Antimicrobial Resistance

in New Zealand

Updated August 2016

New Zealand position paper

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Definitions

Antimicrobial resistance (AMR)

Resistance of a microorganism to an antimicrobial drug that had previously been effective for treatment of infections by this organism. Resistant microorganisms including bacteria, fungi, viruses and parasites are able to withstand attack by antibacterial drugs (e.g. antibiotics), antifungals, antivirals, and antimalarials. Standard treatments then become ineffective and infections persist, increasing the risk of adverse outcomes, including death, and spread of the infection to others[1].

Antimicrobial stewardship (AMS)

Coordinated interventions designed to improve the appropriate use of antimicrobials. Antimicrobial stewardship promotes the optimal use of antimicrobials through selecting the appropriate agent, dose, therapy duration and administration route. The major objectives of antimicrobial stewardship are to achieve best clinical outcomes related to antimicrobial use while minimising toxicity and other adverse events, and to limit the selective pressure on bacterial populations that drives the emergence of antimicrobial-resistant strains[2].

Executive Summary

The New Zealand Adult Medicine Division Committee (NZ AMDC) of the Royal Australasian College of Physicians (RACP) represents clinicians practicing in a number of subspecialties in New Zealand. Antimicrobial resistance (AMR) as a major concern in global public health, with the potential for major impacts on the health of New Zealanders and on New Zealand's health system.

The RACP sees AMR as a multifaceted public health issue. RACP members are concerned about rising rates of resistance to antimicrobials which have the potential to impact the delivery of community- and hospital-based patient care. AMR poses critical threats to the health of populations globally: directly through increases in untreatable infections and indirectly through economic impacts on gross domestic product and trade.

The RACP believes a national, evidence-based approach coordinated by central government and involving Ministries, District Health Boards (DHBs), the private sector and comminities is vital to contribute to the global effort to combat AMR.

This paper outlines the international context of AMR. It identifies the three most common pathogens showing increased resistance to antibiotics, and a risk for the health of New Zealand populations. Minimising the impact of these and other multiple-drug resistant organisms (MDROs) through clinical governance and antimicrobial stewardship (AMS) is essential in the areas of infection prevention and control (IPC) and prescribing guidelines.

The RACP encourages physicians to:

- Remain informed and up to date on the emergence of AMR in New Zealand and globally, and which resistant pathogens will have impacts on New Zealand populations

- Collaborate with colleagues to strengthen hospital IPC programmes and report any findings and experiences to inform quality improvement

- Engage with clinicians experienced in infectious diseases, pharmacology, training, continuing professional development, and work with DHB management on primary and secondary care AMS programmes

- Educate consumers by ensuring people are provided with information and resources to support their understanding of the relationships between antibiotic consumption and antimicrobial resistance.

This paper provides physicians practicing in any subspecialty with an overview of current issues related to the emergence of antimicrobial resistance, and outlines how physicians can be involved in existing antimicrobial stewardship programs in their workplaces.

Physicians are encouraged to lead the health sector in efforts against increasing antimicrobial resistance in New Zealand.

Recommendations

The RACP supports a centrally coordinated, national initiative to respond to increasing antimicrobial resistance in New Zealand. Antimicrobial resistance is a national and global public health issue, and New Zealand must contribute to international management AMR approaches, such as implementing the World Health Organization's (WHO) Six-point Strategy.

The RACP supports the Ministry of Health proposal to implement a stand-alone five-year national plan to combat AMR and minimise potential risks from AMR to the New Zealand public.

A national AMR plan based on international best practice incorporates:

1. A single national prescribing guideline

- The RACP will work with the Ministry of Health to contribute Fellow expertise to develop new guidelines and inform current best practice
- The RACP supports the revitalisation of the Wise Use of Antibiotics campaign to inform the public on antimicrobial resistance

2. A national quality improvement programme

- The RACP supports quality improvement as a central component of the national plan to improve clinical practice

3. Clinical networks and multidisciplinary clinical governance approaches

- The RACP will work with DHBs to support governance of AMR

4. Support for health practitioners to be proactive, remain informed and engaged in stewardship programmes to improve patient outcomes

- The RACP's EVOLVE initiative informs practitioners of low-value clinical interventions
- The RACP's education, training and continuing professional development programmes support physicians to engage with developments in clinical practice

The RACP believes New Zealand cannot rely on its geographic isolation to prevent the impacts of increasing rates of antimicrobial resistance globally. As people travel nationally and internationally with greater frequency, visit multiple countries and stay in countries for extended periods of time, drug-resistant strains of different pathogens will be introduced into New Zealand at an increasing rate. Early action to prevent this situation is essential.

Introduction

No action today, no cure tomorrow: why antimicrobial resistance now

AMR is recognised as an emerging risk to global population health due to the increasing use and misuse of antimicrobials worldwide, inadequate IPC programmes, and a lack of development of novel antimicrobials[3].

Since the discovery of penicillin, antibiotics have been considered the "magic bullet" in combating infection[4]. Infectious diseases such as pneumonia and tuberculosis, which resulted in high mortality rates prior to the 1940s, could be treated effectively and economically. Antibiotics could treat infections entering the body through a cut or scratch, or acquired following surgery or childbirth.

In his acceptance speech for the 1945 Nobel Prize for Medicine, Alexander Fleming warned that bacteria would eventually develop resistance to penicillin. By the 1960s, 80 per cent of community- and hospital-acquired *Staphylococcus aureus* (*S. aureus*) isolates were resistant to penicillin[5, 6]. While developing resistance to antimicrobials is an expected evolutionary process for a microorganism, resistance is accelerated by widespread use of antimicrobials (including overprescribing), and drug misuse in both human and food-producing animal populations[5].

Resistant strains of a virus or bacteria can propagate and spread through populations in countries where IPC is poor, for example where humans and animals are in close contact or poor sanitary conditions. Other contributing factors are unrestricted purchasing of antimicrobials over the counter without a prescription, and the quality of these medications[1, 5, 7].

Inadequate IPC programmes and the absence of programmes to develop new antimicrobials undermine the ability of prescribers to provide effective treatment for a growing number of infections. The projected effects on people and economies show spiralling costs. Without action, AMR could be attributed to 10 million deaths each and cost 100 trillion USD to the global economy by 2050[7].

The RACP welcomes the Ministry of Health's AMR Action Plan scheduled for release in May 2017. The RACP considers this an important step forward and supports inclusion of a national antimicrobial prescribing guideline, and systematic measuring, monitoring and surveillance of AMR to include animal populations, as well as surveillance of antimicrobial consumption in DHBs and community settings. The RACP notes that the New Zealand Veterinary Association also suggests a multidisciplinary 'one world, one health' approach to raise awareness of the links between animals, humans and the environment, due to the threats from AMR on human and animal health[8].

This paper outlines the international context of AMR and its impact on New Zealand. It identifies three common pathogens showing increased resistance to antibiotics, and a risk for the health of New Zealand populations. Minimising the impact of these and other MDROs through clinical governance and AMS is essential in the areas of IPC and prescribing guidelines.
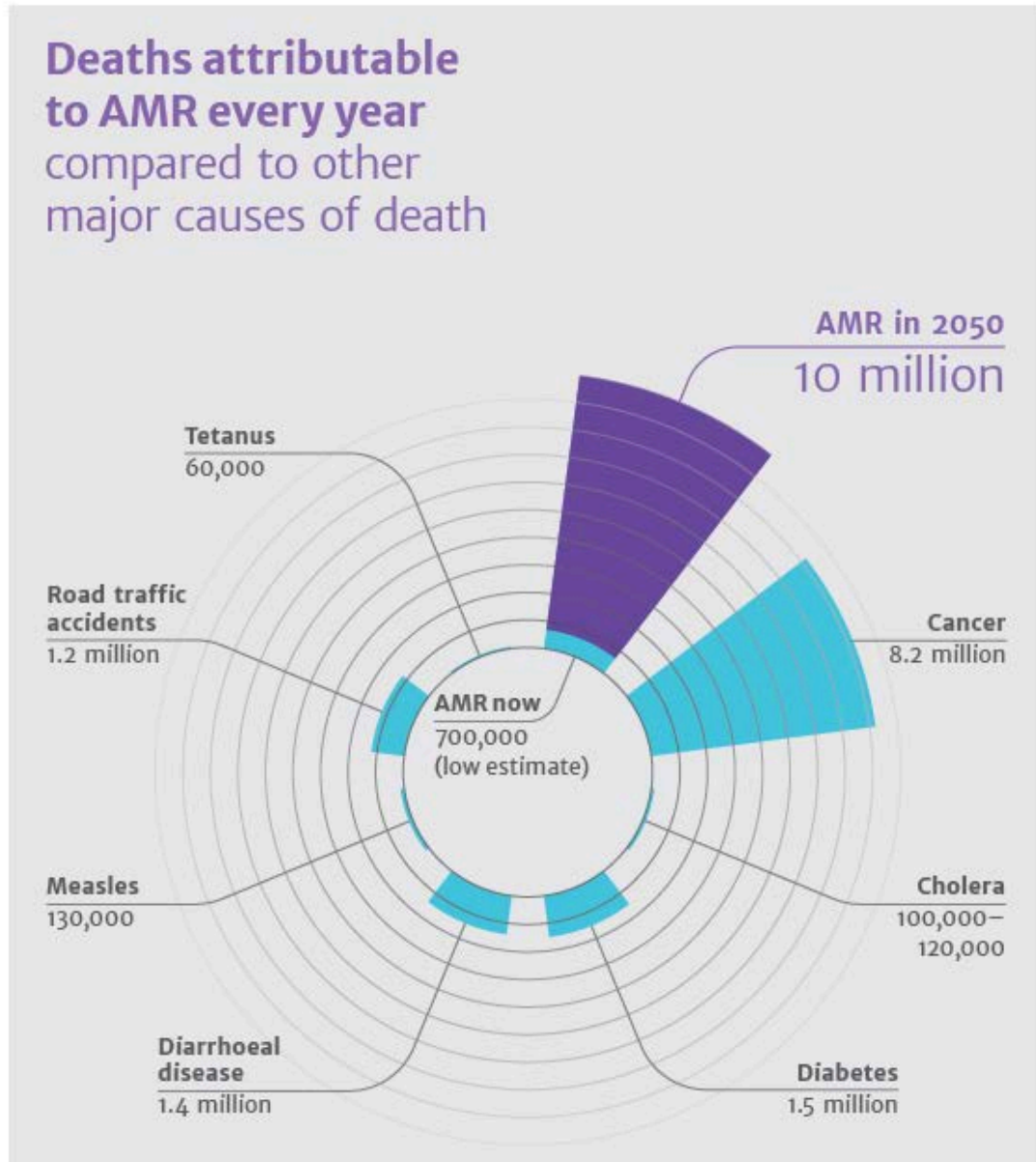
Figure 1. Major causes of mortality worldwide (2012). Without intervention, deaths attributed to a resistant infection could reach 10 million annually[7].

The WHO Six-point strategy

In 2001, the WHO announced a global strategy for the containment of antimicrobial resistance, calling for an international response to position AMR at the forefront of health policy[9]. Member countries were encouraged to initiate surveillance programs monitoring resistance in human and animal populations, and introduce national frameworks and best practice guidelines to control the misuse of antimicrobials in populations.

The WHO's 6-Point Strategy to combat AMR was released on World Health Day 2011, outlining critical actions for all stakeholders to engage in locally to promote change on a global scale. The Strategy encourages countries to introduce central government-led programs to combat AMR, including national frameworks and surveillance with a focus on quality and safety[9]:

1. Adhere to a comprehensive, financed national plan with accountability and civil society engagement
2. Strengthen surveillance and laboratory capacity
3. Ensure uninterrupted access to essential medicines of assured quality
4. Regulate and promote the rational use of medicines, and ensure proper patient care
5. Enhance infection prevention and control
6. Foster innovation, research and new tools

A 2015 evaluation examined national responses to AMR within the WHO regions and assessed members states' ability to meet the Strategy[10]. The report notes:

- Only 25% of member states had a comprehensive national plan
- Public awareness of AMR remained limited, even among healthcare workers
- Few member states had national IPC programs, and fewer programs in all tertiary hospitals.

To effectively contain and control AMR countries must initiate a coordinated approach, encompassing government, industry and society. No single measure is likely to be successful in isolation. New Zealand will need to ensure comprehensive surveillance, particularly where there are regional and geographic healthcare disparities, and in community settings[10].

Three common pathogens of concern in New Zealand

Antimicrobial resistance, healthcare associated infections and vaccine-preventable infections were among the most common public health threats identified by high-income countries in the Western Pacific region, which includes New Zealand and Australia[10]. Of the nine bacterial pathogens identified by the WHO in 2015 as being of international concern, three are of particular concern in community and hospital settings in New Zealand:

- Community-associated methicillin-resistant *S. aureus* (CA-MRSA)
- *Enterobacteriaceae*
- Multi-resistant *Neisseria gonorrhoeae* (*N. gonorroheae*)[10, 11.]

S. aureus, *Enterobacteriaceae* and *N. gonorrhoea* are medically important bacteria and increased resistance in these and other pathogens present a major threat to human health.[11] We have chosen to focus on resistance in these pathogens as these bacteria are common in community and hospital settings, present as a range of infections (for example, skin and soft tissue infections (SSTI), urinary tract infections) and are increasingly resistant to major classes of antibiotics including penicillins, fluoroquinolones and third-generation cephalosporins.[11] The impact of resistance is driven by practices such as antimicrobial prescribing and consumption, the profile of infectious diseases in the community, population movement and IPC programmes.[1, 3, 7]

Community-associated methicillin-resistant Staphylococcus aureus

New Zealand has a higher prevalence of *S. aureus* infections than in frequently-cited comparison countries, such as the United Kingdom and Australia. *S. aureus* can be classified as invasive, as in cases of respiratory and bone infections, or non-invasive, such as SSTI. The majority of *S. aureus* infections in New Zealand are due to community-associated methicillin-susceptible *S. aureus* (CA-MSSA), rather than CA-MRSA, although presentations of the latter have increased since early 1990s[12, 13].

New Zealand has seen a significant change in the epidemiology of *S. aureus* disease in the last 25 years, notably in *S. aureus* SSTI, with higher rates of infection in Māori and Pacific populations, low-socioeconomic communities and children under 5 years of age. In Auckland, rates of non-invasive CA-MSSA disease increased substantially from 2001 through 2011, when the incidence in children aged 0-5 was 800 per 100,000 population[13].

One of the key contributors to AMR globally is widespread and often unregulated or overuse of antimicrobials. While this is exacerbated in countries where antimicrobials are available for purchase without a prescription, prescribing practices will vary between and within countries.

Between 2000 and 2010, the global consumption of antibiotics increased by nearly 40 percent, with rapidly developing countries like Brazil, South Africa and India accounting for nearly three quarters of this growth[7].

In New Zealand, the connection can be made between the increased prevalence of *S. aureus* infections (both MSSA and MRSA) and the use of topical antibiotic treatments such as fusidic acid, for SSTI since the early 1990s, particularly in children. While fusidic acid is commonly prescribed to treat a range of dermatological conditions, evidence-based prescribing supports the use of topical antimicrobials for a narrow range of indicators such as localised impetigo and eczema[12,14].

Resistance to mupirocin, the active ingredient in the topical antibiotic Bactroban©, was present in less than 5 percent of *S. aureus* isolated from Auckland DHB-based patients in 1992; however by 2000 the prevalence of resistance had risen to greater than 20 percent of isolates[15]. Bactroban© could be purchased over the counter without a prescription between 1991 and 2000, coincident with the increase in the incidence of community-associated MSSA and MRSA[16].

CA-MRSA clones have been identified as an increasingly dominant strain within healthcare contexts, leading to the suggestion that CA-MRSA will eventually replace HA-MRSA in the hospital setting. Contributing factors to the increase could include changes in the delivery of healthcare, which is increasingly focused on the treatment of patients in the community rather than in the hospital system[12, 13].

Surveillance of MSSA and MRSA (both community- and hospital-acquired) will need to be continuously monitored, with particular focus on predominant strains, for example AK3 MRSA, which has seen a significant increase in cases since 2006[16]. National surveillance of antimicrobial resistance in New Zealand is conducted by Environmental Science and Research (ESR) for the Ministry of Health, though the reporting tends to be snapshot rather than continuous, and limited patient demography contributes to the dataset[17].

Enterobacteriaceae

In 2012, 4000 cases of extended-spectrum beta lactamase (ESBL)-producing *Escherichia coli* (*E. coli*) and *Klebsiella pneumoniae* (*K. pneumoniae*) were observed in New Zealand. ESBL *E. coli* and *K. pneumoniae* are resistant to many types of penicillin and all cephalosporins[16]. New Zealand data reported to the WHO shows that in 2011 resistance to third generation cephalosporins was present in 4.7 percent of bloodstream isolates; and in 2.9 percent of urinary isolates[5].

Rates of resistance in ESBL-producing *E. coli* have risen steadily in New Zealand, as they have in many regions globally: in 2006-2008, approximately 2.6 percent of *E. coli* blood stream isolates in New Zealand were resistant; by 2011, this figure has nearly doubled to 4.7 percent[10]. In Europe, the WHO reports resistance in ESBL-*E. coli* to third-generation cephalosporins at 19.8 percent of invasive isolates for Italy, 14.9 percent for Greece and 11.3 percent for Portugal[5].

International migration patterns, people and organic products moving around the globe influence resistant pathogens, which are transferred between regions via human and livestock movement. Travel to countries that display a high prevalence for strains of ESBL-producing *E. coli*, for example, India and regions of South East Asia, is a risk factor for acquiring an ESBL-producing *Enterobacteriaceae* infection[18].

Many of the 4000 patients identified as having an infection caused by multiple-resistant ESBL- *E. coli* or *K. pneumoniae* in New Zealand in 2012 required hospital-based intravenous antibiotic therapy, as the most effective antibiotics to combat these infections, carbapenems, cannot be administered orally[16].

Infections due to carbapenem-resistant *Enterobacteriaceae* (CRE) have been detected in New Zealand. While the majority of these cases contracted the infection overseas, in 2015 a limited spread in two hospitals in New Zealand was reported[19]. There is a greater risk of pathogens spreading geographically and through populations as people are increasingly mobile in a globalised society through migration, trade and tourism[18]. The number of CREs has increased dramatically since 2009: in 2015 alone, 41 isolates were identified, compared to 35 isolates between 2009 and 2014[19].

As numbers of patients presenting with multiple-resistant infections rises, the corresponding effect on the health system will be increased numbers of patients requiring in-hospital treatment, which will exert pressures on hospitals and clinical resources.

Neisseria gonorhoeae

N. gonorrhoeae is the causal bacteria of gonorrhoea, the second most-prevalent sexually transmitted infection (STI) in the world, with approximately 62 million new cases of infection each year[20, 21]. There is currently no vaccine for gonorrhoeal infection, and its transmission via sexual contact means that infection can spread rapidly. As gonorrhoea is asymptomatic in around 50 percent of infected women, it proves harder to treat in a timely and effective manner, and untreated N. gonorrhoeae infection can lead to an increased risk of the disease entering the bloodstream and cause disseminated infections[21]. In line with resistance levels in other infections, increasing resistance in N. gonorrhoeae has limited the efficacy of first line antimicrobials, including penicillins, narrow-spectrum cephalosporins, tetracyclines, macrolides, and fluoroquinolones[20].

As a STI frequently occurring in at-risk populations where contact with a doctor may be sporadic, the ideal treatment of *N. gonorrhoeae* is a single agent, taken orally with few side effects[22]. The current recommended empiric treatment of *N. gonorrhoeae* is an intramuscularly-administered antibiotic (ceftriaxone), combined with an oral dose of another antibiotic (azithromycin). While no isolates of multi-drug resistant *N. gonorrhoeae* have been identified in New Zealand, cases of decreased susceptibility to third-generation cephalosporins such as ceftriaxone have been reported in the Auckland and Waikato regions[23]. A case of multi-drug resistant gonorrhoea was seen in Australia in 2014, raising concerns about the risk of its emergence in New Zealand in the near future[24].

The New Zealand Sexual Health Society (NZSHS) noted there is considerable regional variation in rates of *N. gonorrhoeae* infection between DHBs. Tairawhiti and Hawke's Bay DHBs, both on the East Coast of the North Island, have consistently experienced the highest rates of gonorrhoea infections in New Zealand, with the 2012 rate for Tairawhiti DHB more than four times the national rate, at 408 cases per 100,000 population reported. The staged introduction of the highly sensitive nucleic acid amplification tests (NAATs) in New Zealand since 2010 saw a sharp increase in confirmed diagnoses of gonorrhoea in Auckland in 2011. NZSHS guidelines recommend laboratory cultures be taken in cases where gonorrhoea is diagnosed via NAAT prior to the administration of antibiotics, in order for susceptibility testing to be conducted. For patients displaying persisting symptoms, the guidelines note that laboratory culture must be performed to determine whether the infecting strain is one with antimicrobial resistance[25].

Comprehensive action is needed to address AMR in New Zealand through a national strategy which focusses on prevention and immediate intervention. Retroactive policies to manage an emerging public health issue will remain insufficient in New Zealand and as a contribution to the global movement to contain resistance.

In 2015, the New Zealand government proposed the Health (Protection) Amendment Bill, which adds a number of infectious diseases, including gonorrhoea, to New Zealand's Schedule of Diseases Notifiable to a Medical Officer of Health under the Health Act 1956. New presentations of gonorrhoea will be subject to non-identifiable contact tracing, giving public health authorities greater insight into the pattern and spread of an outbreak, and strengthening the surveillance of STIs, which is currently conducted only via laboratory-based surveillance[26].

While the Bill will extend the scope for monitoring an outbreak in effect, actions are needed to address prevention and management in infectious diseases such as methicillin-resistant *S. aureus*, ESBL producing Enterobacteriaceae such as *E. coli* and *K. pneumoniae*, and multi-drug resistant *N. gonorrhoeae*.

An important first step in preventing an increase in AMR would be the implementation of evidence-based guidelines to reduce the selective pressure on bacterial populations that drive the spread of AMR. This would guide change in the selection, dose and delivery of antimicrobials, and minimise unnecessary use of these therapies[7, 10, 16].

Antimicrobial governance and stewardship: where to from here for New Zealand

The RACP considers AMS a whole of sector responsibility and believes collaborative approaches to engage clinicians in the design of AMR solutions and interventions would improve sector participation, and increase the likelihood of supporting clinical practice changes.

Physicians and paediatricians can contribute to containing and controlling antimicrobial resistance in New Zealand by keeping up-to-date on resistance in New Zealand and global contexts through education and CPD opportunities. Physicians and paediatricians can also engage in local antimicrobial resistance strategies and initiatives by working with hospital IPC teams and antimicrobial stewardship committees.

Antimicrobial stewardship

Antimicrobial stewardship (AMS) is defined as coordinated interventions designed to improve the appropriate use of antimicrobials by promoting the selection of the optimal antimicrobial drug agent(s), dose, duration of therapy and route of administration. The major objectives of antimicrobial stewardship are to achieve best clinical outcomes related to antimicrobial use while minimizing toxicity and other adverse events, thereby limiting the selective pressure on bacterial populations that drives the emergence of antimicrobial-resistant strains[2].

Currently, infection control and antimicrobial usage sits within the New Zealand Health and Disability Services (infection Prevention and Control) Standards NZ8134.3:2008. Standard 6 states that:

> Acute care and surgical hospitals will have established and implemented policies and procedures for the use of antibiotics to promote the appropriate prudent prescribing in line with accepted guidelines. The service can see guidance from clinical microbiologists or infectious disease physicians[27].

Actions incorporated into a comprehensive, coordinated strategy are reducing the prevalence of AMR within New Zealand. These are managed by AMS committees or teams who oversee stewardship activities within their own hospitals and DHBs. AMS encompasses staff education, maintaining and enforcing a restricted hospital antimicrobial formulary policy, IPC programmes, antimicrobial guideline dissemination and outcome measures to evaluate stewardship programs and locate activity within a quality improvement framework.

Smaller DHBs and hospitals need to be supported to develop and implement AMS programs as part of wider infection control programs. Clinical expertise in infectious diseases, clinical microbiology and clinical pharmacology needs to accessible to health practitioners in all healthcare settings in New Zealand.

Infection prevention and control practices in health care settings

Preventing the spread of harmful bacteria to reduce reliance on antimicrobials is proven to reduce subsequent infections, and health systems that invested in hygiene programmes have shown a reduction in the risk of infection in community and hospital settings.[28, 29]

Hand hygiene practices are a proven and effective intervention that can reduce the incidence and prevalence of healthcare-associated infections (HAI) reducing potential harm for patients and costs for the health system[29].

Compliance with hand hygiene guidelines remains is improving in New Zealand, where the rate at or above 80 per cent across all observed professional and patient interactions[30]. The New Zealand Health Quality and Safety Commission's (HQSC) Infection Prevention and Control programmes focuses on the prevention of central line associated bacteraemia, reducing the incidence of surgical site infections and improving hand hygiene in health care settings[31].

The HQSC incorporates the WHO Clean Care is Safer Care programme, designed to improve patient safety through IPC practices[32]. The programme identified five moments of hand hygiene in patient management to strengthen infection control and minimise contamination in health care settings:

1. Before patient contact
2. Before procedure
3. After procedure or body fluid exposure risk
4. After patient contact
5. After contact with patient surroundings

Comprehensive hand hygiene relies on full health workforce compliance operating concurrently to effect a safer environment for health care professionals, patients and their families/whānau. Families also need to know health professionals' hands, any equipment and the environments within health care settings all require appropriate IPC measures, such as the widespread availability of alcohol-based hand rub (ABHR) within hospitals and clinics, and adherence to best practice standards on glove use and decontamination of reusable equipment. Having ABHR freely accessible in healthcare settings to patients and their families/whānau encourages broad adoption of hand hygiene practices.

DHB guidelines on IPC include procedures for the decontamination of reusable patient equipment to ensure patient safety and minimise the risk of transmission of infection. For example, equipment such as stethoscopes and pulse oximeters require disinfecting with an alcohol-based surface wipe or swab after each patient use, while more complex devices such as endoscopic equipment requires additional, detailed hygiene protocols[33]. In addition to hand hygiene, a review of the United Kingdom's national evidence-based guidelines for preventing HAI identified hospital environment hygiene, the use of personal protective equipment (PPE), the safe disposal of sharps and principles of asepsis as essential components of IPC programmes to ensure the safety of patients, their family and whānau and healthcare professionals within hospital environments[34].

In accordance with NZ8134.3:2008, DHBs must include hand hygiene, PPE, standard and transmission-based precautions, and cleaning, disinfection and sterilisation of reusable medical devices as part of IPC programmes[27].

Safe prescribing of antimicrobials

The misuse of antimicrobials, including excessive use in outpatient settings, over-the-counter (OTC) purchasing and risky prescribing practices has contributed to the emergence and selection of resistance[5, 7, 35]. In high-income countries, the majority of prescriptions for antibiotics for treatment of people are prescribed in the ambulatory-care context for acute respiratory tract infections (RTIs): surveys have shown that physicians are under pressure to prescribe antibiotics, where symptom management may be more effective[35, 36].

The Medical Council of New Zealand's *Good Prescribing Practice* states that doctors should prescribe both clinically and ethically. The guidelines outline appropriate prescribing practice including:

• Considering whether a prescription is warranted given the nature of the patient's complaint
• Prescribing in accordance with accepted practice and any relevant best practice guidelines
• Periodically reviewing the effectiveness of the treatment and any new information about the patient's condition and health[37].

Community-based prescribing and consumption increased significantly between 2005 and 2012 in New Zealand. Annual per capita consumption of antimicrobials rose at an average of 6 per cent per year during this period, and by 2012, there were 25 defined daily dosages per 1000 population per day across all the classes of antibiotics[16]. Given levels of community prescribing in New Zealand and the particular pathogens of concern, it is critical that AMR governance considers public health, sexual health medicine, general practice and pharmacy alongside infectious diseases and hospital IPC programmes.

Antibiotic consumption and the variety of antimicrobials prescribed differ between regions and DHBs in New Zealand. Prescriber and patient behaviour factors such as access to healthcare, incidence of infectious disease within the community (for example, acute rheumatic fever and skin infections), socioeconomic conditions and cultural beliefs may influence prescribing practices and attitudes[38].

Increasing best practice prescribing through good clinical governance and clinical guidelines is known to be effective. In New Zealand, the *Antibiotics: Choices for Common Infections* developed by the Best Practice Advocacy Centre provide guidance for antimicrobial prescribing in community settings and primary care. This resource encourages antibiotic prescribing only when required, selecting an appropriate medicine at the lowest cost, the recommended dose and with the narrowest spectrum of antimicrobial activity[39]. PHARMAC's Hospital Medicines List and the New Zealand Formulary are available for prescribers in hospital settings[40, 41].

Conclusion

AMR is a complex and urgent public health concern. The RACP believes New Zealand can be proactive in combating AMR by promptly introducing measures to reduce the potential threat posed by pathogens resistant to existing treatments.

The RACP acknowledges work by the Ministry of Health in collaborating with the Ministry of Primary Industries and other stakeholders to develop a national plan to reduce the risk of AMR for New Zealand populations, the health system and the economy. To ensure consistency with global approaches, we recommend that action is based on the WHO six-point strategy to ensure changes can be measured and compared to understand effectiveness and inform joint learning.

We recommend that the New Zealand antimicrobial strategy incorporates a single national prescribing guideline to provide consistency and reduce duplication; with advice from infectious diseases physicians and paediatricians, microbiologists, general practitioners and pharmacologists. This would be implemented through clinical networks and coincide with a public awareness campaign to increase understanding of the use of antimicrobials and the risks of resistance. Information and resources for the health and agricultural sectors and for the public should be framed in a New Zealand context for greatest relevancy.

The RACP believes evidence-based and systematic improvements in practice are essential to support clinical governance. This provides expert clinical leaders with access to skills and experience to solve complex problems such as AMR to improve patient outcomes. Clinical governance and multidisciplinary teams are an essential component of effective antimicrobial stewardship. To support this approach a national stewardship programme must incorporate quality improvement approaches that ensure clinicians maintain their knowledge and currency with evidence-based practice on the profile of resistance of key pathogens in New Zealand.

New Zealand laboratories require greater resourcing and support in order to monitor increases in AMR. A coordinated and integrated action plan for antimicrobial resistance in New Zealand includes appropriate surveillance of human and animal laboratory samples through laboratory testing. Following the results of the WHO's worldwide country situational analysis on antimicrobial resistance report in 2015, New Zealand can identify areas for improvement, including laboratory capacity, with the Western Pacific Antimicrobial Resistance Surveillance unit.

The RACP is collaborating with specialty societies in New Zealand and Australia through its EVOLVE initiative. EVOLVE encourages each medical speciality to think about the clinical circumstances in which some of the practices, whether medical tests, procedures, or interventions – should have their indication or value questioned and discussed by physicians. These may be overused, inappropriate or of limited clinical effectiveness in a given clinical context[42].

The RACP has made a significant investment in its educational programs and continued advancement of its education training and continuing professional development programs has enabled the RACP to respond and adapt to developments in clinical practice.

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