Improving medication safety in both adults and children: what will it take?

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Accepted 6 June 2024
Published Online First
20 June 2024

Medications continue to represent a major cause of harm, both in inpatients and outpatients and in adults and children. In a recent large study, medications were the leading cause of harm in inpatient adults, and the same was true for adult outpatients.[1 2] Medications were also the most frequent cause of harm in a large paediatric inpatient study.[3] Despite these and other data, the magnitude of this issue has been systematically underestimated by healthcare organisations.

The main reason for this is that operational estimates of both medication harm and error rates have relied on spontaneous reporting, which is ineffective in this instance. We found in a study published 30 years ago that spontaneous reporting only finds about 1 in 20 harmful drug events.[4] It almost certainly finds an even lower proportion of the total number of medication errors.[5] But despite these and many other studies, little has changed at most hospitals.

In this issue of *BMJ Quality and Safety*, Li and colleagues[6] compared the number of medication errors identified with direct observation and audit to those recorded in an incident reporting system at paediatric hospitals in Australia. They found that only 3 of 1000 clinical medication errors found at audit and direct observation resulted in an incident report. Incident reporting data does not provide an accurate reflection of medication error rates or an accurate picture of which medications are causing harm, and they should not be the primary resource for managing safety. As these authors conclude, we need new electronic tools to manage medication safety.

The situation is different for other safety conditions, with hospital-acquired infections representing a particularly important example. The Center for Disease Control's National Healthcare Safety Network allows tracking of these infections using clearly prescribed criteria with dedicated resources across many institutions, and while this approach is far from perfect, some national data suggest that the rates of multiple key types of infection have fallen.[7] This makes sense because if you can readily measure the frequency and consequences of a safety issue, it is easier to justify devoting resources to reducing its frequency. Furthermore, several highly effective strategies for improving safety such as central line bundles have been developed and spread widely.[8]

With the widespread adoption of electronic health records, it is possible to use electronic tools most of which are currently rule-based to go through the record and identify both medication-related harm and medication errors, most of which do not result in harm. We believe the former will be especially useful because errors that cause harm are the most important. When doing this, the signals of harm such as the identification of a new increase in the serum creatinine temporally associated with the use of a nephrotoxic drug are evaluated by a person and adjudicated. The major limitation of this approach is false positives, and there can be many more signals than true positives. However, with the advent of large language models, it should be possible to identify adverse drug events rapidly and effectively with higher sensitivity and specificity than was previously possible. If medication-related harm can be measured in near-real time in operations, it will be possible to manage this issue and devote appropriate resources to it.

Linked

► http://dx.doi.org/10.1136/bmjqs-2023-016711

Check for updates

To cite: Bates DW, Sakuma M. *BMJ Qual Saf* 2024;**33**:619–621.

MEDICATION SAFETY BY AGE

When considering the issue of medication safety by age, there are important differences. Adults prescribed medications for multiple chronic conditions have considerably higher rates of adverse drug events than healthier adults or children. At the same time, powerful medications are being rapidly introduced, and while these are beneficial in the aggregate, they can cause harm, even in relatively young populations.

In adults, most medications in developed countries are now prescribed electronically both inside and outside hospitals, but the medication-related decision support which is intended to improve safety by checking for issues such as allergies and drug–drug interactions works poorly, with far too many warnings so that clinicians are ignoring most of these warnings, even though some of them are very important. In one study, we found that physicians overrode all 6000 renal dosing suggestions delivered by a clinical application, we believe largely because they were poorly designed and not sufficiently specific.[9] We have also found that it would be possible to turn off many of these warnings with better decision support, while at the same time identifying more unsafe situations.[10] In that study, we found in a retrospective evaluation that a novel platform triggered 94% fewer alerts than EPIC (the most frequently implemented electronic health record in the USA) in the inpatient setting and 93% fewer in the outpatient setting, with much higher sensitivity and specificity.

In hospitalised children, the rates of adverse drug events are similar to those in adults, but very small children, especially neonates, are at especially high risk.[11] The situation is complex because most dosing in small children is weight-based, and the weights especially for premature neonates are often very low. The frequency of 10-fold overdose appears to be much higher than in adults and occurs because of the huge variations in premature neonatal weight. It is therefore critical that weight-based dosing be used for children especially in neonates and for certain medications.

The GenPRES project is a good example of such a clinical decision support system developed specifically for children's formularies. The system integrates the formulary and includes almost all parenteral and reconstitution steps as decision rules. Needs and functions such as weight-based drug dosing, anthropometric analysis, immunisation tracking, specialised growth charts and forecasting are common to paediatric settings. These needs and functionalities are often not addressed by adult-oriented systems, and if they are absent they will adversely affect safety in paediatric settings. Moreover, such systems may cause increases in errors and harm until they are modified with customised decision support, such as weight-based and body surface area-based dosing.

THE FUTURE OF MEDICATION SAFETY IMPROVEMENT

Algorithms and tools based on artificial intelligence (AI) also have the potential to play a significant role in proactively improving medication safety by making it easier for prescribers to customise medications for the individual. By providing timely and accurate clinical decision-making, they can help in detecting and preventing medication-related harm. A recent scoping review identified the most promising areas in which AI could be used to reduce adverse drug events.[12] The review highlighted that most of the current studies evaluated technical algorithm performance and very few evaluated the use of AI in clinical settings. Additionally, only a small number of studies incorporated genetic data. Over time, as more patients at risk of adverse drug events are accurately identified before a medication administration or are monitored efficiently after a medication administration, a greater proportion of these events will become preventable. However, the lack of integrated high-quality datasets, where adverse drug events have been accurately captured, remains a challenge. Further development of AI tools in paediatric settings is needed, addressing paediatric-specific issues and contributing to improvements in medication safety.

CONCLUSIONS

Medication safety is an area that requires urgent attention, both for adults and children: it continues to cause far too much harm. We suggest that the first need is to implement tools that make it possible for organisations to count the frequency and severity of adverse drug events in routine care. Such tools are already commercially available for use within electronic health records, although they will benefit from refinement and are currently rule-based. When they leverage large language models and other AI techniques, they are likely to work even better. This will give organisations a picture of the cumulative frequency of harm and target prevention strategies.

Regarding prevention, the first key will likely involve leveraging electronic health records to deliver better clinical decision support across a variety of areas, including allergies, drug–drug interactions, renal and age-based dosing, drug-condition warnings and others. Downstream, newer approaches may become available, such as leveraging AI to choose the best drug for an individual patient based on their characteristics.

Paediatric medication safety represents a particularly urgent area of need that has been neglected for too long. The highest priority here is weight-based dosing. While this is widely used, it should be universal below a certain age and for a specific group of medications. Overall, medication-related decision support is behind for children.

Voluntary reporting of medication errors is of little value, and should probably be discontinued, except

for errors that result in substantial harm, which can be important learning opportunities. Voluntary reporting consumes too many resources and gives organisations a distorted picture of the causes and magnitude of the problem. This would save substantial resources. Audit and direct observation to identify medication errors are still valuable for research purposes but are too intensive for routine operational use.

If these steps are taken, it should be possible to substantially reduce the frequency of medication-related harm, for adults and children, and inside and outside hospitals. This will enable us to get the full benefits of our increasingly large portfolio of medications.

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Contributors All authors contributed to the paper and are responsible for its contents.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests DWB reports grants and personal fees from EarlySense, personal fees from CDI Negev, equity from Valera Health, equity from Clew, equity from MDClone, personal fees and equity from AESOP, personal fees and equity from FeelBetter, personal fees and equity from Guided Clinical Solutions and grants from IBM Watson Health, outside the submitted work. MS reports no disclosure.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Commissioned; internally peer reviewed.

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REFERENCES

1 Bates DW, Levine DM, Salmasian H, *et al*. The safety of inpatient health care. *N Engl J Med* 2023;388:142–53.
2 Levine DM, Syrowatka A, Salmasian H, *et al*. The safety of outpatient health care: review of electronic health records. *Ann Intern Med* 2024;PMID:2024.
3 Sakuma M, Ohta Y, Takeuchi J, *et al*. Adverse events in pediatric Inpatients: the Japan adverse event study. *J Patient Saf* 2024;20:38–44.
4 Cullen DJ, Bates DW, Small SD, *et al*. The incident reporting system does not detect adverse drug events: a problem for quality improvement. *Jt Comm J Qual Improv* 1995;21:541–8.
5 Bates DW, Boyle DL, Vander Vliet MB, *et al*. Relationship between medication errors and adverse drug events. *J Gen Intern Med* 1995;10:199–205.
6 Li L, Badgery-Parker T, Merchant A, *et al*. Paediatric medication incident reporting: a Multicentre comparison study of medication errors identified at audit, detected by staff and reported to an incident system. *BMJ Qual Saf* 2024;33:624–33.
7 Eldridge N, Wang Y, Metersky M, *et al*. Trends in adverse event rates in hospitalized patients, 2010-2019. *JAMA* 2022;328:173–83.
8 Berenholtz SM, Lubomski LH, Weeks K, *et al*. Eliminating central line-associated bloodstream infections: a national patient safety imperative. *Infect Control Hosp Epidemiol* 2014;35:56–62.
9 Shah SN, Amato MG, Garlo KG, *et al*. Renal medication-related clinical decision support (CDS) alerts and Overrides in the inpatient setting following implementation of a commercial electronic health record: implications for designing more effective alerts. *J Am Med Inform Assoc* 2021;28:1081–7.
10 Shah SN, Seger DL, Fiskio JM, *et al*. Comparison of medication alerts from two commercial applications in the USA. *Drug Saf* 2021;44:661–8.
11 Kaushal R, Bates DW, Landrigan C, *et al*. Medication errors and adverse drug events in pediatric Inpatients. *JAMA* 2001;285:2114–20.
12 Syrowatka A, Song W, Amato MG, *et al*. Key use cases for artificial intelligence to reduce the frequency of adverse drug events: a Scoping review. *Lancet Digit Health* 2022;4:e137–48.