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RESEARCH ARTICLE

School Stock Inhaler Statutes and Regulations in the United States: A Systematic Review*

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ABSTRACT

BACKGROUND: Children with asthma should have immediate access to rescue medication. Yet, <15% of children have access to this life-saving drug while at school.

METHODS: A search was conducted in the all states database of Westlaw to identify which the US states, territories, and the District of Columbia have a law for K-12 schools. Terms searched included (inhaler or asthma/s medic!) and school and (prescription or order) from conception to December 2020. Demographic data from states with and without a policy were compared. All policies were examined for the following components: (1) type of law (statute or regulation); (2) type of school (charter, private/parochial or public); (3) training requirements; (4) devices; (5) prescriptive authority/safe harbor; (6) medication requirements; and (7) mandated documentation, reporting and funding.

RESULTS: Our systematic search revealed 15 locations with existing laws. States with a law had a higher percentage of children under 17-years than states without a law ($p = .02$). Common components described were the applicability to various types of schools, training requirements for those empowered to administer, and civil liability protections for trained school personnel.

CONCLUSIONS: Existing stock inhaler laws differ vastly across the United States that may impact access to stock albuterol for children at their schools.

Keywords: health policy; albuterol; school; asthma; emergency medication; short-acting beta2 agonist.

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ABBREVIATIONS

AAP: asthma action plan
UAP: unlicensed assistive personnel
NSLP: national school lunch program
VHC: valved-holding chamber
IQR: interquartile range
BLS: basic life support
MDI: metered dose inhaler
EMS: emergency medical system
RN: registered nurse
CDC: Centers for Disease Control and Prevention

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Asthma affects approximately 10% of school-aged children in the United States.[1] Children with asthma should have immediate access to rescue medication (albuterol sulfate) at school to quickly relieve their symptoms.[2] Yet, <15% of children have access to this life-saving drug while at school.[3] Schools can ensure access to rescue medication for all children by implementing a stock inhaler program at their school. Albuterol sulfate is a short-acting beta2-agonist that is used to treat or prevent bronchospasm.[4] The medication is usually delivered as a nebulized solution or through a pressurized, metered-dose inhaler (MDI).[5] MDI's are the preferred method of medication delivery in the school setting because they are small, portable, and do not require a power source.[5] During nebulizer use, less than 10% of the aerosolized drug reaches the lungs resulting from drug lost to the surroundings or deposits on the apparatus or child's face.[6-8] Furthermore, MDIs in conjunction with a spacer have demonstrated increased effectiveness in young children who presented to the emergency department and faster symptom resolution.[6] MDIs afford schools with an easy and cost-effective solution because they can also be sanitized between uses and therefore, when used in conjunction with a spacer, can be used by multiple children for respiratory distress.[9] Previous stock inhaler programs have demonstrated that most children who are promptly treated with rescue medication return back to their classroom and learning environment.[10] However, implementation is difficult without appropriate laws that protect unlicensed school personnel, schools, and prescribing authorities from civil liability. These laws are necessary because most schools do not have a licensed, school nurse who can administer the medication under a physician order to a child in respiratory distress. Even when a licensed nurse is present at the school, the school may not be aware of a student's asthma diagnosis, so asthmatic children who do not have the appropriate paperwork on file may be denied life-saving medication. Given the safety and efficacy drug profile of albuterol sulfate in children, stock inhaler laws provide schools with a legal passageway to implementation.

All 50 US states and the District of Columbia have enacted laws that allow students to carry and self-administer quick-relief asthma medication while at school, but these laws are insufficient for children who do not have, or may be unable to access, a personal inhaler during an episode of respiratory distress.[11] Almost all states have laws that allow schools to stock epinephrine for anaphylaxis emergencies. States have recently begun enacting laws that enable schools to maintain a stock inhaler for respiratory distress events but current lists that tabulate which states have laws and the components of each states' laws remain incomplete.[11-13] Given vast regional differences between the 50 states including geographical, population, and political differences, understanding how demographic factors are associated with the adoption of stock inhaler legislation remains important. The objectives of our systematic review of stock inhaler policies for K-12 schools were to: (1) identify states/territories with existing stock inhaler statutes or regulations, (2) compare population characteristics between states/territories that have existing statutes or regulations versus those that lack a stock inhaler statute or regulation, and (3) describe components of stock inhaler statutes or regulations among states/territories.

METHODS

Search Strategy

We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to examine existing stock inhaler policies from conception through August 2021 across US states/territories and the District of Columbia (Supporting Informations).[14] Our team developed a terms and connectors search within the all content and all states jurisdictional database on Westlaw Edge, a subscription-based legal research service (Eagen, Minnesota).[15] Table 1 provides the full search string used.

Data Selection

Four authors (SO, BN, HP, and LBG) independently screened each state's statute and/or regulation for inclusion criteria, focusing on policies regarding stock albuterol/levalbuterol medication. We defined statute as any legislative or regulatory action taken by a US state governmental body. Regulations were defined as any rule promulgated by a state agency such as the Board of Education or Public Health Department. Both statutes and regulations were screened for inclusion criteria using the pre-specified eligibility criteria outlined in the search protocol (Supporting Informations; Table 2).

Data Collection, Statute/Regulation Screening, and Data Extraction

A data collection spreadsheet was used for all data extraction (Supporting Informations). Data were independently extracted by four individuals (SO, BN, HP, and LBG) and then reviewed by the entire team. Differences were reconciled by consensus.

Table 1. **Full search strategy conducted in Westlaw, 2021**

Database	Full Search Algorithm
Westlaw	(Adv: ("inhaler" or "asthma"/s medic!) and "school" and ("prescription" or "order"))

Table 2. **Inclusion and exclusion criteria for stock inhaler law review, 2021**

Inclusion Criteria	Exclusion Criteria
1. Statute or regulation passed in the 50 US states or territory or the District of Columbia 2. Description of procedures or processes for stocking emergency medication for asthma in K-12 schools specified within the statute or regulation	1. All search results that did not address a stock inhaler medication (eg, student self-carry, nurse administration of student inhaler, etc.) in K-12 schools

Demographic data for each US state and territory were extracted from the US Census and other public data sources (Supporting Informations).[16-21]

Data Analysis

Demographic differences between states and territories with an existing stock inhaler statute or regulation and states and territories without an existing stock inhaler statute or regulation were examined using a nonparametric Mann-Whitney test for continuous outcomes or a Wilcoxon Rank Sum test for categorical data (Table 3). All statistical analyses were conducted in Stata Version 16.1 (College Station, TX).[22]

We examined each statute and regulation that met our inclusion criteria for the following outcomes: (1) type of policy (statute or regulation); (2) type of school (charter, private/parochial, and/or public); (3) training requirements; (4) devices (valved-holding chamber (VHC), stock inhaler, and/or nebulizer); (5) prescriptive authority/safe harbor; (6) medication administration requirements; and (7) mandated documentation, reporting, and funding. We created a concept matrix to summarize these outcomes by the US state and the District of Columbia (Table 4).

RESULTS

Our systematic search produced 234 statutes and 80 regulations that were screened for our inclusion and exclusion criteria. After consolidating these statutes and regulations by the US state and territory, we identified 14 states and the District of Columbia as having a corresponding stock inhaler statute or regulation: Arkansas, Arizona, District of Columbia, Georgia, Illinois, Indiana, Kentucky, Missouri, Nebraska, New Hampshire, New Mexico, Ohio, Oklahoma, Texas, and Utah (Figure 1). States with an existing stock inhaler statute or regulation had a higher percentage of children under 17-years ($p = .02$). No other significant differences in the demographic characteristics were identified (Table 3).

Stock Inhaler Statute/Regulation Components

Law type. Ninety-three percent of locations (14/15) had a currently enacted statute regarding a stock inhaler in their state or district.[23-47] Four states (Arizona, Georgia, Illinois, and New Mexico) had a regulation regarding stock inhalers in K-12 schools in addition to their statute.[29,48,49] One state (Nebraska) had a regulation only.[50-52]

School type. Among states and territories with a statute/regulation, almost all ($n = 12$) included language that specified the types of schools to which the stock inhaler statute or regulation applied (Table 4). Eight states identified charter schools in their policies.[23,24,30,33,37,38,44,48,53,54] Nine states addressed private or parochial schools.[23,26,30,33,37,38,44,55-57] Twelve states specified public schools.[23,24,30,33,37,44,48,54-57] Both Missouri and Oklahoma specified school types broadly by using language such as ''school districts'' and Kentucky used ''schools''[27,58,59] However, Nebraska incorporated

Table 3. **Demographic characteristics of the US states and District of Columbia by presence or absence of an existing stock inhaler statute or regulation, 2021**

Characteristics	Total ($N = 54$)	WITH existing statute or regulation ($N = 15$)	WITHOUT existing statute or regulation ($N = 39$)	*p*-value
Population density, no. of people per 100,000/mi^2, median, IQR	37,912 (13,603-65,476)	43,394 (20,592-96,877)	37,528 (6257-127,024)	.76
No. of children under 17-years of age, (mean %), SD	22.2 (2.1)	23.2 (2.6)	21.8 (1.7)	**.02**
No. of active physicians, per 100,000, median, IRQ	260 (227-293)	283 (219-281)	264 (232-295)	.18
No. of licensed pharmacists, per 100,000, median, IQR	39 (15-73)	50 (25-105)	32 (14-70)	.76
No. of public school districts, median, IQR	1315 (721-2331)	1807 (1061-2425)	1264 (599-2255)	.36
No. children who qualify for NSLP, median, IQR	298,113 (108,723-492,332)	361,303 (178,757-689,825)	243,798 (73,986-413,539)	.12
Children < 18 years in poverty, median, IQR	163,788 (60,110-283,218)	225,710 (87,445-456,925)	149,495 (36,709-259,720)	.10

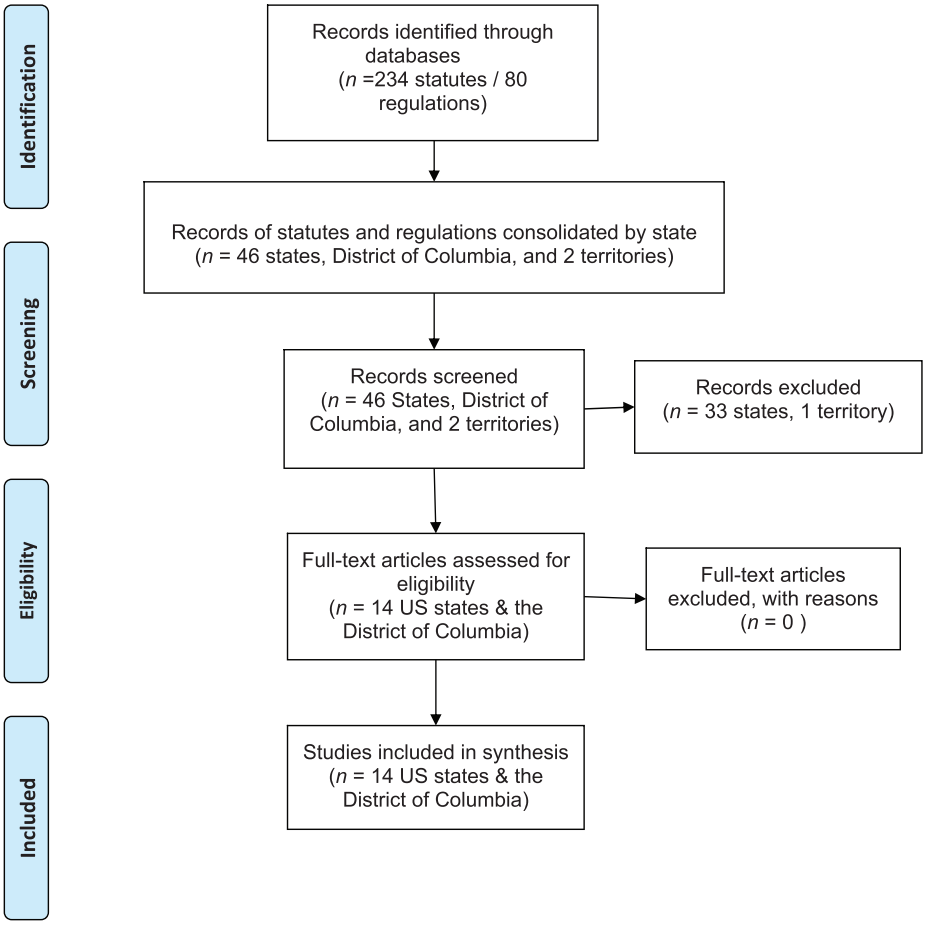
Abbreviations: IQR, Interquartile Range, NSLP: National School Lunch Program.

Table 4. Components of stock inhaler statutes and regulations by the US State and District of Columbia, 2021

Location (N = 15)	Law Type	School Type	Training Requirements	Devices	Prescriptive Authority/ Safe Harbor	Medication Administration Requirements	Mandated Documentation, Reporting and Funding
Arizona	×	×	×	×	×	×	×
Arkansas	×	×	×	×	×	×	×
District of Columbia	×	×	×	×	×	×	×
Georgia	×	×	×	×	×	×	×
Illinois	×	×	×	×	×	×	×
Indiana	×	×	×	×	×	×	×
Kentucky	×	×	×	×	×	×	×
Missouri	×	×	×	×	×	×	×
Nebraska	×	×	×	×	×	×	×
New Hampshire	×	×	×	×	×	×	×
New Mexico	×	×	×	×	×	×	×
Ohio	×	×	×	×	×	×	×
Oklahoma	×	×	×	×	×	×	×
Texas	×	×	×	×	×	×	×
Utah	×	×	×	×	×	×	×

Location (N = 15)	Law Type	School Type	Training Requirements	Devices	Prescriptive Authority/ Safe Harbor	Medication Administration Requirements	Mandated Documentation, Reporting and Funding
Arizona	×	×	×	×	×	×	×
Arkansas	×	×	×	×	×	×	×
District of Columbia	×	×	×	×	×	×	×
Georgia	×	×	×	×	×	×	×
Illinois	×	×	×	×	×	×	×
Indiana	×	×	×	×	×	×	×
Kentucky	×	×	×	×	×	×	×
Missouri	×	×	×	×	×	×	×
Nebraska	×	×	×	×	×	×	×
New Hampshire	×	×	×	×	×	×	×
New Mexico	×	×	×	×	×	×	×
Ohio	×	×	×	×	×	×	×
Oklahoma	×	×	×	×	×	×	×
Texas	×	×	×	×	×	×	×
Utah	×	×	×	×	×	×	×

Figure 1. **Prisma Flow Chart of Stock Inhaler Statutes and Regulations, 2021**



highly specific language, such as, ''schools accredited by the State Board of Education.''[33] Lastly, Utah specified ''any private or public educational facility'' and Ohio stated ''school-districts and community schools''.[32,37]

Training requirements. Forty-seven percent (7/15) of locations included language regarding how the stock inhaler training should be delivered to school personnel (in-person or web-based; Table 4).[23,24,27,30,31,37,55,56,60-63] Kentucky and Kansas were the only states that did not include any language in their statute that required staff training before albuterol can be administered in the school setting.[40,59,64] Both Arizona and Illinois allowed training to be conducted either a web-based or in-person, while Missouri required an in-person training.[23,27,48,56] Arizona and New Hampshire's statutes and regulations further specified that training should be conducted by a nationally recognized organization with experience in training laypersons in emergency health treatment.[23,48,60] Utah's statute did not specify the mechanism of training delivery, whereas the District of Columbia and Missouri's statutes broadly specified that school personnel shall be trained by a medically-certified individual.[27,37,61,65] Georgia required that school boards provide information to school personnel on how to recognize the signs and symptoms of respiratory distress and detailed instructions on how to administer a stock inhaler.[55] Only two states specified the minimum number of trained individuals per school (Arizona: at least two; New Mexico: at least one).[23,30,48] Overall, Illinois' statute contained the most stringent training requirements which required school personnel to complete an asthma-specific training every 24 months and school personnel designated to administer the stock inhaler complete a Basic Life Support (BLS) course before becoming certified to administer the beta2-agonist medication.[56] The frequency of training required in Utah was every 12 months, in Arizona and Illinois it was 24 months, and in the District of Columbia it was 36 months (Table 4).[23,48,56,61,65]

Devices (VHC, stock inhaler, and/or nebulizer). Delivery devices remain a key component of guideline-concordant care and must be specifically included

within stock albuterol inhaler legislation to ensure proper implementation in the school setting. While a metered-dose inhaler (MDI) can be administered with or without a VHC and a nebulizer with or without a facemask for individual use, a stock albuterol inhaler must be administered in conjunction with a VHC and a stock albuterol nebulizer must be used with a facemask.[9] Six states (Arizona, Kentucky, New Hampshire, New Mexico, Ohio, and Oklahoma) specified the use or requirement of a VHC in conjunction with an MDI within the statute or regulation, but no states specified use of a facemask in conjunction with a nebulizer.[23,30,31,48,58,59,64,66] Sixty percent (9/15) of locations specified either a stock inhaler or nebulizer can be utilized (Table 4).[23,26,29,31,33,48,55,56,58,66]

Prescriptive authority/safe harbor. Seven locations (Arizona, Arkansas, Indiana, Kentucky, Nebraska, and Texas) explicitly stated who may sign a standing medical order for a stock inhaler to be used in school;[23,24,41,48,50,59,64,67] most commonly, laws indicated physicians and nurse practitioners who were licensed in the state. Arizona further specified that a chief medical officer for a county health department may prescribe and sign the standing medical order for a stock inhaler.[23,48] Eighty percent (12/15) specified which health care professionals may prescribe albuterol to individual schools or school districts.[23,24,29,35,41,47,48,50,55,56,58,66-68] Arkansas, Georgia, Illinois, and Missouri specified that licensed physicians, nurse practitioners, or physician's assistants were eligible to prescribe a stock inhaler to a school,[24,27,55,56] while Kentucky, Nebraska, New Hampshire, and Texas used more general language such as ''health care provider'' or ''person who has been delegated prescriptive authority''.[41,50,57,59,64] Lastly, 10 states had a pharmacy dispensing law relevant to the stock inhaler (Table 4).[23,24,27,29,41,48,50,67,69] Seventy-one percent (11/15) of locations provided specific language regarding indemnification or liability shield for medication administration.[23,24,26,27,29,32,35,45,55,59,64,69-71] New Mexico was the only state that did not specify in their policies indemnification for school personnel who administer the stock inhaler in good-faith.[29,69] Nine locations (Arizona, Arkansas, District of Columbia, Illinois, New Hampshire, Ohio, Oklahoma, Texas, and Utah) provided language specific to the school entity for release of liability; however, Illinois was the only state that required a parent to sign an acknowledgement of release of liability (Table 4).[23,24,32,35,45,48,49,56,58,72,73]

Medication administration requirements. Only Texas required that school districts provide their approval for a stock inhaler program on an annual basis.[42] Two states (Texas and Utah) specified that legal guardian permission was required before the stock inhaler could be administered.[33,42] Illinois allowed parents to opt-out their child for stock inhaler eligibility by written notification.[56] Oklahoma required school districts to notify all parents or guardians that the stock inhaler may be used in any student experiencing respiratory distress.[58] Four states (Missouri, New Hampshire, Texas, and Utah) required that a prior asthma diagnosis was on file for a child to use a stock inhaler.[27,28,33,41] Texas required a parent or guardian to provide written documentation of their child's physician-diagnosed asthma annually to be eligible to use the stock inhaler.[41] Two states (New Mexico and Texas) required that a licensed nurse (RN) administer the stock inhaler.[29,35] Forty-seven percent (7/15) of locations provided specific language that instructed schools regarding medication administration.[23,24,29,31,48,49,69,71] For example, Arizona and Kentucky adopted a clinical protocol for medication administration where events were stratified based on the individual's initial presentation (ie, severe respiratory distress or mild-to-moderate respiratory distress).[48,59,64] Two states (New Mexico and Oklahoma) required 9-1-1 to be called following the use of the stock inhaler.[29,69] Fifty percent (7/1) of locations did not restrict the availability of the stock inhaler to students and broadened the language to allow other individuals (school personnel or visitors) to be eligible for its use.[23,26,27,31,33,48,56,57,74] Three locations (District of Columbia, New Mexico, and Ohio) specified instructions regarding the maintenance and storage of the stock inhaler.[29,31,75]

Mandated documentation, Reporting, and Funding. Sixty percent (9/15) of locations required documentation of each stock inhaler event (Table 4).[23,29,31,48,51,56,66,76,77] Only three states (Arizona, New Hampshire, and New Mexico) mandated retention of documentation for schools that used a stock inhaler.[23,29,33,48,66] Two states (Illinois and Ohio) had mandated reporting requirements to the State Board of Education.[31,56]

Fifty-three percent (8/15) of the policies included language that specified how schools could fund or procure a stock inhaler or stock nebulizer.[23,24,31,43,48,55,58,59,64,66] Arizona, Kentucky, and New Hampshire statutes included language that allowed schools to obtain a stock inhaler through grants, monetary gifts, or donations.[23,59,64,66] In Arkansas and Georgia, schools were permitted to create an agreement with the manufacturer to receive free, inhaled short-acting beta2-agonist, at market value, or at reduced cost.[24,55] In Texas, the statute clearly specified that schools were not required nor mandated to purchase a stock inhaler or a nebulizer.[43]

Conclusions

This systematic review identified policies in 14 states and the District of Columbia that permitted schools to procure, stock, and administer a stock inhaler. States with a current stock inhaler law employed a wide variety of differences in specificity and language that may impact access to stock albuterol and create barriers in its use for school children. We found that stock inhaler statutes and regulations were more likely to be enacted in states with a higher percentage of children under 17-years than in states without a statute or regulation. This suggests that states with more children may be early adopters of policies that affect children.

In general, most states did not address all types (ie, charter or public versus private/parochial) of schools, creating variable access to medication among children within the same communities. Training for school personnel is another key component that was poorly defined in most states' statutes and regulations. Only Arizona, the District of Columbia, Missouri, and Oklahoma required a health care professional to lead training programs for school personnel.[23,27,48,58,65] The omission of training requirements regarding the material covered and frequency of training could potentially cause a failure to recognize asthma symptoms or respiratory distress or a delay in the prompt administration of albuterol to a child. More specific language should be added through statutory or regulatory revisions to ensure that laws are optimally designed to enable children to have access to beta2-agonists in the event of respiratory distress.

Although asthma is the most common chronic condition affecting school-age children, it remains undiagnosed in some.[1,78,79] In a survey conducted among 122,829 school-aged children, 17.2% self-reported asthma-like symptoms with no formal asthma diagnosis.[80] Furthermore, insured children are two times more likely to have an asthma diagnosis as compared to uninsured children.[81] These data highlight the importance of legislation that specifies albuterol may be given to any child experiencing ''respiratory distress.'' This specification considers the barriers many families experience when accessing care and the subsequent effect on school personnel who may not be aware of a child's asthma status or students who may not have the necessary paperwork on file at school. When policies specify that a child must have ''physician diagnosed asthma'' before using a stock inhaler, the prompt administration of albuterol is delayed, thereby increasing the risk for worsening symptoms, emergency department visits, hospitalization, or even death.[4] Missouri, Illinois, New Hampshire, and Texas' policies either limit the access to stock inhalers by requiring an asthma diagnosis prior to medication administration or by allowing families to opt out of stock inhaler use.[26-28,41,56] Future legislative efforts should model Oklahoma's approach to parental notification which required that school districts only inform parents or guardians of a stock inhaler program and Arizona's law which allows any child, regardless of their asthma status, access to rescue medication.[23,48]

Another key component of stock inhaler laws is to ensure medication administration is not required to be completed by a nurse. The benefits of the licensed, school nurse are well established.[82] Children who attend schools with a full-time, licensed nurse have less chronic absenteeism and improved academic outcomes.[83] Furthermore, asthmatic children who attend schools with a full-time, licensed nurse experience improved disease management and health outcomes.[83,84] While we advocate for a full-time licensed nurse in every school, the reality is most schools do not allocate funding for licensed nurses and instead employee unlicensed assistive personnel. Therefore, when stock inhaler policies require that a nurse administer the medication, schools are severely restricted in their ability to provide care for a child in respiratory distress. While we advocate for a full-time nurse in every school, the reality is that most US schools do not have a full-time nurse available.[85] Unlicensed Assistive Personnel (UAPs) are the most common person to administer medications in schools, therefore, without language stating that trained UAPs may administer the stock inhaler, many schools would not be able to use it.[86,87] One concerning finding was that two states allow UAPs to administer epinephrine but only allow nurses to administer albuterol (Texas and New Mexico).[29,39,41] Given the wide safety profile of albuterol,[4] the very common occurrence of respiratory distress, and the fact that respiratory distress can be life-threatening, this restriction strongly affects the safety of children. Requiring schools to call 9-1-1 after the stock inhaler is administered is also problematic as many children can return to class after a mild-to-moderate episode of respiratory distress. Evidence for this is provided by a study in Arizona which found that 84% of children returned to their classroom after using the stock inhaler. Both New Mexico and Oklahoma require that EMS be summoned after each stock inhaler event.[10,29,58] However, EMS notification should be reserved for severe respiratory distress events.

A systematic review of statutes and regulations is outside the traditional scope of systematic review of clinical trials and studies; however, this type of review can assist policy advocates in adopting the best parts of existing laws and can expedite the diffusion of innovation.[88] A limitation of our review was the focus on statutes or regulations enacted by individual states and territories. For example, we omitted New York from our review as they lack a statute or regulation.

While the New York State Department of Education has issued a policy for stocking albuterol, this is not codified in the state's regulations or statutes; therefore, it does not provide notice to health care professionals prescribing or dispensing the stock inhaler and it may not fully protect schools, school personnel, and prescribing authorities for their good faith use. We also acknowledge that this review does not include any executive orders from governors.

At the time of our initial search, the COVID-19 pandemic had begun and nebulized albuterol in schools became a significant concern. Stock albuterol delivered by a nebulizer poses an enhanced infection risk to the person administering the medication and to other individuals located in the same room as the treated person due to aerosolization. The Centers for Disease Control and Prevention (CDC) acknowledged the potential infection risk to others when a nebulizer is used and SARS-Cov-2 is transmittable even when an infected individual is asymptomatic or pre-symptomatic.[89] Therefore, current recommendations state that nebulizers should be used away from other individuals or in a well-ventilated space and we suggest that state policies prioritize the use of stock inhalers with VHCs instead of nebulizers for reduced infection risk.[89]

IMPLICATIONS FOR SCHOOL HEALTH

To our knowledge, this is the first systematic review of stock inhaler policies, statutes, and regulations among US states and territories. Our results indicated a large variation between key legislative components included within each state's law. These variations can both positively and negatively impact the care of children with asthma. Using clear language that incorporates best practices should be modeled by US states and territories with no current stock inhaler policy and current laws should be improved to account for the issues discussed to ensure access to stock albuterol for all school children who experience life-threatening respiratory distress. Future research should focus on passing legislation throughout the United States, and implementing stock inhaler policies in US schools. Stock inhaler programs should be evaluated to understand the impact of the programs on academic and health outcomes.

Conflict of Interest

Lynn B. Gerald reports product donations from Thayer Medical Corporation. Other authors have no financial relationships to disclose.

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SUPPORTING INFORMATION

The following Supporting Information is available for this article:

Appendix S1: PRISMA checklist, protocol for systematic review without meta-analysis, and data dictionary

Additional supporting information may be found online in the Supporting Information section at the end of the article.