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Poor Usability of Electronic Health Records Can Lead to Drug Errors, Jeopardizing Pediatric Patients

Challenges can stem from product design, clinician use, and customization

Overview

While digital records have improved the delivery of health care and introduced features—such as alerts about potential drug allergies—that can prevent medical errors and patient harm, they have also created unforeseen safety risks and contributed to serious mistakes in treatment. Unintended consequences have resulted from challenges with electronic health records' (EHRs) usability—meaning the design of these tools, how they're implemented, and the way clinicians use them.

These errors can be especially significant when they involve medications—wrong drugs, overdoses, and delayed treatments. Pediatric patients, for whom dosages may be adjusted by weight or age, are especially susceptible. However, the federal requirements for EHRs do not reflect the differences in care provided to adults and children, and EHRs in use today often do not adequately address specific challenges that emerge in pediatric settings. In the 21st Century Cures Act (enacted in 2016 and known as the Cures Act), Congress directed the Office of the

National Coordinator for Health Information Technology (ONC)—the federal agency that oversees EHRs—to write voluntary rules for electronic records used in pediatric care.

To inform the regulations, The Pew Charitable Trusts worked with two children's hospitals and one large mid-Atlantic health care system to identify and investigate incidents in which EHRs reportedly contributed to drug prescribing or administration errors that jeopardized safety for pediatric patients. Researchers at each facility uncovered thousands of such cases from error reports filed internally at the time of the incident. This issue brief details 12 cases that illustrate common usability problems, from issues with the display of information and how data are entered, to communication errors and problematic impacts on clinician workflow. For privacy purposes, identifying information about the patients, their health outcomes, locations of treatment, and caregivers has been removed. The full results, analysis, and study methodology were published in the journal *Health Affairs* in November 2018.

The volume and diversity of issues identified by this research underscore the need for health information technology developers, hospitals, and clinicians to work together to design and implement EHRs, and to rigorously test them before and after deployment in each facility.

ONC has an opportunity to focus on pediatric safety

Current federal requirements to test EHRs are not sufficient to detect risks to patients arising from usability problems. ONC's certification rules do not require testing after an EHR has been customized for, or implemented in, a health care facility. Testing requirements for the product design and development phases examine the presence of safety-related features, such as drug allergy alerts, but not whether they are effective.

The Cures Act requires ONC to develop voluntary certification regulations on EHRs used in the care of children, giving the agency an opportunity to begin to address these shortcomings.[1] The agency could require the inclusion of EHR features that focus on risks prevalent in the care of children—such as weight-based dosing—and test that those functions are able to effectively prevent medical errors. ONC could also encourage EHR developers to work with the user community to detect and prevent errors once those systems are implemented.

This issue brief details examples of reported safety events drawn from the research published in Health Affairs on the consequences of inadequate usability of EHRs.[2] It also provides ONC leaders with several areas to consider when developing rules for electronic systems used in the care of children. By understanding these events, those who develop, customize, use, and regulate these important health care products can work toward innovations and improvements to help keep young patients out of jeopardy.

Examples of EHR usability-related medication safety events

The usability challenges identified by the research fall into four broad categories:[3]

- Information display: EHRs may display information in confusing ways, or data may be hard to find or missing.
- Difficult data entry: Entering data in an EHR can be challenging, which may cause delays for orders and lead to clinicians using workaround solutions.
- System feedback: In some situations, EHRs may not clearly communicate to users that an action has been taken, such as when a patient has already received a medication.
- Workflow support: Challenges can occur when clinicians must share information or tasks with others on the care team or across departments.

Drawn from these categories, the 12 cases below reflect the EHR design, customizations, and workflow present in that specific health care facility.

Information display

Case 1: Inaccessible information led to inappropriate drug administration

EHRs can provide clinicians with multiple free-text fields where they can enter notes to other members of the care team, such as guidance to nurses on when to administer a drug. The effectiveness of these fields depends on the ability of other team members to access those notes. Unfortunately, staff may not be able to clearly discern which of these fields their colleagues can access or easily view. In one instance, a doctor placed an order in a patient's EHR for amlodipine, a drug that lowers blood pressure. The physician also entered comments in free text, instructing that the medication not be given if the child's blood pressure was below a certain threshold. However, that field was designed for use by the pharmacy; the EHR view used by the nurse did not display that information. As a result, the nurse did not see the doctor's note and administered the drug, putting the patient at risk of dangerously low blood pressure.

> Orders to not administer a drug were inaccessible to nurses.

Case 2: Patient received drug overdose due to entry of wrong weight

Some EHRs allow measurement documentation in U.S. customary units, such as pounds and inches, instead of the metric units traditionally used in medicine. In one case, a clinician entered a child's weight in pounds when the EHR was configured to receive weight in kilograms. The misunderstanding effectively doubled the child's actual weight, resulting in the patient later receiving twice the appropriate acetaminophen dose. Given the potential for errors to occur if a patient's data are entered incorrectly, EHRs should clearly specify the appropriate units of measurement and flag when a potentially erroneous value has been entered. Absent safeguards, staff can unknowingly submit erroneous data that lead to treatment errors.

Case 3: Poor information display contributed to a missed antibiotic dose

EHRs typically can list all past and scheduled future drug doses, including the time of administration. In one case, the information displayed to the nurse in the EHR failed to show the scheduled administration time for an upcoming dose of the antibiotic gentamicin and did not prompt the nurse to open the order to see that information. This led the nurse to conclude, erroneously, that the dose had been given. In addition, the EHR did not subsequently indicate a missed dose. Thus, the patient never received the scheduled dose, which could have contributed to an uncontrolled infection.

Case 4: Display problems with automatic medication holds caused missed dose

EHRs can allow clinicians to enter medication orders ahead of time for different phases of pre- and post-surgical care, with the drugs being prepared for administration as needed. When the patient's location within the hospital changes, record systems can automatically place holds on future orders. Staff at the receiving location must remove the holds so that the drug can be prepared and delivered. However, usability flaws can lead clinicians to overlook these holds and associated care instructions. For instance, a clinician used the hospital's EHR to order the administration of amphotericin B, an antifungal medication, at a specific time after the patient was expected to transfer from post-operative care to another unit. When the patient unexpectedly returned to the operating room the same day, the EHR held this medication order. The clinicians were unaware of the held dose because their default views of the EHR did not indicate the held medication. Held orders were also not listed as active orders for nurses on their display. Because the display did not show the necessary information, the drug omission was not corrected until the next day, putting the patient at risk for a prolonged infection.

Difficult data entry

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> An EHR added an inappropriate vaccine schedule to an infant's record.

Case 5: Incorrect vaccine schedule entered via automated EHR function

EHRs can have built-in processes, such as a standard vaccination schedule based on date of birth. These features are intended to reduce data entry, but can create safety risks if clinicians are unable to override them when appropriate. For example, in one case, a 4-month-old infant was admitted to the hospital. The EHR's default settings automatically checked a box to indicate that the patient was greater than 6 months old and generated a vaccination schedule based on this inaccurate data. Clinicians spotted the EHR's mistake and did not administer inappropriate vaccines, but the system would neither let them uncheck the box showing the wrong age nor modify the vaccine plan. These types of errors could lead to harm since physicians and nurses treating the patient in the future could rely on the information in the EHR, and clinicians may not always identify the mistake.

System feedback

Case 6: A time change was associated with a missed organ rejection drug

EHRs can allow clinicians to order recurring doses of a drug at specific times or intervals. System defaults, however, may supersede these instructions without staff realizing it. In one case, a clinician prescribed an immunosuppressant medication used to prevent organ rejection in kidney, liver, and heart transplant patients and directed it to be administered every 12 hours. The pharmacy prepared the drug to be given that evening, but the EHR defaulted the administration time to the next morning and the patient received the medicine half a day late, elevating the risk for rejection of the transplant.

Case 7: Hidden medication order settings contributed to a lapse in care

EHRs can offer preset choices for the duration of a prescription, such as five, 10, or 30 days, to help calculate the quantity of a drug to be dispensed. However, in one case, a provider intended to prescribe indefinite antiviral therapy for a transplant patient, but accidentally selected the EHR's preset 30-day, "no refills" prescription order. The error was detected at a follow-up visit after a five-day treatment lapse that increased the risk of infection and transplant rejection.

> An organ transplant patient missed medication for days following confusion with drug refill settings.

Case 8: Failure to alert clinicians to a documented drug allergy

EHRs are designed to record patient drug allergies and alert clinicians when a prescription order may risk an adverse reaction. Since clinicians can grow dependent on these alerts, it is important for EHRs to flag any possible allergies; if this does not occur, patients may be exposed to drugs that may cause an adverse reaction. This can be a challenge for medications prescribed as part of an order set—a series of medications, tests, and procedures bundled together in the system to save clinicians time. For example, an anesthesiologist ordered prochlorperazine, a medication used to treat nausea and vomiting, as part of an order set for a patient whose record noted an allergy to the drug. Yet, the EHR did not provide an alert for the medication when listed as part of an order set, and the order was subsequently filled.

Case 9: Auto-verification of a medication contributed to a delay in its administration

Some EHRs can connect with automated medication dispensing machines that give hospital staff outside of the pharmacy access to common medications, such as acetaminophen. However, communication problems between these tools and EHRs can delay care. In one case, a clinician ordered a patient to receive the antibiotic ampicillin. The EHR incorrectly processed the medication as if it were in the dispensing machine. Thus, the pharmacy was not prompted to prepare the drug, and the clinician was not alerted. After a two-hour delay, the pharmacy was notified of the error; that delay could have led to a serious infection.

Case 10: A medication was discontinued automatically in the EHR

EHRs can list drugs that are either intended to be administered indefinitely or set to be discontinued after a set duration. However, clinicians may not be able to clearly distinguish between the two types of orders in EHR system interfaces. In one event, a clinician in the emergency department ordered antibiotics for a patient with suspected sepsis, a serious complication of an infection. After the patient was admitted to the hospital from the emergency department, another physician reviewed the active orders and saw that the patient appeared to be on the correct antibiotics. The physician later noticed that the medications had been automatically discontinued. The physician reordered the antibiotics, but the delay could have increased the risk of death.

Workflow support


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> A child got a duplicate chemotherapy dose due to fragmented record-keeping systems.

Case 11: Workarounds arising from EHR limitations led to duplicative chemotherapy

Clinicians use EHRs to document many facets of care, but some systems may lack the necessary features to treat patients with complex medical needs. In these cases, clinicians may document care both in the EHR and by other means, including on paper, a fragmented documentation that can lead to harm. In one hospital, oncologists use a combination of the EHR and a paper chart to manage their patients' chemotherapy. When a patient received a scheduled dose of vincristine, a powerful cancer medication, the treatment was documented in the EHR but not on the paper chart. When reviewing the paper chart, clinicians concluded that the patient had missed the scheduled treatment and administered an additional and unnecessary dose without consulting the EHR.

Case 12: Inability to adjust workflow to emergency needs held up newborn care

To complete some EHR functions, clinicians must enter data in specific fields for a record to be created or orders to be processed. In some situations, those requirements can delay care. For example, the EHR in one hospital would not allow clinicians to create a record for newborns unless staff first entered the child's weight and Apgar score, a composite measure of health indicators. This slowed treatment for a baby girl who required emergency care before an Apgar score could be obtained. As a result, clinicians could not establish a record for the baby, and thus could not order blood for an emergency transfusion. They eventually placed the order through her twin brother's record, which delayed the transfusion and introduced risks that the blood would be given to the wrong infant.

> An EHR blocked doctors from ordering blood for a newborn's emergency transfusion.

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Conclusion and recommendations

These real-world examples highlight how EHR usability can contribute to medical errors in children, including receipt of erroneous chemotherapy treatment, delay in receiving life-saving antibiotics, and other medication-related safety challenges. In many cases, these errors occur because EHRs are designed for use in adult patients and may not effectively reflect the needs of children.[4]

ONC has an opportunity to address this discrepancy when implementing the 21st Century Cures Act. As part of regulations for the certification of EHRs used in the care of children, the agency could include safety-related requirements to reduce the likelihood that these types of errors occur. For example, ONC can encourage the testing of systems for safety by pediatricians and other clinicians who provide care to children.

Similarly, as EHR vendors and hospitals evaluate systems, new features, or site-specific customizations, they should use more robust and rigorous tests to detect and prevent safety-related challenges throughout the entire life cycle of the product, such as after the implementation of systems in hospitals.

By taking these steps, ONC, hospitals, clinicians, and technology developers can improve the safety and quality of care for many of the nation's most vulnerable patients—children.

Endnotes

1 Office of the National Coordinator for Health Information Technology, "Health IT Certification Program Overview" 1.2 (2016), https://www.healthit.gov/topic/certification-ehrs/about-onc-health-it-certification-program.

2 Raj M. Ratwani et al., "Identifying Electronic Health Record Usability and Safety Challenges in Pediatric Settings," *Health Affairs* 37, no. 11 (2018): 1752-59, https://doi.org/10.1377/hlthaff.2018.0699.

3 Jessica L. Howe et al., "Electronic Health Record Usability Issues and Potential Contribution to Patient Harm," *Journal of the American Medical Association* 319, no. 12 (2018): 1276-78, https://www.ncbi.nlm.nih.gov/pubmed/29584833.

4 Raj M. Ratwani, Ben Moscovitch, and Josh P. Rising, "Improving Pediatric Electronic Health Record Usability and Safety Through Certification," *Journal of the American Medical Association Pediatrics* 172, no. 11 (2018): 1007-08, https://jamanetwork.com/journals/jamapediatrics/article-abstract/2698968.

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