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Aerosol Spacers with Asthma Inhalers: Best Practice for School Health Nurses

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by

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Abstract

Healthcare providers do not have adequate knowledge regarding the use of aerosol spacers and asthma inhalers. Inappropriate use of asthma inhalers may lead to poor medication distribution in the lungs and poor asthma control. The utilization of aerosol spacers with asthma inhalers is shown to increase medication distribution to the lungs. Asthma is the number one chronic condition seen by school health nurses. An online learning module was created for school health nurses to reiterate the best practice use of aerosol spacers with asthma inhalers. After completion of the online learning module, school health nurses answered nine questions on an agreement Likert scale survey. Fifty school health nurses stated they gained new knowledge regarding asthma, asthma pathophysiology, and the use of an aerosol spacer with a bronchodilator/rescue inhaler. Participants also agreed they were confident in suggesting the use of and explaining the rationale behind the benefits of a spacer to students, families, and practitioners. The nurses reported recognizing the value of utilizing an aerosol spacer and stated they would promote the use of a spacer when they encountered a student with asthma.

Keywords: spacer, inhaler, asthma, school nurse, school health**,** spacer, inhaler, asthma, school nurse, and school health

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Problem Recognition

Asthma is a serious chronic lung disease for which there is no cure. Asthma makes it harder to move air in and out of the lungs and can be life-threatening if not managed properly (American Lung Association, 2020). Asthma affects 6 million children in the United States; is responsible for 545,000 emergency department visits; 90,000 hospitalizations, and greater than 13 million missed school days yearly (Lozier et al., 2019). Childhood asthma is a significant public health issue and the leading cause of chronic disease-related school absenteeism, impacting the quality of life, morbidity, and is linked to lower academic performance, particularly in urban, minority children (O'Rourke et al., 2020).

In North Carolina alone, over 105,000 children are reported to have asthma, but many of these children do not have their asthma under proper control (North Carolina Department of Health and Human Services, 2018-2019). Asthma is the most common chronic health condition reported to school nurses and is the leading cause of student absenteeism in the state (North Carolina Department of Health and Human Services, 2018-2019). Students attend school for 180 days of the year for approximately 7 hours per day. The fact that school nurses see more students with asthma than any other chronic health condition, combined with recent data suggesting one-third of school-age children live with uncontrolled asthma and can indeed die from asthma attacks, leads to the obvious need for best-practice asthma inhaler use in emergency situations (Lozier et al., 2019; North Carolina School Health Services Report, 2018-2019).

Current research suggests the use of an aerosol spacer as part of a best-practice plan for all populations but especially young children when administering emergency

asthma medications or corticosteroids with an inhaler. As reported by Rosenzweig and Nickels (2017), spacer use is important for drug delivery and can lead to improved outcomes. In fact, the efficacy of an inhaled drug to a large extent depends on the amount of drug deposited on the bronchial tree of the lungs (Plaza et al., 2018). Thus, an inadequate inhalation technique may cause insufficient drug delivery and distribution leading to an ineffective dose of inhaled medication. Next, according to the pediatric respiratory physician Dr. Richard Chavasse (2020), with guidance from the British Thoracic Society, asthma guidelines recommend the use of a spacer with children and young people and suggest it should be mandatory. Further, Chavasse (2020) notes incorrect inhaler technique contributes to morbidity and mortality and the discontinuation of spacer use is linked to a deterioration in the control of asthma or can lead to an unnecessary asthma attack. The use of a spacer corresponds to more medication in the lungs as opposed to the mouth and throat and less medication is needed to achieve an effective dose (Delicia et al., 2016). Similarly, Ming et al. (2019) concluded spacers are recommended for patients under the age of 16 as the spacer has consistently proven to decrease the medication deposited in the mouth and throat and increase the amount of medication reaching the lung.

Under a systematic review, healthcare professionals who care for patients with asthma have insufficient knowledge regarding the correct use of inhaler devices (Plaza et al., 2018). The aforementioned review from 55 studies involving 6,304 healthcare professionals suggests a substantial majority of the healthcare professionals do not use inhalers properly, including spacer use, and inhaler technique skills have worsened in recent years (Plaza et al., 2018).

In summary, uncontrolled asthma in school-age children is prevalent, school health nurses see more students with asthma than any other chronic condition, aerosol spacers are part of a best-practice protocol in controlling asthma exacerbations, and health care professionals have insufficient knowledge concerning inhaler techniques and skills. An asthma educational learning module geared towards school health nurses caring for students with asthma will increase the nurse's knowledge of best-practice aerosol inhaler and spacer techniques.

Needs Assessment

A needs assessment is necessary when conducting evidence-based research. It assists the researcher in identifying disparities between the current condition and the ideal condition of the clinical problem at hand and allows the researcher to gather the required information to develop a plan for the project (Zaccagnini & Pechacek, 2021). The clinical issue concerned the education of approximately 150 school health nurses on the appropriate use of aerosol spacers with inhalers. The PICOT statement was: In school health nurses, how does an educational learning module on aerosol spacers impact the school health nurses regarding new knowledge attained concerning asthma spacers and the confidence of the school health nurses to educate and recommend asthma spacers to students, families, and practitioners?

The stakeholders impacted by the project are numerous. The priority stakeholders affected by acquired education from the learning module were county students with asthma who encounter school health nurses. Students with asthma will potentially obtain health benefits from the best-practice use of aerosol spacers with their inhalers. Aerosol spacers allow better medication distribution to the lung tissue as opposed to the mouth

and throat (Ming et al., 2019). Better medication administration can lead to a decrease in the following: asthma attacks, missed days of school, doctor appointments, emergency room visits, and hospitalizations. In turn, the parents and family members of students with asthma were considered stakeholders as they are primary caregivers for this underage population.

The county's emergency rooms, pediatricians, and asthma specialists were stakeholders impacted by the project. The project leader collaborated with a local asthma specialist for the project. School health nurses with current best-practice education can distribute their renewed or newly acquired knowledge to families and students leading to better asthma control and fewer asthma attacks. Managing asthma in school-age children will lessen the burden on families, emergency departments, and pediatrician offices.

Another group of stakeholders was school health nurses and the health department for which they work. Although asthma is the number one chronic condition seen by school health nurses, it is not the only health condition encountered. School health nurses are consumed by a variety of responsibilities such as acute illnesses or injuries, type 1 diabetes, immunization requirements, and mental health concerns. Providing school health nurses with current best-practice information regarding the use of asthma aerosol spacers in an educational learning module will potentially be impactful to the nurse's workday when they encounter students with asthma. The learning module provided nurses the knowledge and confidence to educate students and families on asthma spacers and advocate for their use with practitioners. The health department benefited from the project by having 50 of their employees educated on the best-practice use of spacers for students with asthma. Working with a local asthma specialist stakeholder allowed the

practitioner to have input on the project ensuring their voice was heard by all school health nurses. The practitioner benefited by reaching a captive audience of school health nurses who in turn impact the school-age community.

When conducting an organizational assessment, it was noted the health department and school health program share mission and vision commonalities with the educational project. The school health program supported the county's school system through health education, maximizing student participation in school, improving the quality of students' lives, and fostering lifelong health skills (Mecklenburg County Government, 2020b). Asthma is a chronic lifelong illness requiring education from health professionals to improve a student's quality of life and minimize missed school days to due asthma flare-ups. The mission of the health department was to protect the public's health and the vision of the health department commits to assuring health for future generations (Mecklenburg County Government, 2020a). The project served to affect the public health of asthmatic school-age students with valuable best-practice information to be carried throughout their lifetime as a person with asthma.

As an organization, the health department had many positive attributes that were helpful to achieve the project objective. One major strength of the organization was the support the project leader received from the leadership team of nurses. Their willingness allowed a Doctor of Nursing Practice (DNP) student to work with the school health nurses leading to a successful first step in planning the project. Another strength included the quantity of school health nurses available to participate in the project. There were approximately 150 school health nurses who were asked to participate in the educational module. The potential high number of participants allowed for stronger data collection

and analysis. Another strength the project leader indicated was the project was completed remotely.

The culture of the school health department was one of positivity and encouragement of lifelong learning for their staff and nurses. The health department supported the remote learning module and had full comprehension that the project leader would not be on their facility grounds or in schools with nurses during COVID-19 restrictions. The school health leadership team appreciated the opportunity to host a DNP student and be part of active learning and research. Nursing is a profession of lifelong learning and the school health nurses were a captive audience who require yearly educational experiences.

A potential organizational weakness arose from a discussion with the Director of Nursing (DON) at the Health Department. A few months into the project creation, the DON asked if the project topic was firm or up for discussion. Not wanting to disturb the positive direction of the project, the project leader stated the topic was open to further ideas from the assigned school health nurse supervisor. The project leader was aware that organizations are often not open to admitting or recognizing their system may have flaws and need improvements. It was believed the DON at the Health Department felt the school health nurses had all the information they needed regarding aerosol inhalers and would not require additional education on the topic. The project leader learned from personal communication with nurses in the health department school health division there was a place for the educational project being presented. The project leader used information from personal communication and research to explain that healthcare providers, in general, are not utilizing asthma equipment to include spacers correctly

(Plaza et al., 2018). Also, the project leader explained how research indicated that inhaler misuse is among the most important modifiable risk factors for uncontrolled asthma but can be corrected with appropriate education on proper inhaler technique (Gleeson et al., 2020).

An important opportunity the project leader encountered involved contact with a nurse who was a member of the county asthma coalition. The nurse connected the project leader with researchers and practitioners in asthma-related fields. Partnership with the additional asthma specialist assisted the project leader with achieving project objectives. The project leader leveraged the communications with the researchers and asthma coalition to bring validity to the project as the project leader continued to work with the health department leaders. Another value-adding opportunity came in the form of local statistical data stating over 105,000 children were reported to have asthma in North Carolina (North Carolina Department of Health and Human Services, 2018-2019). Additionally, asthma is the number one chronic disease among students in the county with over 6,500 students in the school district diagnosed with asthma (Asthma Community Network, 2020). The strong statistical data supported the value of and need for an educational learning project on the use of aerosol spacers with asthma inhalers.

A potential threat to the project included the idea that the work responsibilities of the committee members could drastically change due to the COVID-19 pandemic. For example, if the committee members no longer had time to participate due to work obligations or a change in a job position. The project leader leveraged the strength of remote communication to minimize the impact of the threat. The project leader set up brief, concise virtual communication meetings so as not to require an abundant amount of

the committee members' time. The project leader worked efficiently to not unnecessarily waste their time.

Due to the nature of the remote learning project, the resources needed were minimal. The project leader created an online learning module from home, using a personal computer and equipment. Communication resources were readily available with nurses and committee members by email, phone, and zoom conferencing. The project leader utilized the SurveyMonkey® survey application for data analysis support. The nurses who participated in the project were encouraged to complete the module as a part of their yearly education. Despite strict restrictions in place for COVID-19, the online remote learning module was created and distributed without difficulty and with minimal outside resources.

The desired outcome of the project was to determine if school health nurses would gain new knowledge regarding asthma and the best-practice use of aerosol spacers with asthma inhalers, would recognize the value of utilizing a spacer with an asthma inhaler, and would have the confidence to suggest the use of and explain the rationale behind the use of a spacer with an asthma inhaler. A 9-question Likert scale agreement survey was utilized after the module completion to determine if the outcomes were met. The project leader expected the outcome to show an increase in knowledge concerning asthma and the aerosol spacer use with asthma, a recognition of the value of utilizing a spacer with an asthma inhaler, a strong likelihood to suggest the use of and explain the rationale behind the use of a spacer with an inhaler to students, families, and practitioners. In short, the expected outcome was: school health nurses will gain new knowledge regarding asthma and the best-practice use of aerosol spacers with asthma

inhalers, will recognize the value of utilizing a spacer with an asthma inhaler, and have the confidence to suggest the use of and explain the rationale behind the use of a spacer with an asthma inhaler.

The full DNP project team included the Associate Professor of Nursing as the Project Chair from the University. The practice learning environment was a local county health department. The Project Practice Partner was a master's prepared registered nurse serving as the Director of Nursing for the Health Department. Another committee member included a master's prepared registered nurse serving as a School Health Supervisor MSN, RN. The second project committee member was both a published Physician's Assistant working in family medicine who also was a Clinical Associate Professor at a University.

The costs associated with the project were minimal. Distribution of the educational learning module, as well as the post-module survey, took place electronically. The Project Leader utilized the Canva platform at no cost and the SurveyMonkey® tool for data collection and analysis for $400. Communication with team members took place by email, phone calls, or zoom conferences. The project leader completed the project on a personal computer with personal internet services.

The benefits anticipated as a result of the successful implementation of the project were boundless. With up to 150 school health nurses participating in the learning module, representing approximately 175 schools and thousands of students, the best-practice information regarding aerosol spacers for asthma inhaler use can save lives. Although asthma is a chronic condition, the inflammatory bronchial constriction that occurs during an asthma exacerbation can lead to decreased airflow via ventilation. The lack of oxygen

to the brain and other organs causes respiratory distress which can lead to acute respiratory failure and even death. Currently, the school health nurses receive asthma education as part of their new-hire orientation process but do not receive mandatory annual asthma education and updates. Knowing how to use an aerosol spacer with an asthma inhaler for better concentration and distribution of medication can lead to better asthma control, fewer missed days of school, and fewer emergency room visits for the county's student population. If the project were utilized as a yearly requirement, the impact could be broad-reaching for years to come.

When weighing the cost of the project versus the benefits, both short and long term, the benefits prevail. The costs were minimum and the benefits outweighed the costs exponentially. The project leader believed the project was a worthwhile investment of time, energy, and cost. Although the educational learning project seemed simple, the potential influence can be far-reaching, longstanding, and even lifesaving.

In conclusion, the scope of the educational learning module on aerosol spacers for asthma inhalers provided up-to-date best-practice instruction for school health nurses at the county health department in a convenient online module. The learning module did not certify school health nurses would transfer the information they gained to their assigned students or student families. The project did not ensure school health nurses would answer the post-module survey questions with honesty. The project did not suggest knowledge alone would save the life of someone having an asthma exacerbation. However, the project did suggest school health nurses gained new knowledge on asthma and aerosol spacers saw the value in using an aerosol spacer with an asthma inhaler, and

suggested school health nurses are likely to recommend aerosol spacers to students and families.

Literature Review

A review of the literature was conducted using the database Proquest. Keywords used for searching appropriate articles included spacer, inhaler, asthma, school nurse, and school health.

Articles published between the years 2015-2020 were sought out and included. Findings indicated health professionals lacked appropriate knowledge regarding the best-practice use of aerosol spacers with asthma inhalers were strengths from the articles. Areas of weakness were also discovered and included very few articles specifically researching the use of aerosol inhalers with asthma spacers.

Table 1

Articles Published Between 2015-2020

Citation	Purpose of Study	Methods	Findings
Lozier, M., Zahran, H. & Bailey, C. (2019) Assessing health outcomes, quality of life, and healthcare use among school-age children with asthma	Explore information on the relationship between asthma control and quality of life indicators and health care use among school-age children	Multivariable logistic regression models examined asthma control and asthma attack status among school-age children with asthma from 35 states and the District of Columbia.	One-third had uncontrolled asthma. 56.8% reported ≥1 asthma attack in the past year. The above results were significantly associated with activity limitation missed school, ED visits, and hospitalizations Long-term control medication use was higher among respondents with uncontrolled asthma

Citation	Purpose of Study	Methods	Findings
Chavasse, R. (2020). Hold that space(r): asthma in the press.	Document the frequency of images using incorrect inhaler techniques/no spacer use	Searched popular national news sites for images. Assessed for age of the subject, inhaled medication, and device.	46 of 51 photos (90%) showed the child using an inhaler without a spacer
Ming, S., Haughney, K., Ryan, D., Patel, S., Ochel, M., d'Alcontres, M., Kocks, J., Thornhill, S., Price, D. (2019). Comparison of adverse events associated with different spacers used with non-extra-fine beclometasone dipropionate for asthma.	To compare inhaled corticosteroid-related adverse events between patients co-prescribed Aerochamber compared to the licensed Volumatic® spacer.	Marginal effect estimate (MEE) was calculated from questionnaire-based and electronic medical record (EMR)-based on adverse events. 1471 matched pairs of subjects.	Total adverse events did not differ significantly between Aerochamber and Volumatic. Did not show a significantly different number of EMR-recorded adverse events between Aerochamber and Volumatic. Co-prescribing Aerochamber with non-EF BDP does not increase the risk for patient-reported and EMR-recorded ICS-related adverse events compared to co-prescribing Volumatic.
Delicia, E. S., Krishnakumar, K., Jayaprakash, K., & Panayappan, L. (2016). An add-on part for Asthma Inhalers.	Compare 2 inhalation methods when using a pressurized metered-dose inhaler with valved holding chamber.	A Randomized Controlled Trial	Less medication is needed for an effective dose to reach the lungs. Fewer side effects from corticosteroid residue in the mouth.
Plaza, V., Giner, J., Rodrigo, G. J., Dolovich, M. B., &	Assess the inhaler technique	Systematic review of 55 studies	Inhaler technique was considered correct in 15.5% of

Citation	Purpose of Study	Methods	Findings
Sanchis, J. (2018). Errors in the use of inhalers by health care professionals: A systematic review.	proficiency of HCPs in using pressurized metered dose and dry powder inhalers.	published between 1975 and 2014 that directly assessed the inhaler technique skills involving 6,304 HCPs who performed 9,996 tests	cases decreasing over time from 20.5% from the early period to 10.8%
Rosenzweig, D. & Nickels, A. S. (2017). #Asthma #Inhaler: Evaluation of visual social media depictions of inhalers and spacers.	Characterize the visual depiction of inhalers on 3 prominent social media sites (Facebook, Twitter, and Instagram) Hypothesized that spacer use would be depicted in the minority of photos showing inhalers.	Observational study daily for 3 days on 2 separate occasions using the hashtags #asthma and #inhaler. Native search engines and service TwiPho (photo search) of 3600 photos were screened Photos with inhalers were included in the analysis.	Depictions of inhalers on social media infrequently include spacers
O'Rourke, A., Zimmerman, A., Platt, H., & Pappalardo, A. (2020). Preventing asthma emergencies in schools.	Describe the current state of asthma in Illinois, an innovative policy solution to address asthma emergencies in schools, and the steps taken to advocate for stock asthma rescue medication in Illinois.	Case Study	Stock Asthma Rescue Medication in Schools was signed into law by the governor of Illinois in August 2018. Public Act 100-0726 went into effect on January 1, 2019.
Barsky, E., Giancola, L., Baxi, S., Gaffin, J. (2017)	Highlights necessary	Pragmatic Review	Successful management involves

Citation	Purpose of Study	Methods	Findings
A practical approach to severe asthma in children	steps to ensure proper diagnosis and effective management, discusses current areas of debate in the characterization of asthma, and provides updated information on U.S. Food and Drug Administration (FDA)–approved therapeutics		optimization of medication delivery, comorbidities, the school, and home environment, and targeted individualized therapies, including the use of newer steroid-sparing agents such as biologics and tiotropium. Practical application of these principles require a multidisciplinary approach that can assess and intervene to improve the patient's asthma in the clinical, home, and, often, school environment.
J., Gerald, Brown, M., Billheimer, D., C., Fisher, J., Clemens, C., Moore, M., Carvajal, S., Bryson, D., Stefan, N., Gerald, L. (2017) Supervised asthma medicine in schools: The Sams Study	To determine if 1 year of treatment with students in immediate intervention schools would achieve lower (better) scores on the Juniper Asthma Control (ACQ) questionnaire than students in delayed intervention schools.	The Supervised Asthma Medicine in Schools (SAMS) study was a prospective, parallel-group, delayed intervention, randomized controlled trial of a comprehensive school-based asthma program.	No differences in ACQ scores were observed between children assigned to the immediate and delayed intervention groups
Bowman, A., Copeland, D., Miller, K. (2020) Asthma health	Provide an overview of current health	Policy and Best Practice Review	NPs are in a pivotal role to advocate for comprehensive

Citation	Purpose of Study	Methods	Findings
policies in schools: Implications for nurse practitioners	policies and to discuss methods for advocacy in policy development and implementation of asthma-related guidelines for nurse practitioners (NPs), school nurses, and other school and health care professionals.		policies addressing school-based asthma care. Likewise, these policies should complement and inform the practice of pediatric-focused NPs to ensure they are providing families with the knowledge and resources to manage this chronic disease and its exacerbations.
Winter, B. & Carlton, E. (2019) Efficacy of different techniques using a metered-dose inhaler with Spacer to relieve symptoms in children with acute asthma	To establish which inhaler with spacer technique provides the greatest improvement in symptoms in children with acute asthma.	Shortcut review, four papers	Tidal breathing technique, with a minimum of three breaths per inhaler activation, is likely equivalent in efficacy to a single breath and hold technique, and easier for a breathless child to perform.
Gleeson, P., Feldman, S., & Apter, A. (2020) Controller inhalers: Overview of devices, instructions for use, errors, and interventions to improve technique	Summarizes the literature on inhaler design, use, and interventions to improve technique. The aim is to help clinicians identify patients with poor inhaler technique, recognize the most important errors, and correct techniques using evidence-based	Clinical Commentary Review	Ongoing research in inhaler design and use, and durable educational interventions aimed at the most vulnerable patients is needed to ensure optimal drug delivery of inhaled medication.

Citation	Purpose of Study	Methods	Findings
	interventions.		
(2018) Top 5 back-to-school asthma management tips from the American Lung Association	Provide Asthma Management tips	Informational	Have an asthma action plan, parents should ensure the child knows how to use medication, take preventive allergy measures, perform self carry assessment tool, ensure clean air at home
Perry, T., Turner, J. (2019) School-based telemedicine for asthma management	Discuss the potential benefits of school-based asthma telemedicine programs, explore potential implementation models, and provide a comprehensive review of the literature including programs that use telemedicine in schools to assist with the management of asthma.	Literature Review	Telemedicine is a feasible approach to increasing access to primary and specialty asthma care; however, there is a need for future randomized trials to establish best practices for implementation of telemedicine programs to aid in the care for children in school settings.
Burudpakdee, C., Kushnarev, V., Coppolo, D., & Suggett, J. (2017) A retrospective study of the effectiveness of the AeroChamber Plus Flow-Vu Antistatic Valved Holding Chamber for asthma control	Compare AeroChamber Plus Flow Vu Antistatic Valved Holding Chamber (AC-FV AVHC) with non-antistatic control VHCs in terms of asthma exacerbations,	Retrospective data-based	The AC-FV AVHC was associated with lower exacerbation rates, delayed time to first exacerbation, and lower exacerbation-related costs when compared to control non-antistatic VHCs.

Citation	Purpose of Study	Methods	Findings
	resource use, and cost in an asthma population		
Callaghan, C., Smith, N., Barry, P., Denyer, J. (2017) Development of an intelligent spacer data logger system	Develop a Spacer Data Logger device to record patient adherence and whether patients had shaken the pMDI, actuated it soon after shaking, and inhaled a sufficient volume from it.	Descriprive Comparison	Confirmed the importance of using the pMDI spacer correctly by actuating directly after shaking and inhaling the aerosol from the spacer as soon after actuation as possible to optimize the dose available for inhalation.

Goals, Objectives, and Mission Statement

The goal and purpose of the project were school health nurses will: gain new knowledge regarding asthma and the best-practice use of aerosol spacers with asthma inhalers, recognize the value of utilizing a spacer with an asthma inhaler, and have the confidence to suggest the use of and explain the rationale behind the use of a spacer with an asthma inhaler.

The objectives needed to reach the goal were multifaceted. The outcomes objective was: after completing the educational module on best-practice use of aerosol inhalers, the school health nurses will express an increase in knowledge regarding asthma and the best-practice use of aerosol spacers with asthma inhalers demonstrated from their responses in an online survey utilizing a Likert Scale while acknowledging the value of utilizing a spacer and expressing the confidence to suggest the use of and explain the rationale behind the use of a spacer on the Likert scale survey. The process outcomes

listed below included specific steps the project leader took to achieve the outcome objective.

Process Outcome

- The project leader would secure a full project team/committee by September 30, 2020.
- The project leader would complete DNP project Theoretical Underpinnings, by September 20, 2020.
- The project leader would complete DNP project Work Planning, by September 30, 2020.
- The project leader would complete the DNP project Planning for Evaluation by October 16, 2020.
- The project leader would incorporate feedback from the DNP Project Chair, finalize the DNP Project Proposal for approval, and prepare to submit it to IRB by October 31, 2020.
- The project leader would complete DNP project Implementation by March 31, 2021.
- The project leader would complete the DNP project Interpretation of the Data by May 31, 2021.
- The project leader would complete the DNP project Utilization and Reporting of Results by June 27, 2021.

Mission

The mission of the project was to promote superior inhaler medication distribution to the lungs of school-age students with asthma to prevent asthma flare-ups, reduce student absenteeism, and decrease emergency room visits.

Theoretical Underpinnings

A scholarly DNP project requires a solid theoretical foundation. Theoretical underpinnings create a framework for the DNP student to utilize as a guide when planning the project steps. The theory that guided this DNP project, a learning module intended for school health nurses, was Knowles' Adult Learning Theory. Knowles' andragogy theory gives insight into the principles of adult learning by understanding adult learners need collaborative and interactive learning experiences that will apply to their real-world problems (Allen, 2016).

Knowles introduced the term andragogy, the art, and science of teaching adults, in the United States in the1970s. Before this, the term pedagogy had been utilized in the United States to describe the art and science of teaching children. In education, pedagogy describes an educational system whereby the teacher has control and responsibility for the full aspects of learning to include content, evaluation, and teaching strategies (Utley, 2011). Knowles' term andragogy recognizes adults have unique and different learning needs compared to children. The term adult, according to Knowles, is defined from a psychological perspective as a person who performs roles in society that demonstrate personal responsibility such as an employee or citizen (Utley, 2011). When first introduced, the idea of andragogy was groundbreaking, sparking research and

controversy (Knowles et al., 2015). Knowles' ideas triggered revolutionary thoughts in adult education and workplace learning.

The Adult Learning Theory and its assumptions were significant to nursing and this project as nurses in the workplace must keep up with continuing education for the entirety of their careers. One of the Adult Learning Theory assumptions was the idea of self-concept. Knowles notes adults move from being dependent on others to self-direction as they mature (Kurt, 2020). This assumption resembles Benner's Novice to Expert model in nursing. Benner's model notes how nurses developed skills and understanding of patient care over time while moving through five stages of proficiency. The Benner stages favor the Adult Learning Theory's idea of adult learners becoming more independent and self-directed in their thinking as the nurse does when moving through the Novice to Expert stages (Kurt, 2020). Knowles viewed becoming an adult as a process that is achieved by stages as the individual learner accepts increasing responsibility for their life and becomes self-directed whereby Benner's five stages mirrored this process as the nurse moves from novice, advanced beginner, competent, proficient, and finally, expert (Utley, 2011).

Another way the Adult Learning Theory is significant to nursing can be observed in Knowles' assumption that adult learners have a "need to know" attitude. Nurses learn to critically think and use clinical judgment about patient situations from data collection via health assessment and analyzing diagnostic data. According to Knowles, adult learners need to know the why, what, and how of a situation as well as pull out the valuable and useful portions of what is being taught (Utley, 2011). Similarly, nurses must

sift through a variety of data to determine what is the most important “need to know” information to care for a client.

Other assumptions of Knowles’ focus were the adult learner’s readiness to learn and orientation to learning. According to Knowles, an adult’s readiness to learn is enhanced by their need to acquire knowledge and skills for new roles such as a new career (Utley, 2011). Nurses are in a never-ending state of learning from the moment they step out as new graduates. Nurses must maintain a state of readiness to acquire new knowledge and skills throughout their careers. The need to be safe patient care providers and patient advocates enhances a nurse’s readiness to learn new concepts or skills throughout their career. Secondarily, Knowles’ “orientation to learning” assumption describes how adults are problem-centered learners as opposed to subject-centered learners as problem-centered learning provides more meaning to them (Utley, 2011). This assumption corresponds to how nurses use the nursing process and critical thinking along with clinical judgment in decision-making regarding a patient-centered problem. Nurses are trained to weed through data to identify problems in need of nursing or medical interventions.

The project leader’s doctoral project was a learning module aimed at school health nurses who cared for students with asthma. The project leader applied the Knowles Adult Learning Theory when creating the learning module. Specifically, the project leader started by presenting the module topic as relevant and useful to their careers as school health nurses by providing the most recent data on school health asthma encounters across North Carolina along with data surrounding missed school days and hospitalization from childhood asthma. Knowles posits that adult learners retain

information best when it is relevant and useful to them and teachers should explain the reason for learning the topic (Kurt, 2020). The module provided data-driven background information that tapped into an adult's intrinsic motivation to learn (Kurt, 2020). By creating a self-paced learning module, the project leader applied Knowles' idea that the success of an adult learning program relied on autonomous, self-directed learning that challenged the adult learner at their intellectual ability (Kurt, 2020).

As indicated by Knowles, self-directed adult learners like to take the initiative to assess their own needs and create goals (Kurt, 2020). The intrinsic motivation of an adult learner prompts the nurse to examine their present knowledge level and prepares them to gain new knowledge or build upon what they already know. The learning module presented a problem, which in short was the need for additional asthma and inhaler/spacer education. The project leader presented the problem as relevant and useful to their chosen career as a school health nurse per the assumptions and principles of the adult learner (Utley, 2011).

Nurses in all work settings are subjected to continuing education and adult learning for the entirety of their careers. The project leader utilized Knowles' Adult Learning Theory, andragogy, along with its assumptions to guide the doctoral project. The learning module for school health nurses followed learning theory principles for adult learners. This learning module ensured up-to-date best-practice information was shared regarding asthma inhalers and spacers.

Work Planning

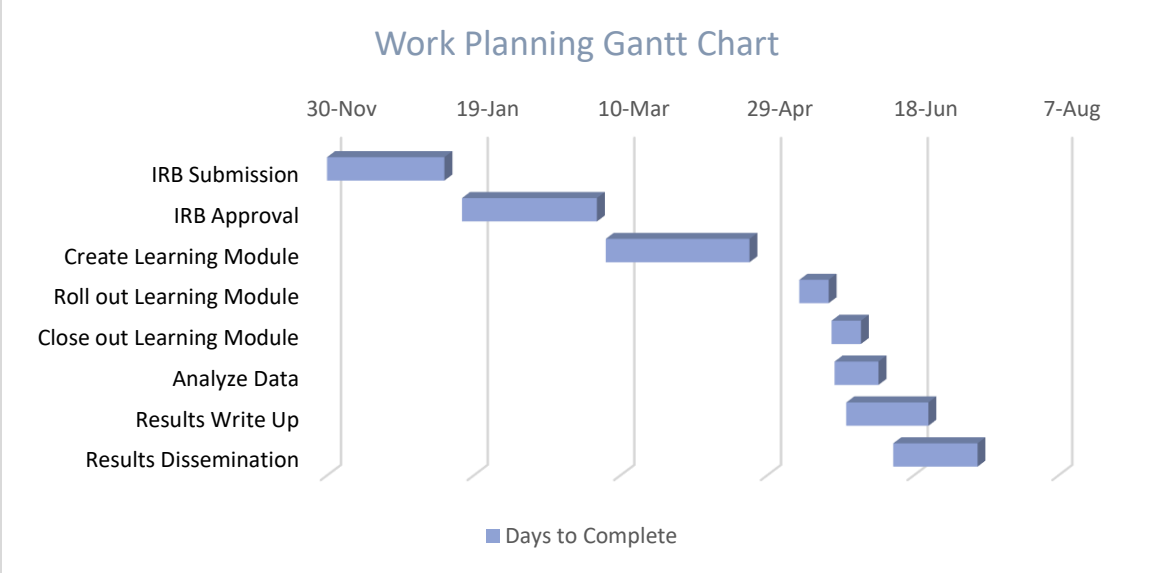
The DNP project offered a learning module to school health nurses in a large urban county in North Carolina. The learning module offered background information regarding asthma and school-age students to include research stating asthma is the most common chronic health condition reported to school nurses and is the leading cause of student absenteeism in the state (North Carolina Department of Health and Human Services, 2018-2019). In addition, recent data suggesting one-third of school-age children live with uncontrolled asthma was included in the module to reiterate the need for the Project Leader's chosen topic (Lozier et al., 2019). A large systematic review from 55 studies involving 6,304 healthcare professionals suggested a substantial majority of the healthcare professionals do not use inhalers properly, including spacer use, and inhaler technique skills have worsened in recent years (Plaza et al., 2018). Thus the project leader's clinical problem for quality improvement was "nurses have inadequate knowledge of the use of asthma inhalers and spacers." The project leader developed a learning module on the use of asthma inhalers and spacers aimed towards school health nurses. After completing the learning module, the school health nurses completed a 9-question agreement Likert scale survey for data collection.

The major milestones of the project included, Institutional Review Board (IRB) submission, IRB approval, creation of the learning module, offering of the module to school health nurses, data analysis, results write-up, and dissemination. The timeline began with the project leader's submission to IRB by November 30th, 2020, and receiving IRB approval by mid-January of 2021. The project leader created and rolled out the learning module in mid-May 2021. Data analysis and results write-up took place from

May-July of 2021. Project results were disseminated via written, oral, and electronic dissemination in July 2021. For the DNP Project, the project leader utilized the Excel Gantt chart, Figure 1, to assist with project management.

Figure 1

Work Planning Gantt Chart



Developing and maintaining a budget is an important step when developing a doctoral project. When considering the budget for this project, the resources needed were minimal due to the nature of the remote learning project. Because the project leader created an online learning module in Canva from their home, using their personal computer, and equipment, there were no costs associated with creating the project.

Although the project leader did spend $400 for a year's subscription to SurveyMonkey® for data collection and analysis. Communication resources were readily available with nurses and committee members via email, phone, or zoom conferencing. The nurses participated in the project voluntarily and required no compensation. Despite

strict restrictions in place for COVID-19, the online remote learning module was created and distributed without difficulty and budgetary needs.

Planning for Evaluation

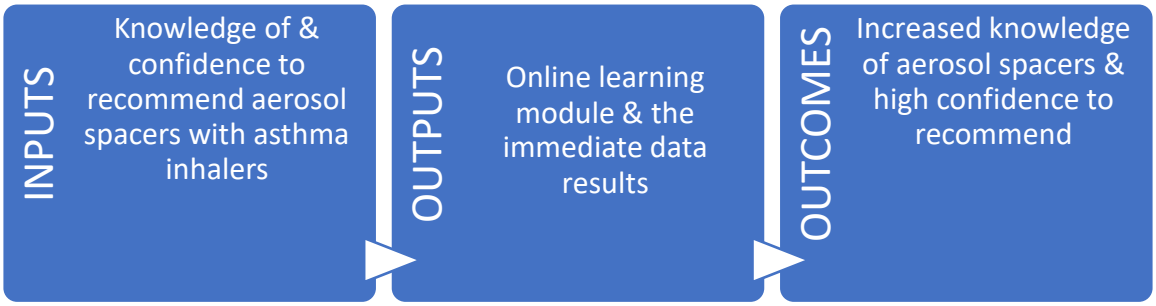
Planning for the evaluation of the outcomes for the DNP project was a foundational step in the undertaking. The evaluation provides clarity for the project while measuring outcomes determines whether the project is successful (Zaccagnini et al., 2021). The project leader collected data to measure agreement in school health nurses regarding new knowledge attained concerning asthma spacers and the confidence school health nurses demonstrate to recommend asthma spacers to students, families, and practitioners after completing an online learning module.

At first creation, the clinical quality improvement project would have assessed school nurses' knowledge of the online learning module content twice and compared the results. There was early planning for a pre-and post-test questionnaire to assist with evaluating the outcomes. But, as the project progressed, the evaluation method was modified to a 9-question Likert scale evaluation questionnaire to be administered once after the completion of the online learning module. The outcomes the project leader hoped to achieve were increased knowledge of and a high confidence level to recommend aerosol spacers by the school nurses.

The following logic model demonstrated how the program worked. The inputs encompassed knowledge of and confidence to recommend aerosol spacers with asthma inhalers. The outputs included the online learning module and the immediate data results. The outcomes entailed increased knowledge of aerosol spacers and high confidence to recommend.

Figure 2

Inputs, Outputs, and Outcomes



A Likert scale uses a numerical series to represent possible responses along a continuum (Emerson, 2017). Data collection via a Likert scale is easy to collect and report. The Likert scale for the DNP project had an odd number of response categories as this served the purpose of providing a central neutral response and an equal number of positive and negative responses above and below the neutral point (Emerson, 2017). The Likert scale assigned numbers 1-5 as follows: (1) Strongly Disagree, (2) Disagree, (3) Undecided, (4) Agree, and (5) Strongly Agree.

As stated, the project leader created an evaluation plan to identify the effectiveness of the DNP project implementation. The DNP project focused on the amount of knowledge and confidence levels concerning asthma aerosol spacers. The evaluation plan consisted of nine Likert scale questions administered to school health nurses after the completion of the online learning module, also created by the project leader. The project leader hoped the new knowledge would ingrain the use of aerosol spacers with asthma inhalers into the framework of the school health nurses' professional practice.

Implementation

Implementing the DNP project was an exciting effort. The project leader received DNP project approval from the IRB at the University and approval from the research committee at the facility used for implementation. After weeks of planning, recording the online learning module, and waiting for IRB and Research Committee approval, the project leader began implementation of the online learning module to the selected school health nurses in May 2021. An email explaining the DNP project, an invitation to participate, informed consent, and links to the online learning module were sent out by a member of the project leader's DNP committee to potential participants.

Threats and Barriers

A threat to the project included extended time in the IRB and research committee approval process. A barrier to the project was the lack of participation by the school health nurses as there were 50 participants out of approximately 150 school health nurses. The lower than anticipated response rate may have been due to the timing of project implementation in relation to the school health nurses' academic school year and other activities. Implementing the project in May of the academic school year posed a challenge as there are many end-of-year meetings and responsibilities for the school health nurses.

An unforeseen threat was discovered just before the project roll-out. A county survey was to be emailed out to the potential project participants on the same date selected as the DNP project implementation date. It was decided to remain with the original DNP project implementation date due to the county survey remaining open for 3 weeks. An additional threat as discussed in the Monitoring and Implementation section

was the fact that two additional important emails, one regarding nurse's week and the other from the School Health Nursing Leadership Team were sent out on the same day as the initial project email. Thus, fewer results were gathered during the first 5 days of the project than expected.

Monitoring and Implementation

The Project Leader utilized SurveyMonkey® to monitor the number of school health nurses who completed the learning module. The post-learning module survey completion data provided by SurveyMonkey® gave the project leader insight as to how many nurses were viewing and participating in the project daily. On the third day of project implementation, there were 19 completed post-learning module surveys. In a follow-up discussion with the DNP committee member employed at the implementation facility, it was discovered the potential participants not only received the county-wide employee survey via email but also two emails regarding nurse's week and an email from the school health nursing leadership team on the same day. Thus, the DNP project email was one of many emails received by potential participants on the date of implementation.

On day 5 of implementation, an email reminder containing the previous project information was sent to the school health nurses by the selected committee member. The email was sent out on a Friday. Sending the email reminder out on a Friday as opposed to a Monday was a beneficial strategy to attract attention and participation. The second 5 days of implementation resulted in over double the number of participants compared to the first 5 days.

Project Closure

The implementation phase of the DNP project closed 10 working days after implementation began. Survey responses were gathered from 50 school health nurses. The survey collection was closed for future responses on the SurveyMonkey® website. An email was sent to the DNP committee member employed at the implementation facility thanking them for their efforts and participation in the project. The project leader also informed the committee member of the final number of survey participants and provided the project survey results.

Reflecting on the project implementation phase, the project leader recognized having an anonymous learning module and anonymous survey left the project leader in the background during the implementation phase. Although the project leader knew anonymity was the best option, it was difficult to remain mostly idle during the implementation of the project. The project leader trusted in the judgment of the committee member at the implementation facility.

Interpretation of Data

The DNP research study was conducted using a quantitative design approach to examine school health nurse's knowledge of asthma and the use of aerosol spacers. A 9-question survey using a Likert scale was used as the post-learning module survey to determine if there was an increase in school health nurse's knowledge of asthma and aerosol spacers, an increase in confidence levels to recommend aerosol spacers, and an increase in confidence levels to teach the benefits of an aerosol spacer to students, families, and practitioners of school-age students after the completion of an online

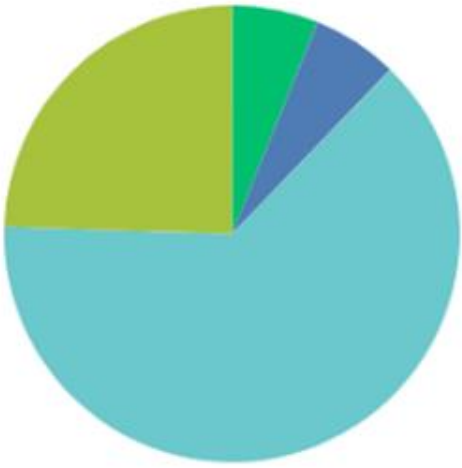
learning module. The online product SurveyMonkey® was utilized to collect data and analyze the results.

Quantitative Data

A total of 50 school health nurses participated in the learning module and subsequent post-module survey**.** Each of the nine Likert scale questions from the survey offered insight into answering the DNP project question. Question 1 investigated gaining new knowledge regarding asthma in school-age students. A total of 12 nurses (24.49%) strongly agreed with question 1 while 31 nurses (63.27%) agreed with the statement. Of the participants, three nurses (6.12%) disagreed with question 1 while three nurses (6.12%) strongly disagreed. One participant did not respond to question 1.

Figure 3

Question 1 Results



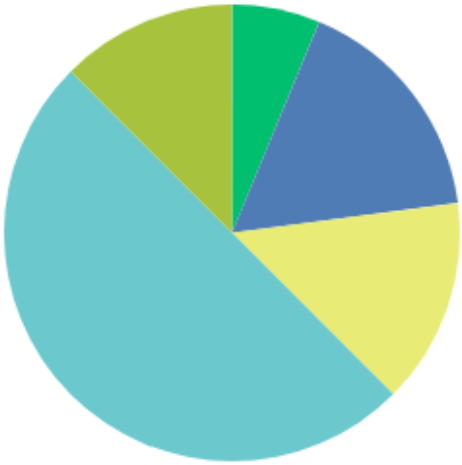
Strongly Disagree Disagree Undecided Agree Strongly Agree

	STRONGLY DISAGREE	DISAGREE	UNDECIDED	AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
School Health Nurses	6.12% 3	6.12% 3	0.00% 0	63.27% 31	24.49% 12	49	3.94

Question 2 inquired about gaining new knowledge regarding the pathophysiology of asthma. There were six nurses (12.5%) who strongly agreed with question 2 while 24 nurses (50%) agreed with the statement. Of the participants, seven nurses were undecided regarding question 2. A total of eight nurses (16.67%) disagreed with question 2 while three nurses (6.25%) strongly disagreed. Two participants did not respond to question 2.

Figure 4

Question 2 Results



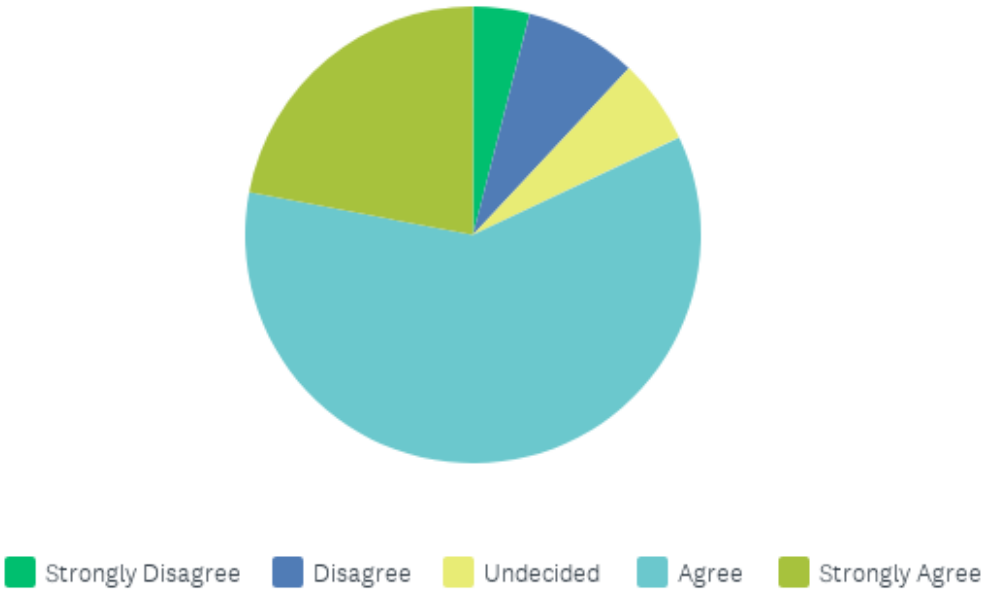
Strongly Disagree Disagree Undecided Agree Strongly Agree

	STRONGLY DISAGREE	DISAGREE	UNDECIDED	AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
School Health Nurses	6.25% 3	16.67% 8	14.58% 7	50.00% 24	12.50% 6	48	3.46

Question 3 examined gaining knowledge regarding the use of an aerosol spacer with an inhaler for students with asthma. A total of 11 nurses (22%) strongly agreed with question 3 while 30 nurses (60%) agreed with the statement. There were three nurses (6%) undecided regarding question 3. Four nurses (8%) disagreed with question 3 while two nurses (4%) strongly disagreed. All participants responded to question 3.

Figure 5

Question 3 Results

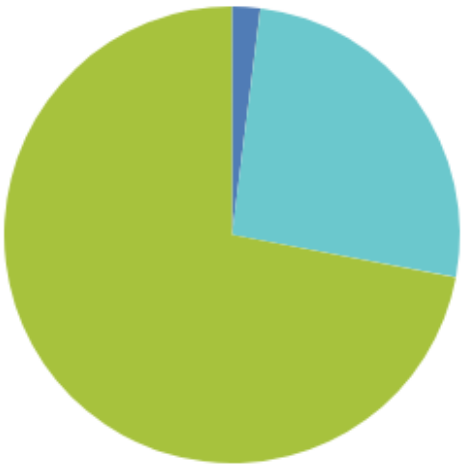


	STRONGLY DISAGREE	DISAGREE	UNDECIDED	AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
School Health Nurses	4.00% 2	8.00% 4	6.00% 3	60.00% 30	22.00% 11	50	3.88

Question 4 explored recognizing the value of utilizing an aerosol spacer with an asthma inhaler. There were 36 nurses (72%) who strongly agreed with question 4 while 13 nurses (26%) agreed with the statement. No participants chose undecided for question 4. Of the participants, one nurse (2%) disagreed with question 4 while zero nurses (0%) strongly disagreed. All participants responded to question 4.

Figure 6

Question 4 Results



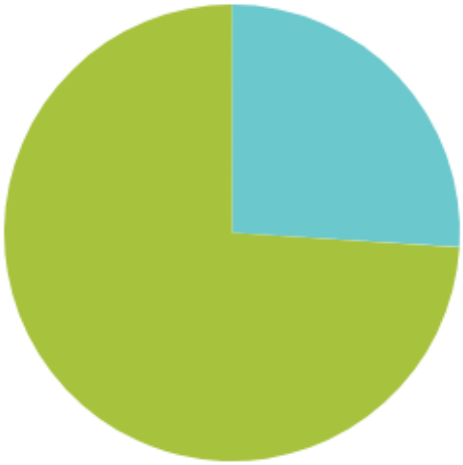
Strongly Disagree Disagree Undecided Agree Strongly Agree

	STRONGLY DISAGREE	DISAGREE	UNDECIDED	AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
School Health Nurses	0.00% 0	2.00% 1	0.00% 0	26.00% 13	72.00% 36	50	4.68

Question 5 inquired about participant confidence in suggesting the use of an aerosol spacer with an asthma inhaler to a student and their family. Of the participants, 37 nurses (74%) strongly agreed with question 5 while 13 nurses (26%) agreed with the statement. No participants chose undecided, disagree, or strongly disagree for question 5. All participants responded to question 5.

Figure 7

Question 5 Results



Strongly Disagree Disagree Undecided Agree Strongly Agree

	STRONGLY DISAGREE	DISAGREE	UNDECIDED	AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
School Health Nurses	0.00% 0	0.00% 0	0.00% 0	26.00% 13	74.00% 37	50	4.74

Question 6 explored participant confidence in suggesting the use of an aerosol spacer with an asthma inhaler to a student's practitioner. There were 29 nurses (58%) who strongly agreed with question 6 while 17 nurses (34%) agreed with the statement. A total of 4 nurses (8%) were undecided on question 6. No nurses chose disagree or strongly disagree for question 6. All participants responded to question 6.

Figure 8

Question 6 Results

Strongly Disagree Disagree Undecided Agree Strongly Agree

	STRONGLY DISAGREE	DISAGREE	UNDECIDED	AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
School Health Nurses	0.00% 0	0.00% 0	8.00% 4	34.00% 17	58.00% 29	50	4.50

Question 7 investigated participant confidence in explaining the rationale behind the benefits of using an aerosol spacer to students and their families. There were 34 nurses (68%) who strongly agreed with question 7 while 16 nurses (33%) agreed with the statement. No nurses chose undecided, disagree, or strongly disagree for question 7. All participants responded to question 7.

Figure 9

Question 7 Results

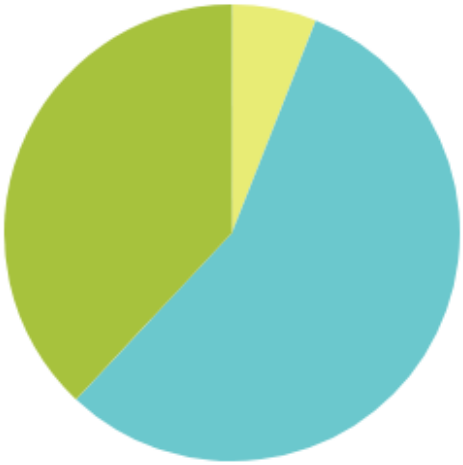
Strongly Disagree Disagree Undecided Agree Strongly Agree

	STRONGLY DISAGREE	DISAGREE	UNDECIDED	AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
School Health Nurses	0.00% 0	0.00% 0	0.00% 0	32.00% 16	68.00% 34	50	4.68

Question 8 inquired about participant confidence in promoting the rationale behind the benefits of using an aerosol spacer to a student's practitioner. There were 19 nurses (38%) who strongly agreed with question 8 while 28 nurses (56%) agreed with the statement. A total of 3 nurses (6%) chose undecided on question 8. No nurses chose disagree or strongly disagree for question 8 and all participants responded.

Figure 10

Question 8 Results



Strongly Disagree Disagree Undecided Agree Strongly Disagree

	STRONGLY DISAGREE	DISAGREE	UNDECIDED	AGREE	STRONGLY DISAGREE	TOTAL	WEIGHTED AVERAGE
School Health Nurses	0.00% 0	0.00% 0	6.00% 3	56.00% 28	38.00% 19	50	4.32

Question 9 determined if participants will promote the use of an aerosol spacer, if not already in use. A total of 33 nurses (66%) strongly agreed with question 9 while 17 nurses (34%) agreed with the statement. No nurses chose undecided, disagree, or strongly disagree for question 9. All participants responded to question 9.

Figure 11

Question 9 Results

Strongly Disagree Disagree Undecided Agree Strongly Agree

	STRONGLY DISAGREE	DISAGREE	UNDECIDED	AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
School Health Nurses	0.00% 0	0.00% 0	0.00% 0	34.00% 17	66.00% 33	50	4.66

Conclusion

The outcome objective for the DNP project was after completing the educational module on the best-practice use of aerosol inhalers, the school health nurses will express an increase in knowledge regarding asthma and the best-practice use of aerosol spacers with asthma inhalers while acknowledging the value of utilizing a spacer and expressing the confidence to suggest the use of and explain the rationale behind the use of a spacer. The project leader analyzed data from the nurse's post-learning module survey with a Likert scale to determine if the outcomes were met.

Of the 49 participants (one participant did not respond), 86.76% of the school health nurses stated they strongly agreed or agreed they gained an increase in knowledge

regarding asthma in school-age students while 62.5% of 48 participants (two participants did not respond) expressed an increase in knowledge regarding the pathophysiology of asthma by choosing strongly agree or agree on the Likert scale. Next, 82% of 50 participants strongly agreed or agreed they gained new knowledge regarding the use of an aerosol spacer with an inhaler for students with asthma. Of the 50 participants, 98% stated they strongly agreed or agreed that they recognize the value of utilizing an aerosol spacer with an asthma inhaler. When responding to confidence levels in suggesting the use of an aerosol spacer with an asthma inhaler to a student and their family, 100% of the 50 participants stated they strongly agreed or agreed. A total of 92% of the 50 school health nurses stated they strongly agreed or agreed in their confidence to suggest the use of an aerosol spacer with an asthma inhaler to a student's practitioner. For survey statements regarding confidence in explaining and promoting the rationale behind the benefits of using an aerosol spacer to students and their families, 100% of 50 participants stated they strongly agree or agreed in their confidence in explaining, and 94% of participants stated they strongly agreed or agree in their confidence to promote the rationale.

From the survey results, it appeared school health nurses gained a greater understanding of asthma and why it occurs. The data implied school health nurses gained new knowledge about aerosol spacers. The data suggested school health nurses recognized the value of using an aerosol spacer with an asthma inhaler and are confident in explaining and promoting the rationale behind the benefits of utilizing a spacer. In addition, the data proposed school health nurses are confident in suggesting the use of an aerosol spacer to students, their families, and the student's practitioners. One final

statement on the post-learning module Likert scale survey asked the school health nurses about promoting the use of an aerosol spacer to a student with asthma. Of the 50 participants, 100% stated they would promote the use of an aerosol spacer with an asthma inhaler in students they encounter with asthma if a spacer was not already in use.

School health nurses were exposed to education on asthma, asthma pathophysiology, and the best-practice use of aerosol spacers with asthma inhalers through the DNP project. The nurses stated increased knowledge in both asthma in school-age students, the pathophysiology of asthma, and new knowledge regarding the use of aerosol spacers with asthma inhalers. School health nurses stated they recognized the value of utilizing an aerosol spacer with an asthma inhaler. After the completion of the online learning module, school health nurses stated they were confident in suggesting and explaining the rationale of the use of an aerosol spacer with an asthma inhaler to students, as well as families, and practitioners of students. Finally, school health nurses stated they would promote the use of an aerosol spacer when they encounter a student with asthma if the product was not already in use.

The impact of the DNP project was projected to be far-reaching. In the school health program, asthma is the number one chronic disease among students in the county. With over 6,500 students in the school district diagnosed with asthma, the up-to-date best-practice information regarding asthma and aerosol spacers could have a broad impact. Students with asthma across the district will potentially be educated on an aerosol spacer with an asthma inhaler. School nurses have indicated they will have conversations with parents and practitioners regarding the best-practice use of aerosol spacers with asthma inhalers. More students with asthma will potentially utilize spacers resulting in

better distribution of rescue inhaler medication in their respiratory tract leading to better asthma control.

The project was planned to be sustained by the school health leadership team sharing results of the DNP project with school health nurses encouraging the best-practice use of aerosol spacers with asthma inhalers with asthmatic students they encounter. The detailed survey analysis report will be shared with current school health nurses and new school nurses participating in onboarding asthma orientation classes. The DNP learning module was added to the school health SharePoint for current and future school nurses to access as needed. The DNP project committee member was a school health representative of a county-wide Asthma Coalition. The Asthma Coalition consists of individuals from a variety of professions in the county who have an interest in and promote asthma education and management for the community. The learning module and survey results were shared with the local county Asthma Coalition via email for their next virtual meeting.

Follow-up data regarding the DNP project can be collected in the future. A follow-up survey at the 6-month and 1-year mark can be administered to assess how many times school health nurses have recommended an aerosol spacer with an asthma inhaler to students, parents, or practitioners. In addition, the survey may ask how many times school health nurses have educated students or parents on either the disease process of asthma or the use of an aerosol spacer with an asthma inhaler. An additional follow-up measure can include the collection of data to compare the number of students with asthma to the number of students with aerosol spacers. Overall, significant changes

related to students with asthma can occur because of the DNP project with the school health nurses.

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