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Emergency Medication Access and Administration in Schools: A Focus on Epinephrine, Albuterol Inhalers, and Glucagon

Rebecca A. McCaughey, MPH[1,2], Ann Marie McCarthy, PhD, RN, FNASN, FAAN[3], Erin Maughan, PhD, MS, RN, PHNA-BC, FNASN, FAAN[4], Maria Hein, MSW[3], Yelena Perkhounkova, PhD[3], and Michael W. Kelly, BSPh, PharmD, MS[1]

Abstract

Access to emergency medications is a growing concern, particularly regarding the availability, safety, and use of these medications in schools. The purpose of this article is to report results not previously published from a national survey, specifically regarding the emergency use of epinephrine, albuterol inhalers, and glucagon. A nonexperimental, cross-sectional design was utilized for this descriptive study. An online survey was distributed to school nurses in 2015, and data from 6,298 school nurse respondents are presented in the analysis. Findings related to stock and student-specific emergency medication use and storage, epinephrine usage data, and delegation of emergency medication administration to unlicensed assistive personnel are presented in this article. Further development of policies and procedures regarding emergency medication administration in schools is needed. School nurses are a valuable resource for obtaining knowledge in this area and keeping students safe at school.

Keywords

epinephrine, albuterol, glucagon, medication administration, school nursing, emergency medication

Children are commonly given medications in schools for chronic, acute, or emergency medical conditions. The school nurse, often working in collaboration with unlicensed assistive personnel (UAP), is responsible for medications administered to children and documentation of care provided (McCarthy et al., 2006). In addition to the administration of student-specific prescription medications, many school administrators obtain stock medication to give any student in a life-threatening situation. Three commonly stocked emergency medications in schools are epinephrine, albuterol inhalers, and glucagon.

Epinephrine is a medication used to treat anaphylaxis, a severe allergic reaction resulting from food or other allergens, which may result in a fully constricted airway or shock (Sicherer & Simons, 2017). It's estimated that 5.8% of children under the age of 18 have a known food allergy (Centers for Disease Control and Prevention [CDC], 2017), and these students may carry prescription epinephrine with them in school. Students with a history of severe allergic reaction(s) may be more aware of the potential for anaphylaxis, but this life-threatening medical emergency can happen to anyone. It's estimated as many as 20%–25% of allergic reactions occur in students with no known allergy (Fortner, 2018). Stock epinephrine may be available in schools to treat students with no known allergies or history of allergic reaction.

An albuterol inhaler is a bronchodilator commonly used to treat bronchospasms in children with asthma. Thirteen percent of children under the age of 17 have received an asthma diagnosis at least once in their lifetime, 8.4% currently have asthma, and 4.6% have had at least one asthma attack in the last year (Federal Interagency Forum on Child and Family Statistics, 2019). Due to frequent shortness of

[1] College of Pharmacy, University of Iowa, IA, USA
[2] College of Public Health, University of Iowa, IA, USA
[3] College of Nursing, University of Iowa, IA, USA
[4] Department of Research, National Association of School Nurses, Silver Spring, MD, USA

Corresponding Author:
Rebecca A. McCaughey, MPH, College of Pharmacy, University of Iowa, 180 S. Grand Ave., Iowa City, IA 52242, USA.
Email: becca.a.mccaughey@gmail.com

breath associated with asthma symptoms and widespread availability of easy-to-use metered dose inhalers, many children have albuterol inhalers available for use at school.

Glucagon is a drug used to treat diabetic hypoglycemia and works by rapidly increasing blood glucose concentrations after injection. The estimated annual incidence of diabetes in youth is 17,900 for type 1 diabetes and 5,300 for type 2 diabetes (American Diabetes Association, 2018). Prompt access to glucagon is a concern particularly for children with type 1 diabetes. For anaphylaxis, acute bronchospasm, and hypoglycemia, rapid medical response and timely access to emergency medications can save the life of a child or adolescent.

School nurses serve as a critical source of information for the health care needs of children, as 96% of U.S. youth attend school outside the home. Nearly 75% of schools have an employed licensed nurse at least part-time, and approximately 39%–54% of schools have a full-time nurse (Hogue et al., 2018; Willgerodt et al., 2018). Accessing and analyzing information acquired from school nurses, specifically regarding the use of emergency medications, can help guide medication administration practices in schools. Policies can be influenced and improved with information regarding the availability, distribution, and administration of emergency medications to students in schools. Established procedures and protocols for urgent or emergency medication administration and follow-up care should be defined and utilized within every school in order to promote student health and development.

Data about the use of emergency medications in schools are beginning to emerge in the literature. Results from a survey by White et al. (2016) found that 38% of anaphylactic events in schools were treated with stock epinephrine auto-injectors, 33.7% were treated with a personal epinephrine auto-injector, 17.6% used oral antihistamine treatment, and all remaining events used an alternative or no therapy. Results from the survey also found that 21.5% of schools permitted all staff to administer epinephrine in an emergency, 15.6% permitted most staff, 55% permitted the school nurse and select trained staff, and 3% permitted only the school nurse to administer epinephrine. Few schools (30.4%) provided epinephrine administration training to all staff, 28.2% trained most staff, 37.3% trained the school nurse and select staff, and 2% trained only the school nurse (White et al., 2016). Results from a follow-up study by White et al. (2017) evaluating the use of epinephrine in schools found that food was the most common trigger for anaphylaxis and accounted for 54% of events. Of those who experienced an allergic attack from any cause, 24.5% had no known allergy. Subsequently, 72.6% of individuals were transferred to a hospital or clinic following an anaphylactic event (White et al., 2017).

Researchers at the University of Arizona, in collaboration with Sunnyside Unified School District in Tucson, AZ, conducted a pilot project evaluating outcomes associated with increasing access to stock albuterol inhalers in schools. Findings revealed that when sufficient access to stock albuterol inhalers exist for students, schools had 20% fewer 911 calls and 40% fewer hospital transports as compared to the control period. Throughout the control period, stock albuterol inhalers were used in 55 children to manage 222 discrete events (Gerald et al., 2016). Data on student-specific and stock glucagon availability and accessibility within schools are still limited at this time (Wilt & Foley, 2011).

Results from studies documenting medication administration practices in schools suggest that school nurses or school administrators, typically principals, may delegate medication administration to UAP depending on state law (Farris et al., 2003; Kelly et al., 2003). In previous studies by the authors, medication administration was delegated to UAP by 75%–78% of responding school nurses (Maughan et al., 2018; McCarthy et al., 2000). The bewildering variety of illnesses being treated and the wide range of medications administered in school result in unique challenges and concerns for safe medication administration (Maughan et al., 2018; McCarthy et al., 2000, 2006). Medication errors have been found to occur more frequently when medications are administered by UAP rather than by a school nurse (Maughan et al., 2018; McCarthy et al., 2000). School nurses have noted that even with training, delegating to UAP such as secretaries can be problematic as many UAP often do not feel that (1) administering medications is their responsibility and (2) they have the underlying medical knowledge about the medications that they are delegated to administer (Kelly et al., 2003).

To date, information on the administration of emergency medication in schools, including policies regarding administration criteria and authorization of staff to administer medication, is limited. In a study identifying medication management problems among school nurses, respondents indicated that the most error-prone component of the medication management process for school nurses is the administration itself (Reutzel & Patel, 2001). Further development of standards for best practices regarding medication administration of emergency medications such as epinephrine, albuterol inhalers, and glucagon in schools is needed to prevent errors and enhance the safety of children in schools.

In 2015, a survey by the authors on medication administration practices in schools was sent to a national sample of school nurses. Results from this national survey related to prescription and nonprescription medications, medication storage, students carrying their own medications, delegation of medication administration, documenting, and medication errors were presented previously (Maughan et al., 2018). The purpose of this article is to report results not previously published from the national survey, specifically practices related to the use, administration, and storage of stock and student-specific epinephrine, albuterol inhalers, and glucagon, with a particular emphasis on epinephrine.

Method

A nonexperimental, cross-sectional design was used for this descriptive study. The Human Subjects Institutional Review Board at The University of Iowa approved this study (No. 201501786).

Participants

The survey was sent to all active members of the National Association of School Nurses (NASN) for participation. Additionally, state school nurse leaders were asked to forward the survey via email to school nurses in their state. Therefore, respondents included both NASN members and nonmembers. It's estimated that at the time this survey was distributed in 2015, there were approximately 16,000 NASN members and 65,000 school nurses nationally. For an individual to be eligible to complete this survey, they had to be a practicing school nurse and actively administering, or delegating administration of, medications in a school. Since many school nurses serve multiple schools, they were asked to reference only one school when completing the survey. The school chosen should have been the most representative of their entire student base. If a respondent failed to indicate a specific number of students within their school or reported over 8,000 students, their answers were excluded from the analysis.

Survey

Previous surveys developed by the authors (McCarthy et al., 2000, 2006) were referenced during the creation of the *School Nurse 2015 Medication Survey* used for this study (Maughan et al., 2018). The experience and expertise of the investigators, feedback on survey drafts from state school nurse consultants, and a pilot trial of the survey with six school nurses were used to tailor survey questions to meet the specific needs of this study. The online survey was unique to each respondent using conditional skip logic; thus, the total number of questions answered by each respondent differed based on individual answers. Questions were mostly multiple choice and closed-ended, and the participant had the option to decline to answer any question.

Demographic information on both the school nurse participants and their representative school was collected on the survey. Questions specifically included information pertaining to each of the following categories: prescription medications, nonprescription medications, medication storage, medication errors, provider information, documentation, use of UAP to administer medication, and use of medications in life-threatening conditions including triggering allergies. The authors were particularly interested in gaining information on the use, administration, and storage of stock and student-specific epinephrine, albuterol inhalers, and glucagon.

The Research Electronic Data Capture (REDCap; Harris et al., 2009) web application was used to collect and manage data for this study. REDCap is a secure tool hosted at The University of Iowa Institute for Clinical and Translational Science and The University of Iowa's National Institutes of Health Clinical and Translational Science Award through the National Institutes of Health under Award Number UL1TR002537.

Procedures for Data Collection

An initial email was sent to school nurse members of NASN, and when possible through state LISTSERVs to all school nurses, notifying them of an upcoming survey. An email with the link to the live survey was sent one week later to NASN members and all other non-NASN member recipients of the initial survey notice. School nurse consultants and leaders in most states shared the survey link with additional school nurses in their state networks for completion. Along with email distribution, the survey link was also published in the NASN Weekly Digest to reach an additional 35,000 school nurse subscribers to that publication. Two weeks after the live link was sent out, a follow-up email was sent to remind participants to complete the survey. Participation in this study was voluntary and anonymous. Completion of the survey served as the respondent's consent to participate in the study. After completing the survey, respondents had the option to enter a random drawing to win one of two iPads.

Data Analysis

The data were downloaded from REDCap and analyzed using SAS/STAT® software Version 9.4. Responses to questions on the survey were summarized with descriptive statistics (means and standard deviations, and frequencies and percentages). Respondents could skip questions, and some questions were offered only on the condition of specific replies to earlier questions. Therefore, the summaries of replies to each question are based on the number of respondents who answered that question. Some questions allowed respondents only one option to check or skip so that skipping this question could indicate either a negative reply or missing data; for these questions, percentages were calculated based on all eligible schools from the survey. The chi-square test was used to compare schools of different grade levels served on their policies on allowing students to carry their medication and on UAP administering emergency medications.

Results

Participants

Responses from 6,298 school nurses were used in the analyses of this study. All 50 states and Washington, DC, as well as the Overseas School Health Nurses Association, were represented with participant numbers ranging from 3 to 617. The school nurses who replied to demographic

Table 1. Student-Specific Emergency Medication.

Emergency Medication	Epinephrine		Albuterol Inhaler		Glucagon	
	Response[a]	*n* (%)	Response[a]	*n* (%)	Response[a]	*n* (%)
Schools with students who have a prescription for the medication	5,501	5,340 (97.1)	5,451	5,395 (99.0)	5,483	3,636 (66.3)
Student-specific medication storage—locked	6,298	3,336 (53.0)	6,298	3,950 (62.7)	6,298	2,802 (44.5)
Student-specific medication storage—not locked, stored	6,298	2,613 (41.5)	6,298	2,057 (32.7)	6,298	2,109 (33.5)
In nurse's office	2,613	2,015 (77.1)	2,057	1,475 (71.7)	2,109	1,608 (76.2)
In main office	2,613	279 (10.7)	2,057	164 (8.0)	2,109	123 (5.8)
With student	2,613	1,219 (46.7)	2,057	1,342 (65.2)	2,109	889 (42.2)
With teacher	2,613	555 (21.2)	2,057	278 (13.5)	2,109	170 (8.1)
Other locations	2,613	213 (8.2)	2,057	82 (4.0)	2,109	64 (3.0)
Student-specific medication—allowed to carry with them	6,135	3,473 (56.6)	6,135	4,534 (73.9)	6,135	1,619 (26.4)
UAP allowed to administer student-specific medication	5,711	3,581 (62.7)	NA	NA (NA)	5,711	2,253 (39.5)

Note. $N = 6{,}298$. UAP = unlicensed assistive personnel; NA = not collected.
[a]The number of schools for which a response was provided varied across items.

questions (approximately 5,200 depending on the question) were typically middle age (mean = 50.6, $SD = 9.8$), non-Hispanic (97.3%), White (95.1%), and females (99%). Most were registered nurses (94.4%), and most held a bachelor of science in nursing or a higher degree (76.4%). Of those nurses who responded to this question ($n = 6{,}138$), 41.3% oversaw multiple school buildings. A detailed description of the sample of school nurses who participated in this survey and are included in this analysis can be found in Maughan et al. (2018).

Respondents were asked to report on medication administration practices for one representative school building that they serve. The majority of respondents served in an elementary school (60.3%, $n = 3{,}796$), 31.3% ($n = 1{,}969$) served in a middle school, and 26.7% ($n = 1{,}679$) served in a high school. The percentages do not add up to 100 because some representative schools included more than one grade level (e.g., both junior and high school). The average number of hours the school nurse was present in the representative school was 31 hours per week. The 6,298 schools included in this study had an average of 733.4 students per school, representing over 4.5 million students. The schools were primarily public schools (95.1%). A more detailed description of the schools in this study can be found in Maughan et al. (2018).

Student-Specific Emergency Medication

Summary of responses to questions about student-specific emergency medications is provided in Table 1. In most schools, at least one student had a prescription for the following medications: epinephrine (97.1% of 5,501 schools for which this question was answered), an albuterol inhaler (99% of 5,451 schools), or glucagon (66.3% of 5,483 schools). Of the 6,135 schools for which information on student-specific emergency medications carry policy was provided, information on the schools' grade level served was provided for 4,778 schools ($n = 2{,}853$ elementary, $n = 927$ middle, and $n = 998$ high schools). These counts are used for comparisons of schools of different grade levels on carry policies. Of the 5,711 schools for which information on UAP being allowed to administer student-specific emergency medication was provided, information on the schools' grade level was provided for 4,466 schools ($n = 2{,}671$ elementary, $n = 866$ middle, and $n = 929$ high school). These counts are used for comparisons of schools of different grade levels on their policies for UAP administering emergency medications.

Epinephrine. More than half of all schools in the study (53% of 6,298 schools) stored epinephrine in a locked location. For 2,613 schools (41.5% of 6,298 schools) that stored student-specific medications in an unlocked location, the school nurses' office was the most common location (77.1% of 2,613 schools). The majority of schools allowed students to carry their prescription epinephrine with them (56.6% of 6,135 schools). The percentage of schools that allowed students to carry student-specific epinephrine increased with school grade level, from 41.3% ($n = 1{,}178$) of elementary schools to 74.7% ($n = 692$) of middle schools and 84% ($n = 838$) of high schools ($p < .001$). The majority of schools (62.7% of 5,711 schools) allowed UAP to administer student-specific epinephrine. By school grade level, 67% ($n = 1{,}790$) of elementary schools, 63.4% ($n = 549$) of middle schools, and 55.9% ($n = 519$) of high schools allowed UAP to administer student-specific epinephrine to a student ($p < .001$).

Albuterol inhalers. Most schools (62.7% of 6,298 schools) stored albuterol in a locked location. For 2,057 schools (32.7% of 6,298 schools) that stored student-specific medications in an unlocked location, the school nurses' office was the most common location (71.7% of 2,057 schools).

Table 2. Stock Emergency Medication.

	Epinephrine		Albuterol Inhaler		Glucagon	
Emergency Medication	Response[a]	*n* (%)	Response[a]		Response[a]	*n* (%)
Schools with stock medication	5,774	3,977 (68.9)	5,752	1,206 (21.0)	5,736	724 (12.6)
Schools with standing protocol/policy for stock medication	5,172	3,575 (69.1)	4,629	554 (12.0)	4,611	193 (4.2)
Stock medication prescribed by [b]						
District provider	3,549	1,479 (41.7)	544	273 (50.2)	190	99 (52.1)
Private MD	3,549	1,256 (35.4)	544	192 (35.3)	190	74 (39.0)
Health department	3,549	600 (16.9)	544	48 (8.8)	190	10 (5.3)
Other	3,549	214 (6.0)	544	31 (5.7)	190	7 (3.7)
Stock medication funded by [b]						
Donated by drug company	3,497	1,633 (46.7)	523	15 (2.9)	179	9 (5.0)
District funds	3,497	1,364 (39.0)	523	357 (68.3)	179	115 (64.3)
Other	3,497	500 (14.3)	523	151 (28.9)	179	55 (30.7)
Stock medication storage—locked [c]	3,977	1,780 (44.8)	1,206	792 (65.7)	724	431 (59.5)
Stock medication storage: not locked, stored [c]	3,977	2,425 (61.0)	1,206	453 (37.6)	724	309 (42.7)
In nurse's office	2,425	1,869 (77.1)	453	402 (88.7)	309	270 (87.4)
In main office	2,425	540 (22.3)	453	24 (5.3)	309	9 (2.9)
With student	2,425	434 (17.9)	453	90 (19.9)	309	66 (21.4)
With teacher	2,425	160 (6.6)	453	13 (2.9)	309	11 (3.6)
Other locations	2,425	520 (21.4)	453	32 (7.1)	309	15 (4.9)
UAP allowed to administer stock medication to a child with known diagnosis	5,711	1,642 (28.8)	NA	NA NA	5,711	2,253 (39.5)
UAP allowed to administer stock medication to a child without a diagnosis	5,711	1,340 (23.5)	NA	NA NA	NA	NA NA

Note. $N = 6{,}298$. UAP = unlicensed assistive personnel; MD = medical doctor; NA = not collected.
[a]The number of schools for which a response was provided varied across items. [b]These questions were asked only of those who have standing protocol/policy for stock medications ($n = 3{,}575$ for epinephrine, $n = 544$ for albuterol inhalers, and $n = 193$ for glucagon). [c]These questions were asked only of those who have stock medication.

The majority of schools allowed students to carry their prescription albuterol inhalers with them (73.9% of 6,135 schools). The percentage of schools that allowed students to carry student-specific albuterol inhalers increased with school grade level, from 63.6% ($n = 1{,}813$) of elementary schools to 90.2% ($n = 836$) of middle schools and 89.2% ($n = 890$) of high schools ($p < .001$). UAP data were not collected for student-specific albuterol.

Glucagon. Fewer than half of all schools in the study (44.5% of 6,298 schools) stored glucagon in a locked location. For 2,109 schools (33.5% of 6,298 schools) that stored student-specific medications in an unlocked location, the school nurses' office was the most common location (76.2% of 2,109 schools). Approximately one in four (26.4% of 6,135) schools allowed students to carry their prescription glucagon with them. The percentage of schools that allowed students to carry student-specific glucagon increased with school grade level, from 16.7% ($n = 475$) of elementary schools to 33.9% ($n = 314$) of middle schools and 46.2% ($n = 461$) of high schools ($p < .001$). Fewer than half of the schools (39.5% of 5,711 schools for which this information was provided) allowed UAP to administer student-specific glucagon. By school grade level, 39.2% ($n = 1{,}047$) of elementary schools, 45.6% ($n = 395$) of middle schools, and 40.8% ($n = 379$) of high schools allowed UAP to administer student-specific glucagon to a student ($p = .004$).

Stock Emergency Medication

Summary of responses to questions about stock medications is reported in Table 2. Epinephrine was available as stock medication in the majority of schools (68.9% of 5,774 schools for which this question was answered) as compared to albuterol inhalers (21% of 5,752 schools) and glucagon (12.6% of 5,736 schools).

Epinephrine. Of 5,172 schools for which this information was provided, 69.1% ($n = 3{,}575$) had an existing standing protocol/policy for administering stock epinephrine in emergency situations. Of the 3,575 schools with a standing protocol/policy, information for the source of prescription authorizations for stock epinephrine was provided for 3,549 schools: A health care provider associated with the school district was the most common source (41.7%, $n = 1{,}479$) followed by a private medical doctor (35.4%, $n = 1{,}256$) and health department (16.9%, $n = 600$). Funding source information for stock epinephrine was provided for 3,497 schools. Stock epinephrine was typically acquired using

Table 3. Emergency Administration of Epinephrine in Schools That Either Had a Student With an Epinephrine Prescription or Standing Protocol/Policy for Stock Epinephrine or Both.

	Total ($n = 5,463$)	Elementary ($n = 2,568$)	Middle School ($n = 836$)	High School ($n = 886$)	Missing Grade Level ($n = 1,173$)
Students Administered Epinephrine	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
0	4,415 (80.8)	2,173 (84.6)	674 (80.6)	627 (70.8)	941 (80.2)
At least 1	514 (9.4)	161 (6.3)	89 (10.6)	155 (17.5)	109 (9.3)
1	367 (6.7)	126 (4.9)	69 (8.3)	97 (10.9)	75 (6.4)
2	94 (1.7)	24 (1.0)	12 (1.4)	36 (4.1)	22 (1.9)
3–13	53 (1.0)	11 (0.4)	8 (0.9)	22 (2.5)	12 (1.0)
No reply on administering epinephrine	534 (9.8)	234 (9.1)	73 (8.7)	104 (11.7)	123 (10.5)

Note. Survey respondents were asked the question in Table 3 if the representative school either: (1) had any students with an epinephrine prescription or (2) had a standing protocol/policy for stock epinephrine or both ($n = 5,463$). Percentages may not total to 100 due to rounding.

drug company donations (46.7%, $n = 1,633$) or district funding (39%, $n = 1,364$).

Of 3,977 schools for which the question about storing stock epinephrine was answered, 44.8% ($n = 1,780$) stored stock epinephrine in a locked location and 61% ($n = 2,425$) stored stock epinephrine in a variety of unlocked locations with the nurses' office (77.1%, $n = 1,869$) being the most common. In an emergency requiring stock epinephrine to be administered to a student, 28.8% ($n = 1,642$) of 5,711 schools for which this information was provided would allow a UAP to administer epinephrine to a child with a known diagnosis. By school grade level, 29.8% ($n = 795$) of elementary schools, 27.6% ($n = 239$) of middle schools, and 29% ($n = 269$) of high schools allowed UAP to administer stock epinephrine to a student with a known allergy in an emergency ($p = .47$). In the absence of a known allergy, 23.5% ($n = 1,340$) of 5,711 schools would allow UAP to administer epinephrine. By school grade level, 25.7% ($n = 686$) of elementary schools, 22.9% ($n = 198$) of middle schools and 22.5% ($n = 209$) of high schools allowed UAP to administer stock epinephrine to a student with no known allergies in an emergency ($p = .07$).

Albuterol inhalers. Of 4,629 schools for which this information was provided, only 12% ($n = 554$) had an existing standing protocol/policy for administering stock albuterol inhalers in emergency situations. Of 554 schools with a standing protocol/policy, information for the source of prescription authorizations for stock albuterol inhalers was provided for 544 schools: A health care provider associated with the school district was the most common source (50.2%, $n = 273$), followed by a private medical doctor (35.3%, $n = 192$). Funding source information for stock albuterol inhalers was provided for 523 schools. Stock albuterol inhalers were typically purchased with district funding (68.3%, $n = 357$). Of 1,206 schools for which the question about storing stock albuterol was answered, 65.7% ($n = 792$) stored stock albuterol in a locked location and 37.6% ($n = 453$) stored stock albuterol in a variety of unlocked locations, with the nurses' office (88.7%, $n = 402$) being the most common. UAP data were not collected for stock albuterol.

Glucagon. Of 4,611 schools for which this information was provided, only 4.2% ($n = 193$) had an existing standing protocol/policy for administering stock glucagon in emergency situations. Of the 193 schools with a standing protocol/policy, information for the source of prescription authorizations for stock glucagon was provided for 190 schools: A health care provider associated with the school district was the most common source (52.1%, $n = 99$) followed by a private medical doctor (39%, $n = 74$). Funding source information for stock glucagon was provided for 179 schools. Stock glucagon was typically purchased with district funding (64.3%, $n = 115$). Of 724 schools for which the question about storing glucagon was answered, 59.5% ($n = 431$) stored stock glucagon in a locked location and 42.7% ($n = 309$) stored stock glucagon in a variety of unlocked locations, with the nurses' office (87.4%, $n = 270$) being the most common. In an emergency situation requiring stock glucagon to be administered to a student, 39.5% ($n = 2,253$) of schools would allow a UAP to administer glucagon to a child with a known diagnosis. UAP data were not collected for stock glucagon use in a child with no known diagnosis.

Emergency Administration of Epinephrine

Additional questions about emergency administration of epinephrine were asked for schools that either had at least one student with an epinephrine prescription or a standing protocol/policy for stock epinephrine ($n = 5,463$). Of these schools, 9.4% ($n = 514$) were reported to administer epinephrine to one or more students (Table 3). By school grade level, 6.3% ($n = 161$) of 2,568 elementary schools, 10.6% ($n = 89$) of 836 middle schools, and 17.5% ($n = 155$) of 886 high schools administered epinephrine to at least one student during the reporting period ($p \leq .001$). The total number of students who received epinephrine in the 514 schools was 771, ranging from 1 to 13 students. Of these schools, 471

Table 4. Allergies Reported by Students Who Received At Least One Dose of Student-Specific or Stock Epinephrine.

Type of Allergy [a]	*n* (%)
Peanut	260 (50.6)
Tree nut	154 (30.0)
Insect stings	69 (13.4)
Egg	52 (10.1)
Shellfish	47 (9.1)
Fish	39 (7.6)
Medication	35 (6.8)
Wheat	34 (6.6)
Latex	32 (6.2)
Soy	28 (5.4)
Other allergy	125 (24.3)

Note. Percentage of schools with at least one student administered epinephrine ($n = 514$). Some students were noted to report allergies to multiple allergens.

[a] Of the 514 schools with at least one student administered epinephrine, some students were noted to report allergies to multiple allergens.

schools (in which there were 682 students receiving epinephrine) had information on students with a known allergy. The number of students who were administered epinephrine and were known to have an allergy was 447 (65.5% of 682). In the 514 schools with at least one epinephrine administration, the most commonly reported allergies were peanuts (50.6%, $n = 260$ schools) and tree nuts (30%, $n = 154$ schools) as shown in Table 4. Additionally, in the 514 schools that administered epinephrine to at least one student, 458 schools (89.1%) had a licensed nurse administer epinephrine and 96 schools (18.7%) had a UAP administer epinephrine.

Discussion

This article describes practices in the school setting related to three specific emergency medications: epinephrine, albuterol inhalers, and glucagon. Recent studies evaluating the availability and use of emergency medications in schools have highlighted areas of concern for school nurses, including student carry policies, storage, and cost (Council on School Health, 2008; White et al., 2016, 2017). Students with a prescription for each of these emergency medications are often allowed to carry the medication with them in school, with permission to carry their medication increasing with age and school level (middle and senior high school students more likely than elementary). Stock supplies of epinephrine, and protocols for administration, are available in the majority of schools, but fewer schools had stock supplies of albuterol and glucagon or protocols for administration. A number of schools lock their emergency medications, limiting access in an emergency situation.

Our results demonstrate that only half of students with a known allergy routinely carry emergency epinephrine. Best practice indicates students should carry their emergency medication, if developmentally able (American Lung Association [ALA], 2014) and self-manage their condition (Jackson et al., 2015). It was surprising that although a high percentage of any middle and high schools allowed students to self-carry, some did not. All 50 states allow for self-carry, but districts or schools do not always follow this practice (ALA, 2014). Developing supportive district policy that reflects best practice and providing training are critical in order to protect the lives of children.

If students are not able or allowed to carry their own emergency medication, it should be immediately available in a known location. Our results indicate that when emergency medications are stored within the school building, 53% of student-specific and 44.8% of stock epinephrine are stored in a locked location. A locked storage poses a potential access problem during an emergency. Although best practice indicates that medications in non–health care settings need to be properly and securely stored, provisions need to be made that appropriate access is given depending on the medication. Emergency medications may need to be stored in a different way so that they are secure and accounted for but also easily accessible (National Coordinating Council for Medication Error Reporting and Prevention, 2007). In order for this to become common practice, school nurses should ensure that supportive district-level policies are developed and include the accessibility of emergency medications.

Two thirds of schools in our survey (68.9%) indicate they have stock epinephrine available for unexpected emergencies. However, stock albuterol and glucagon are much less commonly found. This may be due to the cost of the drugs. Epinephrine is often supplied by pharmaceutical companies at no cost to the school while albuterol and glucagon are not. It then becomes the school district's responsibility to purchase these medications. The cost may become problematic as all of these medications need to be restocked after each use and/or when their expiration date is reached. Wood (2018) suggests that this may become more of a problem as emerging emergency medications, such as naloxone that ranges from US$20–US$40 per dose, are being used more frequently. According to GoodRx, the average retail prices for emergency medications are as follows: US$52.02 for one albuterol inhaler, US$399.64 for two epinephrine autoinjectors, and US$372.21 for one glucagon injection. Community solutions need to be found to remove this financial burden on schools.

Our findings aligned with existing data suggesting that roughly 20%–25% of anaphylactic emergencies occur in the absence of a documented allergy, reinforcing the need for stock epinephrine in schools (Fortner, 2018; White et al., 2017). Data from our cohort suggest that nurses are administering most of these doses in anaphylactic emergencies. This may be due to individual nurse practice acts and state laws regarding delegation. It may also be due to

unclear or undeveloped district policies that may provide improved guidance for schools in the case of an emergency. This is particularly critical if a nurse is covering multiple schools.

Limitations

Limitations of our study that may impact the generalizability of our results are noted here. Due to the distribution strategy of our survey, we could not calculate a total response rate. The absence of this variable limits the significance of our results across all schools. Additionally, we are presenting data collected in 2015 which may be less consistent with today's practices due to the rapidly changing nature of medicine and school policies. Many issues discussed in this article are still of high priority and demand attention by school nurses and administrators to streamline the medication administration processes in schools.

School Nursing Implications

School nurses have a pivotal role in addressing student safety in emergency situations. School nurses can develop or ensure that evidence-based policies regarding storage and administration of emergency medication are in place in their schools. Epinephrine is best prescribed to students with known allergies and in conjunction with an emergency care plan (Sicherer & Simons, 2017). School nurses can ensure that students may carry their medications, if developmentally able, as well as ensure medications are properly stored but also with quick access in the case of an emergency (NASN, 2017). School nurses can focus on implementing a comprehensive approach to medical emergencies from early diagnosis to proper storage, training, and procedures for emergency medications. This approach includes school nurses providing training to staff on signs and symptoms of a medical emergency as well as proper medication administration for authorized individuals (Sicherer & Simons, 2017).

Nurses can also provide general training to staff regarding conditions that may require immediate medical attention and advocate to make their school a safe, asthma friendly, and teal (i.e., allergy alert) classroom environment (CDC, 2015; Jackson et al., 2015; Kids with Food Allergies, 2018; Sicherer & Simons, 2017). They can also advocate for students with diabetes to be able to self-manage their care as well as advocate for noninvasive, nasal glucagon (Food and Drug Administration, 2019; Jackson et al., 2015). Since the most common place to find stock emergency medications was in the nurse's office, it is also important that procedures are in place that only those with authorization can access the medications but that they be quickly available in emergencies.

School nurses can also advocate beyond the walls of their school. They can collaborate with local emergency operators to ensure they are aware of the school procedures and see whether paramedics and first responders have their own procedures in place who dictate when to give a second dose of epinephrine to a child in anaphylaxis and whether transportation to a hospital is warranted (Wang & Sicherer, 2017). As leaders of health in schools, nurses advocate for the safety of all their students. This includes being prepared for emergency situations. In addition, school nurses can advocate for state laws regarding stock emergency medications and identifying partners who may assist in funding the cost of these medications.

Future Studies

Areas of future research on this topic are vast. Due to the wide variety of individuals administering emergency medications in schools, data are needed on the delegation of epinephrine administration to UAP and subsequent safety outcomes. Additionally, further study is needed to determine the best place within schools to store stock emergency medications to enable safe and timely administration of these agents. It is necessary that school nurses are refining these practices within their own schools and helping to report data on a national level for generalizable research. Understanding the current state of emergency medication laws will help school nurses see where gaps may exist and advocate so that schools are prepared when a medical emergency occurs in the school. In turn, schools will be prepared to address emergency situations for optimal health outcomes: keeping students safe.

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Author Contributions

A. M. McCarthy, E. Maughan, M. Hein, Y. Perkhounkova, and M. Kelly contributed to the conception of the manuscript design, acquisition, and analysis of the data. All authors were involved in the drafting and revisions process, gave final approval, and agreed to be accountable for all aspects of work ensuring integrity and accuracy.

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ORCID iDs

Rebecca A. McCaughey, MPH https://orcid.org/0000-0002-3334-5174

Erin Maughan, PhD, MS, RN, PHNA-BC, FNASN, FAAN https://orcid.org/0000-0002-0176-1499

References

American Diabetes Association. (2018). *Statistics about Diabetes*. http://www.diabetes.org/diabetes-basics/statistics/

American Lung Association. (2014). *Creating asthma friendly environments*. https://www.lung.org/lung-health-diseases/lung-disease-lookup/asthma/living-with-asthma/creating-asthma-friendly-environments

Centers for Disease Control and Prevention. (2015). *Food allergies in schools toolkit*. U.S. Department of Health & Human Services. https://www.cdc.gov/healthyschools/foodallergies/toolkit.htm

Centers for Disease Control and Prevention. (2017). *Health, United States*. U.S. Department of Health & Human Services. https://www.cdc.gov/nchs/data/hus/2017/035.pdf

Council on School Health. (2008). Medical emergencies occurring at school [policy statement]. *Pediatrics*, *122*(4), 887–894. https://doi.org/10.1542/peds.2008-2171

Farris, K. B., McCarthy, A. M., Kelly, M. W., Clay, D., & Gross, J. N. (2003). Issues of medication administration and control in Iowa schools. *Journal of School Health*, *73*(9), 331–337. https://doi.org/10.1111/j.1746-1561.2003.tb04188.x

Federal Interagency Forum on Child and Family Statistics. (2019). *America's children: Key national indicators of well-being, 2019*. https://www.childstats.gov/americaschildren/tables/health8a.asp

Food and Drug Administration. (2019). *FDA approves first treatment for severe hypoglycemia that can be administered without an injection*. U.S. Department of Health & Human Services. https://www.fda.gov/news-events/press-announcements/fda-approves-first-treatment-severe-hypoglycemia-can-be-administered-without-injection

Fortner, C. (2018, May 14). *Food allergies: Helping schools prepare to respond*. U.S. Department of Agriculture. https://www.usda.gov/media/blog/2018/05/14/food-allergies-helping-schools-prepare-respond

Gerald, L. B., Snyder, A., Disney, J., Gerald, J. K., Thomas, A., Wilcox, G., & Brown, M. A. (2016). Implementation and evaluation of a stock albuterol program for students with asthma [Letter to the editor]. *Annals of the American Thoracic Society*, *13*(2), 295–296.

Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics*, *42*(2), 377–381. https://doi.org/10.1016/j.jbi.2008.08.010

Hogue, S. L., Muniz, R., Herrem, C., Silvia, S., & White, M. V. (2018). Barriers to the administration of epinephrine in schools. *Journal of School Health*, *88*(5), 396–404. https://doi.org/10.1111/josh.12620

Jackson, C. C., Albanese-O'Neill, A., Butler, K. L., Chiang, J. L., Deeb, L. C., Hathaway, K., Kraus, E., Weissberg-Benchell, J., Yatvin, A. L., & Siminerio, L. M. (2015). Diabetes care in the school setting: A position statement of the American diabetes association. *Diabetes Care*, *38*(10), 1958–1963. https://doi.org/10.2337/dc15-1418

Kelly, M. W., McCarthy, A. M., & Mordhorst, M. J. (2003). School nurses' experiences with medication administration. *The Journal of School Nursing*, *19*(5), 281–287. https://doi.org/10.1177/10598405030190050601

Kids with Food Allergies. (2018, July 19). *Share our teal classroom kit with your child's school to promote food allergy awareness*. Asthma and Allergy Foundation of America. https://community.kidswithfoodallergies.org/blog/share-our-teal-classroom-kit-with-your-child-s-school-to-promote-food-allergy-awareness

Maughan, E. D., McCarthy, A. M., Hein, M., Perkhounkova, Y., & Kelly, M. W. (2018). Medication management in schools: 2015 Survey results. *The Journal of School Nursing*, *34*(6), 468–479. https://doi.org/10.1177/1059840517729739

McCarthy, A. M., Kelly, M. W., Johnson, S., Roman, J., & Zimmerman, M. B. (2006). Changes in medications administered in schools. *The Journal of School Nursing*, *22*(2), 102–107.

McCarthy, A. M., Kelly, M. W., & Reed, D. (2000). Medication administration practices of school nurses. *The Journal of School Health*, *70*(9), 371–376. https//doi.org/10.1111/j.1746-1561.2000.tb07277.x

National Association of School Nurses. (2017). *Medication administration in the school setting: Medication administration in schools* [Position statement]. https://www.nasn.org/advocacy/professional-practice-documents/position-statements/ps-medication

National Coordinating Council for Medication Error Reporting and Prevention. (2007). *Recommendations to reduce medication errors in non-health care settings*. https://www.nccmerp.org/recommendations-reduce-medication-errors-non-health-care-settings

Reutzel, T. J., & Patel, R. (2001). Medication management problems reported by subscribers to a school nurse listserv. *The Journal of School Nursing*, *17*(3), 131–139. https://doi.org/10.1177/10598405010170030401

Sicherer, S. H., & Simons, F. E. R. (2017). Epinephrine for first-aid management of anaphylaxis. *Pediatrics*, *139*(3), Article e20164006. https://doi.org/10.1542/peds.2016-4006

Wang, J., & Sicherer, S. H. (2017). Guidance on completing a written allergy and anaphylaxis emergency plan. *Pediatrics*, *139*(3). https://doi.org/10.1542/peds.2016-4005

White, M. V., Hogue, S. L., Odom, D., Cooney, D., Bartsch, J., Goss, D., Hollis, K., Herrem, C., & Silvia, S. (2016). Anaphylaxis in schools: Results of the EPIPEN4SCHOOLS survey combined analysis. *Pediatric Allergy, Immunology, and Pulmonology*, *29*(3), 149–154. https://doi.org/10.1089/ped.2016.0675

White, M. V., Silvia, S., Muniz, R., Herrem, C., & Hogue, S. L. (2017). Prevalence and triggers of anaphylactic events in schools. *Allergy and Asthma Proceedings*, *38*(4), 286–293. https://doi.org/10.2500/aap.2017.38.4066

Willgerodt, M. A., Brock, D. M., & Maughan, E. D. (2018). Public school nursing practice in the United States. *The Journal of School Nursing*, *34*(3), 232–244. https://doi.org/10.1177/1059840517752456

Wilt, L., & Foley, M. (2011). Delegation of Glucagon® in the school setting: A comparison of state legislation. *The Journal of School Nursing*, *27*(3), 185–196. https://doi.org/10.1177/1059840511398240

Wood, S. (2018, June 4). *As opioid overdose numbers rise, so does the cost of naloxone*. Bill of Health. http://blog.petrieflom.law.harvard.edu/2018/06/04/as-opioid-overdose-numbers-rise-so-does-the-cost-of-naloxone/

Author Biographies

Rebecca A. McCaughey, MPH, is a student at the College of Pharmacy, University of Iowa.

Ann Marie McCarthy, PhD, RN, FNASN, FAAN, is a professor and associate dean for Research at the College of Nursing, University of Iowa.

Erin Maughan, PhD, MS, RN, PHNA-BC, FNASN, FAAN, is a director of Research at the Department of Research, National Association of School Nurses.

Maria Hein, MSW, is a data manager at the College of Nursing, University of Iowa.

Yelena Perkhounkova, PhD, is a statistician manager at the College of Nursing, University of Iowa.

Michael W. Kelly, BSPh, PharmD, MS, is a clinical professor at the College of Pharmacy, University of Iowa.