

Compliance to a Standardized Protocol for Stock Albuterol Medication among School Staff

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Ashley A. Lowe, PhD, MSPH¹ , Joe K. Gerald, MD, PhD²,
Conrad Clemens, MD, MPH³, and Lynn B. Gerald, PhD, MSPH¹

Abstract

A stock inhaler program provided access to rescue medication (albuterol sulfate) for school children. School staff were provided with a standardized protocol for medication administration. We hypothesized licensed nurses were more likely to report compliant events compared to unlicensed school staff. Stock inhaler events were defined as either compliant or non-compliant. A school protocol compliance score was calculated using the total number of compliant events divided by the total number of all events. The protocol for administration indicated 4 puffs for mild respiratory distress and 8 puffs for severe respiratory distress; therefore, events were defined as compliant if the dose of medication was divisible by 4. A Cragg Poisson hurdle regression was used to examine the association between compliance score and school staff experience. One-hundred fifty-two schools reported 999 stock inhaler events. Of these events, 28% were compliant and 72% of events were non-compliant. After controlling for school organizational type, grades served, and school size, school staff experience was not predictive of protocol compliance. Future efforts should focus on improving protocol compliance among licensed nurses and unlicensed school staff.

Keywords

stock inhaler, schools, respiratory distress, school nursing, unlicensed assistive personnel, medication administration, emergency medication, school nurses

Introduction

Asthma is a chronic inflammatory condition that affects 8.6% of children in the United States (US) (Centers for Disease Control and Prevention (CDC), 2021). Children with asthma may experience breathing difficulties that prevents them from fully participating in school activities. When these breathing problems occur at school, quick relief medication (albuterol sulfate) is often necessary to relieve their symptoms. Immediate access to this life-saving drug is a central component of guideline concordant care (i.e., best practice) and often prevents the need for escalated care such as summoning the Emergency Medical System (EMS) (Cloutier et al., 2020; Krishnan et al., 2020; National Heart, 2007). However, less than 12% of asthmatic children have access to this life saving drug while at school (Gerald et al., 2012). School personnel should be trained on how to identify the signs and symptoms of an acute asthma episode (or respiratory distress) and when to administer albuterol to a child (McClure et al., 2020). Albuterol sulfate is often administered by a licensed, school nurse or unlicensed assistive personnel (UAP) who has been delegated the task of medication administration by a licensed provider (National

Council of State Boards of Nursing, 2020). The term UAP is used in the school nursing field to refer to unlicensed personnel who have been trained by the school nurse. However, many schools do not have a school nurse to train UAPs and training among UAPs varies widely. Therefore, in this discussion, we use the term UAP to refer to any school staff member who is not a licensed nurse or health professional.

Albuterol sulfate can be safely administered by any school staff who have been trained to do so because modern day formulas are safe with a wide-therapeutic

¹ Asthma & Airway Disease Research Center, University of Arizona Health Sciences, Tucson, AZ, USA

² Mel and Enid Zuckerman College of Public Health, Department of Community, Environment & Policy, University of Arizona, Tucson, AZ, USA

³ College of Medicine – Tucson Campus, Department of Pediatrics, University of Arizona, Tucson, AZ, USA

Corresponding Author:

Ashley A. Lowe, PhD, MSPH, Asthma & Airway Disease Research Center, University of Arizona Health Sciences, 1501 N. Campbell Ave., Box 245030, Room 2346, Tucson, Arizona 85724, USA.
Email: aaray@arizona.edu

index (Gerald et al., 2014a, 2014b; National Heart, 2007). Schools can prepare for a respiratory emergency regardless of the presence of a full-time licensed nurse by implementing a stock inhaler program (Gerald et al., 2016; Lowe et al., 2021). Stock inhalers are a single, albuterol inhaler used with a disposable valved-holding chamber (VHC) which allows the inhaler to be used by multiple students. Approximately 18 U.S. states have enacted legislation that allows schools to procure, stock and administer albuterol sulfate to students experiencing respiratory distress while at school; however, key components of such legislation vary widely across states (Lowe et al., 2022). Variations in these laws include who can be treated (previously known or unknown asthma) and who can administer the medication (UAPs versus licensed nurses) (Lowe et al., 2022).

Despite the safety and effectiveness of albuterol sulfate in children, medication should be given in accordance with the written directions provided on the standing medical order (for stock albuterol) or a child's individual Asthma Action Plan (AAP) (for personal inhalers). Both a standing medical order and AAP provide school personnel with specific directions regarding how much medication to administer and when the medication should be taken by the child. Wide-ranging differences in the written directives exist among standing medical orders and AAPs which may introduce confusion for school personnel. One of the common variations is the recommended dose of medication. When a child does not receive the prescribed dose outlined in the standing medical order or their individual AAP, a medication administration error occurs.

Given a large proportion of schools rely on both licensed nurses and UAPs, examining compliance to medication administration tasks remains an important component of school nursing care. Previous studies have associated UAPs with increased medication errors causing some concern for liability among both schools and licensed providers who delegate their authority to the UAP for medication administration tasks (Canham et al., 2007; Health, 2009; Maughan et al., 2018; McCarthy et al., 2000). Increased medication errors are further associated with schools that have multiple school personnel responsible for medication administration tasks and schools with high student enrollment or caseloads (Canham et al., 2007; Maughan et al., 2018; McCarthy et al., 2000). While reducing medication errors remains essential to school nursing, stock inhaler laws work outside the Nurse Practice Act which governs the delegation of medication administration tasks. In Arizona, H.B. 2208, "Stock Inhaler for Schools" allows any trained and designated school staff to administer a stock inhaler to any child experiencing respiratory distress while administered in good faith (State of Arizona, 2017). The purpose of this study was to examine medication errors as measured by compliance to the standardized protocol for stock albuterol medication administration in Pima County, Arizona. We hypothesized that schools provisioned with a

full-time, licensed nurse would be more likely to report compliant stock inhaler events as compared to schools with UAPs.

Methods

Stock Inhaler Program and Standardized Protocol

In 2017, Arizona passed H.B. 2208, "*Stock Inhalers for Schools*" which allowed charter/private/parochial and public schools to procure, stock and administer albuterol sulfate to any student experiencing respiratory distress regardless of previously known asthma (State of Arizona, 2017). Schools were provided a toolkit that included a quick relief inhaler (albuterol sulfate), a supply of disposable valved holding chambers, documentation forms, an online training curriculum, a signed standing medical order, and a standardized protocol. The standardized protocol was developed by a team of asthma experts, pediatric pulmonologists, pharmacists, licensed school nurses and stakeholders (see Supplemental Materials). Trained staff were instructed to use the standardized protocol anytime the stock inhaler was administered to a student. The online training curriculum trained personnel in identifying the signs and symptoms of respiratory distress and how to use the standardized protocol to manage a respiratory emergency. Depending on the student's initial presentation and the severity of their symptoms, staff were trained to administer a fixed dose of 4 puffs (inhaler actuations) for mild-to-moderate respiratory distress and 8 puffs for severe respiratory distress. When a child presented with severe respiratory distress, staff were instructed to summon EMS immediately. After each stock inhaler event, school staff were required by law to document the number of puffs administered on the form provided in the toolkit.

Study Design, Setting & Participants

The study population included all charter, private/parochial and public schools located in Pima County, Arizona, that voluntarily enrolled in the stock inhaler program and reported stock inhaler events that included the number of puffs on the event documentation form (Figure 1). The primary findings of this study have been previously published (Lowe et al., 2021). The study was approved and monitored by the University of Arizona Institutional Review Board (IRB) in Tucson, Arizona (approval 1804445166).

Primary Outcome Variable

The primary outcome variable was school protocol compliance score (continuous ranging from 0–100%). Because schools were asked to use a standardized protocol for medication administration, we examined the total number of inhaler puffs (actuations) recorded on the documentation form by trained and designated school staff (see Supplemental Materials). Stock inhaler events were defined as "compliant" if the dose

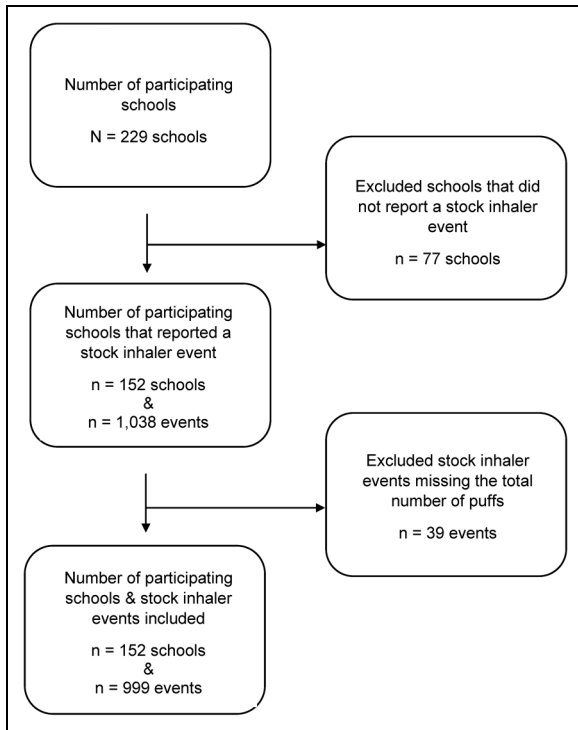


Figure 1. PRISMA flow diagram of school participation and stock inhaler events during the stock inhaler for schools program, 2017–2018.

of medication (i.e., the number of inhaler puffs) was divisible by 4. All events with an odd number of inhaler puffs or events where the number of puffs was not divisible by 4 were considered “non-compliant”. A protocol compliance score was calculated using the total number of compliant events divided by the total number of all events for each school.

Predictor Variable

The main predictor of interest was school staff experience (nurse, nurse-supervised or UAP). Nurses were defined as any licensed nurse who may delegate their authority of medication administration tasks to UAPs in the State of Arizona (i.e., Registered Nurse (RN), Master of Nursing Science (MSN) and Doctor of Nursing Practice (DNP) licenses. Nurse-supervised was defined as schools that had a full-time UAP who was supervised by a full-time, licensed nurse who rotated between multiple campuses. UAPs were often the primary health person responsible for student health, but many schools had unlicensed staff which included teachers, office personnel, physical education teachers and coaches, and designated agents of the school. Therefore, we use the term UAP to encompass any school staff responsible for administering albuterol who was not a licensed nurse. This variable was measured at the school level as it was not completed on most documentation forms.

Table 1. Baseline Characteristics of Schools in the Pima County Stock Inhaler for Schools Program That Reported a Stock Inhaler Event, 2017–2018.

School characteristics	Total N = 152
School staff experience, n (%)	
UAP ^a	22 (14.5)
Licensed nurse (RN, MSN or DNP)	16 (10.5)
Nurse-supervised	114 (75.0)
Organizational type, n (%)	
Charter/Private/Parochial	11 (7.9)
Public	140 (92.1)
Grades served^b, n (%)	
Elementary (Kinder-6 th)	82 (54.0)
Middle (5 th – 8 th)	22 (14.5)
High (9 th – 12 th)	22 (14.5)
Multi-grade (K – 12 th)	26 (17.11)
Student enrollment, median (IQR)	514 (350, 725)
NSLP ^{a,c} , mean % (SD)	60.6 (24.7)
Protocol compliance score, median % (IQR)	0.0 (0.0, 46.8)

^aAbbreviations: RN = Registered Nurse; MSN = Masters of Nursing Science; DNP = Doctor or Nursing Practice; UAP = Unlicensed Assistive Personnel; IQR = Interquartile range; NSLP = National School Lunch Program; SD = Standard deviation.

^bPercentages may not add up to 100% as a result of rounding.

^cMissing data: NSLP = 9.2% (210/229).

Covariates

We controlled for demographic variables at the school level including school organizational type (public or charter/private/parochial schools), grades served (elementary, middle, high and multi-grade) and school size (total number of students) in the model.

Statistical Analysis

Table 1 shows the demographic characteristics of schools that participated in the Pima County Stock Inhaler for Schools Program. One-way ANOVAs were conducted to examine baseline differences of stock inhaler events reported by schools (Table 2). Once stock inhaler events were dichotomized by protocol compliance (compliant versus non-compliant), we examined all stock inhaler events by their compliance outcome. Pearson’s Chi-squared tests (χ^2) were conducted to examine differences across groups including school staff experience, school organizational type, grades served, student gender (male or female), known asthma status (yes or no), and disposition status (returned to class, sent home or EMS summoned) (Table 3). To examine the relationship between a school’s protocol compliance score and school staff experience, we used a Cragg-Poisson hurdle regression (Table 4) (Loeys et al., 2012; Rose et al., 2006). This method allowed us to account for a zero-inflated distribution as most schools only reported

Table 2. Baseline Characteristics of Stock Inhaler Events Reported by Pima County Schools, 2017–2018.

Event characteristics	Total Events ^b N (%) = 999	No. Puffs Mean (SD)	P-value
School Staff Experience			
UAP	178 (17.8)	2.6 (1.0)	.17
Nurse	729 (72.9)	2.7 (1.2)	
Nurse-supervised	92 (9.2)	2.8 (1.2)	
Organizational, mean (SD)			
Public	959 (96.0)	2.7 (1.2)	.00
Charter/Private/Parochial	16 (1.6)	2.2 (0.6)	
Grades served			
Elementary (Kinder – 6 th)	435 (43.5)	2.82 (1.3)	.06
Middle school (5 th – 8 th)	219 (21.9)	2.62 (1.0)	
High school (9 th – 12 th)	193 (19.3)	2.62 (1.2)	
Multi-grade (Kinder – 12 th)	152 (15.2)	2.4 (0.9)	
Gender ^a			
Male	503 (50.3)	2.7 (1.2)	.99
Female	451 (45.1)	2.7 (1.2)	
Known asthma			
Yes	783 (78.3)	2.7 (1.2)	.05
No	118 (11.8)	2.8 (1.4)	
Disposition status ^a			
Returned to class	766 (76.6)	2.5 (1.0)	.00
Sent home	140 (14.0)	3.2 (1.4)	
EMS summoned	6 (6.0)	7 (5.1)	

^aMissing data: Disposition status = 3.8% (999/1,038).

^bPercentages may not add up to 100% as a result of rounding and/or missing data.

Bolded values means these are statistically significant.

Table 3. Characteristics of Stock Inhaler Events Reported by Schools Enrolled in the Stock Inhaler for Schools Program by Protocol Compliance, 2017–2018.

Characteristics	Total Events ^b N (%) = 999	Compliance Score Mean % (SD)	Compliant n = 276	Non-compliant n = 723	P-value
Administrator Experience, N %					
UAP ^c	178 (17.8)	27.4 (26.6)	26 (28.3)	66 (71.7)	.41
Nurse	729 (72.9)	23.3 (25.4)	42 (23.6)	136 (76.4)	
Nurse-supervised	92 (9.2)	27.2 (33.4)	208 (28.5)	521 (71.5)	
Organizational, N %					
Public	959 (96.0)	26.8 (31.6)	8 (2.9)	32 (4.4)	.27
Charter/Private/Parochial	16 (1.6)	19.5 (29.7)	268 (97.1)	691 (95.6)	
Grades served, N % ^b					
Elementary (Kinder – 6 th)	435 (43.5)	31.8 (37.8)	144 (52.3)	291 (40.3)	.009
Middle school (5 th – 8 th)	219 (21.9)	24.0 (21.1)	50 (18.1)	169 (23.4)	
High school (9 th – 12 th)	193 (19.3)	22.0 (24.9)	47 (17.0)	146 (20.2)	
Multi-grade (Kinder – 12 th)	152 (15.2)	21.2 (29.4)	35 (12.7)	117 (16.2)	
Gender ^a , N %					
Male	503 (50.3)	25.3 (30.0)	140 (50.9)	363 (50.9)	.68
Female	451 (45.1)	29.1 (33.3)	131 (29.1)	320 (71.0)	
Known asthma, N %					
Yes	783 (78.3)	26.4 (31.9)	214 (77.5)	569 (78.7)	.50
No	118 (11.8)	28.0 (28.5)	38 (32.3)	80 (67.8)	
Disposition status, N %					
Returned to class	766 (76.6)	24.9 (31.0)	179 (64.9)	587 (81.2)	<.000
Sent home	140 (14.0)	37.2 (34.3)	67 (24.3)	73 (10.1)	
EMS summoned	6 (6.0)	49.5 (38.3)	5 (1.8)	1 (0.1)	

^aMissing data: Known asthma = 9.8% (98/999); All other missing data <5%.

^bPercentages may not add up to 100% as a result of rounding.

^cAbbreviations: UAP = Unlicensed Assistive Personnel, SD = Standard deviation; IQR = Interquartile range; EMS = Emergency Medical System.

Bolded values means these are statistically significant.

Table 4. Cragg Poisson Hurdle Regression Results for Protocol Compliance Score among Participating Schools That Reported a Stock Inhaler Event, 2017–2018.

Variable	Logistic Model (0 vs. >0)			Zero-truncated Cragg Poisson (>0)		
	OR	95% CI	P-value	IRR	95% CI	P-value
School Staff Experience						
UAP*	1.00	—	—	1.00	—	—
Nurse	0.50	0.17, 1.47	.21	1.20	0.43, 3.32	.73
Nurse-supervised	0.49	0.21, 1.21	.12	0.97	0.44, 2.13	.93
Grades Served						
Elementary*	1.00	—	—	1.00	—	—
Middle School	0.39	0.21, 0.75	.004	1.54	0.83, 2.90	.17
High School	0.37	0.13, 1.11	.08	0.96	0.38, 2.42	.93
Multi-grade	0.77	0.41, 1.44	.42	0.93	0.51, 1.69	.81
Organizational Type						
Public*	1.00	—	—	1.00	—	—
Charter or Private/Parochial	1.08	0.34, 3.42	.89	0.70	0.24, 2.04	.52

*No. of students was included as a covariate in the model.

non-compliant events. We examined if school staff experience was predictive of the school's compliance score versus if school staff experience was predictive of the school's compliance score being 0% or >0%. We used an alpha level of .05 for all statistical tests. All statistical analyses were conducted in Stata version 16.1, College Station, Texas (Stata, 2020).

Results

One-hundred fifty-two charter/private/parochial and public schools reported a total of 999 stock inhaler events that included the number of puffs administered to the student. Ninety-six percent of all stock inhaler events reported by schools (999/1,038) were included in our analysis (Figure 1). Seventy-five percent (114/152) of schools had a nurse-supervised UAP who was trained and designated to administer the stock inhaler to a student. Ninety-two percent (140/152) of schools were public and the most common grades served were elementary (82/152). The median student enrollment was 514 students (Interquartile range (IQR) = 350, 725) and the median protocol compliance score among schools was 0.0 (IQR = 0.0, 46.8) (Table 1).

The median number of puffs administered for an event was 2 (IQR = 2, 4). Figure 2 illustrates the standardized protocol used for medication administration of the stock inhaler. Figure 3 illustrates the mean number of inhaler puffs administered by health staff experience level for all n = 999 events. Approximately 90.6% (776/999) events resulted in the student returning to their classroom or being sent home. There were no statistically significant differences in the mean number of inhaler puffs when compared across grades served, school staff experience level and student gender. However, statistically significant differences in the mean number of inhaler puffs were found when compared

across school organizational type ($p = .00$), and disposition status ($p = .00$) (Table 2).

Of the n = 999 events, 28% (276/999) were compliant to the protocol and 72% (723/999) were non-compliant to the protocol. Seventy-nine percent (569/783) of events that included the number of puffs and the child's previously known asthma status occurred in children with previously known asthma. There were no statistically significant differences in protocol compliance when compared across gender and known asthma status; however, statistically significant differences were observed in the percentage of protocol compliant events when compared across grades served and disposition status ($\chi^2(3) = 11.7$, $p = .009$ and $\chi^2(3) = 44.9$, $p < .000$ respectively) (Table 3). Figure 4 illustrates the mean number of puffs for all non-compliant stock inhaler events (773/999) by school staff experience, school organizational type and grade-level served.

After controlling for school organizational type, grade-levels served and school size, school staff experience was not predictive of protocol compliance among schools who reported a stock inhaler event. The only characteristic that influenced protocol compliance was school organizational type where middle schools (grades 6th–8th) were 0.4 (95% CI 0.21–0.75) times less likely to ever report a non-compliant event as compared to elementary schools when controlling for other factors ($p = .004$) (Table 4).

Discussion

Medication administration is a common task completed by school personnel. These tasks include giving students rescue medication during a health emergency. In the absence of a full-time licensed nurse, schools rely heavily on UAPs to manage student health including respiratory emergencies. Our examination of medication errors

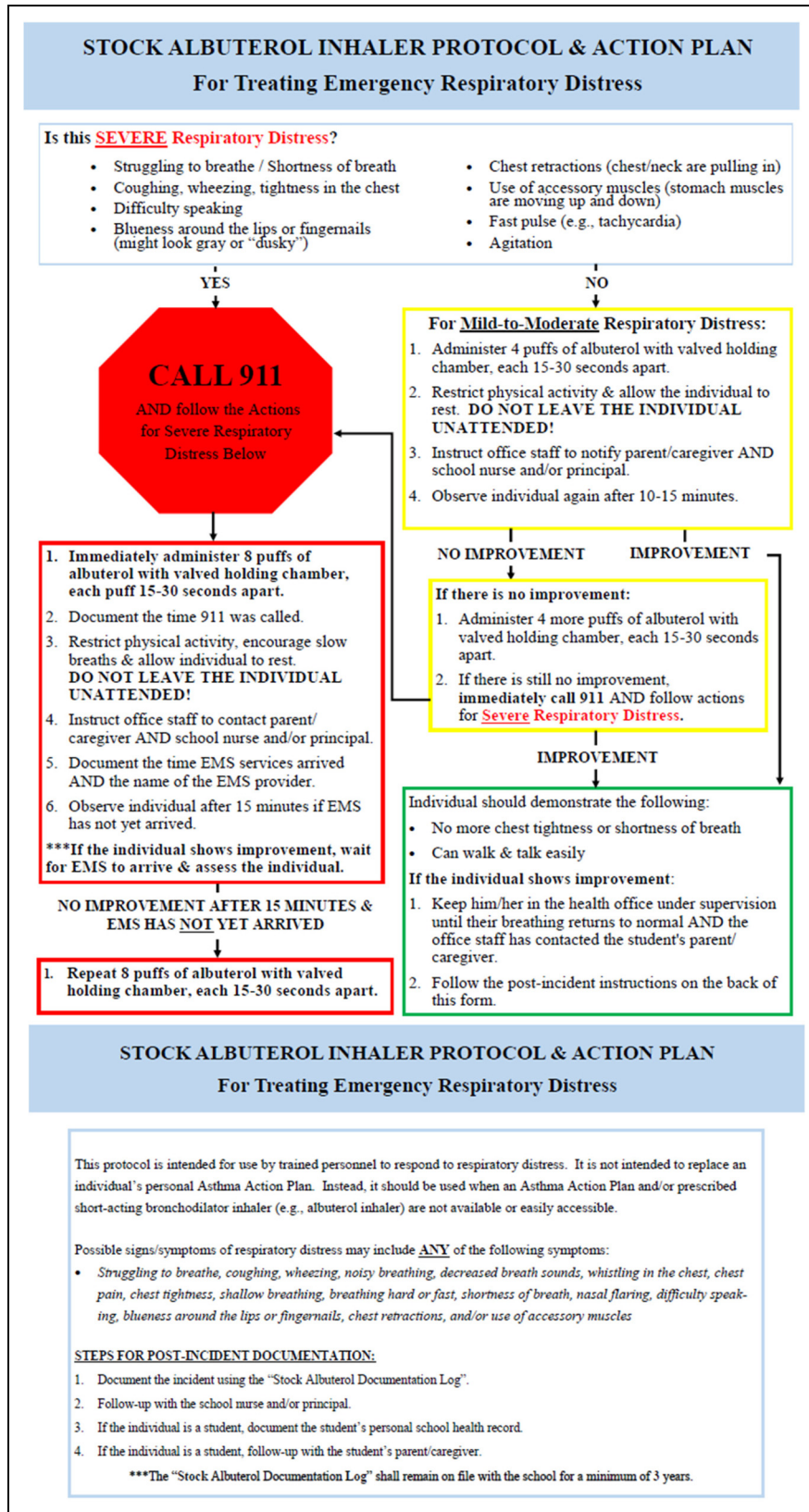


Figure 2. Standardized stock albuterol protocol and action plan for medication administration by trained personnel, 2018.

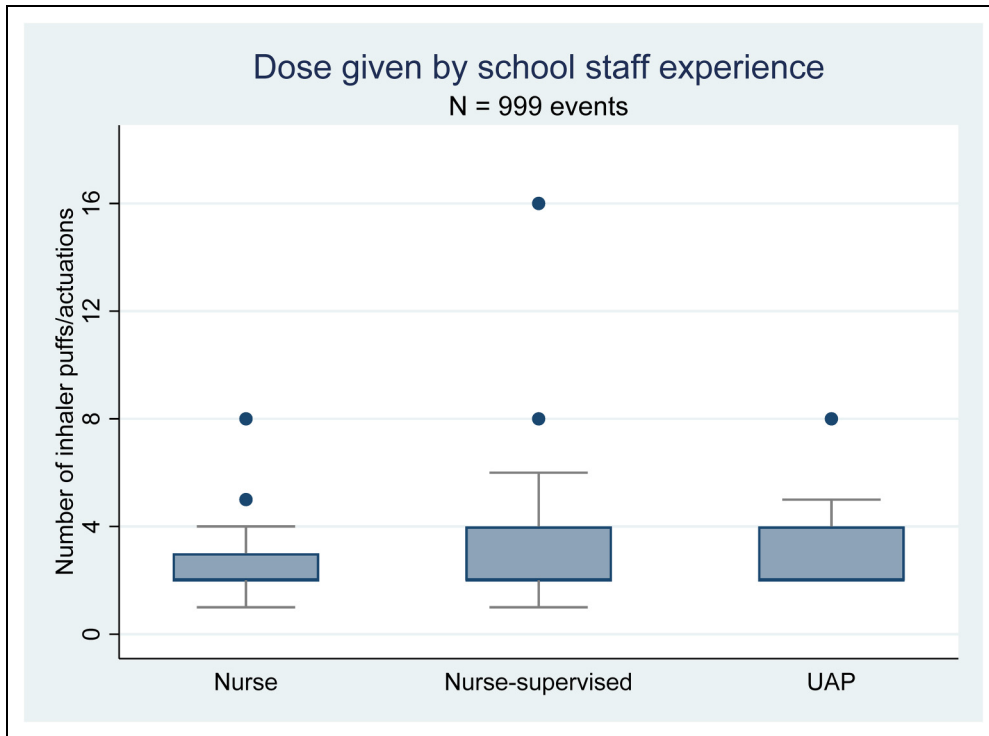


Figure 3. Number of puffs administer by school staff experience level, 2017–2018. Abbreviations: UAP = Unlicensed Assistive Personnel.

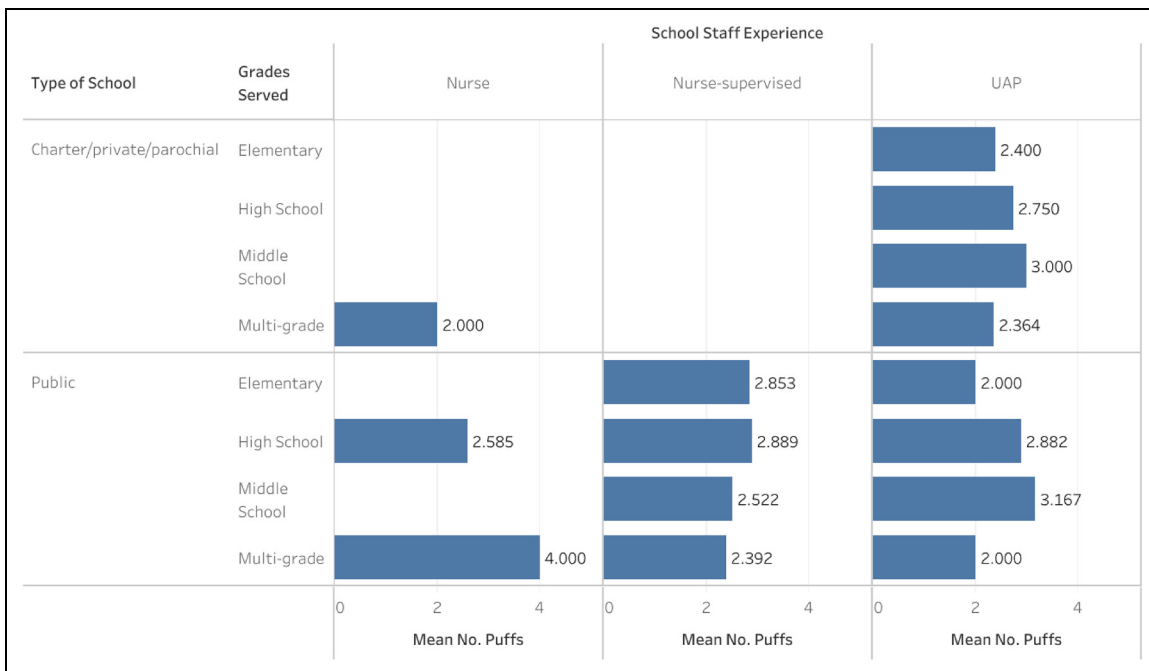


Figure 4. Off-protocol stock inhaler events (mean number of puffs) by school staff experience, school type and grades served, 2017–2018. Abbreviations: UAP = Unlicensed Assistive Personnel.

in the Pima County Stock Inhaler for Schools Program was the first study to examine compliance to a standardized protocol for stock albuterol administration among trained school staff in the U.S. Furthermore, we examined the

association between protocol compliance and school staff experience as an important predictor of medication errors. Results indicated that protocol compliance was very low among all types of schools that participated in

the program regardless of the presence of a full-time licensed nurse or UAP at the school.

While we anticipated high compliance among trained school staff, 65.6% (657/999) of stock inhaler events led to the student receiving 2 puffs of medication instead of the required 4 puffs of medication. Given most events were not severe respiratory distress and 90.6% (766/999) events resulted in the child returning to class or being sent home with their guardian, the non-compliance to the protocol may have resulted from school staff using the traditional approach to administering albuterol sulfate as a dose range (e.g., 2–4 puffs) where the minimum dose prescribed is 2 inhaler puffs. When the standardized protocol was created, asthma experts acknowledged that a dose range left room for interpretation regarding exactly how much medication should be administered to a student and could be confusing for UAPs. Given the wide safety profile of albuterol and the preference for preventing life-threatening events, experts concluded that a fixed-dose protocol of 4 inhaler puffs for mild-to-moderate respiratory distress was most appropriate. Both licensed nurses and UAPs may be more reluctant to administer the higher dose prescribed on the standardized protocol based on their prior experiences with individual students AAPs. Early non-selective beta agonists had increased risks for death with high doses; thus, many experienced school nurses and UAPs may have been previously trained to not administer high doses of albuterol sulfate for asthma (Billington et al., 2017). However, current formulas of beta agonists are selective for the beta-2 receptor and have excellent safety profiles in children. The standardized protocol used in Pima County required that 4 inhaler puffs (i.e., 90 mcg/puff) of medication which is compatible with current asthma guidelines for children who present to the ED with an asthma exacerbation (Camargo et al., 2009). In the ED, children who present in respiratory distress receive 4–8 puffs every 20 min for 3 doses, then every 1–4 hours (Camargo et al., 2009). Our data also suggest that when children were most sick as measured by the severity of their symptoms and disposition status, both licensed and unlicensed staff were more likely to follow the standardized protocol. This may indicate more comfort with higher doses in situations of severe respiratory distress.

Second, the high rate of protocol non-compliance among schools enrolled in the program occurred among school staff trained through a web-based curriculum (Lowe et al., 2021) (Western Public Health Training Center, 2021). This eliminated any opportunity for trained staff to ask specific, clarifying questions regarding the standardized protocol and how it should be used. When presenting the findings on compliance to school staff, many reported confusions regarding when to use the student's individual AAP and when to use the standardized stock inhaler protocol given that many individual AAPs are often written with a range of puffs (i.e., 2–4 puffs) while the standardized protocol specified a fixed dose.

Current training materials now specify when to use the child's individual AAP and when to use the standardized protocol. Current trainings also emphasize the importance of ensuring the correct dose of medication is administered and the fact that the risk for experiencing an adverse event is much greater when a child does not receive enough medication as compared to too much medication and how modern-day albuterol sulfate is extremely safe with a wide-therapeutic index (Gerald et al., 2014a, 2014b; National Heart, 2007).

Finally, these data indicated no association between school staff experience and compliance to the standardized protocol. Regardless of school staff experience, both licensed and unlicensed staff rarely reported compliance to the standardized protocol. When we examined differences among schools such as grade levels served, we found that school staff were more likely to follow the protocol in elementary schools than in schools that served older children. Younger children may be less inclined to speak up about the dose of albuterol they are directed to take from an adult such as the school nurse. These data further indicated that protocol compliance was more likely in elementary children but students in middle and high schools were less likely to take a fixed dose (4 puffs) of albuterol from school staff. During an adolescent's transition to emerging adulthood, they gain greater independence from their parents and obtain more say in their asthma management. This awareness and ability to advocate for their own asthma management may additionally explain the high rate of non-compliance to the standardized protocol. When presenting the protocol compliance findings back to school staff, they indicated that middle and high school students would often refuse the fixed dose of 4 puffs for mild symptoms. Therefore, subsequent trainings have discussed how to properly document when a student (or their legal guardian) refuses the prescribed dose when using the stock inhaler.

Limitations

There are several limitations that may influence protocol compliance among trained personnel who were designated to administer the stock inhaler. First, we acknowledge the methods used to determine protocol compliance by trained and designated health staff and their respective experience level (licensed nurse, nurse-supervised UAP, or unsupervised UAP) did not capture the full extent of compliance to the standardized protocol. Because stock inhaler events could only be examined for the total number of puffs documented on the event form, we could not differentiate between compliant and non-compliant events that were divisible by 4. We reviewed each event for the total number of puffs and the respective level of respiratory distress notated on the form and determined compliance based on these two factors. Unfortunately, this does not account for events where school staff documented the correct number of puffs

and level of respiratory distress, but the level of respiratory distress changed from mild-to-moderate to severe respiratory distress (e.g., 12 puffs) which subsequently changes the dosage of medication that should be administered. Because only 16.7% (1/6) EMS-summoned events were non-compliant, we believe the potential for this circumstance was limited in this sample. Additionally, staff experience was measured at the school level and not the individual event level. While staff position was a field on the documentation form, it was rarely completed. Therefore, we used school level data for the analysis. This means that in nurse-supervised schools we do not know for sure whether the medication administration was done by a nurse or a UAP. However, given that nurses were responsible for 5–15 schools, it is likely that the administration was done by a UAP.

Another limitation of these data were that the event documentation form did not include a unique identifier or personally identifying information in order to remain compliant to Health Insurance Portability and Accountability Act (HIPAA) and Federal Educational Rights and Protections Act (FERPA) regulations. Therefore, we could not examine if events were unique to the same child or multiple children. For example, if an adolescent child used the stock inhaler multiple times and also refused the fixed dose of 4 puffs, these data may not be representative of the staff member's compliance to the protocol, but rather a result of the same child refusing the appropriate dose of medication several times. Another limitation was the inability to examine if the stock inhaler was administered by the same staff person at each school. Given that schools experience frequent turnover and are provisioned with multiple, part-time personnel, our analysis did not examine medication errors among individual school personnel. Rather, these data simply capture patterns across schools during the first year of program implementation.

Implications for School Nursing Practice

As the nation-wide effort to pass stock albuterol legislation and program expansion continues, these results have important implications to the field of school nursing science. These findings uniquely inform licensed school nurses and stakeholder groups involved in the legislation and program implementation efforts regarding important components of medication administration tasks. The Pima County Stock Inhaler for Schools Program was the very first study to examine the use of a standardized protocol for stock albuterol medication administration tasks among trained and designated unlicensed staff. Findings indicated very low protocol compliance among both licensed nurses and UAPs. While school staff were more likely to report compliance to the standardized protocol in younger children, there was no association between protocol compliance and school staff experience.

These findings indicate that both licensed school nurses and UAPs need training on stock inhaler protocols. The

data reported here were from the first year of the program and both school nurses and unlicensed staff were new to the program. We are confident that over time school nurses will be able to provide the education and training for unlicensed school staff who administer medication; however, our data indicate the importance of extensive training for all new personnel whether licensed or unlicensed.

There are several interrelated factors (macro-, meso- and micro-level) that influence the principals of delegating medication administration tasks to UAPs. Shore et al. (2022) found good communication and relationships between the licensed delegator and unlicensed delegates was central to successful medication administration. Further, when policies, skills, training, and supervisory arrangements are aligned with medication administration tasks, school nurses are supported (Shore et al., 2022). H.B. 2208 provides licensed school nurses and UAPs with consistency and clarity surrounding stock albuterol medication administration tasks at the macro-level (i.e., state); however, at the micro-level (i.e., school), this legislation does not ensure good communication practices between the delegator and UAPs are maintained. Furthermore, not all UAPs have a licensed supervisor. To increase protocol compliance, nurse delegators should ensure all designated staff complete the annual training requirements and further facilitate a supportive and communicative environment. Licensed school nurses should consistently review stock albuterol documentation logs that were completed by UAPs and encourage discussion when protocol deviations (i.e., medication errors) occur to ensure that staff understand medication errors and how to properly document such errors. Lastly, when students present to the health office and need to use the stock inhaler, follow-up between the school nurse/UAP and the child's guardian and medical home should subsequently occur. In schools who do not have a licensed nurse, there should be some oversight at the state level to ensure that medication errors are minimized. Further development of these best practices for stock inhalers in schools remains necessary to enhance safety, reduce liability concerns and improve guideline concordant care for children with asthma.

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Author's Note

Lynn B. Gerald is also affiliated with Mel and Enid Zuckerman College of Public Health, Department of Health Promotion Sciences, University of Arizona, Tucson, AZ, USA.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Dr. Lynn Gerald reports product donation from Thayer Medical Corporation, Tucson, Arizona.


Ethical Approval of Study

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ORCID iD

Ashley A. Lowe  <https://orcid.org/0000-0001-6252-0368>

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Author Biographies

Ashley A. Lowe, PhD, MSPH, is a post-doctoral associate at the University of Arizona Asthma & Airway Disease Research Center.

Joe K. Gerald, MD, PhD, is an associate professor at the Department of Community, Environment, & Policy, Mel and Enid Zuckerman College of Public Health, University of Arizona, Tucson, AZ, USA.

Conrad Clemens, MD, MPH, is the senior associate dean of Graduate Medical Education and professor of Pediatrics at the College of Medicine, University of Arizona, Tucson, Arizona, USA.

Lynn B. Gerald, PhD, MSPH, is a distinguished outreach professor at the Department of Health Promotion Sciences Mel and Enid Zuckerman College of Public Health and a Research Scientist at the Asthma & Airway Disease Research Center, University of Arizona Health Sciences, Tucson, Arizona, USA.