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Nurses' knowledge and implementation of antimicrobial stewardship and infection prevention strategies in acute paediatric settings

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SUMMARY

Background: Nurses are the first point of contact for patients and are responsible for monitoring and reporting signs of infection. The COVID-19 pandemic cemented nurses' leadership role in infection prevention. Despite this, nurses' contribution to antimicrobial stewardship initiatives remains under-recognized.

Aim: To determine how paediatric nurses understood their role and contribution to antimicrobial stewardship and infection prevention and control practices in three different acute paediatric wards.

Methods: Forty-three nurses were recruited from an adolescent ward, an oncology ward, and a surgical ward in a metropolitan tertiary children's hospital for a qualitative exploratory descriptive study.

Findings: Thematic and content analysis derived three themes from the data: understanding of preventable infections; embracing evidence-based guidelines to protect the patient; and roles in preventing and controlling infections and antimicrobial stewardship. Associated subthemes were: desensitized to COVID-19; understanding infection prevention and control precautions; correct use of hospital policy and guidelines; restrictions associated with the use of electronic medical records; understanding of sepsis management and the importance of timely microbiological testing; ambivalence on antimicrobial stewardship roles; and high priority placed on consumer education.

Conclusion: Nurses' understanding of their role focused on practices such as performing hand hygiene, standard precautions, and reporting the use of high-risk antimicrobials. A lack of understanding of paediatric COVID-19 transmission and presentations was also

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reported. Education on best practice in infection prevention and AMS was recognized as crucial for both nurses and parents.

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Introduction

In the context of the COVID-19 pandemic, the threat of antimicrobial resistance continues to pose a risk to the human population [1]. Antimicrobial stewardship (AMS) is a comprehensive, multidisciplinary approach to ensuring that patients receive appropriate and safe antimicrobial treatment [2]. During the COVID-19 pandemic, nurses were instrumental in managing patients with COVID-19 infection, and the key role nurses perform in infection prevention and management is now well recognized [3,4]. In contrast, nurses' contribution to AMS has been under-recognized and organizational barriers may inhibit their involvement [5–8]. The COVID-19 pandemic has highlighted the power and potential of nurse leaders, and the approaches implemented during the pandemic may strengthen AMS in the post-pandemic era [2,9].

Healthcare organizations worldwide have policies in place to support and encourage the implementation of AMS programmes and promote active involvement by all clinicians [10–12]. In 2017, the American Nurses Association released a white paper that identified ways in which nurses can positively impact patient outcomes through engagement in AMS programmes [13]. Initiatives by the Australian Commission for Quality and Safety in Health Care have aimed to address gaps in clinicians' understanding of their role in infection prevention and control (IPC) and AMS by providing a clearly defined clinical governance framework [14]. In addition, the National Safety and Quality Health Service Standards define how healthcare consumers can contribute by being actively involved in treatment decision-making [15].

The aim of this study was to determine how paediatric nurses understand their role and contribution to AMS initiatives and IPC practices in three different paediatric inpatient environments.

Methods

Design

A qualitative descriptive method was used to obtain semi-structured interview data from paediatric nurses.

Study site

Participants were recruited from three different settings: an adolescent, a surgical, and an oncology ward at an Australian metropolitan tertiary hospital. The oncology/haematology service provided care to immunosuppressed children that may require specialized and intensive antimicrobial regimens. The adolescent service delivered long-term care to children with chronic respiratory conditions such as cystic fibrosis. Finally, the surgical setting provided the opportunity to

explore nurses' role in AMS, focusing on surgical antimicrobial prophylaxis and perioperative IPC measures.

The study site had recently introduced an electronic medical record (EMR) system, with all administrations and prescriptions of antimicrobials recorded in the EMR. Additionally, the AMS programme placed considerable emphasis on a traffic light system, which is used to flag high-risk antimicrobials that required additional authorization prior to use. The levels of restriction are represented as: red for 'reserve or restricted use', amber for 'watch' relating to antimicrobials with the greatest risk of toxicity or potential for resistance to develop, and green for 'access' which includes low-risk narrow-spectrum antimicrobials that can be administered prior to obtaining pathogen culture and sensitivity results [16].

Participants

Procedure

Nurse unit managers received information about the study at their monthly meeting, and an information flyer was placed on staff noticeboards inviting staff to participate. Interested parties were invited to one of several scheduled focus groups at the study site. All focus groups were conducted by a female registered nurse with paediatric nursing experience and experience in conducting interviews. Focus groups were audio-recorded with the permission of participants. All participants were provided a plain language statement outlining the research purpose and gave written consent before focus group commencement. To protect participant's identities, only minimal information was collected, and participants were assigned anonymous study numbers. No field notes or any other data sources were collected.

Materials

All participants provided information on their gender, age, qualifications, continuous years of practice since graduation, and paediatric nursing specialty. Participants were asked 'What are the key aspects of infection prevention and control that nurses and parents need to know?' and 'What is the role of nurses in ensuring optimal use of antibiotics?'

Ethics

This study was approved by the university and healthcare facility ethics committees. The data were confidential but not anonymous as participants were seen by the interviewer. No identifying information was collected, and if names were inadvertently used by participants they were not transcribed.

Ethics approval was granted by Deakin University Human Research Ethics Committee (2021-319). This project was also approved by Monash Health (RES-21-0000-375L). Informed written consent to participate was obtained from all participants.

Data analysis

All focus groups were transcribed using the Otter.ai v3.14.0 program. The accuracy of transcriptions was checked by a researcher (M.K.) against recordings. Thematic and content analysis was used to identify themes and patterns within the data, frequently used in naturalistic inquiry [17]. Transcripts were examined line by line, and the data were sorted and segmented into common themes, patterns, and categories. The second stage of data analysis included re-examining the pre-grouped categories to identify emerging themes. Data were coded and categorized, and key themes were identified by two researchers (M.K., A.H.), with a third one independently checking the accuracy of the coding and theme identification (S.B.). The study was conducted by paediatric clinicians and experts in IPC, adding rigour to the analysis by obtaining input from experts in the field. The consolidated criteria for reporting qualitative research (COREQ) were followed in the planning and execution of this study to ensure methodological integrity (Supplementary Appendix A1) [18].

Results

A non-probability voluntary sample of 43 paediatric registered and endorsed enrolled nurses was recruited from the workforce of a metropolitan children's hospital. Forty-two participants were female, and 40 were registered nurses. The mean age of all participants was 31 years (SD: 8.5). Academic qualifications of the participants ranged from diploma to masters degree, with almost a third of the sample (32.6%) holding a postgraduate diploma. Most participants had been qualified between 0.5 and 6 years (mean: 8.4 years). Participant recruitment was stopped as soon as theoretical saturation of the data had been achieved.

The focus groups lasted between 20 and 40 min. All 43 study participants discussed the key elements of preventing and controlling infections utilized on their wards. The themes derived from focus groups were: (1) understanding of preventable infections; (2) embracing evidence-based guidelines

Table 1
Identified themes and subthemes

Main themes	Subthemes
Understanding of preventable infections	<ul style="list-style-type: none"> – Desensitized to COVID-19 – Understanding infection prevention and control precautions
Embracing evidence-based guidelines to protect the patient	<ul style="list-style-type: none"> – Correct use of hospital policy and guidelines – Restrictions associated with the use of electronic medical records – Understanding of sepsis management and the importance of timely microbiological testing
Roles in preventing and controlling infections	<ul style="list-style-type: none"> – Ambivalence on antimicrobial stewardship roles – High priority placed on consumer education

to protect the patient; and (3) roles in preventing and controlling infections. Each theme and associated subthemes are presented in Table 1.

Theme 1: understanding of preventable infections

The first theme identified from the focus groups was that nurses understood the importance of protecting patients from preventable infections; they did not, however, articulate their key role in preventing transmission beyond hand hygiene and use of standard precautions. Nurses identified that the public's attitude to the prevention of COVID-19 transmission had changed since the easing of COVID-19 lockdowns and restrictions, as some nurses and parents showed a poor understanding of COVID-19 transmission precautions and paediatric COVID-19 presentations.

Subtheme 1: desensitized to COVID-19

At the time of the focus groups, public health measures had recently been eased in Australia and prevention of COVID-19 transmission was an important topic of discussion. Participants stated that 'Everyone seems to be very focused on COVID, and everything else is just, oh, you've got the flu? Oh, that's not bad, oh you've got gastro. Like everyone is very focused on COVID' (P2), and 'I think people have forgotten that for children in particular, influenza is infinitely more dangerous to children than COVID is', and

Where it used to be a lot more strict. I think on [the old ward] It used to be, 'no you had an infection you stay in your room', but now parents just seem to be always wandering around doing what they want ... I don't think that we emphasize it [IPC precautions] enough. I do think ... since we've come to the new hospital, ... we don't tend to enforce it [IPC precautions] whatsoever. (P10)

Following two years of COVID-19-related activities, nurses and parents also appeared to be less sensitive to the importance of preventing the spread of COVID-19 infection. Nurses highlighted that the public's perceptions of the risks associated with severe COVID-19 infection had declined with the easing of public health restrictions. 'I think attitudes around social distancing has become more lax [relaxed] over the last two years I think right at the start of pandemic, everyone was like 'oh 1.5 m [apart]' (P17); 'I guess it reflects your social life outside of the hospital, like you're at the shops with everyone and his dog and you come here and it's like you expect the same' (P16); and

I get frustrated by the amount of respiratory patients that are out [on the ward] without wearing masks, coughing everywhere in the main space. There was a nine-month-old with a contagious respiratory bug, they [the parents] were asking 'can we go downstairs?' And I ... said 'you have to wear a mask' and she [the mother] said 'but they're only little', and I insisted 'you have to wear mask'. It's like everyone's more scared about the flu [influenza] now and COVID's 'just COVID'. Whereas in the beginning, it was like COVID and everyone was really good. Now we're just kind of immune to it. (P7)

Subtheme 2: understanding of infection prevention and control precautions

Despite the lack of understanding around managing the spread of COVID-19, nurses showed a clear understanding of

basic IPC precautions and the ways to prevent infection spread in acute healthcare settings. Nurses were keenly aware of the precautions necessary to prevent cross-infection amongst patients with cystic fibrosis (CF); for example: 'Making sure we're obeying all the rules especially for like CF patients [with cystic fibrosis that] we're doing the right thing for them ... we use reverse precautions for them ... to stop us from giving bugs to them' (P22), and 'We have our different CF cohorts, the blue and the green [CF cohorts, each colour represents a different bacterial strain]' (P22), and 'So blue doesn't get what green has. We also try and make sure that if a nurse is looking after one CF patient, they don't get the other CF patient and they don't go into that room during that same shift' (P24). Some nurses were more aware of invasive devices and the IPC precautions that were necessary, one nurse stating that 'hand hygiene I think is the biggest one [for managing and preventing infections], and if you're accessing a line, or if you're doing anything like that ... just aseptic non-touch technique or scrub the hub, hand hygiene' (P11).

Theme 2: embracing evidence-based guidelines to protect the patient

Theme 2 highlights that the participants had a thorough understanding of their hospital's guidelines and policies, but often experienced barriers implementing these in practice. Identified barriers included limitations imposed by the EMR system and having to educate medical officers on the guidelines to ensure best practice.

Subtheme 1: correct use of hospital policy and guidelines

Nurses utilized hospital policy and guidelines to protect their patients. This was particularly important to the oncology nurses who reported '... Because we have oncology patients, we know what the protocol [for febrile neutropenia sepsis] is, so we enforce it before the doctors [are aware]. ... If the child's febrile, we do the temperature, we know [and commence] the plan [febrile neutropenia sepsis protocol]' (P26).

Nurses who cared for adolescents also ensured that they followed hospital policy, stating, for example:

Making sure that infection control [team] are up to date as well and they're on the same page as you. So, if there's anything that is reportable, that you are fully aware, and that people are in the correct, negative pressure rooms if necessary for their illness. (P22)

Key policies that were referenced were the local sepsis management pathway and IPC policies. For example, one nurse stated '[we have a role in] making sure hand hygiene [products] are available at all key points. I'm an auditor, so just making sure we are auditing when we can, just to make sure we are following the 'five moments of hand hygiene'' (P23).

Participants saw their role in AMS as maintaining the traffic light system and identifying high-risk antibiotics. Participants stated: 'if it [the antimicrobial] needs ID approval, and that hasn't been done, we'll do that as well' (P29); 'I associate it with the traffic light system ... like the green, the orange and the red, like when you can give them without ID approval and all that' (P1); 'I check which antibiotic falls into which category as to whether we need permission to give it' (P13). Some nurses identified monitoring patient allergies and adverse drug reactions as part of their role. One nurse stated: 'Often, reminding

the doctors that they've [patients] who have got allergies to antibiotics, or they'll chart it and we'll be like, no, that's not going to work' (P28).

Subtheme 2: restrictions associated with the use of the electronic medical records

It became apparent that there were restrictions imposed on nurses' practice and contribution to AMS when using the EMR. Nurses highlighted that they were often unable to contact the medical team if there were issues with a prescription recorded on the EMR or if the patient required urgent antibiotics. One nurse stated:

We only have a paging system here, so it is frustrating, if you can't get hold [of one doctor] ... technically you have to call the [medical team] consultants and you really don't want to have to do that. (P22)

Additionally, some nurses highlighted that using EMR made it more difficult for inexperienced users to adjust medication administration times if needed; 'When you're on paper, we were so much better at it [adjusting medication times], because we would plot it out over the next 24 h ...' (P10). Nurses also noted that the antimicrobial approval process had become more difficult since the introduction of EMR. One nurse stated:

We did traffic lights years ago. And [back] then we were so vigilant: that's a red, we can give one dose and we're not giving another one until we've got the ID consultants [approval]. When we were on paper, I think it was so much more visual, everything was all good, and then we went to EMR, and I think it just [fell apart]. (P22)

Subtheme 3: understanding of sepsis management and the importance of timely microbiological testing

Participants highlighted the importance of recognizing and responding to sepsis, which included early administration of antibiotic therapy, stating, for example:

Well, you know what, the kid's got sepsis, and I just need to give this [antibiotic] because I don't have time to chase it [AMS approval] up right now. As you know, from an antimicrobial stewardship person [perspective], you don't give it [antibiotic, unless] you have approval. From our point of view, that patient could die of sepsis, so I'm going to give it. (P10)

Participants also showed a clear understanding of the importance of early (before antimicrobial administration) microbial testing, and its importance in ensuring optimal selection of antimicrobial therapy, for example: 'broad spectrum antibiotics until they get the bug back and then we can give targeted' (P22) and 'Obviously, you're giving them antibiotics, because they've got some sort of infection, and if you start giving an antibiotic, it's going to start killing off that infection. So, it's not going to make an accurate blood culture' (P25).

Nurses commented on how they would often refer junior medical staff to the sepsis guidelines to ensure that age-appropriate sepsis treatment was prescribed in line with hospital policy. One participant described a recent experience as follows:

We recently had a baby that was on the ward being treated for sepsis. Usually, we have for sepsis, benpen [benzylpenicillin], and gent [gentamycin] and this baby was written up for, I think,

ceftriaxone and something else, so that put red flags up. We had to go through a few avenues to make sure are we actually treating for sepsis or are we treating for something else? ... We did pull up the [policy] and say: look, we have looked at the sepsis for a neonate [policy], and I think it was under three months [of age, X is indicated]. And then the [junior doctor] is like, oh, I'll have to go to my senior doctor, and that's when things changed ... (P17)

Theme 3: roles in preventing and controlling infections

The final theme was that nurses had a poor understanding of AMS roles within the interdisciplinary team. Nurses highlighted their role in educating consumers on antimicrobials and IPC practices and wanted more AMS education.

Subtheme 1: ambivalence on antimicrobial stewardship roles

In all focus groups, the role of nurses in antimicrobial review lacked consensus. Most nurses believed that it was the pharmacists' or medical teams' role to undertake an antimicrobial review and did not see themselves as having a role. For example: 'I don't want a voice. I'm not qualified to have a voice in prescribing antibiotics' (P11); 'They [the medical team] will make the decision. We will question it if we think there's something wrong, but we have no choice' (P29); 'Pharmacists, usually, look over it and they'll flag to the [medical] team, you've [the patients] been on [an antibiotic] for too many days or the dose is not right' (P19); 'No, it's not pharmacy. It's a doctor that reviews it and says, this person should be on this antibiotic or recommends a different one' (P6); and

Pharmacy actually comes by and assess a kid's chart depending on what they're on. They'll do that daily. Depending on if it's an orange or red one [traffic light system ranked antibiotic], then you obviously need ID approval, and they won't supply it unless there's an actual reason for it. (P25)

Of note, participants did not comment on their role in communicating their clinical assessment of the patients' response to antimicrobial therapy to the interdisciplinary team, despite this being a key part of the antimicrobial review process.

Another aspect that may be compounding nurses lack of recognition of their role is the perception that they had inadequate knowledge and were not receiving further AMS education. Most of the training that nurses received focused on implementation of the traffic light system for antimicrobial administration, and did not explore other aspects of the nurses role in AMS, for example: 'I reckon I've gone to maybe two in-services in 25 years' (P10), 'you know, probably the only in-service was the traffic light system, and that was years ago' (P22), and 'I learnt about it a little bit of [antimicrobial stewardship] at uni [university]. I don't think I've had much training since then' (P24).

Subtheme 2: high priority placed on consumer education

Education of consumers was a high priority. Nurses identified that it was their role to educate patients and their parents on IPC precautions and antimicrobial use. However, nurses thought their role was to clarify education around antimicrobials and to focus more on the timing of administration following discharge; as two nurses stated: 'sometimes they

[the parents] have questions after the pharmacists have been in, so then you, as long as you so you know what pharmacy said, you can reiterate the same thing' (P23) and 'I find that when giving discharge paperwork to the patient, or their parents I often write down the last antibiotic that was taken so that they know, and you can talk to them about when the next dose is due when they get home' (P24).

Discussion

This study showed that nurses have a thorough understanding of hospital clinical guidelines and IPC practices, but their involvement in sepsis management and AMS could be limited by junior medical staff members' knowledge and communication barriers. Despite a limited perception of their role in AMS, nurses knew essential IPC practices that would effectively prevent infection transmission. However, barriers such as parents' perceptions of the significance of COVID-19 infection in children and the use of EMR did make it challenging to follow IPC and AMS guidelines. Participants appeared to be unaware of the national government standards regarding their role in AMS and IPC.

The EMR programme and hospital communication systems were identified as barriers to timely medical care for patients. Nurses often had to wait long periods for the medical team to respond to pagers as direct contact numbers were not provided; consequently there could be delays in patient care, including for children with time-critical infections such as febrile neutropenia. Use of an EMR is widely believed to reduce medication errors, but some studies have shown otherwise. Pettit *et al.* found that EMR implementation did not lower medication errors, whereas Carayon *et al.* reported an increase in certain types of medication errors after EMR implementation [19,20]. This could be due to human and system factors, lack of leadership and support, and user fatigue impacting on prescribing and administration practices [21]. Nurses have also reported difficulties identifying antibiotic classes in EMR, leading to confusion about when to obtain ID approval; this suggests that use of digital technology can hinder guideline adherence. Cairns *et al.* suggest optimizing existing EMR systems through better patient identification, more timely AMS rounds, and integrating functions within EMR such as automatic stop dates for antimicrobial therapy [22].

Nurses showed thorough knowledge of multiple guidelines, including sepsis recognition and response, medication adverse reactions, and microbe testing. This finding is in line with previous studies; Harley *et al.* reported that nurses can identify and articulate their role in sepsis recognition and management [23]. Additionally, Sangojyo *et al.* found that nurses often can take the lead in sepsis management [24]. This highlights that a nurse-led sepsis management pathway within paediatrics could be beneficial and improve patient outcomes by reducing time to antibiotic and facilitating the implementation of AMS activities in paediatric settings.

Since the COVID-19 pandemic, healthcare workers' understanding of, and the public adherence to, IPC has increased [25]. However, since public health messaging on COVID pandemic restrictions has lessened, it appears from this study that nurses and parents have become less vigilant about transmission-based precautions in acute care settings [26].

Despite nurses and parents presenting as desensitized to COVID-19, nurses showed a good understanding of IPC precautions and the management of infections through hand hygiene practices, separation of patients with CF, and caring for patients with neutropenia [27].

Nurses in this study had a limited view of what their role was in AMS; they were aware of the traffic light system for managing antibiotics, and some were aware of the hospital AMS team. Despite extensive research indicating that nurses have a key role in multiple AMS activities, several nurses stated that they did not have or want a role in reviewing antimicrobial prescribing, preferring to focus solely on safe antimicrobial administration [4,5]. The education of parents and patients was, however, a key priority for nurses.

One strength of this study is the design, which allowed us to gather data on IPC practices from three clinical areas. One potential limitation is that some participants might have been hesitant to voice their opinions in focus groups in the presence of senior nurses. Such reluctance could give rise to a social desirability bias. Regardless of this limitation, the data obtained and the analysis provide rich data enabling a deeper understanding of current IPC and AMS nursing practices in acute paediatric settings.

In conclusion, nurses' understanding of their role focused on practices such as performing hand hygiene and standard precautions and reporting the use of high-risk antimicrobials. A lack of understanding of paediatric COVID-19 transmission and presentations was also observed. Education on best practice in infection prevention and AMS was recognized as crucial for both nurses and parents. Additionally, nurses reported facing barriers such as EMR use and medical hierarchy when attempting to implement hospital guidelines and policies in practice.

Author contributions

M.K., A.H., E.M., and S.B. all contributed to the study design and the concept of this paper. M.K. conducted the focus groups and analysed the data with contributions from A.H. and S.B. All authors provided significant intellectual contributions to the paper. All authors contributed to the revision of the manuscript and approved the final manuscript.

Conflict of interest statement

None declared.

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Appendix A. Supplementary data

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