COMPUTERIZED PHYSICIAN ORDER ENTRY WITH CLINICAL DECISION SUPPORT IN PREVENTING WRONG DOSE ERRORS IN PAEDIATRIC MEDICATION ORDERS: A SYSTEMATIC REVIEW

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Background and importance

Prescribing is a specific high-risk task within the paediatric medication-use process, which is why defenses are needed to prevent or stop errors.[1-3] Such system-centric barriers include electronic health record (EHR) systems with computerized physician order entry (CPOE).[4] Clinical decision support (CDS) tools can be integrated into the CPOE systems to assist safe prescribing.[5]

Aim and objectives

The objective of this systematic review was to examine the effects of CPOE systems with CDS functions on preventing wrong dose errors in paediatric medication orders.

Materials and methods

This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 criteria and Synthesis Without Meta-analysis (SWiM) items.[6,7] The study protocol was registered in PROSPERO. The literature search was conducted in MEDLINE Ovid, Scopus, Web of Science and EMB Reviews in January 2022. Study selection and data extraction were carried out by two independent reviewers. After this, the quality of evidence of the included studies were assessed. Finally, vote counting method was used to evaluate the effect of CPOE-CDS systems to reduce wrong dose errors.

Results

A total of 18 studies published in 2007-2021 met the inclusion criteria. The most common CDS tools appearing in the studies were dose range check (n=14/18), dose calculator (n=8/18) and dosing frequency check (n=8/18). In nine studies, a specific alert function was added to the CDS tool, whereas alerts were recorded in 15 studies. A statistically significant reduction in wrong dose errors was found in eight studies. None of the studies reposted an overall increase of wrong dose errors.

Conclusions and relevance

CPOE-CDS systems have a great potential to promote paediatric medication safety. System customization for paediatric populations, implementing CDS alerts, and the use of dose range check seem to be most useful interventions to reduce wrong dose errors. However, CPOE-CDS systems cannot prevent all wrong dose errors as human errors continue to occur. Implementation of new technology can also pose new medication safety risks, such as alert fatigue. Therefore, further studies and systematic development activities are needed to optimize the safe use of CPOE-CDS systems in paediatric care settings.

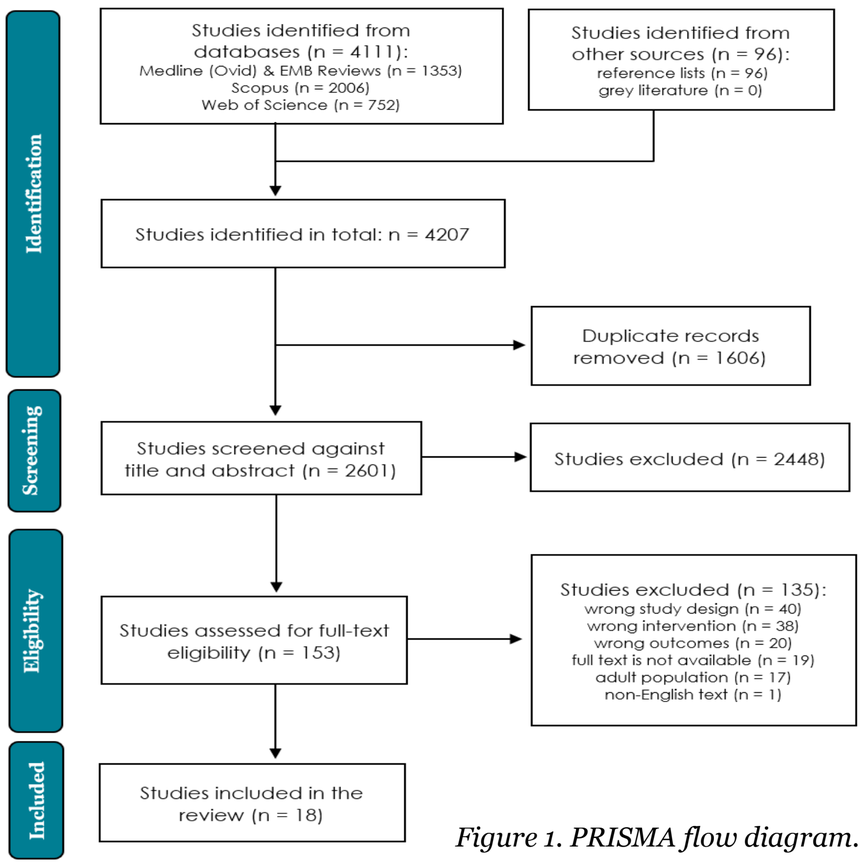

Figure 1. PRISMA flow diagram.

Table 1. The effects of CPOE-CDS system on wrong dose errors with effect direction and the use of clinical decision support. Publications are categorized by the aim and presented according to the effect direction of the outcome measure.

Study (year)	Measures	Description	Effect direction	Types of CDS alerts
Wrong dose error rates after implementation of a new or modified CPOE-CDS system (n=9)				
Hou et al. (2013)[8]	Overall* wrong dose error rates	Error reduction	▲	soft-stop
Balasuriya et al. (2017)[9]	CDS alert rate	Increase in CDS alert rates suggested less potential wrong dose errors as after the alerts more orders were cancelled or modified and less orders were submitted unmodified	▲	soft- and hard-stop
Kazemi et al. (2011)[10]	1. Overall* wrong dose error rates 2. Overdosing error rates 3. Underdosing error rates	1. Error reduction 2. Error reduction 3. Error reduction	▲$_3$	soft-stop
Ginzburg et al. (2009)[11]	Acetaminophen and ibuprofen: 1. Overdosing error rates 2. Underdosing error rates	1. Error reduction 2. The CPOE-CDS system could have caused more errors	▲$_2$	none
Kadmon et al. (2017)[12]	1. Overdosing error rates 2. Underdosing error rates	1. Error reduction 2. More underdosing errors, possibly caused by the CPOE-CDS system	▲$_2$	soft- and hard-stop
Hashemi et al. (2021)[13]	Overall* wrong dose error rates	Error reduction	▲	soft- and hard-stop
Kadmon et al. (2009)[14]	Overall* wrong dose error rates	Error reduction	▲	soft- and hard-stop
Stultz et al. (2019)[15]	Overall* wrong dose error rates	Reduction when indication specific dosing suggestions were used	▲	soft-stop
Killelea et al. (2007)[16]	The acceptance rate of orders with CDS suggestions for dose and frequency	The effect of CDS system on wrong dose errors remained unclear	▷	none
End-users' reactions to CDS alerts and how alerts impacted on wrong dose errors (n=8)				
Scharnweber et al. (2013)[17]	The compliance rate for CDS alerts	The compliance rate for underdosing alerts was lower than overdose alerts.	▲$_2$	soft-stop
Del Beccaro et al. (2010)[18]	CDS alert rate	After the CDS system was optimized, there was no increase in wrong dose error rates. Higher percentage of dosing alerts in the ambulatory setting than in the inpatient settings	▲$_2$	soft-stop
Stultz and Nahata (2014)[19]	CDS alert rates	Customized dosing related CDS alerts were more appropriate than non-customized. 8% (n=115/1935) of the alerts for an incorrect dose were overridden and caused an over- or underdose.	▲$_2$	soft-stop
Perlman et al. (2011)[20]	CDS alert rate	CDS alert function recognized mostly overdosing errors out of all wrong dose errors and could have prevented them.	▲	soft-stop
Sethuraman et al. (2015)[21]	1. Wrong dose error rate 2. CDS alert rate	1. Significant dosing error rate reduction (from 8 to 5.4/100) after the implementation of CDS alerts. 9% (n=88/959) of the overridden alerts caused wrong dose errors. 2. Majority of dosing alerts were false-positive (71%, n=684/959), but 20% (n=187/959) of the alerts prevented wrong dose errors.	▲$_2$	soft-stop
Stultz et al. (2014)[22]	1. CDS system's sensitivity to identify wrong dose errors when the system was or was not customized 2. CDS alert over-ride rate	1. Customized CDS system had higher sensitivity for identifying dosing errors than non-customized 2. All dosing errors had an alert over-ridden by the prescriber and 41% (n=63/155) of dosing errors with alerts were administered to the patient resulting in two errors that caused patient harm	▲$_2$	soft-stop
Neame et al. (2021)[23]	1. Overdosing error rates 2. The severity of harm associated with reported overdosing incidents after CDS system	No significant change after CDS system Decreased after CDS system	▷$_2$	soft-stop
Kirkendall et al. (2014)[24]	CDS system's alerts capability to identify overdosing errors	The CDS system with an alert function recognized mostly overdosing errors but could not prevent all extreme overdoses (>10000%) as the system interpreting extended infusions as one-time doses.	▷	soft-stop
The safety of the used CPOE systems with CDS tools using simulated patients and test orders (n=1)				
Chaparro et al. (2017)[25]	The rate of recognized wrong dose errors when using CPOE-CDS test orders.	CPOE-CDS systems seemed to be the best to identify inappropriate single doses by detecting 81% (mean) of the test orders with wrong dose error.	△	none

Notes*: *Overall wrong dose errors: underdosing and overdosing errors and other wrong dose errors;*
Abbreviations: CDS = clinical decision support; CPOE = computerized physician order entry;
Interpretation of the arrows*: Sample size:* final sample size (number of orders) in intervention group large arrow >60000; medium arrow 10000–60000; small arrow <10000 (or no data reported); *Effect direction:* upward arrow = CPOE-CDS systems were beneficial on wrong dose error prevention; downward arrow = CPOE-CDS systems caused negative effects on wrong dose error prevention; sideways arrow = no change/conflicting findings; *Statistical significance:* black arrow P<0,05; grey arrow P>0,05; empty arrow = no statistics/data reported; *Number of outcomes constituting the effect direction:* one (1) unless indicated in subscript beside effect direction.
The quality of evidence (GRADE[26,27]): *low (n=18)*

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