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How do healthcare professionals manage uncertainty in making decisions? Applying theory to nurses' experiences of uncertainty regarding antibiotics in residential aged-care facilities

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The experience of uncertainty is inherent to the practice of medicine. It influences healthcare professionals' perceptions of risk and decision-making. Our objective was to provide empirical insights into how healthcare professionals manage uncertainty and navigate risk related to antibiotics in residential aged-care facilities. Interview data from aged-care nurses was coded deductively, drawing on a taxonomy of uncertainty tolerance in medical decision-making developed by Han and colleagues (2021). Additional themes that did not map onto existing codes were inductively coded. Views from the 16 nurses in the study revealed use of a wide range of strategies that often co-occurred when managing their uncertainty. Consulting with colleagues and deferring to others were the most commonly used strategies to reduce uncertainty. 'Avoidance' and 'reflection' were response-focused strategies that had not been previously described in the taxonomy. Managing uncertainty is an active and ongoing process that requires clinicians to engage multiple strategies, often with conflicting aims. These findings have implications for deepening our understanding of how uncertainty affects healthcare professionals engaged in risk work. They also highlight the need to expand educational interventions to include cognitive strategies focused on managing uncertainty. Additionally, the findings point to the importance of involving multiple stakeholders in sharing the burdens associated with uncertainty in clinical decision-making.

Keywords: uncertainty tolerance; anxiety; antimicrobial; stewardship; aged care; medical decision-making

Introduction

Uncertainty and risk in healthcare settings

Uncertainty is conceptualised as a problem in the practice of medicine. It inhibits our ability to use past experiences and information to predict the future (Fox, 2000). Within healthcare contexts, contemporary models commonly propose three interrelated dimensions of medical uncertainty that shape clinical practice and decision-making (P. K. Han

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et al., 2011). Some of these sources and issues of uncertainties can be quantified into risk estimates through statistical analysis to guide clinical decisions. However, these risk estimates rely on having sufficient data and stable variables for meaningful predictions (Renn, 1998). In healthcare, applying population-level data to individual patients creates tension between statistical generalisation and clinical specificity, potentially reducing some uncertainties while amplifying others (Han, 2021; Han et al., 2017). Although data-driven protocols may reduce scientific uncertainties, they increase personal uncertainties for clinicians, particularly around accountability and deviation from protocols (Castel, 1991). Moreover, using average probabilities in risk modelling can mask the inherent subjectivity of underlying assumptions and methodological choices. Risk modelling frameworks are transforming organisational governance and professional practice towards evidence-based approaches (Power, 2004). However, their implementation presents new challenges for clinicians in balancing institutional demands for standardised practices against professional judgement, liability concerns, and patient relationships (Brown & Gale, 2018). In contrast to the idea of technical risk estimates, sociocultural approaches to the theorisation of risk selection and perception argue that risk is socially constructed, influenced by personal values and preferences, alongside common sociocultural categories and organisational dynamics (Douglas & Wildavsky, 1982). These individual and cultural factors influence the meaning attributed to expected gains and losses, meaning the perception of risk is always subjective (Slovic, 1987). Reflecting this, the third dimension of uncertainty in Han et al. (2021) framework outlines the interpretive nature of risk, examining how different stakeholders subjectively construct and experience uncertainty in healthcare decision-making. This dimension acknowledges that uncertainty resides not merely in objective probabilities, but in the diverse mental models and meaning-making processes of patients, clinicians, and other stakeholders. The subjective experience of uncertainty includes both positive (excitement) and negative (anxiety) psychological experiences, shaping how individuals process risk information (Anderson et al., 2019). As such, individual variations in uncertainty tolerance (UT) have the potential to influence risk perception and management (Hillen et al., 2017).

Uncertainty and antimicrobial risk in care settings

Clinicians in residential aged-care facilities (RACFs) face complex uncertainty and risk management challenges (ACSQHC, 2018). Diagnostic uncertainty is heightened due to atypical symptom presentation, sampling difficulties, and multiple comorbidities (Beckett et al., 2015). Limited access to prescribers or on-site testing and staff rotation further complicate diagnosis, while residents' cognitive decline and compromised immunity increase practical uncertainties in making accurate risk assessments (Fleming et al., 2014). Within this setting, antibiotics serve as critical interventions for potentially fatal infections or other adverse consequences (e.g., functional decline), particularly in residents with dementia (Hall et al., 2022). However, decisions regarding their use can create tensions with families' trust in the quality of care. The growing threat of antimicrobial resistance (AMR) exacerbates these challenges, highlighting the tension between individual patient needs and broader public health concerns (McKenna & Gale, 2022). These conflicts become particularly pronounced when families advocate for empirical antibiotic use, often due to delays in diagnosis or concerns about the adequacy of care (Degeling et al., 2023). Consequently, antibiotic overprescribing remains prevalent in RACFs globally (Raban et al., 2020), driven by diagnostic uncertainty and the need to balance

clinical safety with the maintenance of relationships (McKelvie et al., 2019; Singh et al., 2024).

AMR is a widespread concern across health settings, however the organisational context of RACFs introduces unique pressures. In Australian RACFs, registered nurses (RNs) play a pivotal role in coordinating clinical care, initiating diagnostic testing, and liaising with general practitioners (GPs) to inform prescribing decisions. While GPs depend on RNs for information regarding residents' baseline health status, functional changes, and ongoing monitoring, they also report varying levels of confidence in staff assessments and pressure to prescribe antibiotics empirically (Chaaban et al., 2019; Hall et al., 2022). RNs additionally fulfil administrative duties, supervise care staff, and manage relationships with residents and families, positioning them as key information brokers among multiple stakeholders (Kirby et al., 2020). As such, they must balance the need for timely infection treatment against the risks of unnecessary antibiotic use (Lim et al., 2015). Many RNs report anxiety in managing subclinical infection signs, collaborating on antimicrobial stewardship, and navigating family expectations equating antibiotic use with quality care (Degeling et al., 2023; Dowson et al., 2020).

While the role of uncertainty in shaping risk perceptions and clinical decisions is recognised, its management in the context of antimicrobial resistance (AMR) remains understudied. McKenna and Gale's (2022) concept of 'seeking coherence' provides a framework for understanding the overarching goal of how clinicians navigate competing demands, integrating risk knowledge, policy mandates, and relational dynamics to guide antibiotic decision-making in time-sensitive situations. The current study aims to further our understanding of how RNs reconcile uncertainty, interpret risk, and manage relationships within RACF organisational constraints. In our analysis, we employ a conceptual framework of uncertainty tolerance across four self-regulatory categories: ignorance-focused (reducing uncertainty through knowledge acquisition and probabilistic risk estimation), uncertainty-focused (enhancing awareness of uncertainty), response-focused (managing psychological responses to uncertainty), and relationship-focused (leveraging social relationships to navigate uncertainty) (P. K. Han et al., 2011; 2021).

Methodology

Data collection

This interview-based study draws on the experiences of nurses working in RACFs in a variety of nursing roles and explores uncertainty, antibiotic use and stewardship. All procedures were reviewed and approved by the University of Wollongong Human Research Ethics Committee (HE2021/015). Data collection took place between November 2021 and March 2022 by SS via phone, video or in-person. A semi-structured interview guide (see Supplementary Material 1 and 2) was used, informed by the current Aged Care Quality Standards (ACQSC, 2019) and the expert input of the research group (social scientists, aged care researchers, clinical psychologists and academic nurses). We approached the design of the study with a subjective and pragmatic worldview that recognises the limits to objectivity and the influence of subjectivity in one's understanding of truth and the world (Allemang et al., 2022) It therefore follows that multiple perspectives that are evolving and co-constructed by the various stakeholders involved in decision-making can exist and are expected to emerge out of the research. This approach was used to collect and analyse data to prioritise providing the best understanding of the initiation of antibiotics from the perspective of

a key stakeholder – the registered nurse (RN), in the RACF. All interviews were digitally recorded and transcribed by a professional transcribing service. We did not anticipate any harm to participants; however, psychologists were available for debriefing if needed (SS and FD).

Sampling

Convenience and snowball sampling was used to recruit participants to an online survey using Qualtrics software distributed the Ageing and Dementia Health Education and Research (ADHERe) Centre at the University of Wollongong from August 2021 to August 2022. ADHERe has a membership of 1,400 gerontological specialist nurses and allied health care practitioners working in clinical practice, education, research, and policy areas. The survey was also posted through nursing organisations (e.g., the New South Wales Nursing and Midwives Association; NSWNMA) and social media. Participants were invited to opt in to be interviewed at the completion of the survey. Eligibility was determined by participants currently working or having previously worked as a registered or enrolled nurse in residential aged-care facilities in Australia. A total of 20 nurses indicated a willingness to complete an interview following the survey. Four participants did not respond following attempts to contact them, leaving 16 nurses.

Analysis

Interview data were analysed using a content analysis approach, incorporating both deductive and inductive coding strategies (Gale et al., 2013; Green & Thorogood, 2018). A stepped approach was employed, allowing for the application of predefined categories while also identifying emergent themes from the data. The first author (SS) listened to and read the transcripts repeatedly to achieve familiarisation. A code book using a conceptual taxonomy developed by P. K. Han et al. (2021) was used in consultation with FD, CD, and PC. This process involved agreeing on a definition for each code and identifying how each code could be differentiated from other codes (Table 1).

The framework used in this paper defined uncertainty as a subjective mental state that encompasses both the state of unknowing or 'ignorance' and the higher-order awareness of this ignorance (Anderson et al., 2019; P. K. J. Han, 2021). As such, ignorance-focused strategies aim to reduce a clinician's 'ignorance' or gaps in objective knowledge through technical approaches: risk assessments, evidence-based medicine, and organisational policies informed by population-based estimates. These strategies form the core of traditional medical decision-making. Uncertainty-focused strategies involve the self-reflective awareness of one's own ignorance, shaping the subjective experience of uncertainty as a metacognitive state (P. K. J. Han, 2021). These strategies, therefore, entail actions based on clinicians' conscious recognition of uncertainty, emphasising their metacognitive engagement with decision-making (P. K. Han et al., 2021). In contrast to ignorance- and uncertainty-focused strategies, which aim to 'cure' uncertainty by addressing gaps in knowledge, response- and relationship-focused strategies seek to palliate the aversive effects of uncertainty, managing its emotional and cognitive impact.

Transcripts were coded line by line to identify examples of the strategies participants used in managing uncertainty. SS and DR analysed six transcripts and

Table 1. Definitions for uncertainty-management strategies.

	Deductive Codes	Inductive Codes	Differential Criteria/Other Comments
Ignorance-focused: directed at eliminating or decreasing medical uncertainty by reducing the ignorance that constitutes its objects.	Initiating diagnostic evaluation Instituting therapeutic trials Consulting with colleagues Searching the medical literature.	N/A	The aim of these strategies is to 'cure' uncertainty.
Uncertainty-focused: directed at the conscious awareness of uncertainty as a metacognitive state, in service of dealing with uncertainty.	Maximizing attention on uncertainty (e.g., '"double-checking"' or maintaining a high index of suspicion) Minimizing attention on uncertainty Disengaging from uncertainty (e.g., transferring the responsibility of dealing with it to others) Adjusting epistemic expectations (e.g., acknowledging the impossibility of perfect medical knowledge) Ordering uncertainty (e.g., imposing some logical structure or process).	N/A	Ignorance focused strategies are aimed at reducing uncertainty whereas uncertainty-focused strategies are about managing the metacognitive awareness of ignorance.
Response-focused: Directed at managing one's own psychological responses to uncertainty (can be good or bad).	Withstanding negative effects of uncertainty. Cultivating virtues (e.g., thoroughness or due diligence in patient care). Compartmentalizing psychological responses Self-affirmation (e.g., acknowledgement of one's own core strengths that transcend one's limitations) Self-forgiveness.	Avoidance Reflection	These strategies differ from ignorance- and uncertainty-focused strategies in attempting not to reduce or '"cure"' uncertainty but to mitigate or palliate its aversive psychological effects.
Relationship-focused: Directed at social relationships between physicians, other clinicians, and patients with the aim of palliating its aversive psychological effect.	Sharing with colleagues. Sharing with patients.	Sharing with residents' families.	Differs from ignorance focused information-seeking strategies in relating with other persons not as a means of curing uncertainty but of palliating its aversive psychological effects.

compared coding, conflicts were resolved with discussion with the wider team (FD, CD and PC) and further development of the coding framework. Instances of strategies that could not be coded onto the existing taxonomy were assigned a new code. The new codes emerged from the literature review and were subsequently discussed with the broader research team. SS analysed the rest of the transcripts. All instances of a given code were grouped together and analysed comparatively by SS (see Supplementary Material 3). This step involved crystallising the data, allowing ideas to emerge across the four codes in consultation with the wider team. The final step involved comparing and contrasting across the type of uncertainty management strategies to identify shared conceptual terrain between aspects of uncertainty management.

Findings

Ignorance-focused strategies

Almost all the RNs described using clinical observations and assessments to inform the need for diagnostic evaluation. They reported resident's deviations from their 'baseline' informing the need to engage strategies, such as referring to previous medical history or initiating tests to resolve scientific uncertainty. RNs described these assessment processes as both automatic and deliberative. Participants discussed accessing residents' previous history to use the number of events/episodes of this particular illness to predict future trajectory of illness, and the likely consequences for the resident's wellbeing. Information about past events was extremely valuable to managing uncertainty because:

> It's a real fine line sometimes between prescribing or not prescribing. It's probably knowing the individual and the situation, also, and prior medical history as to what the best outcome will be for that resident. [P8]

Other nurses described using diagnostic testing after initiation of antibiotics to determine if antibiotics were working and to make sure that antimicrobial resistance was not developing.

Consulting with colleagues was the most commonly described strategy to reduce scientific uncertainty. RNs usually consulted a nursing manager when they were uncertain and GPs when they were the most senior person available. RNs also relied on personal care assistants (PCAs) for noting and reporting differences in resident behaviours because:

> They [PCAs] get to know so much intimate details about people that could be making significant changes to the decisions we make medically for them. [P5]

Practical uncertainties, such as difficulties in soliciting a GP review, were discussed in this way, with some RNs able to rely on alternative support, including geriatricians. RNs managed time constraints on GPs by preparing themselves with facts and solutions to guide the GP's decision-making. Because they were central to efforts to address uncertainty, many of the RNs took this role seriously such that:

> It's like going through the ISBAR and really before you ring that medical practitioner or whatever, have your information, get yourself organised first because that will save time and [help GP] really understand what the situation is. [P6]

Some of the nurses we spoke with described their use of this strategy as a process akin to acting as a broker between, and sometimes an advocate for, residents with their doctors. Recalling experiences where residents were deteriorating while their doctor was waiting for pathology results, one participant noted that:

> I feel like I'm doing everything with what I can and if [the resident] still don't trust me, I need sometimes to push the doctors again to get things sorted out as soon as possible. [P10]

Descriptions of searching medical literature or conducting empirical trials as strategies for resolving scientific uncertainty were rare. Less than half of the RNs discussed using guidelines, policies and seeking training to make up for knowledge deficits. For those who did use this strategy, it was usually in the absence of authoritative colleagues that could provide assurance as to which antibiotics and treatment length were most appropriate. Only three participants discussed using an empirical trial to resolve uncertainty, typically involving stopping long-term antibiotic treatments. They described varying levels of success in being able to use this strategy, depending on prescriber and family preferences.

Uncertainty-focused strategies

Most RNs emphasised the importance of a high index of suspicion to small changes in residents to inform the prescriber, initiate earlier testing and mitigate the risk of worsening of symptoms. One participant stated having a conscious awareness of uncertainty was:

> . . . Very important because especially in aged care with our doctors relying so much on our judgement but it's more like we're their eyes if that makes sense. So our suggestions impact a lot on their decisions. P[4]

RNs described a dynamic process in monitoring residents, specifically attending to a lack of improvements in their symptoms that would increase uncertainty regarding the diagnosis and treatment plan that might necessitate a change in response. They described maximising their attention to the possibility of causing harm beyond preventing catastrophic outcomes (e.g., death) such that:

> It's not as simple as just giving someone medication of any prescribed - who made the decision that they actually needed this medication in the first place and am I doing something that could do harm? P[5]

Close attention to their own uncertainty led to further forms of reflexivity that sought to prevent harms and maximise benefits for residents:

> So we go back and look at our impression, we look back at underlying illnesses and we re-review the patient to see if there is something else. So we don't actually go ahead with antibiotics for the full course; we stop it at that point, or we look for other investigations. P[11]

In direct contrast to the longer-term perspectives noted above, several RNs experienced difficulties in managing risks of immediate and future harms to the residents. Some RNs

described minimising their attention to future risks and focusing on immediate risks to the resident, such that:

> Maybe we're making them resistive [sic.], but at the same time, we're also contesting that it could be life-threatening for them. So, they might not become resistive to it for, let's say, a couple of years. . .you have to convince yourself that this is what I'm going to stick with. P[2]

A few nurses noted the negative impact of maximising attention in increasing anxiety and self-doubt, and described combining strategies by maximising attention to uncertainty in their treatment plan while minimising attention to poor outcomes for themselves.

> It's a balancing act, to not be gung-ho, . . . and really dig deep and try to find the correct answer, but at the same time, not just send everybody into ED because it's the easiest thing to do, and it's going to save you. Nobody's going to sue you for sending somebody into hospital. P[3]

A few RNs also focused on minimising attention to unknowns by focusing on the certainties regarding treatment:

> I think what makes us nervous is the unknowns. So, there is the fear of antimicrobials becoming resistant and resulting in the next big problem. But the actual treatment for someone with antimicrobials, there're some knowns, because it's just a very logical process. P[5]

Prior negative experiences were described to temper the use of this strategy in making the RNs more sensitive to the likelihood of poor outcomes in the future:

> I always think about what will be next, because I've experienced it before with other people, with other patients. P[12]

Most RNs reported either deferring to a manager or doctor to determine next steps, particularly when the resident (or family) raised concerns amid wider social pressure to give antibiotics. Amid such pressures, prescribing was ultimately seen as the doctor's decision:

> So, look, doc, I've explained it all but look, you're the doctor, you're the one who prescribes, it's your patient. You're there to treat the disease . . . Society said – society still believes if you've got an infection give them antibiotics. P[7]

A few nurses also pointed to ethical concerns regarding diagnosing residents being outside the scope of their role. A few nurses also described the difficulty of handling uncertainty, particularly in the context of high workloads. RNs that deferred to others were often perceived by their peers to avoid questioning decisions, disengaged from critical thinking and assumed a passive role in the escalation process. However, some RNs perceived deferral to others as an acceptable compromise by demonstrating they were doing 'something' to appease families rather than doing nothing amid the uncertainty:

> Having lots of people to give medications to, trying to sort out behaviours that are changing or baselines that are changing … Then you've got families who are saying what are you going to do? I think you'll cave [give in], I just think you do. But you've done something, even if it doesn't work [at least] you've done something. P[16]

As well as deferring decisions to senior colleagues, some RNs responsible for the daily care of residents described cognitively distancing themselves from uncertainty to cope with competing demands of their role:

> So, it just sounds like you don't think about it, or you don't care, but, again, you can't do four things at once. You can't have four different scenarios at once. P[2]

RNs also described the impossibility of providing a timely diagnosis and perfect medical treatment for residents due to a number of factors unique to RACFs, including the decline in functioning due to resident's age or variations in perceptions of quality of care such that:

> You can make it better, you can manage a bad situation better, but you're not going to be able to completely fix it. P[7]

A few RNs also described accepting the high probability of making mistakes and a need for more defensive forms of practice in a RACF due to the lack of organisational support.

> You're going to make mistakes, it's going to happen, we're human … you've got to be honest about it and you're not going to lose your registration over it because a lot of RNs, that's what they are concerned about. P[6]

Amid these multi-dimensional challenges, RNs described using mental processes to enforce logic onto uncertainty through trying to explore as many different scenarios as possible, to making 'pros and cons' lists, or to deferring to a personal 'threshold' for taking action towards doing something (e.g., calling the ambulance). To begin to manage the constraints inherent to RACF contexts optimally:

> You have to do pros and cons … there's guidelines as to what you should do, but sometimes they're not practical enough. P[2]

Response focussed strategies

Most RNs described experiencing significant anxiety and frustration in managing risk, unfamiliarity with residents (and other staff) and the quality of care they were able to provide in the RACF context. Some RNs described physical manifestations (e.g., heart palpitations, nausea, difficulty sleeping) of these emotions, while others ascribed a general 'weariness' to approaching decisions:

> I sit there, and I think, this person is going to end up going into emergency department … they're going to go in there simply because I can't do what I need to do to get the answer. P[3]

RNs also described having to withstand feelings of self-doubt and powerlessness when experiencing uncertainty regarding how to help the resident, and the possibility of prolonging suffering in the context of 'watch and wait' strategies. These feelings of guilt and blame were more pronounced when family members expressed doubt regarding the care of the resident.

> I felt very powerless to do anything if that makes sense. I wasn't sure what to do and again I had very little I could do … Then having her family questioning what we were doing. Yeah, I guess it just – I think at times it just made me feel frustrated and like oh God, what. P[4]

Some RNs also recounted circumstances where they felt blamed by their organisation or the resident's family in the context of making mistakes. RNs ascribed difficulties in articulating their uncertainty based on intuition and reported fears that may not be viewed as credible by prescribers.

> The fear is to be deemed as not credible. For saying things because it is hard to articulate things without needing the knowledge because you know that there's something wrong but you don't know what's wrong. P[9]

Cultivating virtues was the most commonly described strategy to ameliorate the negative effects of uncertainty. Cultivating thoroughness and humility was used to reinforce perceptions of 'doing the best' for the resident, as demonstrated through emphasis on documentation, communication, planning and advocacy for residents. The importance of this strategy was expressed by one participant:

> It's like a big blow to your confidence as a nurse especially when … you are not being able to do the best you can and then you just feel very low that now you are not able to do the best you can. P[4]

The importance of empathising with the residents' (and families') experiences was linked to being diligent, despite pressures when dealing with difficult behaviours and managing expectations of care:

> [I]think of it that, if this was, let's say my mother, my grandmother – not mother, maybe grandparent, what would I do? Will I make sure that everything that I could have possibly thought of was done? P[2]

Similarly, flexibility, curiosity, and humility to avoid adopting an entrenched position amid their approach to uncertainty was also described by a number of RNs:

> It's – lots of decisions won't go your way, lots will. It's not about – it's not a matter of winning or losing. It's really what's best for the resident.P[7]

Amid these different pressures, RNs described the difficulties of juggling competing demands on their time and mental capacity. They compartmentalised their psychological responses in an effort to persevere on tasks despite experiencing negative effects of uncertainty. A few RNs found it difficult to articulate the mechanisms underlying the compartmentalisation of their responses. Some RNs described taking a break and relaxation strategies to ameliorate the negative effects of uncertainty. Others described

intentionally minimising attention to negative feelings or focusing on other aspects of resident care:

> When somebody has a possible infection, then sure, you're very conscious of it, but there are just so many other things going on, that some days I don't even think about it. P[14]

Several RNs discussed being resilient in approaching difficult conversations, asserting oneself and handling rejection from stakeholders. Positive evaluations of themselves were perceived to be protective of their capacity to withstand negative effects of uncertainty.

> I'm 68 years old and still working, that people can hear that I am interested, I am passionate. I'm not just doing this to fill in time. P[7]

Most RNs described a gradual increase in confidence in dealing with uncertainty through gaining experience over time in their role. Increased clarity regarding the scope of their role and having the appropriate language to communicate their uncertainty, and thereby assert themselves in the diagnostic process, challenged the self-doubt that was commonly identified by RNs earlier on in their career.

A number of RNs described positive experiences of uncertainty in providing novelty to their work: opportunities to recognise and address gaps in knowledge were seen as increasing feelings of competency when dealing with uncertainty.

> So slightly anxiety provoking, slightly concerning, but I guess it's also given me a bit of confidence in a way that I know what questions to ask for and how to get that information in order to be able to make the best decision for my patients. P[11]

A number of RNs reported significant feelings of anxiety, negative evaluations of being able to do their job and struggling to forgive themselves in the context of making mistakes:

> I would carry that in my conscience for eternity . . . So if that happens, then it will devastate me. I don't know what I'm going to do. P[9]

Such difficulties were evident in the smaller number of RNs that described using self-forgiveness. A few RNs described accepting making mistakes in being human and re-framing mistakes as opportunities for learning, noting the role of colleagues in facilitating these shifts in perceptions.

> I guess it's a matter of like making this a norm, like you're okay to make mistakes, you're okay to not know things. But as long as you do something about that finding, then that's acceptable. P[11]

Several RNs described a loss of confidence in their ability to navigate the decision-making process. Many attributed this to previous negative experiences, leading them to default to calling an ambulance in the absence of an available prescriber or, in some cases, avoiding work altogether as a means of managing their distress. Rather than engaging in 'wait-and-see' strategies, they opted for actions that provided immediate certainty and reduced perceived risk:

> Which then becomes almost a self-feeding – a feedback thing, where they're [nursing staff] thinking, well I'd like to know, they don't think of me much, and now I really can't make a decision, and I'm going to play the safety card every time. P[3]

Other RNs described difficulties in being able to compartmentalise, such that uncertainty continued to intrude, even after making decisions.

> They do say that you should be able to compartmentalize, which obviously doesn't happen. Like, theoretically, you should be able to compartmentalize and turn around and say, you know, these were my eight hours, 10 hours, it's done. But sometimes you're woken up in the morning or in the middle of the night, mostly morning, turn around, you feel like you're still at work … P[2]

A few RNs described trying to avoid living with uncertainty after making decisions by seeking reassurance to alleviate their distress, particularly earlier on in their careers:

> I wanted to make sure the person is safe, their condition is not worsening. If we send someone to the hospital [I] always wanted to know how they are doing in the hospital, so we ring them [to find out]. P[10]

A small number of RNs described engaging in a reflective process (Nguyen et al., 2014) by questioning their thoughts and feelings regarding states arising from their uncertainty. This strategy was not described in the taxonomy proposed by P. K. Han et al. (2021). RNs often combined using the metacognitive awareness of their emotions with virtues, such as honesty and humility, to relieve the negative effects of uncertainty and guide their actions:

> I think it's the kind of thing that you become a little bit used to, and sometimes it's heightened when you're really unsure, or when it seems straightforward, but there's a little nagging voice, and so you learn to listen to the nagging voice behind your head. I think you develop strategies, and one of those strategies is about being really honest. So even when I see somebody who seems pretty straightforward, and seems, for example, to have an aspiration pneumonia, and I'm going to give them some IV antibiotics, but you know what, who knows, something else could be going on there, because we can't see, while we can't do the tests that we would do in hospital. P[3]

Relationship focussed strategies

Most RNs described sharing uncertainty with managers or colleagues. These conversations usually consisted of steps they took vis-a-vis resident care and were primarily discussed during team meetings and handovers. Specific debriefings were usually solicited with managers on an ad-hoc basis. Formalized supervision was only discussed by one participant, who noted:

> But on the other hand, [maintaining a high index of suspicion] does make you probably more, generally a more anxious person … That's what I found on supervision. P[12]

No specific agenda was identified regarding these consults, with conversations usually focused on seeking reassurance and relieving feelings of distress. Clarity regarding

aspects of care, and positive reinforcement regarding doing a good job in the context of an isolated workforce emerged as secondary benefits.

> But I think because you're going through all that internal upheaval, you need someone else who's probably been through exactly the same thing … P[13]

Uncertainty was rarely discussed explicitly in these conversations with colleagues, except for two participants who reflected on the impact of consolidating positive experiences of uncertainty by sharing these with a colleague.

> Probably not directly but when you sit and chat about certain situations or scenarios that have happened, I think you do it indirectly but not directly. You don't – definitely don't talk about how uncertain you felt at the time. P[8]

Feelings of shame regarding making mistakes or feeling uncertain, and fear of being perceived as being incompetent were commonly discussed as barriers to sharing uncertainty with colleagues:

> … It's not discussed a lot because - and that's what I see too is RNs don't want to admit to their mistakes or to be uncertain … P[6]

Sharing uncertainty with the resident was discussed by a small number of RNs in service of resolving issues of personal uncertainty. RNs that attempted to share their uncertainty with patients identified variations in tolerance of uncertainty among residents, as understood due to personality or limitations in their cognitive capacity. However, they emphasised the importance of clarifying the resident's understanding and communicating caring about the resident's distress despite these difficulties. RNs also discussed balancing uncertainty of the unknowns with certainty of the next steps when disclosing their uncertainty to residents.

> I am then just very, very honest and say, "this is what I think might happen", or "I haven't got an answer to that question", or "I truly don't know", or "I feel 90 per cent sure that this is the way it will go", and just being very honest, and "these are your options". P[3]

Alongside sharing with residents, most RNs described the need to involve families in making decisions. Some RNs acknowledged sharing the diagnosis and treatment plan with family members as part of routine practices, while others emphasised the importance of fostering trust with families. Some RNs described being honest about their uncertainty regarding diagnosis, and outlining the steps they would take to reduce uncertainty by using simple language and providing reassurance for the families. Consistency in following up on issues and providing updates, and identifying common goals between the family and the care team, were considered conducive in building rapport:

> So again, the biggest issue for families is that their loved one is forgotten and [not] followed up on … It's that follow-up and they need to believe that - they need to trust you. Look, it's so much easier to gain trust initially than to regain it once you've lost it. They'll never trust you again … P[6]

RNs described their own negative experiences of uncertainty as barriers to disclosing uncertainty (e.g., families reacting negatively). Family members' negative experiences with the organisation were also discussed in fracturing trust:

> It's very hard to come back once you've lost trust . . . all it takes is that maybe if 10 years ago our facility's done the wrong thing. P[5]

Earlier experiences with healthcare institutions could therefore be very pertinent for understanding (dis)trust.

Discussion

A major contribution of this study is the finding that these nurses' epistemological beliefs about uncertainty influenced their positioning on antibiotic use and decision-making. Additionally, previous experiences in navigating uncertainty seemed to further shape their attitudes, reinforcing particular approaches to managing clinical uncertainty. For example, difficulties forgiving oneself due to previous negative experiences and cognitive dissonance emerged as common themes related to disengaging with uncertainty. Cognitive-behavioural theories suggest that strategies like compartmentalisation, deferral to others, and avoidance rely on similar coping mechanisms that reinforce self-beliefs regarding inability to cope with uncertainty and/or anxiety in the long-term (Anderson et al., 2019). In contrast, the nurses in this study who employed strategies of reflection, cultivated curiosity and humility often combined these approaches to buffer against the negative effects of uncertainty. Many nurses reported that these strategies enabled them to engage in difficult conversations and assert themselves more effectively, with increasing confidence developing over years of experience. A small number of nurses described positive reappraisals of uncertainty in providing novelty, suggesting that positive experiences of navigating uncertainty might be protective in mitigating its negative effects.

Reflecting these shifts in uncertainty tolerance, research has demonstrated that uncertainty tolerance is amenable to change. This underscores the importance of interventions that encourage reflective and deliberative decision-making in clinical practice, and the development of metacognitive awareness (Stephens et al., 2023; Quinlan & Deane, 2021; Strout et al., 2018). Dual-processing models of decision-making suggest that the experience of negative emotions (e.g., anxiety) favour automatic processing of information (Djulbegovic et al., 2012). Therefore, engaging in deliberative reflection on affective and cognitive states is likely to facilitate more rational risk evaluations and promote uncertainty tolerance (Nguyen et al., 2014).

Additionally, difficulties in compartmentalising negative emotions and cognitions in the face of uncertainty emerged as a significant challenge, with some nurses avoiding difficult conversations with families as a means to regulate their distress. Social theories of risk emphasise the importance of relational dynamics in handling uncertainty and risk in everyday clinical practice – an aspect often neglected in traditional medical perspectives on uncertainty, which primarily focus on reducing clinicians' ignorance through the use of objective risk information (Brown & Gale, 2018; Raban et al., 2020). Findings from our study suggest that strategies focused on managing relational dynamics were particularly salient in addressing personal uncertainty and (re)distributing the burden of decision-making. However, nurses' self-perception as experts with specialised knowledge may act as a barrier to disclosing uncertainty, driven by concerns that doing so could undermine trust and credibility.

These concerns are well-documented among existing studies of healthcare professionals, who frequently hesitate to disclose uncertainty when anticipating negative reactions from patients, reinforcing barriers to shared decision-making (Simonovic et al., 2022). Furthermore, this expert stance shapes power dynamics in clinical practice, influencing how professionals navigate decision-making. The expectation of expertise may leave nurses vulnerable to cognitive biases that tend towards risk-reducing, action-based treatments, as shaped by societal norms that associate expertise with decisive action (Brown & Gale, 2018; Fox, 2000; Tarrant & Krockow, 2021). Additionally, existing literature suggests that family members often favour antibiotic treatment and/or increased GP involvement, particularly when previous negative experiences with facilities have eroded trust (Degeling et al., 2023). Taken together, these findings underscore the significance of relationship-focused strategies in fostering a shared understanding of uncertainty and rational risk evaluations among clinicians, residents, and their families.

Similar to prior research with physicians, nurses described engaging in multiple, often conflicting strategies to achieve an adaptive equilibrium between engaging with and accepting their uncertainty and disengaging with it to be able to meet the demands of their role (P. K. Han et al., 2021). The iterative and ongoing nature of managing risk was evident in the bi-directional process described by nurses, whereby they exchanged information with stakeholders while maximising attention to small changes in residents' health. A combination of ignorance and uncertainty-focused strategies was often used to resolve issues of scientific uncertainty and mitigate risk. Although efforts to enhance antibiotic stewardship in RACFs emphasise educational interventions that target professionals' ignorance (Raban et al., 2020), only a small number of nurses in our study endorsed using educational materials and most nurses preferred consulting with colleagues to resolve their uncertainty (McCaughan et al., 2005). The process described by nurses was similar to the concept of 'seeking coherence' previously formulated within the literature that places demands on professionals to continuously negotiate risk and relational dynamics when making decisions (McKenna & Gale, 2022).

Disengaging from uncertainty – whether by deferring to others, minimising attention to the future risk of AMR, or initiating antibiotics while continuing to investigate alternative causes of symptoms – underscores the substantial cognitive and emotional resources required of healthcare professionals in performing risk work related to AMR. RNs who disengaged from uncertainty were less likely to ask questions or actively participate in the shared burden of decision-making. Our findings illustrate that, in certain situations, disengaging from uncertainty in risk management may be an adaptive response. In contexts where immediate consequences must be addressed for a specific resident, technical risk assessments could be less useful, as they did not always align with the urgent, practical realities of frontline care. Rather than categorising coping strategies as inherently 'good' or 'bad,' this study suggests that nurses must often navigate an adaptive equilibrium – balancing competing demands to reach a level of certainty that enables decision-making in complex and uncertain clinical environments.

Our findings support the applicability of the taxonomy proposed by P. K. Han et al. (2021) in reconciling the various forms of uncertainty that influence nurses' daily practice in managing risks regarding antibiotics within RACFs. The results further contribute to the growing evidence on the psychological impact of uncertainty on clinicians and highlight the diverse range of strategies used to manage it – including previously underexplored approaches, such as avoidance and reflection.

The study adds empirical depth in understanding how clinicians 'seek coherence' at a micro level by organising strategies according to their aims in either curing uncertainty or palliating its negative effects within individuals (McKenna & Gale, 2022). Our findings also highlight limitations in contemporary uncertainty tolerance models, which often assume behaviours serve a single, specific goal (Han et al., 2021; Han et al., 2017; Pomare et al., 2018). Instead, we find risk management requires simultaneous deployment of multiple strategies that both address and accommodate uncertainty. Rather than reflecting sequential, discrete approaches, this process appears more dynamic and continuous, aligned with the concept of 'seeking ongoing coherence' (McKenna & Gale, 2022). The frequent co-occurrence of these strategies suggests that the management of uncertainty is a complex and dynamic process, subject to influence by internal (e.g., previous experiences) and external factors (e.g., team culture). These strategies interact and accumulate over time, shaped by organisational constraints and situational demands. Given that these strategies may not represent the optimal clinical response, developing uncertainty tolerance skills – including the ability to tolerate ambiguity and continue monitoring patients despite uncertainty – may offer a more constructive approach. Strengthening these skills could enable clinicians to navigate uncertainty more effectively while maintaining patient safety and stewardship priorities.

Lastly, our study highlights the significant cognitive and emotional demands on clinicians managing antibiotic-related uncertainty. Traditional stewardship interventions have focused narrowly on addressing knowledge gaps, overlooking the broader challenges clinicians face in managing uncertainty amid competing demands. While these interventions address scientific uncertainty, they fail to support clinicians in navigating persistent tensions and competing demands on their time and cognitive resources. These findings suggest the need for interventions that directly address the experience of uncertainty in clinical decision-making. Incorporating relational strategies could help clinicians manage negative emotional states while promoting more rational risk evaluation in antibiotic stewardship.

Limitations

Most RNs were experienced and held senior positions, so it is possible that this group was more aware of and engaged with stewardship than the usual workforce in RACFs in New South Wales. The study was also undertaken during the COVID-19 pandemic, which possibly limited participants' capacity to engage with uncertainty due to increased work demands. Three participants reported cultural differences in practices due to having been trained overseas, which could not be explored in depth. Finally, some of the strategies mapped onto the taxonomy more easily than others. For example, some uncertainty and response-focused strategies (e.g., avoidance/minimising attention; cultivating virtues/self-affirmation strategies; adjusting expectations/disengaging from uncertainty) tended to be more difficult to distinguish and required greater interpretation and discussion among the team.

Conclusion

Disentangling uncertainty and employing appropriate strategies to manage its effects relies on metacognitive processes that are conscious, deliberative, and resource intensive. While traditional approaches to managing clinical uncertainty emphasise

technical training and access to evidence-based resources (Shabestari et al., 2024), emerging perspectives suggest a more comprehensive socio-relational approach. Stephens et al. (2023) demonstrate that clinicians can exhibit adaptive behaviours despite negative emotional responses to uncertainty, suggesting that effective uncertainty management requires recognising and appraising emotional responses while developing context-specific coping strategies. There is growing recognition that healthcare education must address the behavioural, cognitive, and emotional dimensions of uncertainty management. The current study highlights the potential mechanisms through which individual and relational experiences of uncertainty shape clinical decision-making in the context of antibiotic risk. Furthermore, it provides insight into how response- and relationship-focused interventions can support clinicians in navigating uncertainty.

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