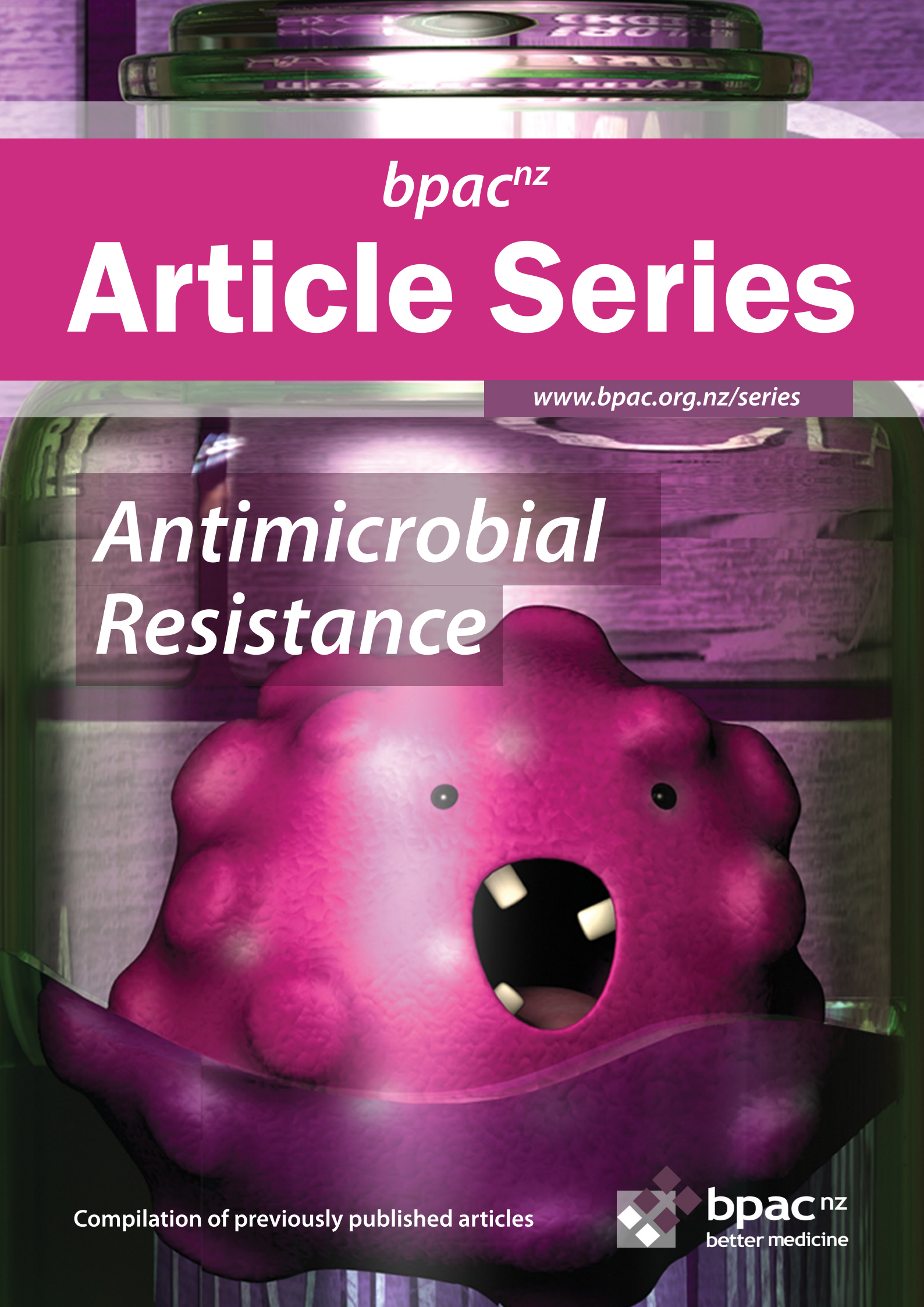

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Antimicrobial Resistance

Compilation of previously published articles

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RESISTANCE TO ANTIMICROBIALS

– an increasing problem in our community

Contributed by **Dr Rosemary Ikram**, Clinical Microbiologist, MedLab South

Resistance to antimicrobials has provided continuing challenges in the treatment of infections since the first agents were used more than 70 years ago. Most antimicrobials are based on molecules that are produced by one organism to kill or inhibit the growth of other microorganisms. The organism producing the natural antimicrobial substance must also have a mechanism to avoid being killed or damaged itself. Resistance to antimicrobial agents can occur when the genes that are responsible for the "defence mechanism" in the original organism are transferred to other organisms, thus also rendering them resistant. Unfortunately this process has led to increasing resistance to most new antimicrobial agents within years of their introduction.

For many years the pharmaceutical industry has managed to stay ahead of the game by continually developing new antimicrobials. However, fewer new agents are now being developed, largely due to economic reasons – the short-term nature of an antibiotic course does not provide the returns associated with long-term medicines, and resistance means that the antimicrobial becomes obsolete within a short time period. Late in 2009, the Infectious Disease Society of America called for a worldwide commitment to achieve the development of ten new antibiotics within the next ten years (the 10 x 20 initiative). The World Health Organisation (WHO) has identified antimicrobial resistance as "one of the three greatest threats to human health". We may well be

The era of antibiotics is coming to a close. In just a couple of generations, what once appeared to be miracle medicines have been beaten into ineffectiveness by the bacteria they were designed to knock out. Once, scientists hailed the end of infectious diseases. Now, the post-antibiotic apocalypse is within sight. – *Sarah Boseley, The Guardian, UK.*

entering an age where, once again, it is not possible to successfully treat a range of infections caused by common bacterial pathogens.

In the past, antimicrobial resistance was largely limited to infections acquired in hospitals, but in recent years it has increasingly become a problem with infections acquired in the community, leading to the emergence of multiple drug resistant organisms. The WHO has recommended several interventions to reduce the spread of these organisms.

These interventions include educating people about:

- Basic hygiene measures to help prevent infection
- The need for rational use of antimicrobials
- The problems posed by antimicrobial resistant bacteria

Healthcare professionals should also be educated about resistant organisms, infection control and the benefits of restricting antimicrobial use to those who have definite indications for treatment.

Understanding the threat of multiple drug resistant organisms in New Zealand

From overseas surveillance studies it is apparent that many of the multiple drug resistant organisms are clonal i.e. have the same origin, and have been able to spread widely. As an example, most methicillin resistant *Staphylococcus aureus* (MRSA) isolates in New Zealand have originated from overseas. Extended spectrum beta lactamase (ESBL) producing *Klebsiella pneumoniae* was first recognised in Hawke's Bay and has now spread around the country – Hawke's Bay still had a high rate of this organism in surveillance performed in 2008. Many of these organisms have become widespread in the community as well as causing infections in healthcare settings.

The major factor responsible for this resistance problem is the misuse of antimicrobials, which includes inappropriate prescribing by healthcare professionals (wrong choice of agent, prescribing when an antimicrobial is not indicated,

inappropriate dose or duration of therapy) and lack of compliance by patients. Microbiologists have been talking for years about widespread resistance potentially occurring, but the reality is that it is happening now.

It is essential for everybody to contribute to the efforts to prevent antimicrobial resistance. Widespread emergence of multiple drug resistant organisms will impact on all healthcare sectors, leading to increasing morbidity and mortality, due to the difficulty of treating increasingly resistant bacteria.

What strategies could work? There needs to be a greater focus on educating the general public about increasing antimicrobial resistance and the fact that viral infections do not respond to antimicrobial treatment. There have been some programmes that have focused on these issues already e.g. PHARMAC's "Kick that Bug" Wise Use of Antibiotics campaign, but the messages need to be continually promoted, in a variety of changing ways to keep the issue in the forefront of everybody's mind.

The current situation of antimicrobial resistance in New Zealand could be used to strengthen the message and illustrate the consequences of antimicrobial misuse. To do this, comprehensive data are required. Surveillance is presently carried out through Environmental Science and Research (ESR) and is published on its website (**www.esr.cri.nz**). However this is national data and does not reflect the situation in some smaller centres, which may have clones of resistant bacteria, but the numbers are too small nationally to raise awareness. The spread of the ESBL producing *Klebsiella pneumoniae* from the Hawke's Bay is a good example of this.

Local information needs to be collected and analysed so that each area can determine what specific issues need to be addressed. For example, in South Canterbury a multidrug resistant *E.coli* has become more prevalent over the last two years. This area has the highest quinolone use in New Zealand, leading to antimicrobial resistance, and strategies are currently being developed to reduce this. In Christchurch, "MRSA USA 300" has emerged in at least a couple of residential care facilities, and without intervention will spread widely including into acute care hospitals.

Regional information needs to be used to inform healthcare professionals about the issues through local meetings and workshops. Resources, such as patient information

pamphlets, are required to assist in reducing unnecessary prescriptions. Targeted interventions can be developed to reduce the prescription of specific antimicrobials,which appear to be increasing local resistance.

Antimicrobial resistance in the community is becoming an increasing problem. Interventions must be implemented on a large scale to be successful and unfortunately this is not a simple process. The solutions for many of the issues of resistance also remain unclear. However, this is not a reason to ignore the problem and failure to respond effectively will only increase the prevalence of these potentially incurable infections in our communities.

ACKNOWLEDGMENT Thank you to Associate **Professor Mark Thomas**, Infectious Disease Specialist, University of Auckland for expert guidance in developing this article.

This article is the first in a series devoted to understanding and addressing the problem of antimicrobial resistance in New Zealand. Subsequent articles will cover appropriate and rational use of antimicrobial agents, strategies to minimise the problem of resistance and an overview of antimicrobial use and resistance in New Zealand.

We challenge you to examine the use of antimicrobials in your practice and to consider ways in which you may contribute to reducing resistance in our communities.

Prescribers, please complete the accompanying questionnaire about antimicrobial use in primary care. This is also available online at: ***www.bpac.org.nz***

ANTIMICROBIALS

How should they be used in primary care?

Contributed by **Dr Rosemary Ikram**, Clinical Microbiologist, MedLab South

The first article in this series (BPJ 30, Aug 2010) outlined the problem of antibiotic resistance in the community. This article considers what interventions could lead to improved use of antimicrobial agents and allow the best chance of slowing the spread of resistant bacteria.

Ideally antibiotics should be reserved for the treatment of known bacterial infection but it is well recognised that they are often prescribed empirically "just in case" or inappropriately when the infection is highly likely to be viral. For a specific infection, the antibiotic with the narrowest useful spectrum should be selected and the entire treatment course should be taken. To accomplish this, in some cases it may be appropriate to take a sample for testing or consult antibiotic susceptibility guidelines.

Is this a bacterial infection?

Deciding whether a patient has a bacterial infection can sometimes be challenging. The difficulties and uncertainties are partly reflected by the variability in microbiology test ordering patterns in primary care. A United Kingdom based study investigated microbiology test ordering rates for different practice localities and found a 200% variation in rates for urine samples and an 800% variation for wound swabs.[1] This suggests that more education is required to guide practitioners on appropriate microbiological testing along with the implementation of guidelines. In this era of increasing antibiotic resistance it may be necessary to re-evaluate some of the current practices. For example, we know that more resistant bacteria will be isolated from patients who have had previous antibiotic treatment[2] and the antibiotic susceptibility of organisms such as *E. coli* is less predictable in those who have travelled to or lived in areas with high levels of endemic resistance.[3]

A useful approach is to ask the question; "How likely is this to be a viral infection?" It is clear that most respiratory tract infections such as sore throats, acute bronchitis, acute otitis media and coryza are usually viral in origin. There may be uncertainty as to the likelihood of a bacterial infection as well as an expectation from the patient or parent/caregiver that an antibiotic should be prescribed. The United Kingdom National Institute of Health and Clinical Excellence (NICE) recently published a short clinical guideline on antibiotic prescribing for respiratory tract infections.[4] After a face-to-face consultation, including patient history and an examination, patients can be categorised into three different management groups - antibiotics are not recommended, a delayed ("back pocket") prescription is given or antibiotics are prescribed.

Prescribers are encouraged to download a copy of the NICE guideline and use it to help inform their prescribing decisions: **www.nice.org.uk/nicemedia/live/12015/41322/41322.pdf**

Interventions to improve prescribing – what works?

There is currently insufficient research to determine which single approach to rational use of antimicrobials is the most effective. A recent Cochrane review suggests that multifaceted approaches and interventions targeting patients show the most promise. The main conclusions were that:[5]

- Patient based interventions including information, education and delayed or "back-pocket" prescriptions, consistently decreased patient antibiotic use (a patient information pamphlet is available from bpac[nz])
- Multifaceted interventions which combined education for doctors and patients with public information campaigns consistently reduced antibiotic prescribing for inappropriate conditions
- Educational outreach including reminders to doctors and audits had mixed effects on prescribing practices
- Educational meetings improved antibiotic prescribing, but effects were variable and generally modest
- Printed educational material such as flyers or leaflets had little effect on prescribing behaviour

The authors suggested that the most effective interventions are likely to be those that address local prescribing behaviours and barriers to change, and include patients and the public in the educational programme. Local barriers should be addressed before major educational efforts are implemented. An example of this is the variable rate of rheumatic fever in New Zealand – some areas, particularly in Northland, have very high rates but in the South Island much lower rates occur. Therefore a protocol implemented across the whole population will be neither the most appropriate nor worthwhile intervention.

Should children be educated about antimicrobial use?

In some countries children are taught the fundamentals of antimicrobial use at primary and secondary school level. The main issues covered are resistance and appropriate use, e.g. antibiotics are ineffective for colds and influenza. Finland and Moldova were the first countries to implement this as part of the school curriculum and a positive effect on parent knowledge and education about antibiotics has been observed.

These initiatives have recently been expanded in Europe with the development of a web site for school educational use (e-bug). Teaching children about antibiotic use would seem a logical approach given the need for wider public knowledge of the issues. Several pilot studies have been carried out in New Zealand, but the concept is not yet widespread. Bpac[nz] supports this initiative.

www.e-bug.eu

Delayed prescriptions

A study in Auckland reported that delayed ("back pocket") antibiotic prescriptions effectively reduced antibiotic use.[6] Interestingly, GPs valued empowering patients to be more involved in decision making about their health care management more than patients did. GPs generally viewed the strategy as providing reassurance to patients and meeting their expectations. Both patients and physicians agreed that delayed prescribing is not appropriate for everyone, but currently no consistent criteria have been established.

Antibiotic choice and use

When prescribing antimicrobial treatment it is important that a narrow spectrum antibiotic is chosen in most cases and the length of treatment is kept as short as possible. Antibiotic treatment affects both the pathogen it is targeted against, and the whole bacterial flora of the patient. There is evidence that antibiotic treatment leads to the presence of more resistant bacteria in the normal flora and also in subsequent infections.[2] In general practice it has been shown that this effect is prolonged and can also be related to the length of treatment. Broad spectrum antibiotics have more effect on the flora than narrower spectrum agents.

It is necessary to provide local antibiotic susceptibility data to the primary sector to allow antibiotic guidelines to be formulated locally. To enable this to happen there needs to be communication between the laboratories testing microbes from the community, referrers and local experts in the treatment protocols relevant to specific geographical areas. In the United Kingdom the Health Protection Agency have produced a document: "Management of Infection Guidance for Primary Care for Consultation and Local Adaptation".[7] Using this document and other guidelines it should be possible to develop a similar document for New Zealand primary care.

In Summary...

Both health professionals and patients need to review how antimicrobials are currently being used. This involves being aware of the susceptibility of bacteria locally, having a clear understanding of when antimicrobials are not indicated and using resources such as education for both prescribers and patients to enable optimal use of these valuable medicines. If this can be achieved we shall be on the way to at least slowing the spread of antimicrobial resistance in New Zealand.

ACKNOWLEDGMENT Thank you to **Associate Professor Mark Thomas**, Infectious Disease Specialist, University of Auckland for his contributions to this article.

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RESISTANCE TO ANTIMICROBIALS

is an increasing problem in our community

We challenge you to examine the use of antimicrobials in your practice and to consider ways in which you may contribute to reducing resistance in our communities.

Prescribers are invited to complete a questionnaire about antimicrobial use in primary care. This is available online at:

www.bpac.org.nz

ANTIMICROBIALS Where are we now?

Contributed by **Dr Rosemary Ikram**, Clinical Microbiologist, MedLab South

Two previous articles in this series have outlined the main issues related to antimicrobial resistance within the community in New Zealand (BPJ 30, BPJ 31). This article will review the data we have available now. This enables interventions to be targeted towards issues which are local and current.

Bacterial resistance in the New Zealand community

Surveillance of antimicrobial resistance is currently co-ordinated through the Institute of Environmental Science and Research (ESR) and reports are made available on its website. The following organisms will be discussed in more detail: methicillin resistant *Staphylococcus aureus* (MRSA), extended spectrum β-lactamase producing Enterbacteriaceae (ESBL-E), *Streptococcus pneumoniae* (*S.pneumoniae*), *Neisseria gonorrhoeae* (*N. gonorrhoeae*) and *Haemophilus influenzae* (*H.influenzae*).

MRSA

Initially this organism was detected mainly in hospitals as a result of healthcare associated infection (HA-MRSA). Strains of MRSA more closely associated with community acquisition (CA-MRSA) have now been recognised. An epidemic MRSA (EMRSA) first emerged in New Zealand hospitals in 2000. This strain was imported from the United Kingdom most likely by both patients and staff.

The situation as it was at the end of 2009 is shown in Figure 1 and the distribution of strains among DHBs is shown in Figure 2. EMRSA–15 is a healthcare associated infection, but the other named types (WSPP and AK3 MRSA) are community acquired. This data suggests that the amount of EMRSA-15 is decreasing, however, the number of community strains is increasing. This pattern of change is similar to that experienced in other countries.

ESBL-E

ESBL-E produce a β-lactamase that renders them resistant to all penicillins and cephalosporins. Many of these organisms are resistant to other groups of antimicrobials as well and are classified as multi-drug resistant organisms, i.e. resistant to three or more classes of antimicrobial.

Figure 3 shows the annual/annualised incidence of ESBL-E from 2000 to 2009, demonstrating a rapid increase in isolates since the beginning of the decade. Figure 4 shows the annualised incidence of ESBL-E-producing infections by

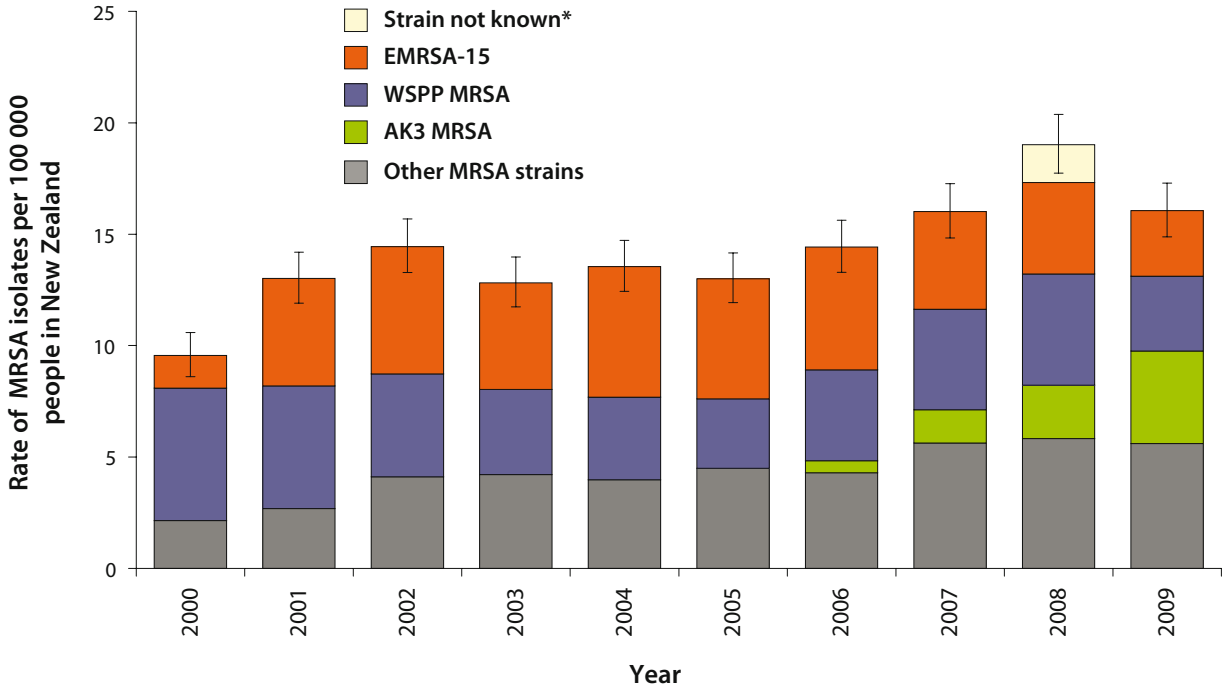

Figure 1: MRSA point-prevalence rates, 2000–2009, showing 95% confidence intervals (ESR data)[1]

*The category "Strain not known" for 2008 represents the number of people identified with MRSA by Middlemore Hospital laboratory which did not refer the isolates to ESR for strain identification.

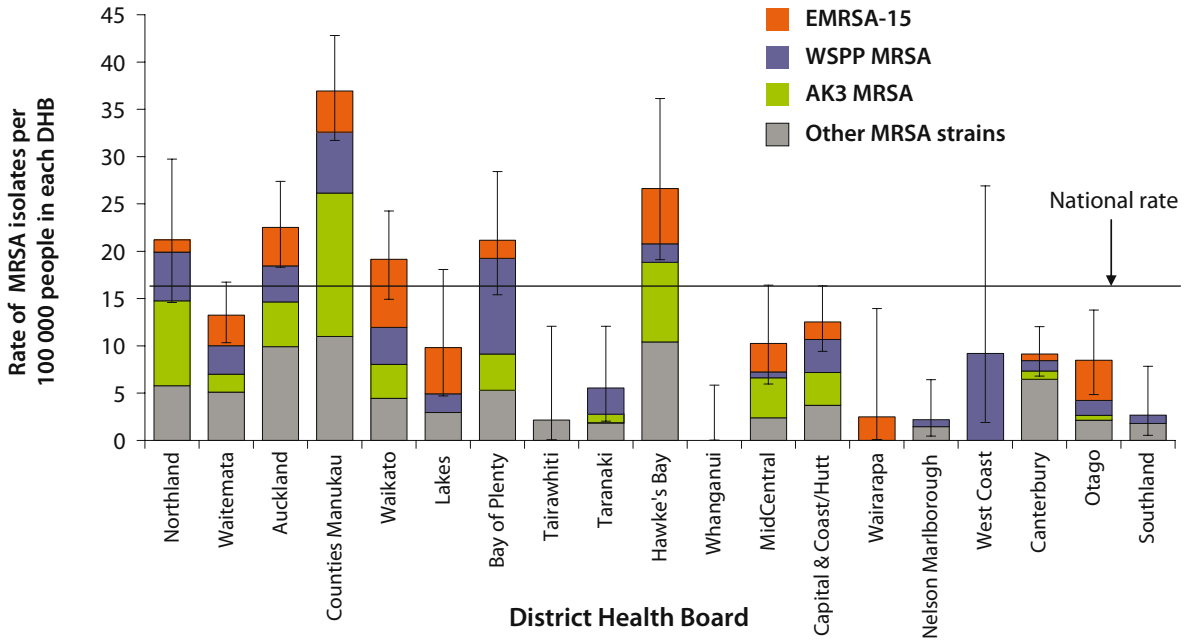

Figure 2: Point-prevalence rates of MRSA by district health board, 2009, showing 95% confidence intervals (ESR data).[1]

N.B Data for the Capital & Coast and Hutt District Health Boards (DHBs) is combined as "Capital & Coast/Hutt", and data for the Canterbury and South Canterbury DHBs is combined as "Canterbury".

DHB in 2009. This distribution shows that more infections are encountered in the North Island compared with the South Island. Community onset was assigned for 36% of these infections.

N.B. In the ESR data, healthcare-associated infection includes samples referred from emergency departments, outpatient clinics or residential care facilities.

Streptococcus pneumoniae

In 2008 a survey of community isolates of *S.pneumoniae* was performed to provide baseline serotype and susceptibility data on community isolates, prior to the addition of the 7-valent conjugate vaccine (PCV-7), Prevenar, to the vaccination schedule. Isolates were collected by two community laboratories - Diagnostic Medlab in Auckland and MedLab South in Christchurch. Overall 17% of isolates were resistant to penicillin and 13.8% were resistant to penicillin and erythromycin. A total of 12.7% were multidrug resistant. The only difference in the prevalence of susceptibility between Auckland and Christchurch was the susceptibility to chloramphenicol which was 4% in Christchurch isolates and 0.7% in Auckland. With the introduction of the PCV-7 vaccination programme, it would be expected that *S.pneumoniae* will be more susceptible because most of the resistant serotypes are present in the vaccine.

Neisseria gonorrhoeae

Regular surveillance reports on the susceptibility of *N.gonorrhoeae* started in 2005. Since that time, ciprofloxacin resistance has increased from 15% to 25% (2008 data). However, there is considerable local variation in susceptibility in smaller centres. For example, in an outbreak of infection in South Canterbury over the December to January period 2009/2010, none of the isolates were susceptible to ciprofloxacin.

The rate of penicillin resistance has remained relatively low although intermediate susceptibility to penicillin rose from 55% in 2005 to 81% in the April to June quarter in 2008. Currently no ceftriaxone resistant isolates have been found.

Haemophilus influenzae

The susceptibility of invasive strains of *H.influenzae* has been monitored since 2000. On an annual basis, relatively

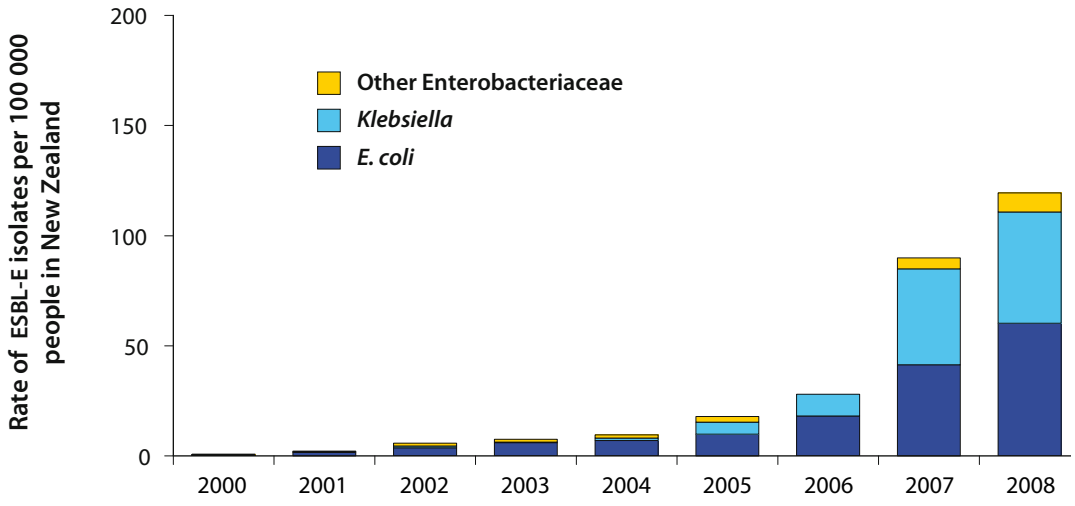

Figure 3: Annual/annualised incidence of ESBL-producing Enterobacteriaceae, 2000-2009 (ESR data).[2]

small numbers of organisms have been tested. The proportion of organisms which were ampicillin resistant by virtue of β lactamase production has varied from about 11% to 34%. Latest data from 2009 showed resistance at 17.2%.

Another type of ampicillin resistance is β-lactamase negative ampicillin resistance (BLNAR). This was uncommon before 2005, but now accounts for approximately half of the ampicillin resistant isolates. In 2008, of the reported non-invasive isolates, 24.7% were ampicillin resistant and 3.7% amoxicillin clavulanate resistant. These latter isolates represent the BLNAR *H.influenzae*, therefore this type of resistance seems to be less common in less invasive organisms.

Antimicrobial use in New Zealand

There is some variability in the number and type of antibiotics dispensed around New Zealand. Figure 5 shows the number of antibiotic prescriptions dispensed per 1000 population, by DHB area (indicated by different colour shading on the map). Bar charts show the percentage of these antibiotics by antimicrobial group. Figure 5 shows less antimicrobial scripts per 1000 population in the South Island compared to the North Island. This mirrors surveillance data from Europe, which shows that in general there is less antimicrobial resistance in areas where less antimicrobials are used.

A portrait of antimicrobial resistance

The surveillance information from ESR, along with patterns of antimicrobial use, highlights the current problem of antimicrobial resistance in New Zealand. This situation has changed, and will continue to change, over time. Infectious organisms are imported to this country and then spread, often in the healthcare setting first, before becoming established in the community. Reducing the use of antimicrobials has been shown to reduce the occurrence of these organisms overseas and this may well be the case in New Zealand too.

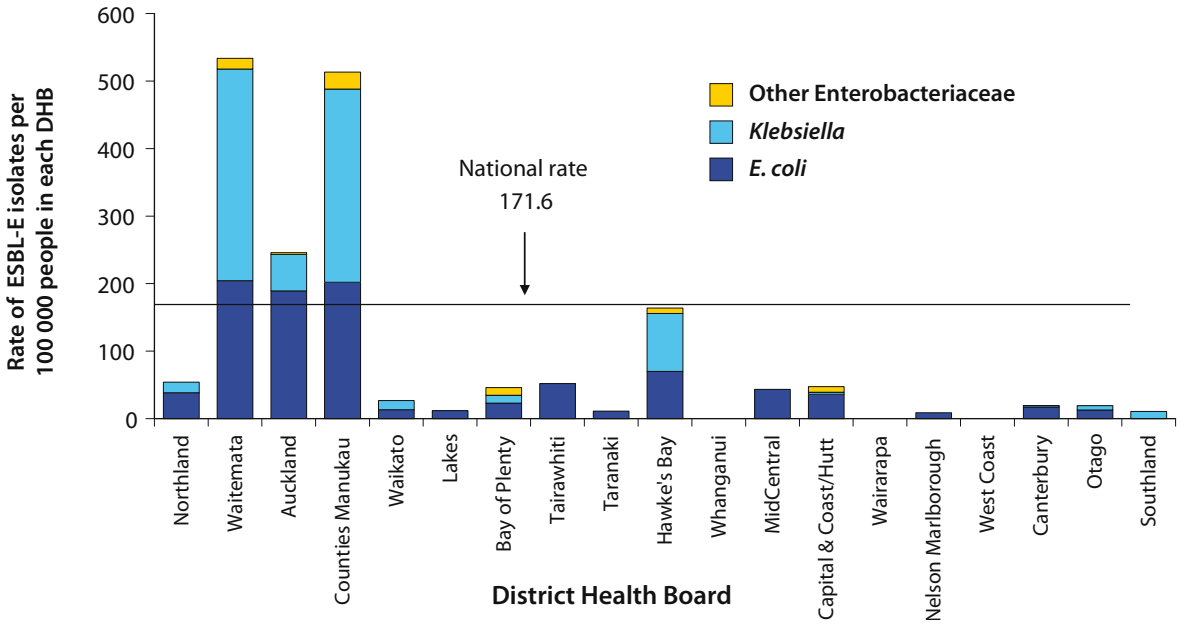

Figure 4: Annualised incidence of ESBL-producing Enterobacteriaceae infections by district health board, 2009 (ESR data).[2]

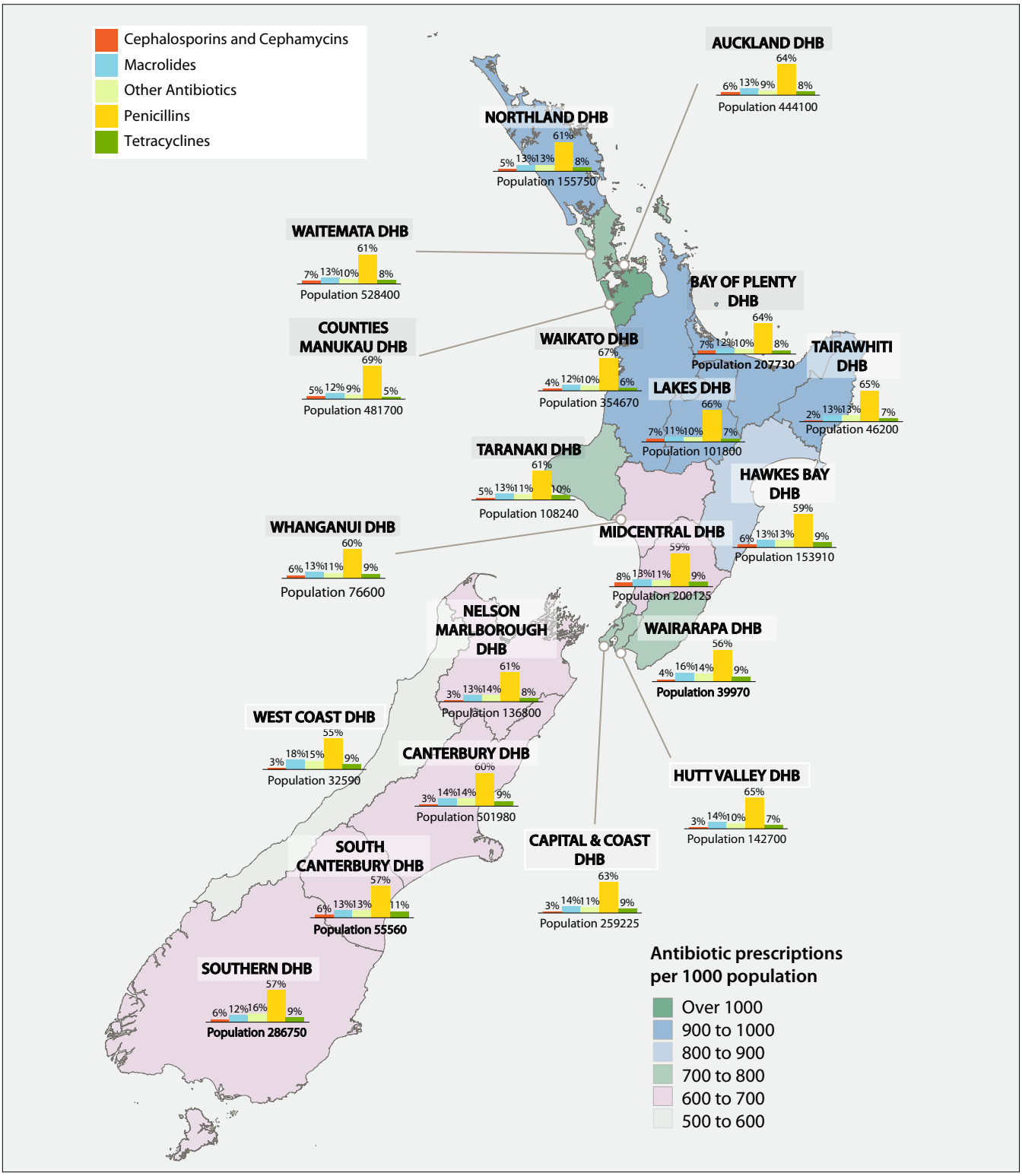

Figure 5: Antibiotic prescriptions dispensed per 1000 population, 2009.

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ANTIMICROBIALS

the way forward

In 2010 we published the first three articles in our four part series on antimicrobial resistance in New Zealand, from guest contributor Dr Rosemary Ikram. The series concludes in this issue. As part of our ongoing commitment to this important topic we will shortly be distributing an antibiotic prescribing booklet.

The World Health Organisation has identified antimicrobial resistance as one of the three greatest threats to human health, along with food shortages and climate change. Antimicrobial resistance is growing rapidly worldwide, there are very few new antimicrobial medicines in development that offer benefits over existing medicines and increasingly limited treatment options for pathogens such as *Staphylococcus aureus* and *Klebsiella pneumoniae*. There is a very real possibility that we will soon be re-entering an age where common bacterial pathogens are unable to be successfully managed and will pose an increasing threat to human health. In the past few years we have seen antimicrobial resistance spread from hospitals to the community, resulting in the emergence of "super bugs" – multiple drug resistant organisms.

A global commitment from both health professionals and the general public is needed in order to contain, or at least slow, this threat until new medicines can be developed to combat resistance. Interventions include education about basic hygiene measures to prevent infection and the problems posed by antimicrobial resistant bacteria, as well as a clear understanding of appropriate use of antimicrobials.

Previous articles in this series have highlighted the significant problem of antimicrobial resistance in New Zealand and worldwide. Various strategies to promote the rational use of antibiotics in New Zealand have been discussed. In this final article of the series we look at the way forward in the battle against antimicrobial resistance. Lessons learned from international interventions can be combined with local ideas for a co-ordinated national approach to address this evolving issue.

Contributed by **Dr Rosemary Ikram**, Clinical Microbiologist, MedLab South

Raising awareness of antimicrobial resistance: international interventions

"Get Smart" in the USA

"Get Smart" from the Centers for Disease Control and Prevention is an ongoing educational and awareness programme on antimicrobial resistance. The programme includes input from all stakeholders and is aimed at both health professionals and consumers.

Education of the general public has included programmes in daycare, kindergartens, schools, websites, posters, radio and television advertising as well as pamphlets available in primary care practices.

… and "Get Smart" on the Farm

The widespread and indiscriminate use of antibiotics in animals and agriculture can contribute to the problem of antimicrobial resistance. The "Get Smart" programme also incorporated "Get Smart on the Farm", targeting educational and awareness interventions to veterinarians and others involved in the delivery of healthcare to animals.

For further information on the Get Smart programme, visit: **www.cdc.gov/getsmart/antibiotic-use/know-and-do.html**

Antibiotic awareness days

Annual awareness days are regularly held in some countries such as the European Antibiotic Awareness Day from the European Centre for Disease Prevention and Control. This programme includes resources and toolkits for education of the public and prescribers in primary and hospital care.

The important message in such an awareness programme is focused on reducing inappropriate antibiotic use. Typical topics and issues included are:

- Antibiotics are inappropriate for treating viral infections
- Recognition of common viral infections
- Adverse effects of antibiotics on the individual as well as the population problem of antimicrobial resistance

http://ecdc.europa.eu/en/eaad/Pages/Home.aspx

Essential aspects for addressing antimicrobial resistance

Co-ordination is the Key

Educational awareness programmes often involve a number of partners to increase the impact. For example, a promotional activity could include the media, health professional groups and consumer groups. Communication and co-ordination are essential to ensure success.

Antimicrobial resistance survey

In 2010, clinicians were encouraged to respond to a questionnaire to determine important issues in primary care which may cause barriers to implementation of reduced antimicrobial use.

Responses were received from 268 people. The main findings of the questionnaire were:

- More than half of respondents very rarely (49%) or never (9%) used data on local resistance patterns to guide antimicrobial choice
- Almost all respondents are either mostly aware (63%), very aware (18%) or somewhat aware (18%) of the pathogens that antimicrobials are active against
- Most respondents find it difficult about half the time (51%) or rarely (43%) to avoid prescribing antimicrobials for patients with a viral infection
- A back pocket prescription, if appropriate, is used most of the time (35%) or about half of the time (41%)
- However, information pamphlets are used rarely (52%) or never (25%), to help patients understand when antimicrobials are not indicated,
- Most people rated the threat of antimicrobial resistance in New Zealand as very high (15%), high (42%) or moderate (39%)

From interpreting the comments received in the questionnaire, it seems that a large number of practitioners are unaware of local susceptibility patterns because they are not supplied by the laboratory. Many practitioners felt that more education needs to be directed to the general public through a variety of sources such as media and education at all levels. There were also some who felt that more information is required relating to strategies for symptomatic relief in viral infections.

Good information is essential

Surveillance at both national and local levels is important. Most laboratories have the capability for generating susceptibility reports. Central co-ordination of these databases would give information about the type of resistance in different geographical areas, which can be useful with the ease of movement from one area to another. This is often well co-ordinated with hospital transfer but does not occur with patients moving. An example of this is the first isolate of MRSA USA 300 in South Canterbury, which was traced to a patient who had moved from Taranaki in the previous month. The information that the patient had moved should have been provided to the practitioners who would be involved in the patient's care.

Promote infection control

Colonisation and infection prevention strategies need to be highlighted to the general population. Contact spread, either direct or indirect, is the most important means of transmission. Therefore, hand hygiene with either soap and water or alcohol gels is the most effective strategy to prevent transmission. General hygiene, e.g. regular laundering of linen and personal clothing as well as regular cleaning also has a role.

Antimicrobial stewardship is the buzz word for reducing the inappropriate use of antimicrobials. This needs to occur

in both hospitals and primary care. Hospitals continue to act as reservoirs, as well as institutions where spread of multiply drug resistant organisms (MDROs) occurs.

Guidelines and information

Antibiotic guidelines are important but it is also important to educate about when antibiotics are not required, e.g. viral syndromes where bacterial infection is unlikely. The NICE guideline ("Antibiotic prescribing for respiratory tract infections") is an excellent document which could be adapted for New Zealand and used to formulate "whether to treat guidelines" rather than simply the appropriate antibiotic for a particular condition. With so many issues to remember in the general practice it is important that information is circulated in a practical and relevant form, and updated regularly. To instigate sustained change in the health sector is a major undertaking and it is important to include all stakeholders when implementing these changes.

In summary

Antimicrobial resistance is with us to stay. How much of an issue it becomes in New Zealand is in our hands. We need to direct efforts to combat this serious threat to our healthcare system and this involves all sectors of our community.