RESEARCH ARTICLE

Firearms Screening in the Pediatric Inpatient Setting

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ABSTRACT

OBJECTIVES: Firearm-related deaths remain a top cause of mortality in American children and adolescents. In a 2012 policy statement, the American Academy of Pediatrics urged pediatricians to incorporate questions about the availability of firearms into their patient history taking. We aim to evaluate the frequency of screening for home firearms in an academic tertiary-care hospital inpatient setting.

METHODS: This retrospective chart review examined patients with the following pediatric diagnoses admitted to a tertiary-care pediatric hospital from 2006 to 2015: asthma, bronchiolitis, cellulitis, jaundice, single liveborn infant, bacterial and viral pneumonia, and all mood disorders. Data analysts then searched the patient charts that met these inclusion criteria for documentation of firearm screening as indicated by use of the terms "firearm," "pistol," "gun," "handgun," "bullet," "ammunition," or "rifle" in the admissions history and physical.

RESULTS: Evidence of screening for firearms in the home was found in 1196 of the 40 658 charts included in the study (2.94%). The most frequently screened diagnosis and admitting service were mood disorders and child psychiatry, respectively (1159 of 3107; 37.3%). Only 19.8% of identified gun-owning families received specific anticipatory guidance.

CONCLUSIONS: Firearm screening and gun safety education occurred infrequently in the inpatient setting. Inpatient encounters may provide an opportunity for increased screening and education because the hospital environment also includes additional resources, exposure to a greater number of providers, and the presence of more family members or caregivers. Further studies are warranted to explore barriers to inpatient screening and possible mechanisms for improvement.

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More children die annually from trauma than from any other cause.[1] Of those children who die in US trauma centers, the second most common cause is firearm injury.[2] The risks of firearm homicide, suicide, and unintentional injuries are more than fivefold greater in the United States than in 23 other high-income countries considered collectively.[2] Hospital charges associated with these injuries amount to an average of $270 million per year.[3]

The American Academy of Pediatrics (AAP) recognizes firearm-related injury as a significant public health problem and supports a number of specific measures to reduce gun violence in the lives of children, including regulatory efforts, health information for parents, education of physicians, and allocation of research funding.[4] The AAP affirms that the most effective measure to reduce homicide, suicide, and unintentional firearm-related injuries in children is the absence of guns in homes and communities.[4] However, the 4 practices of keeping a gun locked, keeping a gun unloaded, storing ammunition locked, and storing ammunition in a separate location have each been associated with a protective effect against suicide and unintentional firearm injuries among youth residing in a household with a firearm.[4,5] The AAP recommends that pediatricians incorporate questions about the presence and availability of firearms into their patient history taking.[4] Pediatric providers have an opportunity for history taking in multiple locations: outpatient clinic, urgent care, emergency department, and inpatient setting. Most available literature regarding pediatrician firearm screening behavior centers on the outpatient or emergency department setting.[6–9] Our purpose in this study, therefore, was to evaluate whether pediatric providers are using the inpatient setting as an opportunity to screen for gun safety and, when applicable, provide education.

METHODS

Setting and Protocol

This institutional review board–exempt retrospective chart review, conducted through the University of Michigan Data Office for Clinical and Translational Research (DOCTR) examined medical charts relevant to an individual hospital admission to evaluate for documentation of firearm screening in the history and physical, progress notes, and discharge summary. This single-center study was done in a state with a gun ownership rate of 28.8%.[10] The national gun ownership rate at the time was 29.1%.[11] The database was queried for the most frequent inpatient general pediatric diagnoses according to the Agency for Healthcare Research and Quality.[12–14] These diagnoses were chosen as a sample of some of the most frequent ones seen by pediatric hospitalists to provide a broader view of this group's common screening practices while avoiding selection bias. Our purpose in the study was to identify cross-sectional screening rates for common admissions, not the screening rates applied to the highest-risk populations, such as those children admitted after traumatic injury. The admitting diagnoses examined for the purposes of this study were as follows: asthma, jaundice, single liveborn infant, bacterial and viral pneumonia, bronchiolitis, skin and subcutaneous tissue infections, and all mood disorders combined. The corresponding International Classification of Diseases, Ninth Revision (ICD-9) and International Classification of Diseases, 10th Revision (ICD-10) codes are listed in Table 1. We included all patients from birth to 21 years of age admitted to a general care, nonsurgical service between January 2006 and December 2015. Services were categorized as follows: child psychiatry (patients with primarily psychiatric disease requiring inpatient management by a child psychiatrist, child psychiatry fellows, adult psychiatry residents, as well as a nurse practitioner), newborn nursery (term or near-term infants who are sufficiently stable for rooming-in with their mothers and managed by hospitalists or primary care physicians and primarily pediatric residents), and pediatrics (pediatric patients managed on the general care floor by either a hospitalist or subspecialist and primarily pediatric residents). During this time period, our electronic medical record did not include a prompt or check box related to firearm screening.

Data Extraction

We used the DOCTR, a Web-based service for clinical and translational research and practice that offers assistance to study teams seeking to complete complex data searches. The DOCTR fulfilled the data request by electronically searching the medical records of included encounters for written documentation of any of the following 7 terms in the admission history and physical: "firearm," "pistol," "gun," "handgun," "bullet," "ammunition," or "rifle." These terms were selected on the basis of previous work by Freundlich et al,[15] which referenced Google Trends to identify commonly used search terms for firearm and ammunition storage. For this study, we excluded the terms "weapon" and "ammo" because of a lack of specificity and presumed low likelihood of use in the medical record.

Chart Review

Preliminarily, the DOCTR provided deidentified aggregate counts of the number of patients with these key words in their admission documentation. This data included year, admitting service, and International Classification of Diseases codes. As a next step, to validate that the 7 words used in the data search were in fact used by physicians to document firearm screening and counseling, a manual review of 500 randomly selected medical charts that the DOCTR identified as containing 1 or more key words was performed. We chose a sample size of 500 charts to obtain an accurate estimate of the percentage; this ensured a margin of error of no more than 0.033. For the charts selected for manual review, we used a specific instrument called the Electronic Medical Record Search Engine (EMERSE).[16] EMERSE enabled us to search clinical notes from our electronic medical record for terms. It allows for automated data identification with a high level of sensitivity (92%–100%) and specificity (93%–96%).[16] We used it to identify every instance of the following keywords: "firearm(s)," "pistol," "gun(s)," "handgun," "bullet," "ammunition," "rifle," "locked," and "loaded." The EMERSE software allowed investigators to quickly identify all instances of each word in the selected inpatient encounter and review documentation around those words to complete an in-depth screening instrument. The following data points were included in

TABLE 1 Percentage of Patients Screened by Diagnosis

Diagnosis	ICD-9 and ICD-10 Codes	No. Patients Screened	Total No. Patients Admitted	Percent
All mood disorders	296× and F30-F39	1159	3107	37.3
Bacterial pneumonia unspecified	482× and J15×	4	226	1.77
Asthma	493× and J45×	4	1254	0.32
Skin and subcutaneous tissue infections	681×, 682×, 686×, and L00×08	4	502	0.80
Unspecified fetal and neonatal jaundice	774× and P59×	3	707	0.42
Single liveborn in hospital delivered without cesarean	V30.00 and Z38.00	18	23 842	0.08
Single liveborn in hospital delivered by cesarean	V30.01 and Z38.01	4	9761	0.04
Bronchiolitis	466× and J21×	0	1046	0
Viral pneumonia unspecified	480× and J12×	0	212	0

An "×" symbol after the ICD-9 or ICD-10 code indicates the inclusion of all etiologies, manifestations, and severity with respect to that code.

the chart review tool: did screening occur, were firearms locked, were firearms unloaded, ammunition in the home, ammunition locked, firearms storage practices, and documentation of any anticipatory guidance (Supplemental Information). Five study team members independently validated this tool on simulated patient data to ensure high interrater reliability. All instances of the selected words in each chart were examined for firearm screening by using the instrument, and results were compared by the admitting service.

Statistical Methods

Statistical analysis was done by using R version 3.6.1. The sample size of charts to verify ($n = 500$) was chosen to ensure accurate estimation of the proportion of charts flagged by DOCTR in which firearm screening actually occurred (ie, to validate the search tool). The highest possible margin of error for this sample size (0.033 or 3.3%) was calculated by using Wilson's binomial margin of error with finite population correction (for a finite population of 1196), assuming a proportion of 0.5. Statistical analysis of the extracted data, including calculation of percentages of patients screened for firearms and graphing of the results, was done by using R and the package ggplot2.

RESULTS

Automated Data Extraction

Between 2006 and 2015, 40 658 patients were admitted with 1 of the selected study diagnoses and reviewed by using DOCTR search of the electronic medical record. Of those 40 658 charts, evidence of screening was found in 1196 (2.9%). In the subset manual analysis, 483 of 500 (96.6%) charts flagged as screened with the DOCTR tool were found to be indicative of true screening. The 95% confidence interval with finite population correction is 95.6% to 97.6% for the 1196 flagged charts, ensuring that the high level of accuracy of the search tool is not likely to be due to sampling error. The highest percentage of screening occurred in 2013 (208 of 4898; 4.2%) and 2012 (175 of 4529; 3.9%; Fig 1). The final aggregate count reporting the number of patients screened by diagnosis is displayed in Table 1. The most frequently screened diagnosis reported was mood disorder (1159 of 3107; 37.3%). All other listed diagnoses had evidence of screening in

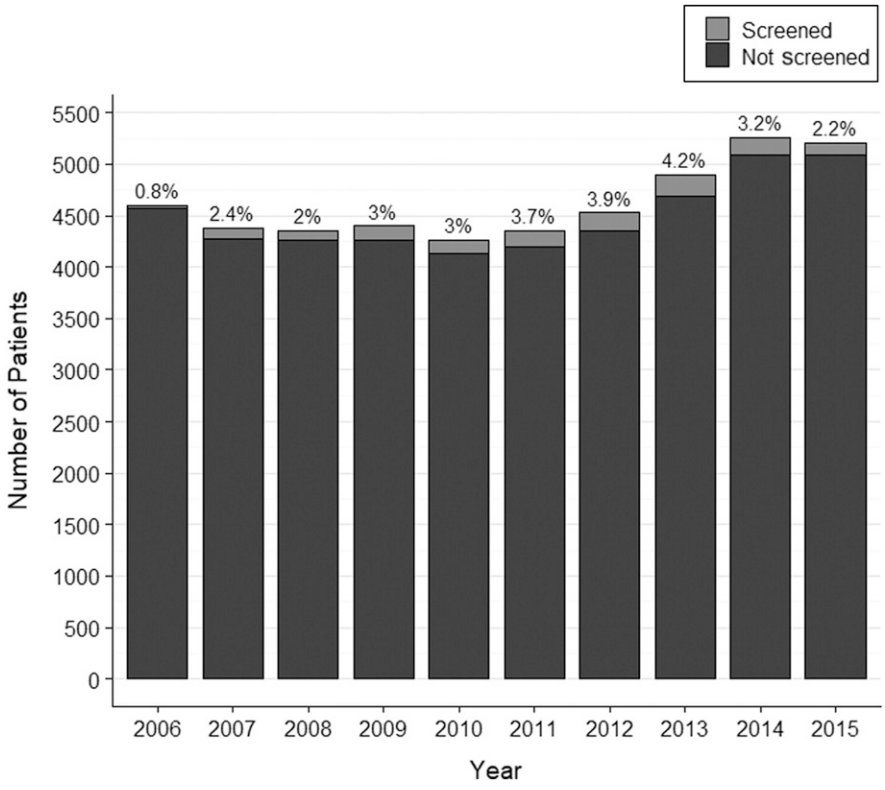

FIGURE 1 Firearm screening rates by year.

18 or fewer patients out of the combined 40 658 medical records.

Table 2 reports the number and proportion of patients screened by the admission service. Child psychiatry had the highest rate of firearm screening (1159 of 3107; 37.3%). Newborn nursery (22 of 33 695; 0.07%) and pediatrics (15 of 3829; 0.4%) had similar and low rates of screening. The percentage of patients screened with no documented service line was 2.3% (104 of 4441).

Chart Review

In the 500 encounters reviewed in detail by using EMERSE, firearm screening occurred in 483 (96.6%). The service that screened the most frequently was child psychiatry (464 of 483; 96.0%). Of those screened, 162 had firearms in the home. Firearms were documented as being locked in 111 of 162 (68.5%). Firearms were documented as being unloaded in 12 of 162 (7.4%). Screening for ammunition occurred in 60 of 162 (37%). Screening for whether ammunition was locked occurred in 23 of 51 (45.1%). Screening for whether ammunition was kept separately from firearms occurred in 39 of 51 (76.5%). Documentation of anticipatory guidance regarding storing firearms separately from ammunition was present in 32 of 162 (19.8%) encounters reviewed.

DISCUSSION

Firearms were the cause of death in 88% of teenaged homicides and 41% of teenaged suicides in 2014.[17] And, although nonfirearm injuries result in death in only 1 of every 760 cases, almost 1 in 4 youth firearm injuries is fatal.[18] Access to in-home firearms is an independent risk factor for suicide.[19] Adolescents with risk factors for suicide were just as likely to report in-home firearm access as those without risk factors,[19] and in a nationally representative survey of US adults, the presence of self-harm risk factors in a child did not impact caregivers' report of in-home firearm presence or storage practices.[20] Only 1 in 3 parents who owned guns stored all guns locked and unloaded regardless of whether their child had self-harm risk factors.[20] Yet, studies have shown that parent education and counseling on firearms can assist in preventing further gun injuries.[21–23]

To our knowledge, this is the first study to specifically examine the prevalence of firearm screening in the pediatric inpatient setting. Inpatient screening for home firearms occurred infrequently in our study. Although still <5%, we found that firearm screening was highest in 2012 and 2013, with the greatest rate increase seen between 2010 and 2011: 0.7%. It is difficult to accurately identify the factors that might have led to this clinically small difference in screening rates. However, in 2012, the AAP released a policy statement about firearm screening that may have impacted results. The AAP guidelines included several recommendations: pediatricians should include questions about the presence and availability of firearms into their initial patient history taking, urge parents to prevent access to guns, and promote safer storage of guns.[4] It is also noteworthy that the tragedies at Sandy Hook Elementary School in Newtown, Connecticut, and what was then known as the Century 16 movie theater in Aurora, Colorado, both occurred in 2012 and may have led to more intentional and unintentional physician focus on firearm safety and injury prevention.

Speculation as to why subsequent years (2014 and 2015) showed a decline in screening may be related to distance in time from AAP policy statement release and multiple concurrent state attempts to regulate firearm screening conversations between physicians and the patient or patient's guardian. In addition, knowledge of the Florida Firearm Owners' Privacy Act, which was signed into law in 2011, upheld in 2014, and ultimately struck down by a federal appeals court in 2017 as infringing on the First Amendment rights of doctors, may have biased providers against firearms screening even though it was from a different state than the current study.[24] This law explicitly prevented physicians from discussing routine firearm screening and/or anticipatory guidance regarding firearm safety. Additionally, the law subjected physicians to harsh penalties for violating this law. Although in a different state from where our study took place, this may have biased providers against firearm screening. Some variability is also potentially attributable to the transience of house officers, who perform the bulk of social history taking and documentation, and in a given year, there may have been residents with a greater zeal for firearm advocacy. Overall low rates may be related to some physicians' preference for targeted rather than universal firearm screening[25] as well as low perceived self-efficacy in firearm counseling.[26] Nonetheless, no federal or state statute prohibits physicians from screening for firearms or providing counseling when such information is relevant to the health of the patient or others.[27]

Yet, even when screening is performed, follow-up counseling may either not be performed or not documented. In a 2014 retrospective study of behavioral health patients in a pediatric emergency department, 25% of the patients reported having access to lethal means; however, only 4% of patients received lethal-means–reduction counseling.[9] This is consistent with the findings in our study and highlights the gap between the practice of screening for firearms and the goal of that practice: to reduce intentional and unintentional injury from firearms in the home. Perhaps more disappointing than the low rates of screening overall in our study was the low rate of action when a positive screen result was obtained, particularly in the setting of unstable psychiatric disease with the highest risk of self-harm. In our

TABLE 2 Percentage of Patients Screened by Service

Admitting Service	No. Patients Screened	Total No. Patients Admitted	Percent
Child psychiatry	1159	3107	37.3
Pediatrics	15	3829	0.39
Newborn nursery	22	33 695	0.07

study, only 19.8% of the gun-owning families identified in screening received specific anticipatory guidance about mitigating this risk. The vast majority of these families had a child with unstable psychiatric disease.

The pediatric inpatient setting presents its own potential challenges, which may explain why screening rates were so low in our study. Understandably, providers may choose to focus on the admitting diagnosis and be less interested in screening and counseling on what are felt to be unrelated topics. Screening rates were higher in our study for encounters with an admission diagnosis of mood disorder, but even in that case, only 37% of the encounters were screened. However, compared with ambulatory and emergency department encounters, inpatient encounters are longer and may afford more opportunities for family and provider interactions. Although a minority of children interact with the inpatient pediatric sphere, other successful initiatives (ie, reducing rates of secondhand tobacco smoke exposure) have used this setting as an opportunity to provide screening and anticipatory guidance with families in a less time-pressured environment than the outpatient sphere.[28,29]

There are several limitations of this study. There may be other terminology that could have been used to document firearm screening that we did not include. Similarly, we chose to examine the top general pediatric admitting diagnoses to obtain a broad view of common screening practices and avoid selection bias, but it is possible that more frequent screening may have occurred with other higher-risk diagnoses not included (such as traumatic injuries). It is also possible that screening was performed without documentation; however, the medical record review study designs, such as that in our study, are less prone to recall bias when compared with self-reported physician screening behavior. In addition, on the basis of our chart review, we found that 3.4% of the charts were falsely identified as having evidence of screening. This would suggest that our true screening percentage may be closer to 2.84% instead of 2.94%. Missing data in large data sets is a known limitation[30]; however, it is one we aimed to mitigate with a large sample size. Lastly, gun ownership varies regionally, so it is unclear if screening and counseling rates would be similar in other settings.

CONCLUSIONS

Firearm screening and gun safety education have widespread implications in the pediatric population, and screening rates are low. The AAP and the American Pediatric Surgical Association have made strong statements on and recommendations for pediatric medical providers in support of firearm screening and gun violence prevention.[2,4] This study demonstrates that medical providers in this single institution are not using the inpatient pediatric setting to accomplish these published goals. The inpatient setting may provide an opportunity for increased screening and education because it provides more time, access to other hospital resources, and exposure to a greater number of providers and allows for the presence of more family members or caregivers. Physicians should feel empowered to perform firearm screening and counseling when relevant to patient health. Further studies are required to determine the exact role of inpatient pediatric firearm screening as well as the barriers to firearm screening and counseling in this setting.

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