



## POLICY STATEMENT

# Electronic Prescribing in Pediatrics: Toward Safer and More Effective Medication Management

## abstract

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This policy statement identifies the potential value of electronic prescribing (e-prescribing) systems in improving quality and reducing harm in pediatric health care. On the basis of limited but positive pediatric data and on the basis of federal statutes that provide incentives for the use of e-prescribing systems, the American Academy of Pediatrics recommends the adoption of e-prescribing systems with pediatric functionality. The American Academy of Pediatrics also recommends a set of functions that technology vendors should provide when e-prescribing systems are used in environments in which children receive care. *Pediatrics* 2013;131:824–826

### BACKGROUND

The American Academy of Pediatrics (AAP) is committed to providing the best and safest health care system possible for children.

Medication prescribing or ordering in pediatrics is an error-prone process that can lead to adverse medication events and patient harm.<sup>1,2</sup> Electronic prescribing (e-prescribing) is widely recognized as a component of the care process that improves quality and reduces costs by facilitating handoffs, improving clinical decision-making, and potentially improving medication adherence.

### NEW INFORMATION

Prescribing error rates in children were estimated to be between 5% and 27% in a recent systematic review.<sup>3</sup> Prescribing errors are most prevalent with antibiotic agents but may occur even with medications that do not require weight-based dosing.<sup>4</sup> Medication errors in children may lead to more severe complications because of narrow therapeutic profiles and the inability of some children to communicate adverse effects. Many existing e-prescribing systems are not well designed for use in pediatric patients and lack the required features outlined in this statement. Parental health and English literacy have been shown to play important roles in the correct medication administration in children.<sup>5,6</sup>

From a legislative viewpoint, the past decade has been an active one for the national medication-prescribing landscape. In particular, 2 major statutes specifically addressed the goal of 100% adoption of e-prescribing through both time-dependent incentives and penalties.

COUNCIL ON CLINICAL INFORMATION TECHNOLOGY EXECUTIVE COMMITTEE, 2011–2012

### KEY WORDS

electronic prescribing, health information technology, medication, pediatrics, prescription, quality improvement

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The recommendations in this statement do not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

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The Medicare Improvements for Patients and Providers Act (Pub L No. 110-275 [2008]) provided for incentive payments to Medicare-participating providers that use e-prescribing software to generate prescriptions. The Health Information Technology for Economic and Clinical Health Act (Pub L No. 111-5 [2009]) established a program of incentive payments for Medicare and Medicaid providers who adopt, implement, and demonstrate meaningful use of health information technology. One of the key requirements of meaningful use is to generate and transmit prescriptions electronically to the pharmacy. The meaningful use requirements also encourage the routine use of medication lists, medication allergy lists, drug–drug interaction and drug–allergy checking, and drug formulary checking.

## CONCLUSIONS

E-prescribing systems can improve the quality and safety of medication administration by reducing preventable adverse drug events,<sup>7–9</sup> reducing dosing errors,<sup>10</sup> improving communication,<sup>11,12</sup> avoiding adverse effects,<sup>13,14</sup> and improving efficiency.<sup>15</sup> The benefits of e-prescribing systems in pediatrics can only be achieved by systems with appropriate functionality and may be hampered by poorly developed systems<sup>16</sup> or implementation strategies.<sup>17</sup> At present, many e-prescribing systems fall short of providing expert-recommended functional characteristics.<sup>18</sup> Specific challenges in pediatric e-prescribing include age- and indication-specific, weight-based dosing requirements, rounding based on formulary (liquid or solid), the conversion of doses from an ingredient amount to a volume for liquids, the desire to provide easily administered home doses, and, when necessary, extemporaneously compounded dosage forms. Although these systems already confer numerous advantages over the paper-based

alternative, they will need to evolve to be an ideal platform for safe and effective pediatric medication prescribing. The features listed in Table 1, derived in part from previous work by the AAP,<sup>19</sup> will help address these challenges to safe and effective pediatric prescribing.

## RECOMMENDATIONS

1. Because safety for children is paramount, e-prescribing systems used for the care of children should include, at a minimum, pediatric-specific medication catalogs; pediatric-specific decision support, such as weight-based dose calculations and individual and daily dose alerts; rounding; ingredient amount-to-volume conversions for liquid medications; metric-only labeling instructions; and pediatric drug information and formulation options. This recommendation may be implemented by sharing reports, such as the
2. When possible, e-prescribing systems should be implemented as part of a robust electronic health record and include drug–drug interaction and allergy checking. When implementing a stand-alone e-prescribing system, consideration should be given to a solid design (including correct field length and standard vocabulary) and the potential future need to generate reports with, transfer data to, or interface the e-prescribing system with an electronic health record. E-prescribing systems must be

**TABLE 1** Pediatric Requirements for Safe and Effective e-Prescribing

Category	Pediatric Requirements
Patient information	Date of birth or age in units more specific than years Weight in kilograms Height in centimeters Any history of intolerable adverse effects or allergy to medications
Medication information	Indication-based dosing and individual and daily dose alerts, using a mg/kg per day or mg/m <sup>2</sup> per day formula, unless inappropriate Weight-based dosing calculations All available formulations, including liquid formulations that may be specific brands Common formulations requiring extemporaneous compounding or combinations of active ingredients
Cognitive support	Dose-range checking (minimum and maximum amount per dose, amount per day based on weight, surface area, and total dose) Automatic strength-to-volume conversions for liquid medications Adverse effect warnings specific to pediatric populations Alternative therapies based on ameliorable adverse effects Tall Man lettering to reduce medication selection errors Medication-specific indications to reduce ordering of sound-alike drugs
Pharmacy information Data transmission	Pharmacies that will create extemporaneous compounds Use of messaging standards for data transmission to pharmacies that include the patient's weight and notes pertaining to weight-based calculations Transmission of strength, concentration, and dose volume labeled in metric units for liquid medications

efficient for use in pediatric offices and must integrate well with existing office workflow. Recommendation 2 may be implemented by educating providers on the required elements of pediatric-appropriate e-prescribing systems through published reports, such as the accompanying technical report.<sup>20</sup>

3. E-prescribing systems should be able to provide patients and their parents with administration instructions based on their level of health literacy and their preferred language. Recommendation 3 may be implemented by educating e-prescribing vendors and providers of the need for this feature.
4. Pharmacies should work to enhance their technology infrastructure and workflows to enable efficient

acceptance and processing of electronic prescriptions generated and transmitted by certified health information technology. Furthermore, pharmacies should be capable of performing the dose-range checks to provide independent redundancy.

5. Private and public insurers and other third-party payers should offer financial incentives to health care providers and pharmacies to use e-prescribing systems with appropriate decision support.
6. States should work to harmonize their respective legislation to the US Drug Enforcement Agency's interim final rule on e-prescribing of controlled substances. Recommendations 4, 5, and 6 may be implemented by continued advocacy activities at the local, state, and national levels.

## LEAD AUTHORS

Christoph U. Lehmann, MD  
Kevin B. Johnson, MD, MS

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## CONSULTANTS

Christoph U. Lehmann, MD  
Kevin B. Johnson, MD, MS

## STAFF

Jennifer Mansour  
Ielnaz Kashefipour, MPP

## REFERENCES

1. Miller MR, Clark JS, Lehmann CU. Computer based medication error reporting: insights and implications. *Qual Saf Health Care*. 2006;15(3):208–213
2. Lehmann CU, Kim GR. Prevention of medication errors. *Clin Perinatol*. 2005;32(1):107–123
3. Miller MR, Robinson KA, Lubomski LH, Rinke ML, Pronovost PJ. Medication errors in paediatric care: a systematic review of epidemiology and an evaluation of evidence supporting reduction strategy recommendations. *Qual Saf Health Care*. 2007;16(2):116–126
4. Kaushal R, Goldmann DA, Keohane CA, et al. Medication errors in paediatric outpatients. *Qual Saf Health Care*. 2010;19(6):e30
5. Leyva M, Sharif I, Ozuah PO. Health literacy among Spanish-speaking Latino parents with limited English proficiency. *Ambul Pediatr*. 2005;5(1):56–59
6. Freedman RB, Jones SK, Lin A, Robin AL, Muir KW. Influence of parental health literacy and dosing responsibility on pediatric glaucoma medication adherence. *Arch Ophthalmol*. 2012;130(3):306–311
7. Ammenwerth E, Schnell-Inderst P, Machan C, Siebert U. The effect of electronic prescribing on medication errors and adverse drug events: a systematic review. *J Am Med Inform Assoc*. 2008;15(5):585–600
8. Jani YH, Ghaleb MA, Marks SD, Cope J, Barber N, Wong IC. Electronic prescribing reduced prescribing errors in a pediatric renal outpatient clinic. *J Pediatr*. 2008;152(2):214–218
9. Garg AX, Adhikari NK, McDonald H, et al. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review. *JAMA*. 2005;293(10):1223–1238
10. Zimmer KP, Miller MR, Lee BH, Yaster M, Miller RE, Lehmann CU. Narcotic prescription writer: use in medical error reduction. *J Patient Saf*. 2008;4(2):98–105
11. Newby DA, Robertson J. Computerised prescribing: assessing the impact on prescription repeats and on generic substitution of some commonly used antibiotics. *Med J Aust*. 2010;192(4):192–195
12. Stenner SP, Chen Q, Johnson KB. Impact of generic substitution decision support on electronic prescribing behavior. *J Am Med Inform Assoc*. 2010;17(6):681–688
13. Classen DC, Pestotnik SL, Evans RS, Burke JP. Computerized surveillance of adverse drug events in hospitalized patients. *JAMA*. 1991;266(20):2847–2851
14. Evans RS, Classen DC, Pestotnik SL, Lundsgaarde HP, Burke JP. Improving empiric antibiotic selection using computer decision support. *Arch Intern Med*. 1994;154(8):878–884
15. The Joint Commission. *A Guide to The Joint Commission's Medication Management Standards*. 2nd ed. Oakbrook Terrace, IL: The Joint Commission; 2009
16. Koppel R, Metlay J, Cohen A, et al. Role of computerized physician order entry systems in facilitating medication errors. *JAMA*. 2005;293(10):1197–1230
17. Han Y, Carcillo J, Venkataraman S, et al. Unexpected increased mortality after implementation of a commercially sold computerized physician order entry system. *Pediatrics*. 2005;116(6):1506–1512
18. Wang CJ, Marken RS, Meili RC, Straus JB, Landman AB, Bell DS. Functional characteristics of commercial ambulatory electronic prescribing systems: a field study. *J Am Med Inform Assoc*. 2005;12(3):346–356
19. Gerstle RS. Electronic prescribing systems in pediatrics: the rationale and functionality requirements. *Pediatrics*. 2007;119(6):1229–1231
20. American Academy of Pediatrics, Council on Clinical Information Technology. Technical report: electronic prescribing in pediatrics: toward safer and more effective medication management. *Pediatrics*. 2012. In press

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