# For children admitted to hospital, what interventions improve medication safety on ward rounds? A Systematic Review

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**Short title:** Improving medication safety in paediatric ward rounds.

# Abstract

## Objective

Every year, medication errors harm children in hospitals. Ward rounds are a unique opportunity to bring information together and plan management. There is a need to understand what strategies can improve medication safety on ward rounds. We systematically reviewed published interventions to improve prescribing and safety of medicines on ward rounds.

## Design

Systematic review of randomised control trials and observational studies.

## Setting

Studies examining inpatient ward rounds.

## Patients

Children and young people aged between 0 and 18 years old.

## Interventions

## Any intervention or combination of interventions implemented that alters how paediatric ward rounds review inpatient medications.

## Main Outcome Measure

Primary outcome was improvement in medication safety on paediatric ward rounds. This included reduction in prescribing error rates, healthcare-professionals’ opinions on prescribing, improvement in documentation on ward rounds.

## Results

Three studies were eligible for review. One examined the use of an acrostic, one the use of a checklist and the other a use of a specific prescribing ward round involving a clinical pharmacist and doctor. None of the papers considered weight-based errors or demonstrated reductions in clinical harm. Reductions in prescribing errors were noted by the different interventions.

## Conclusions

There are limited data on interventions to improve medication safety in paediatric ward rounds, with all published data being small scale, either quality improvement or audits, and locally derived/delivered. Good quality interventional or robust quality improvement studies are required to improve medication safety on ward rounds

## What is already known on this topic

* Medication review should be a part of the inpatient ward round as per the advice from the Royal College of Physicians. There is no universal agreement on how this should be undertaken on a paediatric ward round to improve medication safety.

## What this study adds

* This review shows that the use of an intervention can help to reduce medication prescribing error rates in a paediatric inpatient setting.
* It highlights that, while effective in reducing medication error rates, current interventions have only been carried out on as small, locally delivered initiatives.

## How this study might affect research, practice, or policy

* There is a suggestion that a standardised intervention via a guideline specific to paediatrics may be beneficial in helping to reduce medication errors in children.

# Introduction

A recent safety report from the health safety investigation branch (HSIB) highlighted issues around weight-based medication errors in children (1). The safety report highlighted the clinically harm that can occur in paediatrics when incorrect doses are prescribed and administered, and recommended that best practice principles for medicines be developed to improve paediatric ward rounds (1).

Medication errors commonly occur. Within the UK there are 237 million per year at some point during the medication process, these errors can lead to harm, or even death (2). Children are at an increased risk of harm from medication errors when compared with adults (3). Within the UK, 13% of medications prescribed for children contain errors (4). There are many reasons that children are at increased risk from medication errors (5). These errors can occur throughout the medication process from prescribing to dispensing to documentation (6). With prescribing errors, doses are more commonly prescribed on a weight-based system compared to adults hence create variation (7). Lack of standardisation between formulations and strengths increases the likelihood of medication errors. A recent study highlighted the incidence of 10 times medication errors in children (8). The introduction of the electronic prescribing and medicines administration system (ePMA) has also contributed to errors particularly in relation to tenfold medication errors such as those referenced in the HSIB report (1).

It is not just the variation in dosing that leads to errors in prescribing but also the limited guidance available of prescribing in the clinical ward round environment compared to adult hospitals. The Royal College of Physicians (RCP) expresses that the modern ward round should involve a medication review as part of best practice in the clinical environment (9), however this is in relation to adult care only. When examining interventions that have been undertaken in adults there is evidence that different interventions can be beneficial in reducing errors and improving clinical practice, such as pharmacists in ward rounds (10) and the use of clinical tools ie SBAR (11). Only 14% of medicines are licensed for children at the time they reach the UK market, with this only increasing to about 25% in the next 10 years (12). The lack of evidence and consensus as well as the complexity around medications for children is large compared to adults. There are no systematic reviews and no guidance to examine how different interventions may affect medication safety in the paediatric ward round environment.

The aim of this systematic review is therefore to look at interventions that have been tested with the aim of improving medication safety during paediatric ward rounds. This forms part of a programme of work being led by the RCPCH Joint Standing Committee on Medicines to develop evidence-based guidance in this area.

# Methods

The protocol for our review was registered on PROSPERO (340201). Two investigators (CK and DH) independently performed the initial screening of titles and abstracts, analysed full text reports for eligibility, extracted data, and evaluated study quality. Disagreements at each stage were discussed between the two reviewers (CK and DH) to reach an agreement.

## Information sources and search strategy

Online databases Pubmed, Web of Science and the Cochrane Register of Trials were searched for terms related to “paediatric”, “medicine”, “ward round” and “safety” (see Supplementary File S1 for detailed search strategy) up to July 2022.

## Inclusion criteria and study selection

All study designs (including RCT’s, cohort, time series and quality improvement), that evaluated interventions related to medications that have been applied to paediatric ward rounds in a hospital setting or intensive care environment were included. The primary outcome was medical prescribing interventions that have been applied to paediatric ward rounds in a hospital setting or intensive care environment. Secondary outcome examined interventions that have been shown to improve medication safety on paediatric ward rounds, including prescribing error rates, healthcare-professionals’ opinions on prescribing, improvement in documentation on ward rounds and adverse events.

Studies were included if they examined any intervention or combination of interventions implemented in a hospital setting either the ward or intensive care unit that altered how paediatric ward rounds reviewed inpatient medications including (but not restricted to) acronyms, checklists, and inclusion of a multi-disciplinary team in the ward round environment. Specified outcomes of interest would be reduction in prescription errors, improvement in documentation of medications as an inpatient, healthcare professionals’ opinion regarding improvement in medication prescribing in the ward round environment, reduction in adverse events and adverse drug reactions due to the implementation of the intervention.

Papers were excluded if people aged over 18 years old were included or could not be analysed separately. In addition, studies were excluded if they were not done in a hospital inpatient setting such as an emergency department, or if the intervention examined was not part of the ward round process.

There were no limitations on the search with all languages, time periods and type of study included. When required, translations were sought for papers. A current awareness search was be undertaken prior to publication to identify relevant papers that may have been published post the initial run of the search criteria.

## Ethical consideration

Due to this being a systematic review, no ethical approval was required.

 Assessment of risk of bias

Risk of bias was assessed using the ROBINS-I tool for non-randomised comparative studies (13) and the Cocharane risk-of-bias tool for randomised trials (RoB 2) (14). If there were 10 or more studies available for a meta-analysis publication bias would be assessed using a funnel plot.

## Data synthesis and statistical analysis

From eligible studies, we extracted data using a standardised form that had been agreed between the two independent reviewers (CK and DH). It included the following data items that were extracted:

* Author, country
* Year of publication
* Population
* Location of included population
* Intervention implemented
* Outcome of intervention
* Key findings
* Methodology
* Funding sources

Extracted data were synthesized in descriptive and tabular formats.

Descriptive analysis of the extracted data was undertaken, focusing on interventions and outcomes within and between studies. This allowed a clear identification of themes to arise from the data available. Similar methods of intervention were compared to each other looking at specific similarities and differences. Depending on available data from eligible studies a summary of evidence table would be implemented and the certainty of the evidence would have been examined utilising the GRADE approach due to the systematic review being part of the process to create a guideline.

# Results

 Three studies were identified to be eligible for our review (16-18). The review flowchart is shown in figure 1, with reasons for exclusion of full text papers analysed.

Due to the limitation of data available and the variation in interventions used a summary of evidence table was unable to be performed and the GRADE approach not performed.

The study characteristics are shown in Table 1. All three studies examined a different intervention. One examined the use of an acrostic (18), one the introduction of a specific prescribing ward round with a doctor and clinical pharmacist (16), and one the use of a checklist (17). Two of the studies used specific interventions to improve the quality of the ward round as a whole or reduce prescribing errors (17, 18). The third utilised the experience of others in a multi-disciplinary team in a controlled environment to improve prescribing (16). None of the papers contained specific consideration of weight-based medication errors, none demonstrated reductions in clinical harm, however, there were reductions in prescribing errors noted. Two studies highlighted that the introduction of the intervention was positively seen by the medical team and helped them to undertake ward rounds more effectively (16, 18).

The studies were heterogenous in terms of interventions used and outcome measure, so meta-analysis could not be performed.

*Quality of evidence*

The risk of bias for all studies is available in Table 2. Two of the studies with continuous data were quality improvement studies and had short prospective post intervention data so sustainability cannot be assured (16, 17). The other study was an audit with no continuous prospective data (18). Due to the nature of the studies, none reported on if there was deviation from the intended interventions. Furthermore, for all the studies the intervention implemented was known to the prescribers. Overall, all studies scored as serious risk of bias (16-18). .

*Checklists and mnemonics*

Two studies analysed the use of an additional tool to help during the ward round in remembering to review medications of the patients (17, 18). An audit was undertaken in a large paediatric department and utilised an acrostic in the post-take ward round (this is a consultant-led ward round after a patient has been admitted). They examined 200 case notes over a three year period, 50 notes pre introduction, 50 notes post introduction then 100 notes two years later. They found an initial improvement in documentation of drugs from 26% to 76% pre and post introduction, this increased to 86% two years later, showing a statistical improvement (18). Although this highlights that documentation improved medication errors were not reported. An interrupted time-series, analysing 227 patient records, utilised a consultant led daily inpatient prescribing checklist that was required to be completed during the ward round. They found that that the number of technical errors (those due to prescribing writing errors) significantly improved (a relative decrease of -37.7% (p<000.1)) post intervention (17). There was no change in the rate of clinical errors, those involving omission or wrong dose errors (table 1).

*Ward rounds*

One study, a quality improvement study, analysed the use of the introduction of a separate prescribing ward round in a paediatric intensive care unit, undertaken by a senior clinical doctor and a paediatric pharmacist. The outcome for this was prescribing errors. The ward round was undertaken the same time each day. Overall there was a reduction in prescription errors, the mean number of total errors per bed day decreased (1.66 to 1.19) and clinical prescription errors per bed day (0.46 to 0.3) (16).

# Discussion

There is limited evidence available on the use of interventions to improve medication safety amongst the paediatric population. From the eligible studies there were two themes around ward rounds, the use of a checklist or mnemonic or the use of a separate ward round (16-18). The acrostic was only measured within a particular standard of ward round, the post-take ward round, which are often undertaken by a consultant and involve patients who have recently been admitted, whereas the separate ward round was undertaken in a PICU setting. The variation in setting may contribute to the ability of the intervention to be implemented and the success of the intervention. The interventions were known to prescribers prior to implementation in all studies thus may have impacted how prescribers behaved during the intervention period analysed.

Paediatric ward rounds require their own specific guideline due to the variations around medications that exist within this specific population. Within paediatrics prescribing can vary between the age and weight of the patient; within neonates the working weight of the patient often needs to be updated and thus medications continually reviewed. This is unlike in adult care where patients often will be on the same dose of medicine throughout their care. Due to this although there have been reviews and studies highlighting the use of interventions in ward rounds within adult’s such as checklists (19, 20) and the use of the RCP guideline (9) this is unable to be extracted to the paediatric ward round environment. Specific interventions need to be undertaken in the paediatric environment to see what tools can be used that can improve prescribing and medication safety on ward rounds to minimise errors and prevent harm to patients.

Other interventions that have been shown to reduce medication errors outside the scope of this systematic review and the ward round environment is the implementation of the electronic prescribing systems (ePMA). A previous scoping review highlighted the use of electronic prescribing systems as one of the most common interventions implemented to reduce medication errors, however, there was variation in the degree of reduction and electronic system used in the studies (21). A study by Jani et al. highlighted that within a UK children’s hospital, the inpatient rate of dosing errors did not change with the implementation of an electronic prescribing system (22). This variation seen between studies highlights how there needs to be further standardisation of electronic prescribing systems. Often the ePMA systems have been established for adult settings and thus do not recognise the nuances that occur with prescribing for paediatrics such as weight versus aged based calculations, the use of a specific paediatric ePMA system has been shown to be beneficial and decrease errors (23). This is highlighted in the HISB report, often in paediatrics there is often local configuration of the ePMA systems thus introducing variability and risk. It is important that the use of ePMA systems are separately considered in relation to prescribing errors in children (1).

The use of clinical pharmacists to review drug orders reduced prescribing error rates and reduced potential harm to patients (24, 25). However, even with the use of clinical pharmacists on the ward we know there can be a delay in identifying errors due to the retrospective nature of pharmacist visits to the wards and the availability of clinical pharmacists within paediatrics (26). A systematic review identified that the integration of clinical pharmacists into the ward round would allow pharmacists to identify errors during the prescribing phase and provide real-time recommendations to prescribers (27). This corroborates the outcome seen by Walsh et al, with the use of a pharmacist and a doctor on a prescribing ward round, the pharmacist was able to make real-time change to prescriptions (16).

This systematic review highlights the limitations in this area. These were all quality improvement projects with no robust data on sustainability, and no report on the balancing measures which is increased ward round time, a pressurised commodity. Indeed, one intervention (11) was paused due to time constraint. The essence of QI is testing implementation in specific microsystems and ward cultures, and testing for sustainability, so sharing through publication does not imply it will work in other hospitals. The quality of these studies has been shown to be low. There is heterogeneity between studies when it comes to interventions, subjects of interventions, data collection method and outcome measured. It was impossible to combine the studies due to variation in outcomes and data collection methods. The interventions identified in this systematic review need to be taken with caution.

Notwithstanding the limitations, the findings from this review suggest further scope for improving medication safety in the paediatric population regarding ward rounds. The studies highlight that, similar to adult practice, interventions around medications in the ward round environment are beneficial to reduce medication errors and improve review and documentation of medications. The results of this review highlight some interesting methods that could be tested, but considerable areas of ward round activity related to medications have no published evidence. Further high quality research is required. An understanding of the the views of a representative cross section of paediatricians and stakeholders on the key areas of medication safety would help inform both interventions and future research in this area.

## Conclusion

There is no current standardised intervention nor high level evidence to improve medication safety on ward rounds in the paediatric environment. Studies found short term advantages to implementing an intervention, methodologies which could not exclude the Hawthorne effect of being observed, but must be countered by increased ward round time. This review allows us an initial list of potential interventions and we can utilise those from adult medicine as well to see how we can adapt these to fit the modern paediatric ward round.

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Contributors CK and DH screened, extracted, analysed and interpreted the eligible studies. The manuscript was written by CK. JD, AM, ST, YT, AT, NM and DH critically reviewed and revised the manuscript. All authors read and approved the final version.

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## Data availability statement

Data are available upon reasonable request.

## References

1. Branch HSI. Weight-based medication errors in children. HSIB; 2022.

2. Elliott RA, Camacho E, Jankovic D, Sculpher MJ, Faria R. Economic analysis of the prevalence and clinical and economic burden of medication error in England. BMJ Quality &amp; Safety. 2021;30(2):96-105.

3. Kaushal R, Bates DW, Landrigan C, McKenna KJ, Clapp MD, Federico F, et al. Medication errors and adverse drug events in pediatric inpatients. Jama. 2001;285(16):2114-20.

4. Ghaleb MA, Barber N, Franklin BD, Wong IC. The incidence and nature of prescribing and medication administration errors in paediatric inpatients. Arch Dis Child. 2010;95(2):113-8.

5. Ghaleb MA, Barber N, Franklin BD, Yeung VW, Khaki ZF, Wong IC. Systematic review of medication errors in pediatric patients. Annals of Pharmacotherapy. 2006;40(10):1766-76.

6. 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. BMJ Quality & Safety. 2007;16(2):116-26.

7. Santell JP, Hicks R. Medication errors involving pediatric patients. Joint Commission Journal on Quality and Patient Safety. 2005;31(6):348-53.

8. Tse Y, Tuthill D. Incidence of paediatric 10-fold medication errors in Wales. Archives of Disease in Childhood. 2021;106(7):656-61.

9. Nursing RCoPaRCo. Modern ward rounds. Good practice for multidisciplinary inpatient review. . Royal College of Physcians and Royal College of Nursing 2021.

10. Leape LL, Cullen DJ, Clapp MD, Burdick E, Demonaco HJ, Erickson JI, et al. Pharmacist participation on physician rounds and adverse drug events in the intensive care unit. Jama. 1999;282(3):267-70.

11. Stewart KR. SBAR, communication, and patient safety: An integrated literature review. 2016.

12. Hirota S, Yamaguchi T. Timing of Pediatric Drug Approval and Clinical Evidence Submitted to Regulatory Authorities: International Comparison Among Japan, the United States, and the European Union. Clin Pharmacol Ther. 2020;108(5):985-94.

13. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ. 2016;355:i4919.

14. Higgins JP, Savović J, Page MJ, Elbers RG, Sterne JA. Assessing risk of bias in a randomized trial. Cochrane handbook for systematic reviews of interventions. 2019:205-28.

15. Asthma BGotMo. British Thoracic Society, Scottish Intercollegiate Guidelines Network. Thorax. 2008;63(Suppl 4):iv1-121.

16. Walsh A, Booth R, Rajani K, Cochrane L, Peters M, du Pré P. Introduction of a prescribing ward round to reduce prescribing errors on a paediatric intensive care unit. Arch Dis Child Educ Pract Ed. 2021;106(4):251-4.

17. Lépée C, Klaber RE, Benn J, Fletcher PJ, Cortoos PJ, Jacklin A, et al. The use of a consultant-led ward round checklist to improve paediatric prescribing: an interrupted time series study. Eur J Pediatr. 2012;171(8):1239-45.

18. Newnham AL, Hine C, Rogers C, Agwu JC. Improving the quality of documentation of paediatric post-take ward rounds: the impact of an acrostic. Postgrad Med J. 2015;91(1071):22-5.

19. Johnston J, Stephenson J, Rajgopal A, Bhasin N. ‘Every patient, every day’: a daily ward round tool to improve patient safety and experience. BMJ Open Quality. 2022;11(3):e001829.

20. Dermanis AA. Can Checklists Solve Our Ward Round Woes? A Systematic Review. World Journal of Surgery. 2022:1-2.

21. Conroy S, Sweis D, Planner C, Yeung V, Collier J, Haines L, et al. Interventions to Reduce Dosing Errors in Children. Drug Safety. 2007;30(12):1111-25.

22. Jani YH, Barber N, Wong ICK. Paediatric dosing errors before and after electronic prescribing. Quality and Safety in Health Care. 2010;19(4):337-40.

23. Cordero L, Kuehn L, Kumar RR, Mekhjian HS. Impact of computerized physician order entry on clinical practice in a newborn intensive care unit. J Perinatol. 2004;24(2):88-93.

24. Folli HL, Poole RL, Benitz WE, Russo JC. Medication error prevention by clinical pharmacists in two children's hospitals. Pediatrics. 1987;79(5):718-22.

25. Fernández-Llamazares CM, Calleja-Hernandez MA, Manrique-Rodriguez S, Pérez-Sanz C, Duran-García E, Sanjurjo-Saez M. Impact of clinical pharmacist interventions in reducing paediatric prescribing errors. Arch Dis Child. 2012;97(6):564-8.

26. Farrar K, Stoddart M, Slee AL. CLINICAL PHARMACY AND REACTIVE PRESCRIPTION REVIEW: TIME FOR A CHANGE? Pharmaceutical journal. 1998;260(6995):759-61.

27. Drovandi A, Robertson K, Tucker M, Robinson N, Perks S, Kairuz T. A systematic review of clinical pharmacist interventions in paediatric hospital patients. European Journal of Pediatrics. 2018;177(8):1139-48.

## Figures

Figure 1: Prisma Flowchart of Studies

## Tables

Table 1: Study Characteristics of Included Studies

Table 2: Risk of bias using ROBINS-I tool

Figure . PRISMA flowchart

Records identified from: Pubmed (80), Web of Science (56), Cochrane Trials Register (61)

Databases (n = 136)

Registers (n = 61)

Records removed *before screening*:

Duplicate records removed (n = 43)

Records screened

(n =154)

Records excluded

(n = 117)

Abstracts screened for eligibility

(n = 37)

Reports excluded

(n =25)

Reports assessed for eligibility

(n = 12)

Reports excluded:

Incorrect population (n = 4)

Not in hospital ward round setting (n = 2)

Not assessing medications (n = 3)

Studies included in review

(n = 3)

**Identification of studies via databases and registers**

**Identification**

**Screening**

**Included**

Table . Study characteristics of included studies

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Author, Country** | **Year of publication** | **Population** | **Location of included population** | **Intervention implemented** | **Outcome of intervention** | **Key Findings**  | **Methodology** | **Funding sources** |
| Walsh et al, UK(16) | 2021 | PICU ward | PICU | Prescribing ward round introduced with doctor and clinical pharmacist every day at the same time.  | Prescribing errors. Secondary outcomes to improve the workflow in the unit and reduce the time staff spent on medication queries/prescribing.  | Mean prescribing errors reduced (from 1.66 to 1.18 per day. Staff surveyed believed the round reduced time on medication queries, reduced interruptions, and was well received | Introduction of daily multidisciplinary prescribing round and impact on prescribing errors | None |
| Lepee et al, UK(17) | 2012 | 24 bedded paediatric ward | DGH | Implementation of “Check and Correct” tool | Technical prescription writing errors (technical) and prescribing errors involved in clinical decision errors (clinical) | Errors in writing prescriptions were reduced, no effect on clinical errors was noted | Used a “Check and Correct” checklist. Reviewed error rates for two months pre- and post- intervention | NIHR |
| Newnham et al, UK(18) | 2014 | Paediaitric ward | DGH | Introduction of an acrostic in post-take ward rounds | Completion of documentation before and after introduction of acrostic  | Documentation related to drugs improved (26% vs 76%). Junior doctors surveyed about this approach strongly agreed that it helped quality of documentation | Used an “acrostic” (mnemonic) that included a specific Drugs reminder to improve quality of documentation | None |

Table . Risk of bias using ROBINS-I tool

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | D1 | D2 | D3 | D4 | D5 | D6 | D7 | Overall  |
| Study 1 (16) | No information | Moderate risk | Low risk | No information | Low risk | Serious risk | Moderate risk | Serious risk  |
| Study 2 (17) | Moderate risk | Low risk | Low risk  | No information | Serious risk | Moderate risk | Moderate risk | Serious risk |
| Study 3(18) | No information | Serious risk | Moderate risk | No information | Low risk | Moderate risk | Moderate risk | Serious risk  |

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