

## Antibiotic assemblages and their implications for the prevention of antimicrobial resistance

### Introduction

Antimicrobial resistance (AMR) threatens the treatment of common infections and surgery, organ transplantation and cancer chemotherapy, among other effects (Friedman et al., 2016). It is estimated that in 2019, 4.95 million deaths were linked with AMR, worldwide (Antimicrobial Resistance Collaborators, 2022). One key public health response to this threat is the reduction of antimicrobial use amongst individuals in community settings, particularly oral antibiotics for common infections. The WHO's Global Action Plan asserts that: "Resistance develops more rapidly through the misuse and overuse of antimicrobial medicines. Antibiotic use for human health is reported to be increasing substantially" (World Health Organization, 2015, page 3). In Australia, the government has noted that: "We all need to take responsibility and reduce our use of these important medicines where it is safe and appropriate to do so" (Australian Government, 2021a, page iv). 'Responsible use' discourse can be seen to form an opposition with 'misuse', and sometimes even 'abuse' (David et al., 2022) of antibiotics, with counterproductive effects. Simplistic responsible use/misuse binaries may not properly reflect the lived realities of antibiotic use in community settings, which are likely to be multiple and dynamic. Moreover, despite repeated public health efforts, antibiotic use amongst the general public has reduced very little in Australia (Australian Commission on Safety and Quality in Health Care, 2021b) and Europe (Eurobarometer 478, 2018). In response to these concerns, we employ assemblage theory to shed light on how antibiotics emerge in the lived experience of individuals residing in Melbourne, Australia. By attending to antibiotic use in the diverse circumstances of individual biography, emergent infections and healthcare practices, we aim to build a situated framing of antibiotic use(s) and generate new insights for AMR prevention.

## **Problematising antibiotic use**

Individual antibiotic use has been problematised since the inception of the antibiotic era.

Alexander Fleming famously told the story of Mr and Mrs X in his Nobel Prize speech in 1945.

In the story-cum-folk-tale, Mr X obtains penicillin from a shop to treat his sore throat, but not understanding the microbiological ramifications, he fails to complete the course of antibiotics.

He then passes on a more serious strain of bacteria to his partner who then dies. This master narrative of individual misuse has persisted into twenty-first century formulations of AMR prevention.

Reflecting this AMR prevention narrative of (ir)responsible antibiotic use, individuals are advised that they should not seek out antibiotics for coughs and colds, take antibiotics when and how they are prescribed, not share their antibiotics and dispose of them so that they cannot be used by others (World Health Organization, 2021). Primary care clinicians are asked to prescribe antibiotics only when necessary, consider waiting for a diagnostic test result before prescribing, discuss symptom management, and make decisions in conjunction with patients who should be informed about AMR risk and the need to strictly adhere to treatment instructions (Australian Commission on Safety and Quality in Health Care, 2022). These messages are supported by social marketing led by the WHO (2021) and conducted on an annual basis in participating countries and regions, including Australia (Australian Commission on Safety and Quality in Health Care, 2021a).

Despite these efforts, antibiotic use has only declined slightly and medical practitioners continue to prescribe against recommendations for some conditions. Eurobarometer (2018)

found a drop in reported oral antibiotic use from 34% in 2016 to 32% in 2018. Australian surveillance data showed a very slight increase in the proportion of the general population being given a prescription from 40% in 2018 to 40.3% in 2019 (Australian Commission on Safety and Quality in Health Care, 2021b). Also in Australia, a prescribing audit found that 81.5% of patients with bronchitis and 80.1% with sinusitis received an antibiotic prescription, treatments that are not recommended (Australian Commission on Safety and Quality in Health Care, 2021b).

The persistence of problematic antimicrobial use is commonly attributed to lack of AMR knowledge and a concept of 'patient demand'. Surveys find that general population AMR knowledge remains poor and is shaped by socioeconomic factors (Gualano et al., 2015; McCullough et al., 2016; McNulty et al., 2016; Micallef et al., 2017). Eurobarometer (2018) showed that the least affluent respondents were the most likely to fail AMR knowledge questions. Patient demand for antibiotics has been nominated by medical practitioners as one of the pressures they face in the prescribing relationship (Boiko et al., 2020; Coenen et al., 2006; Kohut et al., 2020). Incomplete AMR knowledge has also been associated with high antibiotic use (Salm et al., 2018). It is presumed that because individuals do not understand AMR, they seek out antibiotics when faced with an infection.

However, there is reason to doubt the lack of knowledge/misuse/demand thesis. In particular, the association might not be causal and indicate the action of additional, not well understood factors. Qualitative research in Melbourne, Australia, showed that only those individuals with a background or interest in science were able to explain AMR with any accuracy [deidentified]. In addition, individuals were mostly unclear about which antibiotics they had

used and may have confused them with other treatments. Lum et al. (2017) found that their interview participants in Queensland, Australia did not recall public awareness campaigns. These findings suggest that lack of knowledge might not be only a deficit of the individual, but also a feature of AMR knowledge that springs from the world of biomedicine, a problem which might limit the reach and impact of social marketing. The assumption that demand for antibiotics is seated in poor AMR knowledge might not itself explain very well how individual antibiotic use emerges.

Moreover, practitioner reports of patient demand are also somewhat suspect. Ong et al. (2007) found that medical practitioners were able to detect demand for antibiotics in 27% of patients who did expect them. Linder and Singer (2003) found that in their survey of patients with respiratory tract infections only 39% of patients wanted antibiotics, whilst 49% sought a diagnosis, 43% sought symptom relief and 13% sought reassurance there was nothing seriously wrong. van Driel et al. (2006) and Del Mar et al. (2012) have argued that patients are more concerned with symptom relief when seeking medical advice than they are in acquiring antibiotics. Knottnerus et al. (2013), noted that a third of Dutch women in their research who presented with urinary tract infections accepted delayed antibiotic treatment. In addition, researchers have found that when practitioners prescribe against guidelines they may be seeking to fulfil their caring role (Wood et al., 2007). They may be seeking to reduce other health risks, particularly for children (Cabral et al., 2015) and avoid health complications among patients with pre-existing conditions and lower socioeconomic backgrounds (Kumar et al., 2003). Relatedly, practitioners face time constraints and may therefore opt for risk averse prescribing (Teixeira Rodrigues et al., 2013). In Australian qualitative research, practitioners reported that they prescribed outside of guidelines to moderate patient anxiety and to

defend against the potential loss of custom (Biezen et al., 2017). Prescribers in remote, rural Australia have been found to prescribe outside of guidelines due to the exceptional needs of their patients, some of whom travelled many kilometres to access care (Broom et al., 2017).

Knowledge about antibiotic use, then, is circumscribed by its typically deracinated and reductive methods of inquiry. The problem of antibiotic use arises in science and biomedicine and therefore not in the life worlds of people who use antibiotics, an arrangement that may foster medical paternalism. This style of research also sharpens the (ir)responsible use binary that has had little or no traction in AMR prevention. The focus on (ir)responsible use also glosses over the complexities of lived experience, which include extra-individual structural, systemic and symbolic factors that may be important drivers of use. The (ir)responsible use binary is unhelpfully problematises the knowledge and intentions of the individual when it is likely that there are factors in antibiotic use over which they have little control. This approach to knowledge generation has the effect also of placing culpability onto the individual, loading antibiotic use with moral judgement and positioning the individual as the AMR prevention 'problem'. As a corrective for these epistemic deadends, it is vital to engage with the action of the individual in light of the material constraints and symbolic systems they are required to navigate when faced with the prospect of an infection that may require antibiotic treatment.

### **Antibiotic assemblages**

An alternative framing of antibiotic use is found in assemblage theory, which has been developed to explain ontological complexity (Deleuze & Guattari, 1984), including with reference to microbe-human interactions (Latour, 1993) and the indivisibly biological and social character of life (Haraway, 1999). Assemblages are understood to be composed of

heterogenous material and symbolic parts (norms, laws, knowledge, technology, embodiment, biomatter) that, in varying combination, have emergent ontological effects (see DeLanda, 2016; Lupton, 2019; Shildrick, 2020). Assemblage theory focusses analysis on the historically-specific, contingent and variable relations of material and symbolic parts in the becoming of life. Significantly, assemblages cannot be reduced to either seamless wholes or causal hierarchies of their parts.

Assemblage theory helps to avoid reducing antibiotic use to a singularity: antibiotic use is always complexly multiple. Using an antibiotic comprises variable relations of many parts, including embodied symptoms and threats to health; bacterial and viral diversity; medical power in consumer-prescriber relations; technologies and regulation of diagnosis, prescription and treatment; and the delivery and costs of antibiotics. Moreover, antibiotics are themselves multiple, in terms of narrow- and broad-spectrum effects on different kinds of bacteria. Antibiotics are commonly prescribed by different kinds of practitioners, for example medical doctors, veterinarians, nurses and dentists, and are used to protect human and animal health to ensure profitable food production.

Assemblage theory captures the temporal and contingent qualities of lived experience, which are very salient for how individuals respond to emergent infections and whether or not to use antibiotics. Assemblage theory acknowledges the scientific, economic and regulatory mechanisms of antibiotic discovery and manufacture (Bud, 2007), the economics of prescribing and purchasing (Flynn, 2021), and the interaction of biomedical authority and patient participation in the prescribing relationship (Ilfie & Manthorpe, 2020; Timmermans, 2020). In Australia, for example, antibiotics used in community settings are nearly always

prescribed by a medical practitioner (Australian Commission on Safety and Quality in Health Care, 2021b), though antimicrobials can be sourced online (Boyd et al., 2017), or without medical advice during travel [deidentified]. Some Australians may use leftover prescriptions or share them with their family (Anderson et al., 2020; Hu & Wang, 2015) or import them from countries of origin [deidentified]. Likewise, US research found that the most common form of off-prescription use were left over prescriptions (Olesen et al., 2018). This research also noted that those least likely to have health insurance were most likely to use off-prescription antibiotics and that in some parts of the US, injecting drug users source antibiotics on the street to treat infections. These varying patterns of antibiotic use, both on- and off-prescription and linked with regulatory structures and socio-economic status, can be understood as expressions of antibiotic assemblages.

Significantly, assemblage theory makes it possible to recognise that infections – and by implication bacteria – are also lively forces in antibiotic use. The symptoms with which infections are associated may shape how and when individuals seek assistance. Symptoms may be painful, interfere with everyday life or be distressing. They may portend progression to worse illness and, in some circumstances, they may be life threatening. For a child with an infection, symptoms may be distressing for them and also for parents and prescribers (Harris et al., 2020). Antibiotics, therefore, perform more than eradicating bacteria: they perform social functions regarding the management of time, reducing risk, alleviating negative emotions and shoring up the moral standing of the individual as responsible for themselves and dependent others, if that situation arises. Nuanced understanding of these features of antibiotic use is likely to deepen capacity to provide individuals with the necessary assistance to manage infections and use antibiotics effectively and perhaps less often.

Assemblage theory also focusses on discursive systems and their hybridisation with the material world, of which antibiotics provide an outstanding example. Antibiotics have a longstanding reputation as miraculous drugs and were marketed as such in the first decades of their introduction in the mid-twentieth century (Bud, 2007). They have undoubtedly saved many lives from infections and extended the capacity to conduct surgery, transplantation, cancer treatments and other life-saving medical interventions. These powerful material antibiotic effects are widely experienced by example, by individuals themselves in their life course, or more generally by populations accustomed to the expectation of easy treatment and prevention of bacterial infections and their effects. Importantly, this reputation of antibiotics provides proof positive of the healing powers of biomedicine and therefore helps to shore up the ontological basis of biomedical hegemony over matters of life and death. This symbolic-material power of antibiotics and implications for medical hegemony helps to explain the moral load that applies to the (ir)responsible use binary that generally informs AMR prevention. Assemblage theory allows purchase on these questions of symbolic worlds and power.

Assemblage theory also leads to consideration of individual action on health outside of the confines of the prescribing relationship. In neo-liberal governmental systems, individuals are expected to take charge of their own health as responsible agents of their life course (Ayo, 2012). A vast menu of consumer products are marketed to individuals so that they can manage their health (Dew, 2021). In Australia, it is estimated that complementary and alternative medicines – vitamins, diet supplements, immune boosters – are used by two thirds of the population (von Conrady & Bonney, 2017). Therapeutic pluralism is also a



common health care practice (Dew, 2021), for example, the blending of biomedical, home remedies, traditional medicine and religious understandings to fashion HIV treatment (Kelly-Hanku et al., 2018), care for autism spectrum disorder (Ha & Whittaker, 2022), and in cancer care (Hansen et al., 2020). Antibiotic users also exhibit this healthcare pluralism. Frawley et al. (2017) note that half the children in their study who had been seen by a GP or a paediatrician had also used complementary medicine. Reid et al. (2016) note that complementary medicine users not only also use biomedical services, but also use them more frequently. The discursive and social positioning of healthcare pluralism with and without antibiotics is a vital expression of antibiotic assemblages.

Crucially in the assemblage frame, 'antibiotic' is both an object and an effect. This dual potency is because 'antibiotic' is not only a pharmaceutical substance, it is also an assemblage property that affects the lives of microbes and humans. Assemblage theory reveals how antibiotic effects in life are made through the contingent co-mingling of antibiotic drugs, the individual and institutional health and social practices that deliver them into bodies, and the historical and economic circumstances under which these actions are possible. Antibiotic assemblages also gel with the notion of antibiotic infrastructures (Chandler, 2019), that is, how antibiotic assemblages have made later modern health care possible, and have become part of the life infrastructures for populations across the globe.

In this article, therefore, we explore the narratives of a sample of the general public in Melbourne, Australia, regarding their experiences of infections and how they act on them, including but not restricted to accessing antibiotics. In what follows, we explore how individuals enact their normative responsibilities to build and maintain their health, especially

considering the increasing risk of AMR. From our research we identify insights to assist in enhancing effective communications and policy for AMR prevention.

### ***Methods***

We used in-depth qualitative interviews to explore personal experience narratives regarding the use of antimicrobials in everyday life. As noted, individual antibiotic use in Australia is patterned by age-related and biomedical factors (Australian Commission on Safety and Quality in Health Care, 2021b). To engage with this diversity, we adopted these purposive selection criteria: a balance of men and women; a range of ages from 18 years +; a balance of respondents residing in inner and outer suburban Melbourne; a mix of educational attainments; and a mix of ethnic backgrounds. To gain the perspectives of those more likely to use antibiotics, we sought out: those with chronic respiratory disease; carers of children and the elderly; and those who had recently been hospitalised; along with participants reporting no health conditions. These criteria promoted the diversity of the sample to help build empirical and theoretical insight regarding the everyday use of antimicrobials and opportunities for reducing AMR.

Participants were recruited in community settings using: flyers displayed in public spaces; social media; and presentations to community groups, including Men's Sheds, Community Centres, Migrant Women's groups, Mother's groups and various digital communities. We found that many people were enthusiastic to speak with us and easily recruited 99 participants. This sample size reflected the number of variables in our purposive criteria which sought diversity as the basis for generating insight and theory. We recruited 58 women and 41 men aged between 18 and 70+ years of age. Thirty-five percent of the interviews

were born outside of Australia and English was not their first language. Twelve percent had not completed high school, thirty-nine percent had a post high school certificate or trade qualification, and forty-nine percent had a Bachelor’s degree or more university education. Thirty-two percent had Asian, SE Asian, Chinese or African backgrounds. Table 1 depicts the health status diversity of the sample. The sample was, therefore, socially diverse and reflected variable health experiences, in keeping with the aim of generating qualitative materials to develop insight and theory on the use of antibiotics.

Table 1. Participants according to health selection criteria (cell numbers do not total 99 as the individuals can appear in more than one selection criteria)

| Experience of chronic respiratory and/or immunity related illness | Experience of surgery (since 2008) | Parent of child under 15 years | Carer for partner/elderly relative | No chronic illness reported |
|---|------------------------------------|--------------------------------|------------------------------------|-----------------------------|
| 9 – self<br>3 – family members                                    | 52                                 | 37                             | 9                                  | 53                          |

The interviews were conducted by DL, with some assistance from MD and AW, primarily with individuals though some were couple interviews occurred according with the preferences of respondents. The interviews were conversational and exploratory to optimise the generation

of personal experience narratives. The interviews covered: management of health and infection; use of antibiotics; and knowledge of AMR. A short television news item about AMR was used to stimulate the discussion. Interviews were conducted at a time and location convenient to the participants and lasted approximately one hour. Written consent was obtained from the volunteer interviewees according to procedures approved by the [deidentified]. Pseudonyms are used in the presentation of the interview fragments.

The interviews were audio-taped and transcribed for input into NVIVO for analysis. We adopted an inductive and iterative method of analysis (Bryant & Charmaz, 2019) oriented to the meanings and narratives of infection, antibiotic use, and AMR. Our analysis therefore linked existing knowledge and understanding in the literature with themes that emerged in the interviews themselves. Using an iterative procedure of open coding, constant comparison and recoding (Bryant & Charmaz, 2019), we developed themes on medical pluralism in connection with antibiotics (deductive coding) and the different ways in which interviews spoke about managing infections (inductive coding). The analysis was also team-based. Five interviews were read by the research team who identified themes and stories as the basis for an agreed code book. The code book was used by DL and MD to code further interviews, though these codes changed through iterative constant comparison. Written memoranda were prepared on key themes and discussed by the research team to deepen and nuance the analysis. These written memoranda formed the basis of this manuscript.

## **Findings**

Antibiotic use was a common but infrequent experience among our participants, although those with chronic lung disease, for example, did appear to have used antibiotics more often

than normal for our participants. Recollections of lifetime experience with infections was diverse, with reference to urinary tract infections, chest infections, colds, sinusitis, throat infection, tonsillitis, earaches, eye infections, foot infections, post-surgery antibiotic use, to name a few examples. Not all of these reported infections were treated with antibiotics. Importantly, too, the recollections provided did not hinge on the antibiotics themselves, which were mostly spoken of in general terms. The tacit status of antibiotics may reflect the fact that these products are most often sourced via prescription in Australia (Australian Commission on Safety and Quality in Health Care, 2021b), which may mean that only the prescriber and dispenser are aware of the antibiotic brand and type. Very few reported using antibiotics off prescription, for example, sourcing them in countries where they are freely available without a prescription and sharing among family members.

These observations are important because they suggest that antibiotics are not necessarily the entry point for general public management of an infection. Moreover, because antibiotic use emerges for most individuals irregularly and under particular circumstances, the conditions of use vary considerably in terms of the infection type, the health status of the individual, their approach to healthcare and if they were responsible for dependent children. As we detail below, antibiotic use was embedded in diverse responses to supposed infections. While some took immediate action, for different reasons, others attempted over the counter treatments and alternative medicine. Some spoke of the moral expectations and risk assessments that arose if a child was thought to have an infection. Some also recounted how they sought to prevent infections through care of the body or avoided antibiotics on their own accord or due to the advice of a medical practitioner. This diversity underscored the assemblages within which antibiotic use can arise. In contrast with conceptualisations of

antimicrobial use based on the *a priori* premise of (ir)responsible use, our analysis creates a picture of individuals reflexively managing the different effects and potentials of infections, their bodies or bodies of others, healthcare practices and the use of treatments, including antibiotics. Our analysis provides a corrective to the deficit model of appropriate antibiotic use and suggests new entry points for AMR prevention.

### *Preventing infection through healthcare pluralism*

Our participants described a range of strategies to prevent infections that intertwined various philosophies of medicine. Importantly, these infection prevention assemblages were ‘lived with over time’ and revisable, providing some assurance but also time-wise flexibility given changing personal circumstances and health status. Most people employed the concept of self-defence immunity [deidentified] to fashion prevention methods. For example, Leonard, spoke of a focus on his immune system given a history of what he said were chest infections:

... because I’m prone to having chest infections I just make sure that I’m always on top of it. And normally when I know that my chest is infected I, you know, just try to, I take garlic tablets or I take, you know, horseradish, lemon and ginger. As much, whatever I can get to try and keep my immune system up. (Leonard, 50-60, chronic illness)

Leonard endorses a widespread view that one possesses an immune system that is amenable to careful stewardship (Davis, 2022). In line with this focus on immunity and health, Fiona explained that breastfeeding was the reason why her child had never used antibiotics. She spoke of ‘a boosted immune system from mum to baby’ which had ‘given him a boost, you know, compared to other children who’ve been more sickly than he has been’ (31 – 40,

healthy, carer for toddler). Similarly, Dana who lived with a chronic immune-related illness understood that her body needed to be monitored to prevent illness:

... if I feel rundown or, 'cause I've been anaemic a lot, if I feel like I'm very low in iron, I know my immune system's gonna go down. So I'll try and maybe take a bit of iron supplements or their garlic and echinacea. And then once a week I try and remember to take a multivitamin. But that's pretty much it. (Dana, 18-30, chronic illness).

These participants endorsed the view that their actions sustained theirs and loved ones' health and, by implication, had strengthened the capacity of bodies to prevent or cope with infections. They demonstrate reflexive engagement with embodied health and illness and the capacity to draw on prior knowledge and consumer products to manage healthcare

#### *Early medical intervention to prevent escalation of infection*

Some respondents reported that they sought out antibiotics to avoid the escalation of symptoms and therefore the risk of worse illness. These respondents often had underlying health conditions (such as asthma, regular tonsillitis, undergoing chemotherapy and suppressed immunity), previous experience with infections, and a regular relationship with a prescriber. They spoke of early intervention as a responsible way of reducing harm and described it as normative for their chronic illness. Craig, in his 50s and with chronic lung disease, explained how he monitored his health and responded quickly to any signs of ill health:

Craig: Just 'cause I know my, I know my body or my body clock. And as soon as I get symptoms I'll go and see my doctor to get some medication, to try and stop myself

getting the flu. 'Cause once I get it I don't know where I am. It could have a run of infections.

DL: So what sort of symptoms do you have when you get these chest infections?

Craig: I get really heavy ... breathing. It affects my breathing. My chest gets real heavy. I bring up heaps and heaps of phlegm. Stuff like that. (Craig, 51-60, chronic lung disease).

Craig spoke of self-knowledge that seemed to be the result of a lengthy period of time with lung disease and the interpretation of changes in his body as signs of the need to consult the doctor. His practice was preventative since it was seen as a method for reducing the potential for further harm. Craig's account and others like it from our participants were suggestive of an infection prevention culture based on antibiotic use among those with chronic illness.

Some individuals sought speedy intervention, however, not because of a pre-existing pattern of antibiotic use. They responded to the pressing urgency of an apparent infection itself. In this infection story, Tamara spoke of a cut foot and a visit to the doctor:

DL: So you said you had a foot infection. What happened?

Tamara: I was at the beach and I cut my foot on a really sharp shell. I think that there are some really nasty bacteria on the rocks and the shells at the beach, and something got in there, and it was like horrific. Like my foot was swollen. I couldn't walk for two weeks. It was really bad ... .. it was quite traumatic ... .. I was okay the day of it. Like I was like, "Oh, I shouldn't really be walking on this." Cleaned it in the salt water. Went home. ... .. The cut was maybe like two, three centimetres and I was fine. It was like on a Saturday this happened. I went to work on Monday and I was like,



“Oh, it’s pretty bad. Like I can’t really be on my foot right now,” so I left work and went to the doctor ‘cause it was just getting worse and worse, like swelling and there was a lot of heat. And like it was going a bit purple.

DL: And so what did the doctor do and say?

Tamara: The doctor cleaned it and then was like, “This is like pretty bad. Like we need to get you on antibiotics asap or else it might go like septic.”

(Tamara, 20-30, chronic illness)

This example captures a form of infection care that is particular to an accident and rapidly changing symptoms. It underscores how individuals may be called on to respond to an unprecedented infection. As Tamara suggests, her symptoms forced her to take action implying that infection is itself a key and recognisable element of antibiotic assemblages. Like Craig, Tamara spoke of seeking help to halt the progression of illness in a timely fashion, suggesting in another way how antibiotics are mingled with the management of embodied time and the prevention of illness. Tamara’s story can also be read as an important variation on the miraculous cure narrative associated with antibiotics when they were first marketed for use (Bud, 2007) and produced what were seen then as amazing cures for life threatening infections. Tamara’s story makes antibiotic use and its effects seem quotidian, though welcome. Missing is discourse on the extraordinary powers of antibiotics over threat to life. We cannot know how Tamara’s infection story would have ended without antibiotics, but it might have been a serious threat to life. It is important to recognise, then, how twenty-first century infection management depends on what appear to be the accustomed life-saving benefits of antibiotics.

### *Self-management of infections*

Far more common in the accounts we collected was 'self-management', where participants spoke of seeking to relieve the symptoms and overcome infection without medical intervention. To mount this approach, respondents spoke of faith in their immune systems and belief in the efficacy of lay or popular medicines. Self-management was also associated with an extensive array of treatments, including acupuncture, Chinese medicines, cough medicines, vitamins, garlic, gargles, herbal teas, hydration, pain relief and rest. Self-management was depicted as a sequence of treatment options that may or may not culminate in a visit to the doctor. In this interview fragment, Riya explained how she managed minor infections, in part based on advice from her doctor:

I use salt and turmeric powder, and do gargling with that. And, if it does not work, then I start using Betadine gargle. And then another type of antibiotic I make is a syrup. Like I make like the ginger then and black pepper. Make in a paste and I put with it a little bit of water. And then that syrup I give them [Riya's children] if they have a chesty cough. Sometimes it works, it becomes better. If it's not working, then I go to a doctor.

DL: Then the doctor gives you antibiotics? [Yeah] So at what point do you decide to go to the doctor?

Riya: First thing, I see if the fever is going down. I give Panadol. And if sometimes it is becoming severe, then I go to the doctor.

[later]

DL: And does the doctor always give you antibiotics?

Riya: No. They say, “First you try the Panadol, simple medicine, and if it does not work, if it’s like taken too long - two weeks - then I’ll give you the antibiotic.” So that’s what I do. Also what I do, first I try that remedy. After two weeks, then I go to the doctor. Then he gives me the antibiotic. (31 – 40, 3 young children, healthy)

Riya describes an elaborate combination of over-the-counter treatments and homemade remedies in her self-care regime. Notably, the word ‘antibiotic’ is used to denote one of her homemade preparations, suggesting how the meaning of the word is not necessarily tied to products that are gained via prescription. This use of the term shows how, from some individual’s points of view, ‘antibiotic’ is a property of any treatment that might reduce an infection. It therefore reflects an important separation of uses of the term antibiotic in therapeutic plurality and orthodox biomedicine. Note also the reference to time in relation to observing the effects of homemade remedies, monitoring fever, and the two-week wait recommended by the medical practitioner. As Craig and Tamara did in relation to preventing the progress of infections, Riya suggests the temporal organisation of self-management, that is, a movement through ‘simple medicine’ through to the medical consultation.

#### *Caring for someone else*

Our participants also indicated that antibiotic use emerged when caring for a dependent person, where responsibility for them was an important theme. Diana related a story of her daughter’s spider bite during a holiday overseas and the moral considerations and risk calculations associated with antibiotic use:

She was admitted and treated, and he [overseas doctor] said it was probably the bacteria from the spider’s mouth that was causing a reaction in her toe ... .. And she

had to have the antibiotics, otherwise it would end up as a secondary infection and it'd get worse and worse ... .. I wasn't all that confident in his diagnosis and I don't like to, especially with kids, I don't like them to go on antibiotics unnecessarily. But, in the end, you kind of had to trust him ... .. I was left without really a choice. (Diana, 41 – 50, no chronic illness, care of 2 children)

Diana is positioned in her narrative as subject to forces and imperatives that are not entirely within her control. Like Tamara, she is swept along by the potential harm of the infection itself and into antibiotic use, but with some misgivings. Her reluctance to use antibiotics does echo social marketing campaigns encouraging the reduced use of antibiotics. But it also shows how this risk awareness adds to the challenges of managing the risk for a dependent child. Van Hecke et al. (2019) interviewed parents about antibiotic use for their children and have argued that advice about AMR prevention needs to articulate more closely with the anxieties and practical concerns of carers, a finding that agrees with ours.

#### *Delaying the use of antibiotics*

Even when participants did consult doctors and were given a prescription for antibiotics, they did not necessarily fill the script and use them. For example, Helena explained how she delayed filling a prescription for her child:

Even sometimes when the doctor prescribes antibiotics we try to wait a little and see how she goes. And maybe get a second opinion, especially with kids. (31 – 40, healthy, carer of 2 children)

Helena said that she preferred to continue with her home remedies in the belief that the

child would recover. In this situation, the prescription acted as a form of insurance against a possible future risk, resonating with the value antibiotics appear to have for preventing future illness in the narratives of other interviewees. Yvonne spoke of seeking antibiotics as a form of insurance against future risks:

Yvonne: She was really small and she kept getting ear infections. And we travel to the farm [of a relative] a lot and I was always worried about when we get into the middle of nowhere and she's got this really bad ear infection.

DL: So how far away is the farm?

Yvonne: Four hours. It's in NSW and so often I would ask the doctor for antibiotics but I wouldn't necessarily take them unless we got up there and it progressed really badly. So I just managed it with Panadol and Nurofen [analgesics] and stuff. That was the doctor's preference anyway because they said it generally just sorts itself out. (41 – 50, healthy, carer of 2 children)

For Yvonne, the insurance effect of the script is heightened due to her life circumstances. At the isolated farm she knows she is unable to access medical assistance if her daughter's infection worsens. As a well-prepared parent, she reports taking steps for such an eventuality and has alleviated any angst she may have felt about taking a sick child to an isolated location. Given their commitment to their children's health amplified by public expectations that parents, especially mothers, must always take action to care for their children's health, they were prepared to use them should the need arise. In this light, antibiotics are means of exercising responsible parenthood. They help parents to manage infections during everyday life's events and uncertainties.

### *Avoiding antibiotics*

Another important theme was the value of avoiding antibiotics linked with a personal position on their value and/or attributed to medical advice. Rebecca spoke of her desire to avoid 'popping pills', for example:

I'll use Chinese medicine instead. I'll have cupping 'cause that tends to help with the chest infection. It moves it through and breaks it up a lot quicker. So, if I can, I'll go to a Chinese doctor and I'll get acupuncture and cupping instead. And then usually within 10 days I'm improving so I don't need to go to the doctor ... .. And I don't believe in popping pills. (41 – 50, recent surgery, healthy)

Rebecca positioned herself as proactively avoidant and appeared to have internalised a view that antibiotics might be a threat to health. Similarly, Ingrid wanted to avoid unnecessary antibiotics and spoke of her desire for doctors to offer alternative treatments:

And I guess perhaps what people can do if it's sort of a low-level illness without having to run to the doctor. Like the doctor shouldn't be sending somebody home with a box of antibiotics. They should be saying, you know, "Go home and get under a doona blanket, and take some vitamin C, and perhaps some elderberry syrup," or something like that. Like it seems to be people just want an answer, which is fine. I mean like you go to your doctor because you want them to take care of you when you're sick but I don't think the answer always needs to be antibiotics. (31 – 40, auto immune disease, carer of toddler)

Ingrid's account queries the actions of medical practitioners who prescribe antibiotics when home remedies might suffice. Narrative on the importance of avoiding antibiotics accords

with public health messages advocating the reduction of antibiotic use (Australian Commission on Safety and Quality in Health Care, 2021a). It suggests that AMR prevention has had some impact and or that the ground on which to build effective prevention education is for some members of the general public, in place and understood.

## **Discussion**

Using assemblage theory (DeLanda, 2016), our analysis helped us to sidestep the antibiotic (ir)responsible use frame and develop a picture of the reflexive management of complex healthcare considerations pertaining to infections and antibiotics. Antibiotic use was shown to be not entirely under individual control, tied as it was to the manifestation of the possible infection itself and prescription by a medical practitioner. Actual or possible infection was an embodied experience of signs and symptoms, the future of which was potentially altered by crafting different methods of self-care and the use (or not) of antibiotics. Antibiotics were depicted as both helpful and possibly harmful, and therefore subject to some tension if and when they were used.

Significantly, antibiotic use was not depicted as the ultimate goal of healthcare. Rather, the responsible management of the future health of the body was paramount. Personal responsibility was a focus and for parents and imbued with moral imperatives on making sound choices for their child's welfare. The narratives suggest that antibiotic use needs to be understood in conjunction with infection prevention practices, the delayed use of antibiotics, avoidance of them, and the self-management practices that may precede a medical consultation. For our research participants, these approaches were all possible and well understood courses of action that could be deployed according to emerging circumstances.

Antibiotics themselves were somewhat vaguely narrated and respondents exhibited sharper focus on the healthy course of their and loved ones' lives. For those with chronic illness, medical consultations were used to pre-empt more serious illness. We also collected stories of antibiotic prescriptions as forms of insurance against future risks.

Our participants exhibited therapeutic pluralism in their management of infections that incorporated easily accessible treatments, homemade remedies, vaccination and medical consultations. They sought to manage symptoms with alternative pharmaceutical remedies such as analgesics and cough syrups as well as self-medicating with herbal teas, infusions and supplements or seeking acupuncture or Chinese medicines, as others have found (Frawley et al., 2017; von Conrady & Bonney, 2017). When doctors were consulted, participants overall stated that they accepted medical advice, including the use of antibiotics or a recommended delay in the hope that symptoms self-resolved, as others have suggested (Del Mar et al., 2012; Van Driel et al., 2006). As others have noted too (Cabral et al., 2015; Del Mar et al., 2012; Van Driel et al., 2006), most patients accept not being given antibiotics but do want to be offered strategies for managing symptoms.

Our participants' stories indicate several points of entry for AMR prevention. Participants endorsed the need to reduce antibiotic use, which coheres with the policy objective to reduce the overall consumption of antimicrobials and improve the application of them according to clinical guidelines (Australian Government, 2021b). Self-management and its strong temporal quality also reflect policy on AMR prevention. Riya, Wei, Rebecca, Ingrid, Helena and Yvonne express valuable examples of infection management that delay any possible turn to antibiotics. Also reflecting the significance of time, individuals show



themselves to be deeply engaged with preventing worse illness through self-care, the use of antibiotics or as a form of insurance for possible infection turning for the worse. Providing advice that captures the varied lived experiences of embodied time and infection risk management may be useful for individuals. Moreover, encouraging infection self-care and monitoring over acceptable timeframes may help individuals to participate in the reduction of antibiotic use and therefore AMR prevention. The therapeutic pluralism described by our respondents and their emphasis of immunity might also be valuable starting points for advice on AMR prevention. Building messages on how individuals think about and act on infections may make sense for them, since it would reflect more closely how they live their lives and respond to health threats. Other important considerations were the moral imperatives and tensions faced by parents. Parental responsibility for the welfare of a child or care of an elder complicates prescribing and for those aware that antibiotic use should be reduced, may produce a form of cognitive dissonance over what should be the best course of action. It might be beneficial to provide advice for parents and carers that helped them to reflect on these caring pressures and construct feasible plans of action. Our analysis also indicates that social marketing for the reduction of antibiotic use could be strengthened with practical *in vivo* assistance for prescribers and consumers along the lines we have suggested.

Significantly for AMR prevention, antibiotics are spoken of as 'part of the healthcare furniture' and are almost invisible to individuals, except in general terms. For some, too, non-antibiotic treatments are afforded antibiotic powers because they are applied to infections, underlining how 'antibiotic' is an effect of action on health as well as a specific class of pharmaceuticals. Moreover, the original status of antibiotics as miracle cures (Bud, 2007) has

become submerged in a context where publics are accustomed to their effects, even for serious infections (see Tamara above). These observations help to explain why social marketing on antibiotic (ir)responsible use has failed to have much impact on the knowledge and practices of individuals (Price et al., 2018), who are more occupied with assembling diverse strategies for managing infections. This antibiotic assemblage point of view serves as a valuable corrective for the reductive and anthropocentric focus on (ir)responsible use. It promotes the insight that antibiotic effects – however they are assembled – are more significant for most individuals than are antibiotic pharmaceuticals themselves. Effective AMR prevention, therefore, may be found in engagement with the variable and contingent ways in which antibiotic assemblages are made in everyday life. Through a turn to effective and timely care of infections, AMR prevention might have increased value for individuals and, on that basis, they might be assisted to more easily and effectively participate in the prevention of AMR.

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