



# Barriers and enablers for safe medication administration in adult and neonatal intensive care units mapped to the behaviour change wheel

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## Abstract

**Background:** Intensive care settings have high rates of medication administration errors. Medications are often administered by nurses and midwives using a specified process (the '5 rights'). Understanding where medication errors occur, the contributing factors and how best practice is delivered may assist in developing interventions to improve medication safety.

**Aims:** To identify medication administration errors and context specific barriers and enablers for best practice in an adult and a neonatal intensive care unit. Secondary aims were to identify intervention functions (through the Behaviour Change Wheel).

**Study Design:** A dual methods exploratory descriptive study was conducted (May to June 2021) in a mixed 56-bedded adult intensive care unit and a 6-bedded neonatal intensive care unit in Sydney, Australia.

Incident monitoring data were examined. Direct semi-covert observational medication administration audits using the 5 rights ( $n = 39$ ) were conducted. Brief interviews with patients, parents and nurses were conducted. Data were mapped to the Behaviour Change Wheel.

**Results:** No medication administration incidents were recorded. Audits ( $n = 3$ ) for the neonatal intensive care unit revealed no areas for improvement. Adult intensive care unit nurses ( $n = 36$ ) performed checks for the right medication 35 times (97%) and patient identity 25 times (69%). Sixteen administrations (44%) were interrupted. Four themes were synthesized from the interview data: Trust in the nursing profession; Availability of policies and procedures;

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Adherence to the '5 rights' and departmental culture; and Adequate staffing. The interventional functions most likely to bring about behaviour change were environmental restructuring, enablement, restrictions, education, persuasion and modelling.

**Conclusions:** This study reveals insights about the medication administration practices of nurses in intensive care. Although there were areas for improvement there was widespread awareness among nurses regarding their responsibilities to safely administer medications. Interview data indicated high levels of trust among patients and parents in the nurses.

**Relevance to clinical practice:** This novel study indicated that nurses in intensive care are aware of their responsibilities to safely administer medications. Mapping of contextual data to the Behaviour Change Wheel resulted in the identification of Intervention functions most likely to change medication administration practices in the adult intensive care setting that is environmental restructuring, enablement, restrictions, education, persuasion and modelling.

#### KEYWORDS

adult, intensive care units, medication errors, neonatal, nurses

## 1 | INTRODUCTION

Medication errors (MEs) have been reported to account for approximately one-quarter of all healthcare errors.<sup>1-4</sup> It is estimated that a third of harmful medication errors occur during preparation and administration<sup>5,6</sup> and 18.7%–56.0% of all adverse events among hospitalized patients result from preventable medication errors.<sup>7</sup> Underreporting affects the rate of medication administration errors (MAE); estimates range from 5% and 25% of administrations.<sup>8-12</sup> In Australia, MAEs are estimated to affect 9% of all medication administrations in hospital.<sup>10</sup> There are significant negative patient outcomes associated with MEs including extended hospital stay, increased mortality and long-term disability<sup>4,6,12</sup> and an estimated USD 42 billion annual impact on total global health expenditure.<sup>13</sup>

Medication administration within clinical settings, is a complex process presenting multiple opportunities for error.<sup>3</sup> Administration errors occur more often in areas where medications are administered frequently such as intensive care units (ICUs).<sup>14</sup> MAEs are the most common clinical error in ICUs with an average of 1.7 daily errors of which 78% are considered serious clinical errors.<sup>15</sup> In ICUs, MAEs are more likely to cause harm as patient acuity is high and patient often have altered mentation.<sup>14,16</sup> Paediatric and neonatal patients are three times more likely to be affected by MEs than adults.<sup>7</sup> Higher error rates are evident during the prescribing and administration stages.<sup>1,4</sup> The number and frequency of medications and weight-based dosages<sup>17,18</sup> and therapeutic range<sup>7</sup> impact the risk for MAEs.

Medication administration is normally performed by nurses and midwives using a specified process (e. g., the "5 rights"; right patient,

### What is known about the topic

- Medication administration within clinical settings, is a complex process presenting multiple opportunities for error.
- Medication administration errors are a common clinical error in intensive care units

### What this paper adds

- There was widespread awareness among nurses of their responsibilities to safely administer medications.
- Behaviour change wheel mapping revealed the intervention functions most likely to change behaviour in the adult intensive care setting were environmental restructuring, enablement, restrictions, education, persuasion and modelling.
- This novel study indicated that nurses in intensive care are aware of their responsibilities to safely administer medications. Mapping of contextual data to the Behaviour Change Wheel resulted in the identification of Intervention functions most likely to change medication administration practices in the adult intensive care setting that is environmental restructuring, enablement, restrictions, education, persuasion and modelling.

drug, dose, time and route<sup>9</sup>). Many factors may negatively impact on this process such as simultaneous demands and interruptions,<sup>6</sup> procedural omissions, lack of clinician experience<sup>19</sup> and system factors.<sup>18</sup> The impact of many factors is context specific. Uniform interventions to improve practice and prevent MAEs have shown to be partially effective.<sup>2,3,19</sup> This is not surprising because practice change approaches which fail to consider the unique enablers and barriers for each context have limited effectiveness.<sup>20,21</sup> Approaches which include an assessment of the capability, opportunity and motivation of clinicians and behaviours needed to produce change have revealed effective interventions resulting in improved adoption of best practice.<sup>22</sup> One such method, which has shown promise is mapping the context using the Capability, Opportunity and Motivation Model of Behaviour (COM-B) and Behaviour Change Wheel (BCW).<sup>23</sup>

The BCW, was informed by a synthesis of 19 frameworks of behaviour change, focused on the COM-B model of behaviour. It has demonstrated reliability in healthcare settings for assessing the context and capability, opportunity and motivation of clinicians and behaviours needed to effect change and develop effective interventions resulting in improved practice.<sup>22,23</sup> Barriers and facilitators are mapped using the Theoretical Domains Framework (TDF).<sup>24–26</sup> Furthermore, COM-B approaches have been used to develop interventions to address medication errors,<sup>27</sup> medication management in the setting of multiple co-morbidity<sup>28</sup> and medication prescribing.<sup>29</sup>

Despite extensive global efforts to enhance medication safety by reporting, evaluating and preventing errors, associated patient adverse events remain high in health care settings seriously compromising patient safety.<sup>30</sup> Many strategies have been evaluated but few have achieved sustainable reductions in MAEs.<sup>5,31</sup> Understanding where medication errors occur, the contributing factors and how best practice is delivered may assist in identifying interventions to improve medication safety.

## 1.1 | Aims

The primary aim of this research was to identify MAEs and any context specific barriers and enablers for best practice in an AICU and a NICU. Further and importantly the secondary aims were to map contextual data to the assessment of the COM-B and BCW<sup>23</sup> in each setting and highlight intervention functions, which could contribute to the design of behavioural change interventions to improve medication administration.

## 2 | DESIGN AND METHODS

### 2.1 | Design

A dual methods exploratory descriptive study was conducted using audits (direct non-participatory observation) and brief interviews with patients, parents and nurses from 11 May to 30 June 2021.

### 2.2 | Setting and sample

The study was conducted in an adult ICU (AICU) and neonatal ICU (NICU) of a 600-bedded tertiary referral hospital in Sydney, Australia which provided a range of specialist services for adults such as neurosurgery, spinal injury, burns and trauma. The AICU was a mixed 56-bedded unit comprising four pods; neurosurgical, cardiothoracic and two general. An intensivist was responsible for patients' treatment with input from other medical specialities. Patients were cared for by registered nurses with a nurse-to-patient ratio of 1:1 for mechanically ventilated and 1:2 or 1:3 for high dependency patients. A total of 260 nurses (230 full-time equivalent positions) worked in the AICU. A pharmacist and other allied health professionals provided input. Patients were cared for in single occupancy rooms.

The NICU was a 6-bedded level 5 unit. A level 5 unit provides comprehensive neonatal care, excluding complex surgical, cardiac and metabolic services, intensive care for critically ill newborns (e.g., ventilation, total parenteral nutrition, exchange transfusion), and the provision of the full range of respiratory support and provision of neonatal care for babies across the state of New South Wales.<sup>32</sup> A total of 105 nurses (approx. 96 full time equivalent positions) worked in the NICU. The neonatal service provided critical care treatments such as mechanical ventilation. Babies requiring more complex care were transferred to specialist paediatric hospitals. Babies were managed by a neonatologist with input from other specialities. Patients were cared for by registered nurses with a nurse-to-patient ratio of 1:1 for mechanically ventilated babies with allied health professional input. The NICU was an open plan except for three single occupancy closed isolation rooms. Policy in both settings dictated that intravenous medications were double checked by two registered nurses and administered according to the 5 rights.

### 2.3 | Data collection tools and methods

#### 2.3.1 | Incident Monitoring System data

In the study site, an New South Wales (NSW) Health public facility, employees were required to report all 'near misses' and adverse events affecting patients via the online NSW Health Incident Monitoring System (IMS+). This system ensured timely management of incidents using a pre-determined standardized procedure and the IMS+ database was a repository for incident data. The data custodian, the Northern Sydney Local Health District (NSLHD) Clinical Governance Unit provided de-identified aggregated IMS+ data for the 12 months prior to the study.

#### 2.3.2 | Audits

The staff in each unit were informed of the timeframe in which the audit was to be conducted. Nurses were informed that aim was to

observe intravenous catheter practices. Nurses were informed that they could opt out. Audits were observations of medication administration requiring two person checking such as intravenous and controlled medications. A structured paper-based medication audit form focused on the '5 rights' (correct checking of medication, route, patient, dose and time) was used ([supplementary file 1](#)). Observations were performed during 2-h periods during peak medication administration times including, 0730-0930 and 2000-2230 h by one investigator. Audits for the two sites did not necessarily occur simultaneously. Investigators recorded details of the medications from the electronic medical record. This involved shadowing nurses physically close enough to hear, for example, whether the nurse checked the medication label. When the researcher could not hear or see evidence of checking using the 5 rights this was recorded as 'not heard' and incorrect. Contextual factors, which could potentially contribute to MAEs were recorded.

### 2.3.3 | Brief interviews

Adult patients treated in AICU were age >18 years old, treated in ICU >24 h for any condition, conscious and able to communicate verbally in English language with sufficient cognitive acumen to understand the study details, and expected to live >24 h were invited. The selection criteria for parents of babies treated in the NICU and expected to live >24 h were similar. Patients in AICU and parents in NICU were approached at the bedside to participate by the researcher after first checking with the nurse responsible. Selection criteria for nurses were that they were permanently employed as a registered nurse working in AICU or NICU. Nurses were invited via advertisements in workplace communications. All potential participants were informed that participation was completely voluntary.

Brief semi-structured interviews were used to elucidate the patient experience of medication administration in AICU and the parent's experience of observing medication administration to their baby in the NICU. Patients were asked to describe a recent time in which a nurse administered a medication in which they felt safe. Parents of NICU babies were asked to describe the details in a recent time, in which they witnessed the administration of a medication to their baby.

Semi-structured interviews were used to elucidate the nurses' understanding of medication administration according to NSW Health policy and best practice, and future possibilities for best practice. Interviews were conducted in the patient's room or in a private office for parents of NICU babies and nurses. Investigators recorded the interview on a digital recorder and transcribed the content verbatim without identifiable information.

Data collectors were three critical care nurses with post graduate critical care nursing qualifications including two with more than 20 years of critical care experience. The less experienced nurse and one experienced nurse worked clinically in the AICU at the time of the study but not during data collection.

#### Understand the behaviour

1. Define the problem in behavioural terms
2. Select the target behaviour(s) most likely to address the problem
3. Specify the target behaviour

#### Identify intervention options

##### Who /What /When /Where /How

4. Identify what needs to change to achieve target behaviour
5. Identify appropriate intervention functions
6. Identify policy categories

#### Identify content and implementation options

7. Identifying behaviours change techniques
8. Determine mode of delivery

**FIGURE 1** Steps in the process of mapping to the Capability Opportunity Motivation-Behaviour Behaviour Change Wheel (COM-B and BCW).

### 2.4 | Data analysis

Descriptive statistics were used to describe the sample of patients for whom the audit was performed. The percentage of correctly checked 'rights' was calculated using the total number of medication administrations (observations) as the denominator. Qualitative content analysis<sup>33</sup> was performed for interview data by two investigators (a very experienced and less experienced critical care nurse). These investigators immersed themselves in the data (re-read), identified units of meaning, condensed and coded the data before categorizing and theming the interview data. A third investigator (experienced critical care nurse) reviewed the themes. Appreciative inquiry<sup>34</sup> was the lens through which the analysis was performed. Briefly, this approach has origins in positive psychology and builds on perceived strengths of individuals and systems to affect change.<sup>34</sup> All study data were mapped to the COM-B and BCW for the AICU setting as there were insufficient data for the NICU. Guided by the BCW, we identified intervention functions of particular relevance using the affordability, practicality, effectiveness, acceptability, side effects and equity (APEASE) criteria.<sup>35</sup> Figure 1 contains an outline of the steps in the process.

### 2.5 | Ethical considerations

Ethical approval to conduct the study was received from the NSLHD Human Research Ethics Committee (reference number: 2020/ETH03068). A waiver for informed consent was provided for the audit. However, written informed consent was obtained from all participants who undertook interviews. Participants were informed about the voluntary nature of the study. A protocol was available for the investigators should they have witnessed potentially dangerous practice. This did not occur.

The risk of social desirability bias was reduced using semi-covert observation. The ethical considerations of this were considered such

**TABLE 1** Audit results adult intensive care unit ( $n = 36$ ).

'Right' number	Descriptor		Correctly checked, n (%)
1	Patient identity (hospital ID band)	Nurse 1	33 (92)
		Nurse 2	27 (69)
	Patient identity medication chart	Nurse 1	34 (94)
		Nurse 2	30 (83)
	<b>Both ID<sup>a</sup> patient and medication chart</b>	<b>Nurse 1 and 2</b>	<b>25 (69)</b>
2	Medication	Nurse 1	35 (97)
		Nurse 2	35 (97)
		<b>Nurse 1 and 2</b>	<b>35 (97)</b>
3	Frequency	Nurse 1	28 (78)
		Nurse 2	23 (64)
		<b>Nurse 1 and 2</b>	<b>21 (58)</b>
4	Dose <sup>b</sup>	Nurse 1	24 (67)
		Nurse 2	17 (47)
		<b>Nurse 1 and 2</b>	<b>19 (53)</b>
5	Route	Nurse 1	35 (97)
		Nurse 2	6 (16)
		<b>Nurse 1 and 2</b>	<b>21 (58)</b>

Note: only recorded as correct if heard by investigators, <sup>a</sup> identity, <sup>b</sup> includes dilution, volume and calculation.

as the deliberately misleading participants. To counter this a practice associated with the focus of the audit (central venous catheter care), was selected as an explanation for our presence. This was selected to mitigate the potential ethical concern associated with misleading participants. Participants knew they were being observed and that their practice was the focus of observations. This was approved by the Human Research Ethics Committee.

### 3 | RESULTS

#### 3.1 | Incident monitoring system data

No medication administration incidents were recorded in the IMS+ for the 12 months prior to the study in either of the study settings.

#### 3.2 | Audits

Thirty-nine structured semi-covert audits were conducted in which nurses were observed preparing and administering medications in the AICU ( $n = 36$ ) and NICU ( $n = 3$ ). The audit for each medication administration took less than 10 min.

The AICU patients for whom medications were administered were predominately male ( $n = 29$ ; 80.5%). Mean (standard deviation) age was 64.5 (19.6) years. Two of the three NICU babies were male (ages were 10, 14 and 44 days).

The results for the audit in the AICU revealed high adherence for checking for some 'rights' but not perfect compliance. The right most

frequently double checked was the correct medication (35, 97%) and the right least frequently double checked was the medication dose (19, 53%) (Table 1). Nurses double checked the patient's identity on 25 (69%) occasions. It took the nurse more than 2 min to find another nurse to perform the medication double check on 5 (14%) occasions. Nurses were interrupted while performing the medication check on 16 (44%) occasions. Interruptions included questions from the medical team, university student facilitator and physiotherapist, and responding to patient needs.

Few intravenous medications were prescribed in the NICU on the days on which the researchers could attend for audits. In addition, during the study period, increased infection control and prevention restrictions limiting 'unnecessary access to clinical areas' were instigated in the study health facility in response to a 'COVID-19 infection wave' in the community curtailing our attempts to conduct additional observational periods. (This affected data collection in the AICU to a lesser extent as there were more opportunities to observe IV medication administration.) For the medications that were administered the audit data collected in the NICU revealed 100% compliance in all aspects of the '5 rights' with no delay in finding another nurse to perform the '5 rights' checks and no interruptions during the checking process.

#### 3.3 | Brief interviews

Three interviews with AICU patients, three interviews with parents of NICU babies and six interviews with nurses were conducted. Data saturation was evident for each distinct participant group. The duration of each interview was <10 min.

### 3.3.1 | Patient and parent participant interviews

#### Theme: Trust in the nursing profession.

The overarching theme from the AICU patient interviews was trust in the nursing profession, the hospital process and medical staff. For example,

*'The nurse was very professional. She's a registered nurse, so she's thoroughly and competently trained. And exhibits a high level of expertise.'* (Patient 2 [AICU]) and,

*'Trust in the nurse, not necessarily what they said or did, it was my trust in them that led me to take the medication without a hitch.'* (Patient 4 [AICU]).

The same participant highlighted that their favourable view of the hospital based on past experiences also contributed to their perceptions of medication safety, *'I trust this hospital implicitly and the medical staff, so I think a history of getting it right and a history of performance at a level which it has gained my trust.'*

Like the patient participants for the AICU, the three parent interviews in the NICU, revealed that trust in the nursing profession was a key theme. For example,

*'Being in the medical field or any profession, you are trained and you go through a certain amount of training and I guess, as myself being a teacher I know that, I hope parents trust me in the field that I'm in just like I trust the nurses that they've been trained and given the right amount of education to be able to look after my daughter.'* (Parent 3 [NICU]).

Parents in the NICU highlighted the thorough checking procedure in which two nurses cross checked all '5 rights'. For example, *'They not only cross checked with making sure it's the correct patient, their ID number, the right dose according to their weight, it was done safely every time.'* (Parent 1 [NICU]).

### 3.3.2 | Nurse participant interviews

Interviews with the two specialities of intensive care nurses revealed three themes.

#### Theme: Availability of policies and procedures

Nurses cited access and adherence to policies, protocols and guidelines as key enablers of medication administration safety. This was highlighted by nurse 6 (AICU). *'[Medication safety is enhanced by] having easily accessible policies and regular updates and reminders on what the policies and procedures are'*, and emphasized by nurse 5 (NICU),

*'Our [medication] protocols are updated regularly, ... And the fact that it breaks down exactly how to make it up and what it is compatible with. So, I guess, in the same*

*way we don't tolerate people doing half of the medication without a second nurse, we don't tolerate people not checking the protocol before they administer it, even if they are very familiar with it.'*

Access and availability of resources such as computers was identified as key enabler or barrier to facilitate best practice. For example, nurse 1 (AICU) stated,

*'Availability of resources, whether that be through the injectables manuals or through having computers readily available definitely assists us provide medications guided by NSW Health policy and best practise.'*

and nurse 2 (AICU) *'... having bedside computers is really helpful as well, especially when you are really busy. You can just bring it up (policies) and do it together.'*

#### Theme: Adherence to the '5 rights' and departmental culture

Adherence to all '5 rights' was identified as having a positive influence that made medication administration safe. Nurse 4 (NICU) remarked, *'We are really good at checking our medication chart with our 5 rights'*, and nurse 2 (AICU),

*'In Intensive Care we follow the 'five rights' of medication in accordance with NSW Health policy and also follow protocols regarding therapeutic goods administration and the guidelines set by both MIMs [online medicine information platform] and CIAP [online clinical information resources], in identifying medications and potential adverse interactions'.*

Departmental culture, routines, behaviours, and attitudes were reoccurring topics for key actions, enablers, and barriers contributing to best medication practice. This was particularly evident among the NICU nurses,

*'...So, every single medication is administered specifically the way its instructed, but they are all administered exactly the same way, ... We have a complete intolerance of someone doing IV medications by themselves and just getting a tick box check by another nurse. Every single time the medications are prepared by two people. And every single component of it is checked by both people. We don't tolerate any deviation from that'* nurse 5 (NICU).

### 3.3.3 | Culture was identified as a key determinant of safe medication practice

*'If you've got a team that its common practise to practise according to the policies, then I think that promotes individual practice. A barrier is a complacent team culture. I think particularly in ICU because it's so acute and we do so many drug administrations I do think we are more*



complacent than my experiences on the ward with drug administration'. nurse 6 (AICU).

### Theme: Adequate Staffing

Adequate staffing was highlighted by nurses as a mechanism to enable safe medication administration practices. For example, nurse 2 (AICU), reflected on an occasion when they were able to administer medication according to best practice,

*'There was adequate staffing at the time to cover my patient who couldn't be left alone so I was able to access the medication and supplies that I needed in a timely manner, and then we were able to check it together. When I was making it, I was uninterrupted and was able to follow the process through from start to finish'.*

In contrast nurse 2 (AICU), noted an occasion when this was not possible,

*'There have been so many times when there is literally no one who can come to the Pyxis [Medication store] with you for an S8, to do a count. And so, you have to have one person watch your patient while you write it up and then you do a swap, and then they go and do the count as well and that's technically not legal but that's all you can do'.*

Notes: an S8 refers to a schedule 8 substance often labelled a 'controlled drug'. These are medications that may only be dispensed with a prescription and are prepared and administered under tight restrictions because of their potential for producing addiction.

Conversely NICU nurses did not, perceive time pressures to be as pressing as their perceptions of staffing were adequate. For example,

*'Protective factors are the fact that we are doing it without time pressure on us'. and '...having well-staffed units helps with timeliness and allows you to do things with less rush'. (Nurse 5 [NICU]).*

Environmental factors such as a quiet workspace without interruptions were identified as key to safe medication administration. For example, *'It helps me to have a quiet atmosphere (Nurse 4 [NICU]).* Nurse 1 (AICU) highlighted the need to eliminate interruptions, *'...ensuring that interruptions to medical personnel or nurses aren't present'.*

### 3.4 | Data mapping to the COM-B and BCW

Data collected for the NICU revealed a 100% adherence to the 5 rights and no apparent need for change. Therefore, only data collected for the AICU was mapped to the COM-B and BCW. [Supplementary file 2](#) contains a table outlining the application of the

**TABLE 2** Step 2 of the COM-B and BCW mapping process (selection of the target behaviour(s) most likely to address the problem).

COM-B component	What needs to happen for change to occur?	Is there a need for change?
Physical capability	Most nurses have the skills necessary to administer medications safely	No change needed
Psychological capability	Nurses' awareness that medication administration errors are an outcome of not checking 5 rights	Change needed
Physical opportunity	Nurses check medication according to policy and observe their patient Nurses do not allow interruptions during the checking and administration of medications	Change needed Change needed
Social opportunity	Nurses adhere to all aspects of policy (and do not omit double checking)	Change needed
Reflective motivation	Nurses view double checking according to the 5 rights as a priority	No change needed
Automatic motivation	Nurses may need to develop new routine habits for medication checking and administration	Change may be needed (dependent on change to behaviours above)

Abbreviation: COM-B, Capability Opportunity Motivation-Behaviour model.

TPB to understand barriers and facilitators for safe medication administration applied to nurses in the AICU (step 1). Building on this we completed step 2 of the COM-B and BCW mapping process (selection of target behaviours) which are outlined in [Table 2](#).

Further mapping was performed to specify the target behaviours in detail (i.e., step 3 of the COM-B and BCW). Thus 5 target behaviours were identified ([Table 3](#)). Step 4 identified what needed to change to achieve the target behaviour ([Figure 2](#)).

The intervention functions likely to contribute most strongly to bringing about behaviour change identified from this analysis (in order of priority) were environmental restructuring, enablement, restrictions, education, persuasion and modelling. [Supplementary file 3](#) contains a table outlining step 5 of the COM-B and BCW mapping and the rationale for intervention function selection.

## 4 | DISCUSSION

In this study we found a high level of adherence to the 5 rights of medication administration among nurses working in NICU but areas

**TABLE 3** Specifying the target behaviours in detail.

Behaviour	Who	What	When	Where	How
Nurses' awareness that medication administration errors are an outcome of not checking 5 rights	Nurses In relation to interruption, also: Allied health professionals Medical team	Awareness campaign	During group handover and pop up reminders in electronic medical record while validating medication administration	Existing ICU communication methods	ICU newsletter Facebook page Role modelling by champion nurses
Nurses check medication according to policy and observe their patient	Nurses Nurse managers	Availability of nurse checker(s)	Peak medication administration times	ICU bedside	Liaise with nurse managers
No interruptions during the checking and administration of medications	Nurses Allied Health Medical team	Awareness campaign and 'protected medication administration'	During medication administration	ICU medication dispensing area and bedside	Liaise with AICU leadership/managers Visible signage around ICU medication dispensing area ICU newsletter
Nurses adhere to all aspects of policy (& do not omit double checking) Legal and evidence base for double checking some medications is found to be absent	Nurses (potentially medical team) Nursing leadership	Nurses on shift self-identify if workload is lighter than others & able to assist with checking Evidence base and legal requirements	During medication administration	ICU medication dispensing area and bedside	ICU newsletter Facebook page Role modelling by champion nurses Check with clinical governance Search peer-reviewed journals
Nurses may need to develop new routine habits for medication checking and administration	Nurses (potentially all other members of the multidisciplinary team)	Suggestions to be obtained from team of nurses	During medication administration	ICU medication dispensing area and bedside	ICU newsletter Facebook page Role modelling by champion nurses

Abbreviation: ICU, intensive care unit.

for improvement for some of the 5 rights for nurses working in AICU. For the AICU nurses, the most frequently double-checked right was the correct medication and the right least frequently double checked was the dose. Nurses double checked the patient's identity less than three-quarters of the time. More than 40% of medication administrations were interrupted. During interviews AICU patient and NICU parent participants expressed their trust in the nurses to administer medications safely. The brief interviews with nurses revealed a high level of awareness of their role and responsibilities in relation to medication administration. Nurses highlighted the availability of policies and procedures, adherence to the 5 rights and departmental culture and staffing resources. Mapping of all the study data to the COM-B and BCW revealed that the intervention functions, environmental restructuring, enablement, restrictions, education, persuasion and modelling were most likely to bring about behaviour change.

The findings for the NICU setting were somewhat surprising and contrast with reports in the international literature, which has highlighted errors in administration e.g., omissions and dosage<sup>36</sup> and time<sup>4</sup> and route<sup>37</sup> indicating that adherence to the 5 rights may be deficient. We acknowledge that our audit findings were limited by the relatively small number of observations on which they were based. However, the brief interviews with NICU parent and nurse participants suggested that the culture within this NICU was characterized by a high level of accountability among nurses and intolerance of deviating from the 5 rights. Parent participants stated that they trusted the nurses. The absence of ME data for the NICU in the incident monitoring system (recognizing that this was dependent on clinicians reporting errors) also indicates the culture within this NICU supported exemplary practice.

The findings for the AICU reflect relatively high adherence to checking the identity of the patient and medication. This was similar



- 1. Nurses' awareness that medication administration errors are an outcome of not checking 5 rights**
  - Change in perception about risks of not checking 5 rights
- 2. Nurses check medication according to policy and observe their patient**
  - Increased availability of nurses to perform medication checks
- 3. Nurses do not allow interruptions during the checking and administration of medications**
  - Other members of the Multidisciplinary Team (MDT) do not approach nurses while they are checking and administering medications
- 4. Nurse adhere to all aspects of policy (& do not omit double checking)**
  - Nurses decline to validate (sign) if 5 rights not checked
  - Availability of nurses to check medications
- 4.a. Legal and evidence base for double checking some medications is found to be absent**
  - New evidence and the law supports single nurse checks
- 5. Nurses may need to develop new routine habits for medication checking and administration**
  - New regimen suggested by nurses in the AICU and all members of the MDT respect this

**FIGURE 2** Target behaviours and what needed to change to achieve the target behaviour.

in other studies in which administering an incorrect medication was infrequent.<sup>4</sup> The frequency of interruptions was high (>40% of administrations) but reflects the experience of other researchers studying this in ICU (47%).<sup>38</sup> Interestingly there was a high adherence to double checking patient identity (69%) when compared to adherence (42%) of nurses in a smaller AICU with similar characteristics in the same country.<sup>38</sup> There was concordance between the audit and semi-structured interview findings. Trust was the overarching theme synthesized from brief patient interviews. Patients were assured that nurses were highly educated and observed the nurses' sense of accountability. This was reflected by nurse interview participants who appeared cognizant of the need for thorough checking and adherence to policy.

There may have been cultural practice differences between the NICU and ACU in relation to double checking. Observations and interviews with parents were suggestive that NICU nurses independently checked medications; thus, there were high levels of adherence as both nurses were cognizant of this requirement. In the AICU it is possible that the nurse requested to check by the nurse administering the medication may have been more 'relaxed' taking the attitude that the other was checking more thoroughly (and vice versa). There is no evidence that independent double checking affords any safety advantage; however, choosing to double check when it is not mandated appears to be associated with fewer MAEs.<sup>39</sup>

Although many of the findings of this study are not unique, this study is to our knowledge the first to have mapped observational audit medication administration data and health care recipients'

and nurses' perceptions about medication administration safety in an ICU setting to the COM-B and BCW. Thus, we were able to suggest interventional functions, which are highly likely to change clinician behaviour. These in order of priority were environmental restructuring, enablement, restrictions, education, persuasion and modelling. Environmental restructuring which focuses on changing work conditions is closely linked to enablement (e.g., use of bar code technology<sup>40,41</sup>). This is considered to be more effective at sustaining change in the target behaviour than education alone which has been shown to improve practices only in the short term.<sup>42</sup> Enablement enhances self-efficacy and positivity towards the target behaviour and has been shown to be an effective intervention function.<sup>43</sup> Restrictions such as 'mandating' that other members of the MDT do not interrupt nurses while they administer medications, may be effective at enhancing the target behaviour but may need careful implementation so as not to offend or increase negative emotions towards the target behaviour. Persuasion and modelling are widely used in health care to encourage adoption of innovations and establish best practice 'norms' which may be effective in enhancing culture and preventing MAEs.<sup>44</sup>

#### 4.1 | Recommendations for further research

Further research is required to investigate the effectiveness of double medication checks; at present the evidence is equivocal for independent and double checking.<sup>5</sup> Thus, the difficulty associated with locating a nurse colleague to check medications would be avoided and may

reduce the likelihood of interruptions. Also, the audits focused only on the health care personnel not on the system. Additionally, the role of human error and the system must be acknowledged and mitigated. There are according to James Reason two categories of health care errors: active failures (a lack of/misapplication knowledge/lapses/human error and overt violations) and latent conditions (system design and the working environment).<sup>45</sup> The 5 rights of medication checking process may prevent errors but is not protective against latent conditions and lapses (human error). Robust systems such as existing technologies for example bar code technology could address at least two of the 5 rights and mitigate human error. These technologies warrant exploration in the intensive care settings.

## 4.2 | Strengths and limitations

There were a number of strengths of this study namely the multimodal data collection approach, consumer involvement<sup>46</sup> and data interpretation using the COM-B and BCW. The multimodal data collection approach included real-world observations, interviews to gain the perspectives of individuals who were the subject of the practice and those practicing and examination of incident data. Observational audits are understood to be best practice in relation to identifying key areas for the improvement for medication administration.<sup>47</sup> The rigour was further enhanced by using semi-covert observation so social desirability was less likely to have biased the findings. In addition, the interpretation of the data mapping to the COM-B and BCW allowed the identification of intervention functions which were most likely to positively affect target behaviours.

The findings of the study must be interpreted with caution as they are highly contextual but also limited by the small number of observational audits (particularly for NICU) and interviews (although data saturation was evident). Medication administration may have been less thorough if there were more to administer during the study period. The findings are therefore not generalizable but the novel approach to exploring medication administration and finding effective intervention functions could be adopted by others wishing to improve this practice.

The study was somewhat stymied by the COVID-19 pandemic; however, our intention is to present the mapping of the intervention functions to the nurses working in the AICU and work together to reach consensus about the selection of behavioural change techniques. For example, behavioural change techniques such as restructuring the social environment to reduce the frequency that nurses are interrupted might include presentation of the study data by nursing leadership to the entire MDT to request them to avoid interrupting nurses during medication administration. Likewise including visual prompts and cues may be useful stimuli to enhance best practice.

## 5 | CONCLUSIONS

This novel exploratory descriptive study provides valuable insights about the medication administration practices of nurses in a NICU

and an AICU setting in Australia. Although there was evidence of areas for improvement regarding adherence to the 5 rights and double checking in the AICU there was widespread awareness among nurses of their responsibilities to safely administer medications. Interview data indicated high levels of trust among AICU patients and NICU parents in the nurses. COM-B and BCW mapping revealed the intervention functions most likely to change behaviour in the AICU setting were environmental restructuring, enablement, restrictions, education, persuasion and modelling.

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### CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest in relation to the conduct and reporting of this study.

### DATA AVAILABILITY STATEMENT

Research data are not shared.

### ETHICS STATEMENT

Ethical and governance approval was provided by the Northern Sydney Local Health District Human Research Ethics Committee. (Ref no.: 2020/ETH03068: Reducing medication administration errors using the behaviour change wheel: the ReMAde project).

Patient consent statement: Participants gave written informed consent to be interviewed. Semi-covert observation was performed for the medication administration audits (participants were aware that they were being observed, but not the exact focus of the observation).

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#### SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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