of those surviving AFE, only 15% remain neurologically intact (Gist, Stafford, Leibowitz, & Beilin, 2009). Unfortunately, there is no universal diagnostic criteria for AFE. Due to the inconsistency in diagnosing AFE, understanding this condition and identifying effective management has been hampered (Clark et al., 2016).

It is crucial for labor nurses, and anesthesia providers alike, to have a thorough understanding of AFE given their involvement in the care of patients undergoing cesarean sections and vaginal births. These clinicians play a crucial role in the diagnosis and management of AFE. Although early recognition and treatment do improve outcomes, quick identification of AFE can be difficult because of the lack of universal diagnostic criteria and limited clinician knowledge and experience. These factors are also coupled with the extremely low incidence rate. AFE does not contain any pathological or serological markers currently (Rezai et al., 2017). Due to this, treatment and recognition can be delayed because AFE is typically a diagnosis of

exclusion (Rezai et al., 2017). Even when AFE is recognized quickly, and treatment is initiated, morbidity and mortality of the condition remain high (Dean et al., 2012).

With the tremendously high rates of mortality and morbidity associated with AFE, accurate and timely identification could be the difference in maternal and fetal survival outcomes. A visual protocol including signs of AFE, management options, and alternative diagnoses would be beneficial for those providers caring for women during labor and postpartum. One of the more novel management strategies to treat AFE is the administration of Atropine, Ondansetron, and Ketorolac (A-OK) (Rezai et al., 2017). With the proposed pathophysiology of AFE better understood, anti-serotonin, anti-thromboxane, and vagolytic therapy have led to successful resuscitations in patients with an AFE. Atropine, Ondansetron, and Ketorolac therapy should be considered in addition to traditional management options (Rezai et al., 2017). It has been theorized that Ondansetron blocks serotonin release which reduces pulmonary vasoconstriction and platelet activation (Rezai et al., 2017). Ketorolac works by blocking thromboxane which further reduces the release of inflammatory mediators. Ketorolac may also work by preventing the activation of the coagulation cascade (Rezai et al., 2017). Atropine works by blocking the vagal reflex which should increase vasomotor tone.

At a local hospital anesthesia providers and labor and delivery registered nurses agree there is a knowledge deficient and need for education and a specific protocol to follow for patients suspected of suffering from an AFE. The aim of this education and protocol will be focused on the pathophysiology, risk factors, presenting signs and symptoms, differential diagnoses, and management options of AFE. Measurable variables will be related to pre/post surveys for providers with knowledge and confidence assessment to be able to identify and treat a patient suffering from an AFE with the newest protocol and education provided. The A-OK

treatment plan will be included in the protocol because of the significant effects in multiple case reports discussed in the next section. The micro-incidence rate makes it difficult to find high-level supporting evidence for specific treatment plans. The main reason for the lack of evidence is the micro-incidence rate as previously stated.

Literature Review

This review includes current evidence surrounding the history and risk factors, pathophysiology, recognition, and treatment of amniotic fluid emboli (AFE). PubMed and CINAHL were the primary sources of inquiry. Search criteria focused on the problem and used the following terms: amniotic fluid embolism, AFE, birthing complications; Intervention; nursing staff education, treatment for amniotic fluid embolism, A-OK protocol; Comparison; AFE treatment outcome data; Outcomes; AFE policy, and patient outcomes. Search criteria was narrowed down by selecting articles in English and within the past five years. After initial review of database results, the search was broadened to articles written in the past 10 years. Sources listed within the primary sources were also used to gain a deeper examination of the evidence. Articles found outside of the 10-year inclusion criteria were excluded from this literature review. Articles providing primarily expert opinion and organizational methodology, or standards were used for background information only, but not as supporting evidence. Due to the rare occurrence of AFE, much of the evidence collected involved case studies in which the A-OK protocol was utilized. In total, 19 articles were reviewed for this collection.

Historical Findings and Proposed Risk Factors

Amniotic fluid emboli are a daunting issue in the labor and delivery setting due to the lack of knowledge behind the generation of an AFE, definitive treatment method, and high

mortality rate when not identified and treated promptly. Through the years many have attempted to identify a set of risk factors for development of an AFE, as well as diagnosis and treatment. Knight et al. (2012) looked at retrospective case data involving AFE occurrences in Australia, the United Kingdom, United States, Canada, and the Netherlands and found that AFE occurrences ranged from 1.9 to 6.1 cases per 100,000 maternities. The US rate of AFE fell toward the upper end of the spectrum at 5.5 cases per 100,000 during the time frame examined by Knight et al. (2012). Within the literature reviewed the themes of maternal age, labor type, gender of the infant, and gestational age appeared through many of the studies.

The first common theme represented in the articles examined was that of fetal gender. Guillame et al. (2013), Knight et al. (2012), and Shen et al. (2016) all found that the majority of births involving AFE involved mothers giving birth to a fetus of the male gender. Each article cited statistics that showed around two-thirds or more of the infants being of male gender.
The second common theme was methods of labor for parturients suffering from AFE. Bonnet et al. (2018) found that 69% of AFE suffering mothers gave birth by cesarean section and 50% required labor to be induced. A10-year study Guillame et al. (2013) supported that majority of mothers with AFE were induced. In contrast, Fitzpatrick et al. (2016) found that only 41% of mothers suffering from AFE required induction of labor. Shen et al. (2016) found similar results but in this study less than one-fourth of labor was induced and another one fourth were by cesarean-section. Overall, studies support that there may be a link between the development of AFE and labor induction and delivery method.

Many of the studies examined in this literature review reference the age of the mother at the time of giving birth and the occurrence of an AFE, leading to the third common theme.

McDonnell et al. (2015) shared findings that most women suffering from an AFE were greater than 35 years of age. This finding contrasts with data from Guillame et al. (2013) stating that the median age of AFE sufferers was 32 years old. While studies by Bonnet et al, (2018), Fitzpatrick et al. (2016), Knight et al. (2012), and Shen et al. (2016) did not have specific median values referenced when describing their maternal age, they did find that the majority of the women in their respective retrospective studies were below the age of 35. In keeping with the theme of age, many of the studies also alluded to commonalities regarding gestational age of the fetus. Knight et al. (2012) and McDonnell et al. (2015) both noted that AFE occurred more frequently when the gestational age of the fetus was greater than 37 weeks. Specifically, McDonnell et al. (2015) found that 73% of the cases of AFE reported in the study involved women with pregnancies 37 weeks or greater.

Outside of the themes highlighted above, a small portion of the articles outlined some other common variables noticed while examining AFE cases. Knight et al. (2012) indicated that within the data gathered in the US, AFE incidence odds increased with parturients suffering from placenta previa and placental abruption. Rath et al. (2014) found similar risk factors to those mentioned by several other articles, but also added parturients with multiple pregnancies as an additional risk factor for AFE.

When examining the data presented above, many similarities are shared by at least two of the studies mentioned. The gender of the child delivered, age ranges of the parturients, and rate of labor induction appeared to be of similar incidence between each study, barring one. While these are not conclusive factors in the pathogenesis and risk factor analysis of AFE occurrence, these aspects should not be overlooked. Having knowledge of these commonalities among AFE

studies can enable the anesthesia and obstetric nursing staff alike to the potential higher possibility of an AFE occurring.

Symptom Presentation and Recognition

Early recognition of symptom presentation is vital to successful treatment and increased positive outcome when combatting an AFE. Unfortunately, universal diagnostic criteria for the diagnosis did not exist prior to 2015 (Sadera et al. (2016). Therefore, AFE was widely understood as a diagnosis of exclusion. In 2016 Pacheco, Et al. recommended that AFE be added into the differential diagnoses when examining maternal complications similar to that of AFE. Clark et al. (2016) was tasked with developing a symptomatology related to identifying AFE criteria. These criteria included sudden cardiac arrest or a combination of extreme hypotension and respiratory compromise, disseminated intravascular coagulation (DIC), rapid onset within thirty minutes of delivery, and the patient being in an afebrile state. Per Clark et al. (2016), only when these four criteria are met can a parturient be diagnosed with an AFE. Benson (2013) suggested that another clinical diagnosis measure could be the progression of either seizures or coma, along with the criteria identified by Clark et al. (2016).

When using the established definitive clinical signs of AFE to examine parturients suffering from an AFE. Fitzpatrick et al. (2016) found that mothers who suffered cardiac arrest as the initial sign of AFE occurrence were at an increased likelihood of death or severe neurological insult. Yufune et al. (2015) found that many of these patients also had an increased incidence of coagulopathy, including DIC, that required blood product administration. In an article written by Leighton et al. (2011), researchers noted consumptive coagulopathy and major cardiopulmonary symptoms as hallmarks of AFE.

Fitzpatrick et al. (2016) and Guillaume et al. (2013) found that 55% of women suffered from cardiac arrest as the first indicator of AFE. In a similar study, McDonnel et al. (2015) found that slightly over one-third of patients fell victim to sudden cardiac arrest and around three-fourths of patients suffered from coagulopathy and experienced hypotension. This study also found that AFE occurred within five minutes of delivery 48% of the time. Likewise, Mu et al. (2015) found that 52% of the time an AFE occurred, symptoms appeared immediately after delivery. This supports that AFE is more common after delivery and may present with a range of symptoms.

After the clinical advancements in symptom clarification and universal diagnosis criteria identification set forth by Clark et al. (2016), enhanced research has been able to be conducted. This has aided researchers and medical professionals to expand their knowledge surrounding AFE risk factors and presentation. Initial ideology related to the pathogenesis of AFE has shifted to a system of mechanisms, including mechanical obstruction and immune related responses (Gist et al., 2009). With this knowledge, researchers have been able to develop a precise method of rapid treatment for cases which may be an AFE. There is no cure for AFE, and diagnosis is still difficult, so supportive treatments are being the primary modality of lowering mortality. However, the work done by past researchers have enabled clearer avenues for increased research for AFE identification and treatment in the future.

Treatment

Guillaume et al. (2013) and McDonnel et al. (2015) both discovered the majority of women suffering from AFE developed sudden cardiac collapse and arrest as the primary presenting symptom. Therefore, Advanced cardiac life support (ACLS) protocol including high

quality cardiopulmonary resuscitation (CPR), invasive airway placement, and cardiac infusion medications should be utilized as soon as possible. Clark et al. (2016) developed a diagnostic criterion which found that after initial cardiac collapse, a massive coagulopathy is on the horizon and creates the next treatment hurdle. This is supported by multiple researchers who found that disseminated intravascular coagulation (DIC) follows AFE and requires extensive management with blood product administration (Bonnet et al., 2018; Fitzpatrick et al., 2016; Guillaume et al., 2013; McDonnel et al., 2015; Mu et al., 2016).

In 2013, the immune-mediated response caused by AFE was first discovered (Copper et al.). Copper et al. (2013) discussed the use of antiserotonin, antithromboxane, and vagolytic medication therapy as the most effective therapies in preventing cardiovascular collapse, DIC, and pulmonary artery hypertension. This discovery helped lead to the usage of Ondansetron (antiserotonin), Ketorolac (antithromboxane), and Atropine (vagolytic) in documented AFE case reports with great success. Atropine, ondansetron, and ketorolac in combination create the A-OK protocol (Copper et al. 2013). These drugs work by preventing the serotonin, thromboxane, and vagolytic effects that come with an AFE. These drugs should be administered as soon as AFE symptom presentation occurs, and other diagnoses are ruled out.

Case studies performed by Rezai et al., (2017), and Copper et al., (2013) analyzed treatment for two women that suffered an AFE. One was undergoing an emergency cesarean section, and the other after the induction of labor had begun. In both situations the providers administered the A-OK protocol via intravenous push and both patients were stabilized. The patient in the Copper et al. (2013) case study was discharged from the ICU after 13 days with minimal neurological and memory defects. The patient in the Rezai et al. (2017) case study was discharged from ICU three days after the AFE with no residual deficits. While case studies are

not the highest level of evidence to support practice, due to the rarity of an AFE, these case studies are the most applicable form of evidence.

Understanding of AFE physiology continues to evolve and the addition of novel treatments like the A-OK protocol for treating AFE provides a low-risk, high reward adjunct to traditional methods of treatment for AFE. Traditional methods include the use of vasopressor administration, intubation, and transfusion of numerous blood products. Atropine, ondansetron, and ketorolac medications are commonly in anesthesia drug supplies and can potentially lifesaving benefits to the mother when used in conjunction to treat AFE.

Gap in Literature

The occurrence of an AFE is extremely rare which creates issues when formulating research studies. With AFE being so rare, one limitation to this literature review was the lack of systematic reviews and meta-analysis conducted surrounding the disease process and treatment modality, as compared to more commonly occurring clinical problems. The research studies available within the search parameters above were made up of retrospective data analysis and case studies. Conducting clinical studies in this population is extremely difficult due to the emergency nature and rarity of the events.

Conceptual Framework

The conceptual framework used for this study was the Larrabee Rosswurm Model developed by Rosswurm & Larrabee (1999). This framework has been used to promote evidence-based practice change within hospital settings. This framework describes a model for guiding nurses and other healthcare professionals through a systematic process for the change to evidence-based practice. In this six-step model the researcher must: assess for a need for practice change; link the problem with interventions and outcomes; synthesize the best evidence; design a

practice change; implement and evaluate said practice change; integrate and maintain the practice change.

The identified need is the lack of a designated protocol for treating AFE at the healthcare center where this project was implemented. An additional need is the knowledge gap found in anesthesia providers and labor & delivery nurses. Analyzing the consequences of delayed or improper action and the benefits of education on AFE, and the addition of quick reference materials or protocols for staff links the problem to the interventions. The best current evidence on AFEs presentation, diagnostic criteria, risk factors, and traditional and novel treatments including the A-OK protocol, will inform the interventions. A badge buddy will be used to encourage practice change after the education intervention. A posttest evaluation of anesthesia providers & labor and delivery nurses' knowledge and confidence in identifying and treating an AFE will be used to evaluate the effectiveness of the implemented educational interventions. Maintenance of practice change will be encouraged through the addition of quick reference materials and a proposed AFE protocol that can be easily referenced for all staff.

Methods

Translational Framework

The goal of this project is to improve the knowledge and confidence of providers caring for obstetric patients to decrease treatment time and increase the survival rate of women suffering from AFE, a deadly obstetric condition that can occur without warning. The aim is to increase provider knowledge of the A-OK protocol via educational sessions and visual aids in patient care areas. This project uses the Define, Measure, Analyze, Improve, and Control (DMAIC) framework, which has been developed by the Lean Six Sigma (Burke & Silvestrini, 2017). The DMAIC framework is a research-based quality improvement framework that is

focused on development of new best practices (Burke & Silvestrini, 2017). Burke and Silvestrini., (2017) found that using DMAIC helps to lead an organization to higher performance outcomes. The first step in this framework is “define” which is the problem, improvement activity, opportunity for improvement, or the project goals. This is followed by “measure” which is defined as process performance. The third step is “analyze” which is using a tool to assess the performance measures. Fourth step is “improve” which is the process of eliminating the root cause of the problem and improving on defects. The final step is “control” which includes looking at the improved process and continuing this in the future.

Project Design

This quality improvement project aims to enhance the knowledge and confidence of healthcare providers in treating patients with AFE by conducting an interactive educational seminar and providing reference materials and visual aids. The project aims to address the knowledge gap in symptom recognition, risk factors, treatment, and A-OK protocol for AFE.

The study design is a quantitative quality improvement project, using pre/post Likert scale surveys (See Appendix A) to measure the impact of the educational session on the knowledge and confidence of nurse anesthetists and labor & delivery nurses. Convenience sampling was used for the surveys, and participants included anyone involved in providing anesthesia or caring for patients at risk of AFE. Breakfast was offered as an incentive for participation. An article by Ahuja (2022) suggests that visual aid materials, such as a badge buddy, can help to reinforce the contents of the educational session. Therefore, following the education and surveys, badge buddy (appendix B) reference materials were distributed to aid in retention of information.

Setting and Sample

This project took place in a metropolitan area in the southeast region of the USA at a satellite hospital of a large medical group. This medical center is a level III trauma center and is known for quality labor and delivery services for a major hospital group that is a941-bed system including three full-service hospitals. The hospital system conducted 8,652 deliveries in 2021, with 2,871 of those occurring at the project site. Population and sample for this project included anesthesia providers and labor & delivery nurses at this facility. Convenience and snowball sampling was used. All staff present on the day of project implementation had the opportunity to participate voluntarily in the educational seminar. Inclusion criteria for this study included anesthesia providers or labor and delivery nurses at the study facility on the day of educational implementation. There were no formal exclusion criteria, but participation was not advertised outside of this facility's relevant staff. There were 29 study participants based on staffed anesthesia providers and labor and delivery nurses.

Recruitment was primarily by email and referrals. Staff emails were obtained from the respective department managers. Two emails were sent to the respective departments, the first two weeks before the educational session and the second one week before. This allowed ample time for staff members to see the email and arrange to be in attendance if they wished to participate.

Consent forms that outlined the requirements and the voluntary nature of this project were attached to the beginning of each survey which was distributed via iPad or laptop with a link to Qualtrics for providers to complete the pretest prior to the presentation. The educational session for all participants was conducted in a conference room prior to surgery start times and after morning shift change for the L&D nursing staff. Six weeks after the initial educational

session we sent emails to the staff and asked them to complete the same survey online to assess changes in knowledge and confidence.

Data Collection

Data collection occurred prior to the initial educational session and within 5 weeks following the educational session. Pretest and posttest data was collected via a Qualtrics survey prepared by the DNP candidates containing a Likert-scale questionnaire (See Appendix A). Pretest questionnaires were accessed by all relevant staff at the study site via iPads and laptops provided by the DNP candidates. The participants were allotted 10 minutes, collectively, to complete the pretest survey provided. These questionnaires were filled out at the staff's discretion and were not mandatory. There was no personal identifying information collected from the study participants. Respondents created a four-digit PIN number to link the pre and post survey results. The questionnaires were then deposited confidentially via the Qualtrics website. Posttest surveys were emailed to all relevant staff members for completion six weeks after the educational session.

Included in the educational session was a 20-minute, in-person, interactive PowerPoint presentation that covers the history and statistics of AFE, clinical presentation, risk factors, pathophysiology, alternative diagnoses, and treatment plans including the A-OK treatment protocol. There were multiple interactive case studies presented throughout the presentation outlining the benefits of using the A-OK treatment plan for AFE. The educational session was followed by a 10-minute Question & Answer (Q&A) session.

Instrument (See Appendix A)

Due to the lack of an existing measurement tool for assessing knowledge and treatment of AFE, the DNP candidates created a tool for use with the help of the DNP project team leader. The tool created is the AFE Knowledge and Confidence Assessment Tool (see Appendix A). The tool includes demographic questions pertaining to the provider's role, experience, and gender. The questions pertaining to the knowledge and confidence of AFE, and the A-OK protocol were ranked based on a Likert-type scale. The answer options for participants were: "strongly agree, agree, disagree, and strongly disagree." The option "neither agree nor disagree" was left out to enhance quality of data in either the affirmative or negative. Questions pertaining to the use of visual aids and quick reference materials was also assessed. Questions involving the participant's knowledge and confidence of the occurrence, risk factors, and treatment of AFE were assessed first, followed by questions about the A-OK protocol specifically. Although reliability and validity are not being tested using the tool that was developed, multiple sources show that Likert-type surveys are valid data gathering tools (Joshi et al., 2015). Qualtrics survey generator was used for distribution of the surveys as well as data gathering. The questionnaire took an average of 3-5 minutes to complete per respondent. In total, each participant committed approximately 30 minutes to participating in this project.

Protection of Human Subjects

While this study was voluntary and confidential, appropriate documentation was submitted to the University of North Carolina at Greensboro's Institutional Review Board, along with the study's Medical Center's offices for Advanced Practice Provider Research. Upon approval by both, it was found that this project contains no research including human subjects. All data gathered by the DNP candidates was collected by them alone and maintained on their

personal devices. All devices are password and biometrically secure to prevent unauthorized access. Once all data was analyzed and verified for accuracy, all surveys completed were deleted from DNP candidate hard drives and Qualtrics accounts. Participant risk for harm was low for this project due to the voluntary nature in both the survey and education presentation.

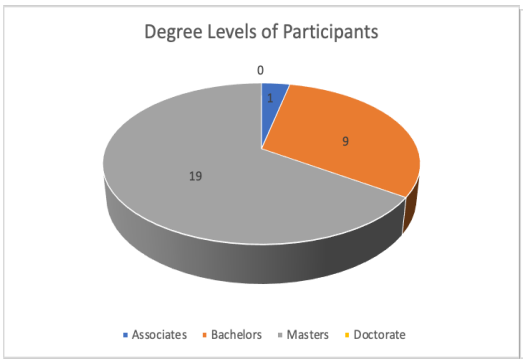
Data Analysis

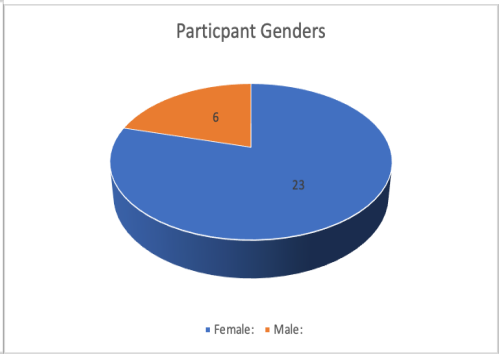
The data was gathered using Qualtrics and organized in Microsoft Excel for data analysis. Using Microsoft Excel, the data was tested for normalcy using a paired t-test and a visual analysis of the correlating bar and pie charts. The data from each question was compared to a p-value of 0.05 using the paired t-test and determined to be correlating. The data gathered from the pretests was compared to the corresponding data from post-tests to determine if there was a statistically significant change in provider knowledge and confidence.

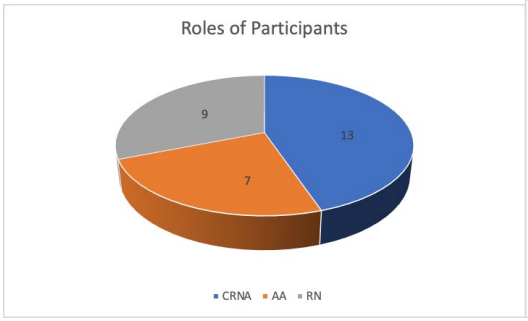
Results

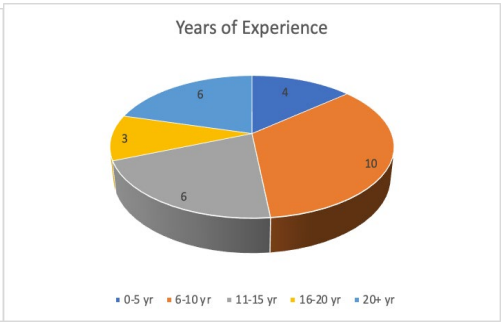
This study included 29 participants in total. Table 1 displays the demographics including participant ages, highest degrees held, years of experience, gender, and professional titles. Among the participants the groups most represented in each category were as follows: females (79%), CRNAs (45%), master's degree recipients (66%), those with 6-10 years of experience (34%), and those in the age range of 30-40 years old (41%).

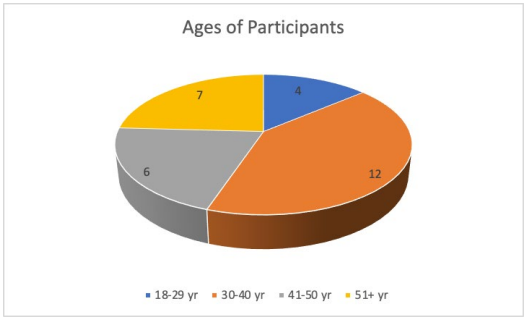
Table 1:











The data was then separated into confidence and knowledge subcategories. The focus of this analysis was the knowledge subcategory. All questions in the knowledge subcategory increased as shown in the data. A p-value of less than 0.05 was utilized, which allows us to reject the null hypothesis and conclude that there is a statistically significant difference from the pre and post test data. Overall, provider knowledge was increased, and the implementation of education and visual aids was shown to be statistically significant.

Table 2

Knowledge questions analysis

	pre knowledge	*post knowledge*
Mean	8.206896552	11
Variance	5.098522167	1.642857143
Observations	29	29
Pearson Correlation	0.468925132	
Hypothesized Mean Difference	0	
df	28	
t Stat	-7.495319641	
P(T<=t) one-tail	1.82647E-08	
t Critical one-tail	1.701130934	
P(T<=t) two-tail	3.653E-08	
t Critical two-tail	2.048407142	

Discussion

At the beginning of this project, it was hypothesized that anesthesia providers along with labor and delivery nurses would have increased knowledge and confidence surrounding the signs and symptoms, pathogenesis, and treatment of an amniotic fluid embolism and the implementation of the A-OK Protocol. This hypothesis was tested via a pre and post education survey that was developed and administered by the creators of this DNP project. After review of the relevant data collected, the hypothesis presented initially was correct. Anesthesia providers and L&D nurses alike conveyed their increased knowledge after the educational session. The

participants in the study also stated that badge buddies in the work environment were helpful to maintaining knowledge.

When developing the tool to assess the participant's knowledge and confidence, three questions were aimed at assessing knowledge and four were meant to assess confidence. There were also two questions used to determine the participant's level of agreement or disagreement regarding the use of educational tools on badges or within the workplace. When evaluating the responses for each of the questions regarding knowledge, each participant's response on the post session survey indicated an increase in knowledge, except for those that had indicated a high knowledge base before the educational session. Only a small portion of the participants indicated high knowledge and confidence, as indicated by a score of four on a scale of one to four, on the initial questionnaire.

When looking at the additional intervention to be implemented beyond the educational session, a badge buddy (Appendix B) was provided to each participant and to the managers of each department for distribution among their respective staff who did not participate. As stated above, the participants were asked about their thoughts regarding the benefit of educational posters or badge cards regarding amniotic fluid emboli and the A-OK protocol. Each respondent indicated to a high degree (score of three or four) that these tools were very useful. The intent of these badge buddies was to help enhance not only long-term retention of the material presented in the educational session, but also to act as a quick reference tool if the situation were to ever arise in which they are caring for a patient potentially suffering from an AFE.

It was the goal of the project developers to not only educate, but to enhance the confidence of providers at varying levels of education and practice capabilities in the assessment and treatment of AFE and the A-OK protocol. As previously stated, the occurrence of an AFE is an extremely rare and consequential pathology, so anything that can be done to improve the provider's ability to respond to these deadly events will save lives.

Limitations

Throughout the course of this DNP project multiple limitations were found. The first limitation was due to testing design. Due to the pre and post test questions being the same or similar, participants may have an altered influence when responding to the questions, as opposed to the questions being completely different. This factor can have a negative effect on external validity. We attempted to mitigate this effect by administering the posttest weeks after the presentation versus immediately after.

A second limitation was related to the sample size of 29. This was a result of implementation time allowed and room size for the presentation. We were allowed a room with only 30 seats and a specific time, on a specific date. This was a limitation that didn’t allow all clinicians to be able to participate. Additionally, the site at which we implemented our project has a smaller staff, meaning less possible participants. Also, with regard to the nursing staff participation, the L&D nurses do not have dedicated days for education in which the entire staff was free to attend, therefore, having a large number of L&D nurses participate was difficult to not compromise patient care needs.

A third limitation of this study is the inability to study direct provider knowledge and confidence in a direct AFE patient scenario. This is due to AFE's being unpredictable and rare in occurrence. This can lead to falsely high levels of knowledge and confidence results without being able to assess these results after a live scenario.

A fourth limitation is related to limited literature. There is limited research on specific A-OK protocols for the treatment of AFE. The majority of our research is based on the mechanism of action of the A-OK drugs and the known and theorized pathophysiology of AFE. There are many successful case studies outlining the use of the A-OK protocol to treat an AFE that aided in the backing of our project, but the lack of significant meta-analysis studies results in a literature review limitation.

Recommendations for Future Study

The study found that using the A-OK protocol improved the knowledge and confidence of anesthesia providers and obstetric nurses in recognizing and treating amniotic fluid emboli. However, it is recommended that future studies have a larger sample size and that the protocol be tested at different institutions. Additionally, it would be beneficial to re-evaluate the knowledge and confidence levels of the same group of participants after a longer period of time (i.e., a year or more) has passed to see if the information from the quick reference guide is being used, and to see how well the protocol performed in actual cases of suspected amniotic fluid emboli.

Conclusion

Throughout this presentation the student developers have attempted to highlight the rarity and danger of an AFE occurrence and the need for enhanced and recurrent education surrounding treatment modalities, including the A-OK protocol. The A-OK protocol offers a low risk, high reward option for providers when they suspect an AFE, despite limitations related to testing. Each of the medications involved in the protocol are commonly given, which means that the mechanisms of action are well known and are easily relatable to the perceived pathogenesis of AFEs.

The development of this protocol increased knowledge and confidence of providers. The use of a badge buddy not only serves as a reminder in times of need, but as a gateway for discourse and continuing education among providers. Participants of this intervention are now able to use their increased knowledge and confidence to educate fellow providers in the hope of saving lives.

References

Ahuja, K. (2022, July 26). *Scribe*. Decoding Quick Reference Guides: Examples, Benefits, Types & Tools. Retrieved from https://scribehow.com/library/quick-reference-guide-examples

Benson, M. D. (2014). Amniotic fluid embolism: the known and not known. *Obstetric Medicine*, *7*(1), 17–21. https://doi.org/10.1177/1753495X13513578

Bonnet, M., Zlotnik, D., Saucedo, M., Chassard, D., Bouvier-Colle, M., & Deneux-Tharaux, C. (2018). Maternal death due to amniotic fluid embolism: A national study in France. *Anesthesia & Analgesia*, *126*(1), 175–182. https://doi.org/10.1213/ANE.0000000000002511

Burnes, B. (2019). The origins of lewin's three-step model of change. *The Journal of Applied Behavioral Science*, *56*(1), 32–59. https://doi.org/10.1177/0021886319892685

Clark, S. L., Romero, R., Dildy, G. A., Callaghan, W. M., Smiley, R. M., Bracey, A. W., Hankins, G. D., D'Alton, M. E., Foley, M., Pacheco, L. D., Vadhera, R. B., Herlihy, J. P., Berkowitz, R. L., & Belfort, M. A. (2016). Proposed diagnostic criteria for the case definition of amniotic fluid embolism in research studies. *American Journal of Obstetrics and Gynecology*, *215*(4), 408–412. https://doi.org/10.1016/j.ajog.2016.06.037

Copper, P. L., Otto, M. P., & Leighton, B. L. (2013) Successful management of cardiac arrest from amniotic fluid embolism with ondansetron, metoclopramide, atropine, and ketorolac: A case report. *Society for Obstetric Anesthesia and Perinatology. https://soap.org/meetings/2013-abstracts-list/2013-abstract-details/?id=S%2047*

Dean, L.S., Rogers III, R.P., Harley, R.A., & Hood, D.D. (2012). Case scenario: Amniotic

fluid embolism. *Anesthesiology, 116*(1), 186–192. https://doiorg.libproxy.siue.edu/10.1097/ALN.0b013e31823d2d99

Fitzpatrick, K. E., Tuffnell, D., Kurinczuk, J. J., & Knight, M. (2016). Incidence, risk factors, management and outcomes of amniotic-fluid embolism: A population-based cohort and nested case–control study. *BJOG: An International Journal of Obstetrics & Gynaecology*, *123*(1), 100–109. https://doi.org/10.1111/1471-0528.13300

Gist, R. S., Stafford, I. P., Leibowitz, A. B., & Beilin, Y. (2009). Amniotic fluid embolism. *Anesthesia & Analgesia*, *108*(5), 1599–1602. https://doi.org/10.1213/ane.0b013e31819e43a4

Guillaume, A., Sananes, N., Akladios, C. Y., Boudier, E., Diemunsch, P., Averous, G., Nisand, I., & Langer, B. (2013). Amniotic fluid embolism: 10-year retrospective study in a level III maternity hospital. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, *169*(2), 189–192. https://doi.org/10.1016/j.ejogrb.2013.02.017

Joshi, A., Kale, S., Chandel, S., & Kumar Pal, D. (2015). Likert scale: Explored and explained. *British Journal of Applied Science & Technology, 7*(4), 396-403.

Knight, M., Berg, C., Brocklehurst, P., Kramer, M., Lewis, G., Oats, J., Roberts, C. L., Spong, C., Sullivan, E., van Roosmalen, J., & Zwart, J. (2012). Amniotic fluid embolism incidence, risk factors and outcomes: a review and recommendations. *BMC pregnancy and childbirth*, *12*, 7. https://doi.org/10.1186/1471-2393-12-7

Leighton , B., Wall, M., Lockhart, E., Phillips, L., & Zatta, A. (2011, December). *Use of recombinant factor viia in patients with amniotic fluid embolism: A systematic review of case reports*. Anesthesiology. Retrieved October 23, 2021, from https://pubmed.ncbi.nlm.nih.gov/21720243/.

McDonnell, N., Knight, M., Peek, M. J., Ellwood, D., Homer, C. S. E., McLintock, C., Vaughan, G., Pollock, W., Li, Z., Javid, N., & Sullivan, E. (2015). Amniotic fluid embolism: An Australian-New Zealand population-based study. *BMC Pregnancy and Childbirth; London*, *15*. http://dx.doi.org/10.1186/s12884-015-0792-9

Mu, Y., McDonnell, N., Li, Z., Liang, J., Wang, Y., Zhu, J., & Sullivan, E. (2016). Amniotic fluid embolism as a cause of maternal mortality in China between 1996 and 2013: A population-based retrospective study. *BMC Pregnancy and Childbirth; London*, *16*. http://dx.doi.org/10.1186/s12884-016-1106-6

Pacheco, L. D., Saade, G., Hankins, G. D., & Clark, S. L. (2016). Amniotic fluid embolism: diagnosis and management. *American journal of obstetrics and gynecology*, *215*(2), B16–B24. Society for Maternal-Fetal Medicine (SMFM). https://doi.org/10.1016/j.ajog.2016.03.012

Rath, W.H., Hofer, S., & Sinicina, I. (2014). AFE: an interdisciplinary challenge: Epidemiology, diagnosis and treatment. *Deutsches Arzteblatt International, 111*(8), 126. https://doi.org/10.3238/arztebl.2014.0126

Rezai, S., Hughes, A. C., Larsen, T. B., Fuller, P. N., & Henderson, C. E. (2017). Atypical amniotic fluid embolism managed with a novel therapeutic regimen. *Case Reports in Obstetrics & Gynecology*, 1–6. vol. # https://doi.org/10.1155/2017/8458375

Sadera, G., & Vasudevan, B. (2015). Amniotic fluid embolism. *Journal of Obstetric Anaesthesia and Critical Care*, *5*(1), 3. http://link.gale.com/apps/doc/A411286742/HRCA?u=gree35277&sid=zotero&xid=f9b0f044

Shen, F., Wang, L., Yang, W., & Chen, Y. (2016). From appearance to essence: 10 years review of atypical amniotic fluid embolism. *Archives of Gynecology and Obstetrics; Heidelberg*, *293*(2), 329–334. http://dx.doi.org/10.1007/s00404-015-3785-z

Society for Maternal-Fetal Medicine (SMFM), Pacheco, L. D., Saade, G., Hankins, G. D. V., & Clark, S. L. (2016). Amniotic fluid embolism: Diagnosis and management. *American Journal of Obstetrics &Gynecology, 215*(2), B16–B24. https://doiorg.libproxy.siue.edu/10.1016/j.ajog.2016.03.012

Yufune, S., Tanaka, M., Akai, R., Satoh, Y., Furuya, K., Terui, K., Kanayama, N., & Kazama, T. (2015). Successful resuscitation of amniotic fluid embolism applying a new classification and management strategy. *Journal of Anesthesia Clinical Reports*, *1*(1), 1–5. https://doi.org/10.1186/s40981-015-0001-x

Appendix A

AFE Survey

The purpose of this survey is to assess the respondent's knowledge and confidence surrounding the recognition and treatment of Amniotic Fluid Emboli. All responses are voluntary, and results will remain confidential to anyone not involved in the development of this project. Completion of this survey implies consent of participation.

Amniotic Fluid Embolism (AFE) Education Seminar

Anesthesia/L&D Provider Knowledge Assessment

Provider (CRNA, AA, MDA, RN):_____ Male/Female/Nonbinary:_____

Years of Experience in current field (yrs. & mo.; RNs: only L&D years): _____.

PIN: _____ Age: _____ Highest Education Level:_____

Encountered AFE: yes or no If yes, how many?:_____

Directions: after reading each question indicate select the answer that most accurately applies to you. For questions with numerical values, an answer of 1 indicates no confidence whereas a 4 indicates complete confidence.

1. **I am able to state at least 4 risk factors that indicate a patient is a high risk for AFE**

Strongly Disagree	**Disagree**	**Agree**	**Strongly Agree**

2. I am able to state at least 4 signs and symptoms of a pt presenting with AFE.

Strongly Disagree	**Disagree**	**Agree**	**Strongly Agree**

3. On a scale of 1 to 4, 1 being no confidence and 4 being complete confidence, how would you rate your confidence with implementing appropriate treatment modalities for a patient presenting with AFE."

1	**2**	**3**	**4**
No Confidence	**Little Confidence**	**Some Confidence**	**Complete Confidence**

4. I am confident in my ability to assess a patient for an AFE.

1	**2**	**3**	**4**
No Confidence	**Little Confidence**	**Some Confidence**	**Complete Confidence**

5. I would feel comfortable caring for a patient with an AFE.

1	**2**	**3**	**4**
No Confidence	**Little Confidence**	**Some Confidence**	**Complete Confidence**

6. I am familiar with the A-OK protocol.

Strongly Disagree	**Disagree**	**Agree**	**Strongly Agree**

7. I am confident with implementing the A-OK protocol when a pt is possibly presenting with AFE.

1	2	3	4
No Confidence	**Little Confidence**	**Some Confidence**	**Complete Confidence**

8. Badge buddy reference cards aid in situations where uncommon situations occur.

Strongly Disagree	**Disagree**	**Agree**	**Strongly Agree**

9. Visual aids in operating rooms and around patient care areas serve as helpful reminders for staff.

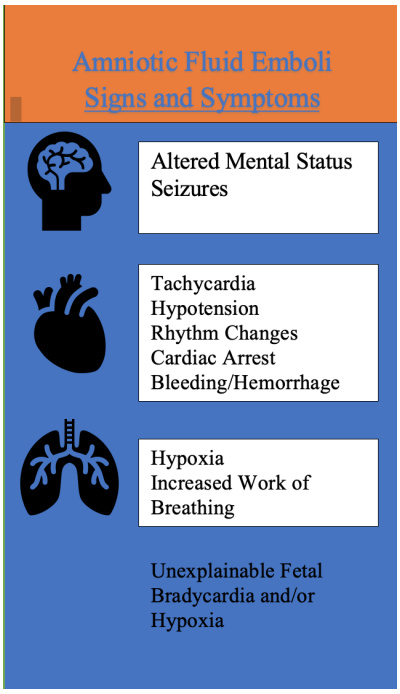
Strongly Disagree	**Disagree**	**Agree**	**Strongly Agree**

https://uncg.qualtrics.com/jfe/preview/previewId/bd031fbe-35cd-4b92-9da8-9e140ad4808e/SV_55ctbgyYW9hRpBk?Q_CHL=preview&Q_SurveyVersionID=current

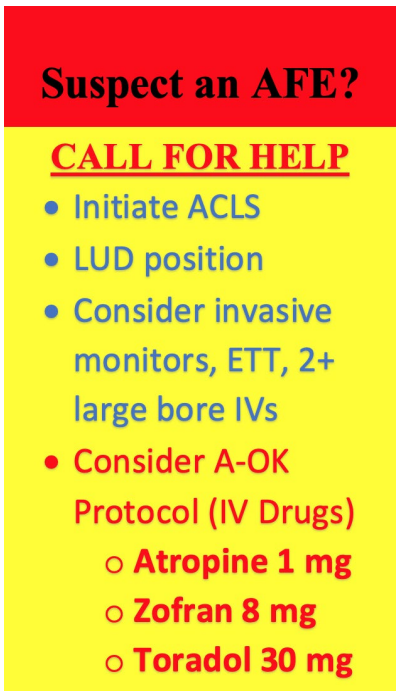
Appendix B

Badge Buddy Tool

Front


Amniotic Fluid Emboli
Signs and Symptoms
Altered Mental Status
Seizures
Tachycardia
Hypotension
Rhythm Changes
Cardiac Arrest
Bleeding/Hemorrhage
Hypoxia
Increased Work of Breathing
Unexplainable Fetal Bradycardia and/or Hypoxia

Back


Suspect an AFE?
CALL FOR HELP
Initiate ACLS
LUD position
Consider invasive monitors, ETT, 2+ large bore IVs
Consider A-OK Protocol (IV Drugs)
Atropine 1 mg
Zofran 8 mg
Toradol 30 mg