Qualitative exploration of practices to prevent medication errors in neonatal intensive care units

a focus group study

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Qualitative exploration of practices to prevent medication errors in neonatal intensive care units: a focus group study

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Abstract

**Background:** Medication errors (MEs) in neonates are frequent and associated with increased potential for harm compared with adults. The effect of learning from reported MEs is potentially lacking due to underreporting, lack of feedback and missing actions to improve medication safety. A new approach involving positive recognition of current and future strategies may facilitate greater exploration of how to improve medication safety in neonates. We aimed to explore current and potential future practices to prevent MEs in neonatal intensive care units (NICUs).

**Methods:** Focus group interviews of physicians and nurses were conducted at three Danish NICUs. Participants were included if they had at least 1 month of working experience and provided direct patient care. A semistructured interview guide involving three questions was used: (a) how do you feel about discussing prevention of MEs? (b) how do you currently prevent MEs from occurring? and (c) how can we become better at preventing MEs in the future? Content analysis was used to identify themes in the interviews.

**Results:** Participants commented that MEs still occur and that action must be taken to improve medication safety. Current practices to prevent MEs involved technology, procedures, education, skills and hospital pharmacy services. Potential future practices to prevent MEs included customizing the computerized physician order entry systems to support optimal prescribing, standardizing the double-check process, training of calculation skills and teamwork and increased use of hospital pharmacy services.

**Conclusions:** Several current and potential future practices to reduce MEs in NICUs were identified, highlighting the complexity of MEs. Our findings support an interdisciplinary multifaceted intervention involving both technical and nontechnical elements to improve medication safety in NICUs.

**Keywords:** hospital, medication errors, paediatrics, prevention strategies

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Introduction

Preventing medication errors (MEs) is essential in high-risk settings such as neonatal intensive care units (NICUs). Neonates, especially preterm and critically ill neonates, are more susceptible to harm from MEs due to their small size, immature organ system and disease severity involving invasive procedures for diagnosis, complex treatment and multiple medications.\(^1\)–\(^3\) Several strategies have been proposed to improve medication safety in paediatric inpatients.\(^4\)–\(^6\) However, comparison and assessment of usability of the improvement strategies is difficult due to differences in the applied methods and definitions of MEs.\(^4\) Further, differences in organizational
and contextual factors impact implementation and the effect of the intervention.\textsuperscript{7–9}

Efforts to reduce MEs mainly rely on retrospective identification and development of strategies to prevent MEs through incident reporting. Although, organizational learning from incident reports has resulted in system change, effects are limited due to lack of feedback and missing actions to improve patient safety.\textsuperscript{10–12} Further, blame cultures still exist, causing underreporting of errors and dissatisfaction among frontline workers.\textsuperscript{13,14} A change towards a more strength-based approach involving affirmation, appreciation and positive dialogue may possibly facilitate change to improve medication safety, eliminating the blame and shame culture.\textsuperscript{15–17} Approaches such as Safety II and Appreciative Inquiry facilitate social-organizational changes through recognizing what goes well, and creative and constructive thinking.\textsuperscript{16,17} In Safety II, frontline workers are acknowledged for their resilience to be flexible and adaptive contributing to patient safety in an ever-changing environment.\textsuperscript{16} Appreciative Inquiry generally involves searching for the strengths and potentials in people and their organizations.\textsuperscript{17} Communicating with frontline workers inspired by Safety II and Appreciative Inquiry may facilitate deeper understanding of what works well in the medication process involving neonates and how medication safety involving neonates may improve.\textsuperscript{16,17} In order to optimize medication safety, the practices that lead to successful medication prescribing, preparation and administration need to be understood. The aim of this study was to explore current and potential future practices to prevent MEs experienced by physicians and nurses working at NICUs.

Method
Attitudes and experiences of preventing MEs among physicians and nurses working at NICUs were explored through focus group interviews inspired by Safety II and Appreciative Inquiry.

Setting
The three largest tertiary NICUs in Denmark were purposively recruited for this study (Table 1). All units were involved in the complex treatment of extremely premature neonates and other newborns with severe complications. At these NICUs, medication orders were documented through an electronic prescribing system. Medications were prepared and administered by nurses. Nurses prepared medications for administration in a medication room located at the unit that stored stock medication, for example, medication frequently used at the unit.

Focus group participants
Two focus groups, one including physicians and one including nurses, were conducted at each NICU. In order to facilitate group discussions, a minimum of three participants had to be recruited to each group. On the other hand, focus groups were limited to a maximum of six participants to allow participants time to express their views.

Physicians and nurses were eligible to participate if they had at least 1 month of work experience at the NICU and provided direct patient care.

Local project managers assisted in the recruitment of participants. Before each focus group interview, an e-mail including information about the study was sent to the participants by one of the local project managers or researchers (RMR).

Data collection
Focus group interviews were conducted in a meeting room at or near each NICU. Prior to each interview, participants were informed of the study both orally and in writing. Further, each participant filled out a written consent form and a questionnaire (Supplement 1). The questionnaire consisted of seven items involving profession, sex, age, number of years since graduation as a qualified healthcare professional, number of years of work experience at the unit and patient safety responsibilities.

A semistructured interview guide consisting of three open-ended questions was used to facilitate discussion. First, participants were asked to express their attitudes towards discussing prevention of MEs. Next, a poster was presented to the participants and the participants were asked two questions: (a) how do you currently prevent MEs from occurring? and (b) how can we become better at preventing MEs in the future? (Figure 1). Different factors potentially influencing medication safety, including management, technology, communication/collaboration, parents, and professional skills were shown on
the poster to prompt discussion. These factors were previously identified through a literature search. We deliberately omitted mentioning specific potential practices to improve medication safety, such as using barcode-assisted medication administration (BCMA) to prevent medication administration errors to avoid response bias. Further, participants were informed that practices were not restricted to only involve the factors presented on the poster.

The first author (RMR) moderated the interview and presented the questions to the participants. A pharmacy student (HLN or SMS) served as a facilitator and assisted data collection. Both the moderator and facilitator contributed to the elaboration of attitudes and experiences by probing.

The setup of the focus groups and the interview guide were pilot tested through five focus group interviews; three involving physicians and two involving nurses, respectively. Participants from the pilot study were not part of the target group.

Focus group interviews were audio-recorded and transcribed verbatim. Two of the six focus groups requested to receive the final transcript of their interview but did not provide any additional comments.
Analysis

Analysis of the focus group transcripts was conducted using qualitative content analysis.18 Three coders were involved in the analysis (HLN, SMS and RMR). Themes derived from the transcripts identified current practices and potential future practices to prevent MEs. The transcripts were initially categorized individually by two coders (HLN and SMS). The two coders met prior to the analysis and predefined categories and colour-codes to be used. As an example, all practices relating to technology were colour coded green and were inserted into a matrix table, including either current or potential future practices. Each practice was inserted into a separate row and markings showed which of the focus groups had discussed the practices. During the analysis process, new themes emerged from the transcripts and predefined categories were corrected. The coders met after finalizing the analyses and evaluated the identified categories in each transcript. A third coder (RMR) reviewed the final analyses and discussed possible additions of categories and changes of current categories with the other coders. Feedback on the findings was provided by three local project managers (SAB, HMG and JFR).

Ethics

This study was approved by the unit managers of each NICU. According to Danish law, no ethics permission was required, as the focus group interviews solely involved attitudes and experiences of physicians and nurses in relation to their work.19 No personal information about patients or frontline workers was collected in this study.

Results

Six focus groups were conducted with three to six participants in each group (Table 2). Nurses from NICU 2 were generally younger, had graduated more recently and were less experienced compared with participants in other groups.

Attitudes towards discussing prevention of MEs were generally positive among the focus group participants. Participants considered it necessary to discuss medication safety as MEs still occurred.
in the NICUs and since discussions could potentially lead to actions to prevent MEs. One group of physicians criticized the current working procedures, where management focused more on efficiency than the prevention of MEs:

“I think of one of the big problems with this [medication treatment of neonates] is that you think it can be made more efficient like anything else. The question is how far you should go to do this quickly?” (Physician, NICU 3.)

Several current and potential future practices were identified in each focus group. Current practices involving technology, procedures, education and experience were felt to help in preventing MEs by the focus groups (Supplement 2). Potential future practices involved technology, procedures, education and experiences, hospital pharmacy services and supplying resources to focus on ME prevention (Supplement 3). In the following, we report the most frequently and uniquely mentioned practices to prevent MEs.

Technology
The majority of the focus groups emphasized the importance of technology such as computerized physician order entry (CPOE) systems including clinical decision support (CDS) systems to prevent MEs. Different types of commercially available CPOE systems were implemented at the three NICUs, where two of the systems provided standardized medication instructions supporting safe prescribing. One of the systems would also alert physicians when double prescriptions occurred. Further development of the CPOE systems was felt necessary, as the systems had not been tailored to meet the needs of prescription for neonates. In one of the NICUs, physicians felt the CPOE system posed a threat:

“[The CPOE system] is built on a whole lot of other concentrations from other paediatric wards that do not fit ours and then we have to customize a prescription (...) and it is a breeding ground for error that you cannot prescribe what you want.” (Physician, NICU 3.)

Strategies to improve medication safety included increasing the use of CDS involving standardized prescribing, automated dosing according to weight, implementing alerts involving allergies, and dosing outside the normal weight range. Alerts were experienced as making the physician aware of a potential problem and would result in a reassessment of the prescription.

Brand names instead of generic names were prescribed at all NICUs and were felt by one group of nurses to pose a risk, when a brand name other than the brand written on the prescription was available in stock. Nurses suggested the hospital pharmacy dispensing system be integrated in the CPOE system to allow physicians to identify and prescribe medications in stock.

BCMA was implemented at one NICU. Both focus groups supported the use of barcode scanning when preparing medications for administration and for patient identification prior to administration. However, a new system had been implemented recently, and nurses felt that only scanning of patient ID was possible and not scanning of the medications. Nurses from another NICU suggested implementing a BCMA system with the ability to perform a technical double check of medications and patient identification instead of two nurses performing the double check:

“I actually wonder, is it [double check of medications] possible to do with technology? (...) If all bottles or ampoules had a barcode then you would simply 'beep', and then you could say 'well, I would like, as a person with my own brain, to calculate which dosage we have to administer', but the computer tells you 'you have to administer so and so much', well, we agree. (...) And if there was a scanner placed at the end of the incubator containing the personal ID number. Then just 'beep'. (...) Well, that could be clever.” (Nurse, NICU 2.)

However, concerns were reported that barcode scanning was too time consuming and that such a system would take years to design.

Double check of medications
Double check of medication preparation and administration was considered a current practice to prevent MEs by all groups. At two of the NICUs (NICU 1 and 2), the double-check process involved two nurses independently checking the medication in relation to the correct patient, the right medication, correct dose, right time and correct route of administration during the preparation stage. At NICU 3, the double-check process involved both preparation and administration of medications where the control nurse was specifically allocated to assist the double-check procedure because of familiarity with the patient’s clinical problem. At the other NICUs, nurses were randomly picked to perform the check by
the nurse who prepared the medication for administration at NICU 1 and 2. The independent check of medication administration included medication for infusion and checking that the infusion pump was set correctly according to infusion rate and volume to be infused.

Nurses from all groups had experience of MEs preventing the double-check process:

“We actually experience catching each other occasionally (...) ‘Hey, it’s not the same [dose] I get’, ‘God no!’ and then the person can truly see that it really does matter.”  
(Nurse, NICU 2.)

The double-check process provided support and reassurance for the nurses. The practice was considered particularly advantageous for less experienced nurses, where one nurse expressed comfort in the process:

“I think it is really nice that you are not faced with the responsibility yourself, because even small changes may have an impact, when it is such small children we are talking about.”  
(Nurse, NICU 2.)

However, nurses felt that MEs still occurred despite the double-checking process and emphasized the need to improve and strengthen the current process. Barriers to double checking involved variability in the process due to lack of resources, workload, time constraints, learned habits, lack of precision on how and which medications to double check, interruptions, and lack of a function to document double check in the CPOE system. Differences in the process involved omitting double-check due to insufficient staffing and only double-check that the right volume was drawn up due to increased workload or learned habits.

Nurses from one group stressed that communication on how to perform the double check to enhance compliance with the procedure would increase patient safety. The importance of a systematic and detailed guideline on how to perform double check of medications was supported by a group of physicians. Further, nurses agreed that only medications with risk of patient harm, including intravenous medications and medications that nurses were unfamiliar with, should be double checked. Nurses at one unit explained how double check of all medications, including vitamins and laxatives considered harmless, added unnecessarily to their workload and distracted them from other important work assignments. As a consequence, nurses feared that they would become blind to medications which were important to double check and potentially omit double check of risk medications when the unit was busy. Oral medications such as vitamins, phosphate and laxatives were deliberately not included in the double-check procedure at NICU 2 and NICU 3.

At one of the units, implementing a new CPOE system had resulted in lack of the previous countersign function. Nurses here agreed that strong self-discipline was required of them to perform the double check because of the lack of support from the system and suggested the CPOE system to be redesigned to facilitate the double check.

The majority of nurses emphasized the need to allocate resources and to have a nurse, whose only function was to double check medications. Having a stationary control nurse to perform the double check in the morning hours, when the unit was most busy, was believed to prevent delayed medication administration, because nurses had to wait for another nurse to finish other work assignments before engaging in double checking. Further, MEs caused by interrupting a colleague, who was preparing medications for other patients at the same time, would also be prevented.

An expansion of the double-check procedure involving double check of administration was suggested. One unit had already implemented this procedure, but nurses felt that double check of administration was sometimes omitted due to insufficient staff. Resources should be invested to allow for this procedure, but one group of nurses considered it impossible to allocate the resources.

Experience, education and training
Nursing skills were experienced as one of the main tools to prevent MEs by all groups. Skills involved knowledge about commonly used medications, how to perform complex calculations, medication preparations and the ability to assess the suitability of the prescribed dose based on the weight of the child.

Calculation assignments were mentioned as current practices to improve medication safety by four focus groups involving nurses and physicians. Training at the NICUs involved an intravenous medication course for new nurses and calculation assignments for physicians in specialty training (NICU 1), e-learning modules
completed every 2 years by physicians and nurses (NICU 2), and calculation assignments for newly recruited nurses (NICU 3). However, nurses in all groups had experience of new and even experienced nurses not being properly trained to perform medication calculations. One nurse with more than 18 years of experience suggested additional calculation assignments for all nurses because of medication calculation difficulties:

“In fact, I think we could have some calculating things occasionally, because I sometimes think that it is really difficult to determine the amount [of a medication] that has been calculated “how did they [physicians] get that?” Because I cannot always remember.” (Nurse, NICU 1.)

In order to be effective, the assignments had to include cases specific to the NICU. Another group of nurses mentioned that nursing schools should improve the calculation training. One group of physicians suggested implementation of simulation training to improve calculation skills of both nurses and physicians.

Two of the focus groups involving physicians expressed their concerns that a high turnover of nurses threatened patient safety. One of the groups suggested setting higher requirements for applicants to recruit the most suitable nurses and implementing incentives to keep them in their jobs. As expressed by one of the physicians:

“So, a thorough selection of who’s coming in here [the NICU] and a very, very active retention policy, where you give some decent incentives to stay and not leave with the vast knowledge you have. It’s really, really important, because then you get that last feeling, the feeling that is our last barrier before the mistake happens ‘this cannot be right’.” (Physician, NICU 3.)

Communication
Effective and clear communication between physicians and nurses was viewed as a key factor to prevent MEs. Physicians in two of the groups felt that the workplace supported a blame-free culture, where frontline staff could openly discuss MEs and prevention strategies. Effective communication was mentioned as crucial in emergency situations by physicians and nurses from NICU 2. In emergency situations, closed-loop communication, where a medication is verbally prescribed by a physician and a nurse accepts, verifies and completes the medication administration, was mentioned to prevent administration errors.

“And always try to make closed-loops with medication. That is also a way to prevent [MEs].” (Physician, NICU 2.)

At the same unit, physicians and nurses described an acute medication chart including precalculated weight-based medication dosages of acute medications and its location near the bed of the patient in order to avoid communication errors. The medication chart was considered effective in preventing MEs by both groups.

Physicians’ communication skills in emergency situations were viewed as a barrier challenging medication safety among the physicians. Simulation training for physicians and nurses was suggested by this group to improve communication and collaboration skills.

The role of parents
Parents were considered as contributing to the safety of their child by most groups. Participants felt that the majority of parents had familiarized themselves with their child’s medication treatment and would make frontline staff aware of deviations involving medication dosages and remind nurses to administer medications on time. However, participants agreed that parents should not be held responsible for preventing MEs.

Hospital pharmacy services
Ready-to-use intravenous antibiotics prepared by the hospital pharmacy were delivered to one of the NICUs in the pharmacy opening hours from 7:30 a.m. to 03:00 p.m. Nurses generally considered intravenous antibiotics prepared by the pharmacy safer than medication preparation conducted by nurses and felt it decreased nurses’ workload and interruptions, because the double check was omitted for these medications.

Nurse 1: “It is nice that you can just go out and pick it up without having to worry about looking for someone to perform double check.” Nurse 2: “It saves us a lot of time. (...) I also think that it [ready-to-use intravenous antibiotics] is safer that way.” (Nurses, NICU 2.)

Medication preparation performed by hospital pharmacy staff as a future practice was generally considered safe and effective by physicians and nurses. However, nurses in one group expressed that they did not feel safe trusting unknown pharmacy staff to prepare medication to a particular
patient who the pharmacy staff would be unfamiliar with. Further, limited opening hours of the hospital pharmacy raised a concern, as 24-hour service was considered necessary to be effective.

Physicians from NICU 3 considered clinical pharmacists effective at improving medication safety. A clinical pharmacist had previously conducted medication reviews and reviewed the medication safety procedures at the unit, but the service was never implemented. Physicians suggested reinvesting in a clinical pharmacist to strengthen medication safety in the future.

Discussion

Nurses and physicians in our focus group interview study reported that MEs are a continuous challenge in NICUs, urging the need for improvement. Identified current medication safety practices needed to be optimized and new interventions were expected to enhance safety of medication prescribing, preparation and administration processes.

The existing practices for preventing MEs reported by all focus groups were double check of medications and nursing skills. Other frequently mentioned current practices included physician skills, calculation assignments including training in prescribing, preparation and administration of medications and ready-to-use medicines for acute situations.

Customized CPOE systems including CDS to NICUs, optimized double-check processes, interdisciplinary communication and training, and increased use of pharmacy services were considered to potentially improve prevention of MEs.

Double check of medications

The double-check process has previously been described as one of the most cost-effective safety tools for intravenous medications in a NICU setting. Our findings emphasize the importance of standardizing the procedure and training frontline staff on how to perform the double check in order to prevent MEs. After data collection, we discovered that one NICU did not have any standardized guideline on how to perform double-check, which may explain the reported variability. A standardized process of double-check preparation and administration of high-risk medications has recently been described by Kellett and colleagues. Also, nurses suggested the implementation of a fixed nurse situated in the medicine room who could assist in double checking to support timely medication administration, elimination of omissions and avoidance of interruptions. However, allocation of a nurse who is familiar with the patients’ clinical problems, including medication therapy and weight, is likely to improve medication safety even further.

Computerized physician order entry systems and barcode-assisted medication administration

Implementation of a CPOE system has previously been shown to reduce the number of potentially harmful MEs in hospitalized children. However, the effect of CPOE systems to reduce harmful MEs has not yet been demonstrated. A greater reduction in MEs is likely to be achieved in the NICU setting by implementing a CPOE system including CDS compared with CPOE systems without CDS.

Physicians from our study generally considered CPOE systems useful but felt that their local commercialized CPOE systems were suboptimal. Actions for redesigning and optimizing the CPOE systems, including exploiting the advantages of CDS should be taken, as poorly designed systems may introduce new risks. Suppliers should engage frontline physicians in the design and evaluation of CPOE systems with CDS to improve functions. Similar to our focus groups, others have recommended the use of paediatric-specific units for age and weight, minimizing the use of free text fields, introducing alerts involving drug interactions, allergies and dose-range checking, and automatic dose calculation, based on specified weight to optimize paediatric CPOE systems.

The effect of BCMA systems to decrease potentially harmful MEs and harmful MEs has previously been demonstrated. However, barriers to using the barcode scanning potentially involve time constraints, distractions from other tasks and faulty equipment, which should be addressed by managers to ensure safe use.

Experience, education and training for excellence in healthcare practice

Focus groups supported training of both new and experienced nurses and physicians to improve medication safety. Simulation training has previously demonstrated improvement of healthcare
professionals’ skills involving communication and team work.\footnote{30} None of the units had implemented simulation training. Implementation necessitates development of a curriculum, purchases of simulation equipment such as simulators and audio-visual systems, training of faculty and allocating space at the unit. Feasible paediatric simulation training systems exist and can potentially be adapted to the NICU setting.\footnote{31}

Our physicians considered a high turnover of nurses in the NICUs a threat to medication safety. Proposed solutions to keep nurses in NICUs involved recruitment of nurses best suited for the job and to offer incentives. Intensive care units, including NICUs, have the highest nurse turnover rate compared with other hospital units.\footnote{32} Turnovers are associated with a decreased quality in nursing care and an increase in costs.\footnote{33} Incentives to retain nurses in NICUs have been suggested by others but do not address the underlying cause of why nurses leave their jobs.\footnote{32}

**Clinical pharmacist involvement**

Physicians and nurses in our study considered medication preparation by hospital pharmacy staff and involvement of clinical pharmacists at the NICU as a potential benefit, although concerns were raised. Studies have previously described the important role and the cost effectiveness of clinical pharmacists in reducing MEs in children,\footnote{28,34,35} including neonates.\footnote{28,34,35} Interventions conducted by clinical pharmacists to reduce MEs in NICUs have previously involved training of nurses in medication preparation and administration and facilitating patient safety in a multidisciplinary collaboration.\footnote{34,35} However, clinical pharmacists are currently not involved in general in the medication treatment at the Danish NICUs and should receive training before involvement, as these units are highly specialized.

**Strengths and limitations**

Strengths of our study are the inclusion of both physicians and nurses in the focus groups and the national representation of three out of four Danish NICUs. However, our study also had potential limitations. In some of the groups, it was felt collaborative dynamics were poor due to informal hierarchy structures which may have suppressed opinions. We also experienced difficulties with facilitating positive discussions inspired by Safety II and Appreciative Inquiry, as some participants appeared to be challenged in discussing and reflecting on successful practices and potential improvement. A focus on malfunctioning practices may lead to missed opportunities to learn from and appreciate well-performing processes.\footnote{16,36} A tendency to focus on negative emotions and experiences may be part of human behaviour but may also represent an unmet need of debriefings and evaluations after experienced MEs in NICUs.\footnote{37}

**Implication for practices and future research**

Our findings support a multifaceted intervention involving technical and nontechnical elements to prevent MEs. The strategy may include the practices mentioned by participants and increased use of debriefings and evaluations after experiencing MEs, but could also involve educational strategies to prevent MEs, standardized concentrations of intravenous medications, smart infusion pumps, a prescribing checklist and multifaceted interventions targeting prescribing identified by others to improve medication safety.\footnote{35,38–41}

The feasibility of the interventions must be considered when implementing change. Since CPOE systems are already implemented in all the NICUs studied, further exploitation of implementing CDS seems advantageous. Training of frontline staff may also seem feasible, as one of the NICUs had already implemented an electronic training program which could possibly be adopted by other NICUs, as well. However, introducing new technologies such as barcode-assisted administration tools are associated with higher cost.

**Conclusion**

Our focus groups considered MEs in NICUs a continuous and complex challenge which needed to be further addressed. Physicians and nurses identified a multitude of practices to potentially improve medication safety in NICUs, including NICU-customized CPOE and CDS systems, BCMA, formalized medication double check, education, training, communication and clinical pharmacist involvement.

Interdisciplinary multifaceted interventions involving both technical and nontechnical elements should be designed and tested in close collaboration with frontline staff to support the missing evidence of strategies to prevent ME.
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Conflict of interest statement
The authors declare that there is no conflict of interest.

Supplementary material
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