Lizzie Morris, MPH
Physician Assistant Program
Oregon Health and Science University
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Medication storage safety for older adult caregivers to decrease accidental overdoses in children

Need for Public Health Promotion Intervention

Accidental pediatric drug overdoses have become increasingly common. These poisonings contribute to significant childhood morbidity as measured by emergency department (ED) visits and mortality, and they exacerbate the burden on the already-overwhelmed American healthcare system. The most recent report from the Office of Disease Prevention and Health Promotion cites 18.0 emergency department visits for medication overdoses per 10.000 children and has specifically set a goal to decrease this incidence to 16.6 per 10,000 children as a part of their Healthy People 2030 campaign.[1] Yet, they report "little or no detectable change" since 2020.[1] These overdoses are entirely preventable, and the continual increase of drug overdose-related pediatric morbidity and mortality over the course of this decade demonstrates a marked need for a public health intervention to protect U.S. children.[2] While a variety of interventions are feasible, increasing evidence suggests that specifically providing one-time medication safety education to older adults who care for children under 5 has the potential to improve caregiver awareness of safe medication storage, increase safe medication storage practices, and decrease the overall incidence of pediatric drug overdoses.[3,4]

Drug Overdose-Related Pediatric Morbidity and Mortality

Between 2004 and 2013, the U.S. had an estimated 640,161 emergency department (ED) visits for unsupervised pediatric medication exposures, 20% of which resulted in hospitalization.[5] Likewise, recent data from the Centers for Disease Control and Prevention (CDC) estimate 35,000

pediatric overdose ED visits annually.[6] These data represent morbidity for infants under one year through adolescents to 18 years; however, over the last 15 years the highest rate of ED visits for unintentional drug-related poisonings was among children under 5 years, with a 2015 study demonstrating that greater than 60% of these ED visits were for children 1-2 years old.[1,5] More recently, pediatric ED visits for any reason had an aggregate cost of $7.8 billion between 2014-2017, with opioid poisoning visits contributing to $157 million – almost 2% of the total 3-year financial burden.[7]

In addition to contributing to the overall financial strain on the US healthcare system, pediatric poisonings contribute heavily to all-cause mortality. According to a 2021 CDC analysis, accidental or unintentional injuries are the leading cause of death among children and adolescents one to 19 years old, with 7,444 unintentional injury-related deaths in 2019 alone.[8] While overall unintentional injury mortality rates were stable in most US states from 2010-2019, rates now continue to rise.[9,10] The increase in mortality rates has largely been driven by growing numbers of fatal poisonings, which increased by 53.16% from 2009-2019 (79 in 2009, 121 in 2019 per 100,000 children and adolescents).[11] Furthermore, over half of all deaths by poisoning occur among children under 5 years, with 40% of these deaths in infants under 1 year.[12] The etiology of these poisonings varies, with some deliberate poisonings; adverse medication effects; or medical errors.[12] But, in a retrospective analysis of 731 cases of poisoning-related fatalities in children under 5 years between 2005-2018, over 40% were attributed to accidental overdose.[12] Additionally, according to 2021 National Poison Control data, 99% of poisoning cases in children under 5 years were ruled unintentional.[13] These data equate to the equivalent of 20 preventable deaths each day, and without public health intervention this trend shows strong potential to increase.[12]

Drugs Contributing to Pediatric Drug Overdoses

Substances responsible for the overdoses commonly include opioids; over the counter (OTC) pain, cold, or allergy medications; prescription medications; other illicit drugs; and environmental chemicals like carbon monoxide, among other substances and foreign bodies.[14] Between 2010-2013, just over 25% of ED visits for unsupervised overdose involved OTC liquid medication exposures.[5] Overwhelmingly, these incidents involved acetaminophen, OTC cough and cold remedies, ibuprofen, and diphenhydramine.[5] These medications accounted for approximately 7,200 visits per year between 2010 and 2013.[5] The most common OTC solid medications (capsules and tablets – chewable, traditional, sublingual, and buccal) involved in pediatric poisonings were vitamins, minerals, and herbal remedies, with greater than 30% related to iron supplements.[5] In the study, topical agents and epinephrine autoinjector exposures made up the greatest percentage of non-classified medications.[5]

Historically, over-the-counter medications and environmental chemicals contributed most heavily to accidental poisonings.[15] With the introduction of the Poison Prevention Packaging Act of 1970, the rate of accidental poisonings from these substances fell substantially from 2.0 per 100,000 children in 1973 to 0.5 per 100,000 by 1980.[15] The Act mandated child-resistant packaging for most medications and other hazards and also required reformulation of substances to make them less desirable to children.[15] The Act also spurred additional legislation that requires both OTC and prescription pediatric liquid medications to always come with an appropriate volume syringe so that the caregiver can precisely dose their child's medication, substantially decreasing the number of accidental overdoses due to caregiver mistake.[2]

However, with the rise of American opioid prescription and use, the number of accidental poisonings has again increased; and the proportion of fatal poisonings due to opioids has more

than doubled, from 24% in 2005 to 52% in 2018.[12] The setback from the previous success in decreasing these preventable pediatric deaths is exacerbated by the frequent introduction of new or more potent opioid sources like fentanyl.[7] The situation is then further complicated by the fact that opioids are now more frequently laced with other toxins that increase the likelihood of pediatric fatality.[16]

Intense effort has been made to intervene in the opioid crisis through prescription drug monitoring programs and by reducing the number of opioids prescribed, limiting drug diversion, and treating substance use disorder; yet these pediatric fatalities continue to rise.[4,17] In fact, though more research is necessary to fully characterize the risk, Lo Re et al. argue that treatment of substance use disorder with buprenorphine may add to pediatric overdose risk.[17] Buprenorphine dosing by weight for children is 6ug/kg, whereas adults are commonly prescribed doses of 16mg daily in a sublingual film or tablet.[17] Even a 2mg sublingual tablet would be 10 times the dose for a 10kg child, leading to rapid onset lethargy and respiratory depression.[17] Furthermore, young children often lick or suck on substances rather than swallow them, so they are likely to ingest the full dose of the frequently prescribed sublingual buprenorphine.[17] As is common in medicine, treating one problem may lead to the exacerbation of another.

Other Factors Contributing to High Incidence Rates of Pediatric Overdoses

Outside of the rise of opioid availability, a slew of other factors contributes to the likelihood of pediatric accidental poisoning, largely related to adult caregiver behaviors. Gaw et al. demonstrated that among the 731 fatal poisonings that were reported from 2005-2018 in children 5 years and under, 65.1% occurred in the child's home.[12] At the time of overdose, the majority of children were being supervised by a biological parent, but 30% were under the care of someone else, most commonly another relative (often a grandparent).[12] Remarkably, most of the reported

case fatalities indicate supervision at the time of the incident (80.9%), with 51.1% of cases within sight of the supervisor, 36.4% having been seen within hours, and 12.5% within minutes.[12]

Medication Safety Practices

As a result of the aforementioned Poison Prevention Act of 1970, prescription and OTC medications are sold and dispensed in bottles with child-resistant locking mechanisms.[2] These barrier methods include traditional "childproof caps" that require particular pressure, button depression, or squeezing in order to open.[2] More recently, manufacturers of pediatric liquid medication have included flow restrictors that occlude the bottle's opening to limit the volume of medication released until the appropriate pressure is met, even if the cap is left off.[2] Additionally, data suggest that the individual packaging of solid medications in blister packages is associated with a 65% decrease in ED visits for pediatric overdose and a 79% decrease in calls to poison control.[2] However, these safety measures are rendered useless if the inciting medications are not stored in their original packaging. Gaw et al. demonstrated that 28% of overdose fatality cases were related to medications stored outside of original packaging or in an open container.[12] Similarly, 32% of these fatalities were related to medications stored in open areas, readily in the child's sight and reach.[12] A 2015 multicenter case-control study of 2887 participants completed in the UK found corroborating data about the benefits of storing medications out of sight and reach and putting medications back safely after use.[18] They noted that if their associations were causal, safe storage practices could prevent between 11 and 20% of annual poisonings in children under 5.[18]

Evidence for a Medication Safety Intervention

In line with the Healthy People 2030 goal of 35% reduction in pediatric medication overdoses, The Preventing Overdoses and Treatment Exposures Task Force (PROTECT) Initiative

specifically developed the "Up and Away" campaign to decrease the number of unintentional medication overdoses in children under 5 years.[6] They utilized data from the National Electronic Injury Surveillance System-Cooperative Adverse Drug Event Surveillance Project (NEISS-CADES) to identify factors associated with pediatric overdoses and create focused education for caregivers on how to keep medications out of young children's sight and reach through 5 evidence-based actions: "out of reach, put meds away, hear the click, teach your child, hear the click."[6] Their strategy is to encourage caregivers to store medications in a location that is too high for a child to see or reach, never leave loose pills or uncapped medications out where a child may access them, always keep medications in their original child resistant containers, teach their child about medication safety to help them differentiate medication from candy, and educate any guests in the home who may bring medications with them about safe medication storage.[6]

Older Adults as a Target Population for Intervention

While a child's parent is statistically the caregiver most likely present at the time of accidental overdose, increasing evidence has emerged that grandparents and other older adults are a potential target population for educational intervention to decrease accidental pediatric overdoses.[19] Older adults appear to be spending more time with young children than in previous generations.[3,19] Furthermore, on average, older adults take more prescription medications than any other population and have statistically higher usage of medications associated with fatal overdoses in young children, including beta blockers, calcium channel blockers, hypoglycemics, acetaminophen, and opioids.[19] Additionally, older adults likely are not present for discussions that healthcare providers or other authorities have with parents about home safety and injury prevention for their children. Therefore, they are more likely to be unaware of potential danger associated with their medication storage habits and are the ideal target audience for education surrounding

medication safety.[19] For example, Agarwal et al. demonstrated that even a one-time educational intervention using resources provided by Up and Away is an effective way to establish safe medication storage habits in grandparents who care for children 5 years and under.[3] The group gave a 30-minute presentation using Up and Away data and graphics to frame the growing problem of accidental pediatric overdoses, demonstrate problems with common medication storage practices, and suggest alternative storage practices to increase medication safety for children.[3] When they followed up with participates 90 days after the one-time educational intervention to reassess their medication storage behaviors, they found that 48% of participants engaged in behavior necessary to meet criteria for safe storage at 50-90-days follow-up compared to 23% before the intervention.[3] Moreover, 80% or participants reported feelings of positive change in their medication storage after the intervention.[3]

Efficacy and Feasibility of a One-Time Educational Intervention

These results clearly demonstrate the effectiveness of this type of one-time educational talk for older adults. Since Agarwal et al. published their study, Up and Away has developed educational handouts specifically targeting grandparents of children under 5, further strengthening this healthcare promotion strategy.[6] To enhance the value of this education, Up and Away also has materials available that are designed for adults to teach children to distinguish medications from candy and to help teach children about medication safety in a fun way.[6] These coloring books and activity guides highlight features of medications and toxic products that children tend to associate with poison or danger and can be discussed and given to older adults to bring home and share their grandchildren.[6] The use of these materials will help solidify safety practices for the adult and spread the knowledge to the children in their lives in a targeted way.

In addition to being effective, a one-time educational intervention for older adults is also feasible for most communities to organize. Up and Away and the PROTECT Initiative provide free, downloadable handouts, posters, and children's coloring books to utilize during the class and to give to participants to take home.[6,20] Additionally, their websites list contact information to request additional information that may include magnets or stickers with phone numbers for poison control and clear instructions for what to do in the event of an acute overdose. They also provide free videos on their website that can be shown during the class to summarize the pertinent safety information. Theoretically, the class could also be recorded and posted online for community members to access in the event that they cannot attend the class in person. Because it's a one-time intervention and the information is freely available for use, the event is adaptable to a variety of community situations.

Conclusion

In summary, accidental medication overdoses in children under 5 years old is a growing and complex problem that continues to evolve as the opioid epidemic forges onward. Child safety protection mechanisms implemented by medication manufacturers and regulated by the Poison Prevention Packaging Act decrease the likelihood of pediatric poisoning; however, these methods depend on safe adult caregiver behaviors to be effective. The CDC's Up and Away campaign has proven an effective educational intervention to instill safe medication storage habits in parents since its inception, but the number of accidental pediatric overdoses can be further decreased by delivering a one-time educational talk about medication safety to the increasing population of grandparents and older adult caregivers given their daily medication burden and growing involvement in childcare for young children.

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