Guidelines for the Control of Multidrug-resistant Organisms in New Zealand

Ministry of Health. 2007. *Guidelines for the Control of Multidrug-resistant Organisms in New Zealand.* Wellington: Ministry of Health.

Published in December 2007 by the
Ministry of Health
PO Box 5013, Wellington, New Zealand

ISBN 978-0-478-31224-9 (online)
HP 4479

This document is available on the Ministry of Health website:
http://www.moh.govt.nz

Foreword

These Guidelines were produced by representatives from the Antibiotic Resistance Advisory Group (ARAG) and invited experts, with members representing several District Health Boards (DHBs) around the country. A draft was distributed to several stakeholders around New Zealand and the final document has benefited from the feedback received.

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Multidrug-resistant organisms (MDROs) have become common around the world and, in recent years, their numbers have begun to increase in New Zealand. Methicillin-resistant *Staphylococcus aureus* (MRSA) is a notable example of a MDRO and there are New Zealand guidelines for its management and treatment (Ministry of Health 2002). Recently other MDROs, particularly extended-spectrum β-lactamase-producing gram-negative bacilli, have become a concern in New Zealand.

In response to the concern about the emergence of these MDROs in New Zealand, some DHBs have developed local guidelines to control their spread. There have been requests to produce national guidelines to act as a resource and support for DHBs in developing their own local guidelines.

In offering these Guidelines, it is acknowledged that there are gaps in our knowledge of the behaviour and spread of many MDROs. In many instances, control measures need to be implemented without definitive evidence of their efficacy. In many cases, too, assessments are necessary to identify the risk of MDRO spread and the benefits of certain measures in particular situations. For this reason it is expected that, based on their assessment of their local context, DHBs may vary in the degree to which they implement some of the recommendations in this document. These Guidelines acknowledge and accommodate differences in approach.

MRSA is not specifically included in these MDRO Guidelines as the *Guidelines for the Control of Methicillin-resistant Staphylococcus aureus in New Zealand* were extensively revised in 2002 (Ministry of Health 2002). These MDRO Guidelines are designed to complement the MRSA Guidelines and should be used in conjunction with them. It is hoped that ultimately these MDRO Guidelines and the MRSA Guidelines will be updated and integrated to produce a single document.

Acknowledgements

DHBs have assisted in the development of these Guidelines. For example, some of the appendices in these Guidelines are adaptations of materials received from DHBs.

Valuable comments on a draft of these Guidelines were provided by Martin Taylor (HealthCare Providers NZ), Francie Morgan (NZNO National Division of Infection Control Nurses), Andrew Stenson (RNZCGP), Sally Roberts and Christine Sieczkowski (Auckland DHB), Suzanne Catt (Counties Manukau DHB), Jan Adams (Waikato DHB), Kay Stockman (Waikato Hospital), Brian Dwyer (Bay of Plenty DHB), Antony Shanon (Tairawhiti DHB), Barbara McPherson (Hawke's Bay DHB), Memo Musa (Whanganui DHB), Lorraine Rees (MidCentral DHB), Wendy Wilkinson (Hutt Valley DHB), Jo Stoddart (Otago DHB), Chiew Fong (Healthcare Otago), Nigel Murray (Southland DHB).

Administrative and document support was provided by Martin Bonné (Senior Analyst).

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1 Introduction

1.1 General background

Controlling multidrug-resistant organisms (MDROs) is important because MDROs:

- are resistant to usual antimicrobial therapy
- increase patient morbidity and mortality
- add to the cost of treatment
- have the potential to spread and act as a reservoir of resistance genes for the transmission to other organisms.

Since the introduction of antibiotics in the treatment of human infections and use in food animals, there has been ample evidence to show that bacteria can mutate and adapt to survive. Bacteria develop mechanisms to resist the action of antibiotics and in this way become resistant to their use in clinical practice.

Certain bacteria seem to develop resistance more readily than others. These bacteria can develop multiresistance to several antibiotics which may severely limit therapeutic choices.

The number of MDROs will increase if the selective pressure of antibiotic use continues and the resistant organism is able to spread from one person to another. Therefore the control of antibiotic resistance needs to focus on both:

- rational antibiotic use to minimise selective pressure
- the practice of effective infection control measures to prevent the spread of resistant organisms.

These *Guidelines for the Control of Multidrug-resistant Organisms in New Zealand* provide general advice on MDRO control but focus mainly on those MDROs that are currently considered most important in New Zealand in terms of emergence and risk of transmission. In particular, they focus on extended-spectrum β-lactamase (ESBL)-producing organisms and vancomycin-resistant *Enterococcus faecium* and *E. faecalis* (VRE). General international resources include the Centers for Disease Control and Prevention (CDC) *Management of Multidrug-Resistant Organisms In Healthcare Settings* (Siegel D, Rhinehart E, Jackson M, et al 2006 http://www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf), and other CDC resources for preventing antimicrobial resistance in health care settings available on: http://www.cdc.gov/drugresistance/healthcare/default.htm.

The development of these Guidelines for publication has been largely stimulated by concerns over the recent increase in the number of ESBL-producing organisms being isolated in some parts of the country.

It is hoped that these Guidelines will facilitate the development of guidelines at the local level. Local practices have to be appropriate to the particular situation, and must take account of the local prevalence of MDROs and the hospital resources that are available.

Defining MDROs

Multidrug-resistant organisms can be defined in two ways. Organisms that are resistant to:

1. several antimicrobial agents to which they would normally be susceptible, or
2. all but one or two antimicrobial classes, regardless of the mechanism of resistance (and often susceptible to only one or two commercially available antibiotics).

Such organisms include ESBL-producing enterobacteriaceae and VRE. Methicillin-resistant *Staphylococcus aureus* (MRSA) is also a MDRO, but is covered in other guidelines (Ministry of Health 2002).

Organisms that are resistant to a first-line antibiotic are commonly also included in the definition of MDROs. These include organisms that are intrinsically resistant and readily acquire additional resistance mechanisms and become multi-drug resistant (eg, carbapenem-resistant *Acinetobacter).*

1.2 ESBLs and VRE internationally

1.2.1 ESBL-producing enterobacteriaceae

The production of β-lactamase enzymes is the most common mechanism of bacterial resistance to β-lactam antibiotics, such as the penicillins and cephalosporins. These enzymes catalyse the hydrolysis of the β-lactam ring of the antibiotic molecule thereby destroying the antimicrobial activity of the antibiotic. The first plasmid-mediated β-lactamase in gram-negative bacteria, TEM-1, which confers ampicillin resistance, was described in the 1960s.

Over the last 20 years many new β-lactam antibiotics have been developed specifically to resist known β-lactamases. Unfortunately, new β-lactamases have emerged to combat each new class of β-lactams.

Plasmid-mediated, extended-spectrum β-lactamases (ESBLs) emerged in gram-negative bacilli in Europe in the early 1980s. ESBLs, so named because of their increased spectrum of activity, confer resistance to:

- third- and fourth-generation cephalosporins (eg, ceftriaxone, cefotaxime, ceftazidime, cefepime and cefpirome)
- monobactams (eg, aztreonam)
- the earlier generation cephalosporins and penicillins.

ESBLs are inhibited in vitro by β-lactamase inhibitors such as clavulanic acid and tazobactam. They are usually derived from earlier, narrow-spectrum β-lactamases (eg, TEM, SHV, OXA enzyme families) and differ from the parent enzyme by a small number of point mutations, which confer an extended spectrum of activity. More recently another family of ESBLs, the CTX-M types, has emerged and these ESBLs are becoming increasingly common (Bonnet 2004).

Over 150 different ESBLs have been described (Lahey Clinic 2006). ESBLs have been reported worldwide in many different genera of enterobacteriaceae and in *P. aeruginosa*. However, ESBLs are most common in *Klebsiella pneumoniae* and *Escherichia coli*. ESBL-producing organisms are often multiresistant to several other classes of antibiotics, as the plasmids with the genes encoding ESBLs often carry other resistance determinants. Initially ESBL-producing organisms were usually isolated from nosocomial infections, but these organisms are now also being isolated in residential care facilities and the community (Pitout et al 2005).

The plasmid-mediated nature of ESBLs poses an additional problem for infection control as the genetic determinants can be readily transferred to other strains and bacterial species.

1.2.2 Vancomycin-resistant *E. faecium* and *E. faecalis*

Acquired vancomycin or glycopeptide resistance in *E. faecium* and *E. faecalis* (VRE, also referred to as GRE) was first detected in Europe in 1986 (Uttley et al 1988; Leclercq et al 1988). Since that time, VRE have become common in many countries, in particular in the United States and Europe.

Differences in the epidemiology of VRE in Europe and United States have often been described.

- In the United States, most VRE are hospital-acquired, multiresistant and clonal. Heavy hospital use of vancomycin, for example to treat MRSA infections, has probably contributed to their emergence and spread in United States hospitals.
- In Europe VRE are not considered principally a hospital organism, are not usually multiresistant and are polyclonal. Animals appear to be the main source of VRE acquired by humans, as in Europe the glycopeptide avoparcin was extensively used in the rearing of food-producing animals.

While *E. faecalis* accounts for most enterococcal infections, *E. faecium* accounts for most VRE infections. *E. faecium* belonging to a particular genetic lineage, the multilocus sequence type 17 (ST17) complex, are highly transmissible and have spread globally. Vancomycin-resistant *E. faecium* belonging to this lineage have been associated with nosocomial spread and outbreaks. Early identification of these highly transmissible ST17 complex VRE is a critical part of any VRE control programme (Willems et al 2005).

Five acquired vancomycin-resistant phenotypes have been identified in *E. faecium* and/or *E. faecalis*. The phenotypes can be distinguished to some extent on the basis of the level of resistance to vancomycin and teicoplanin (Table 1.1).

The VanA and VanB types account for the vast majority of VRE. The VanA type is characterised by inducible resistance to both vancomycin and teicoplanin. Strains of the VanB type have inducible resistance to various levels of vancomycin but not teicoplanin. The VanD, VanE and VanG types have only been rarely identified.

Constitutive low-level resistance to vancomycin (VanC type) is an intrinsic property of the motile enterococci: *E. gallinarum*, *E. casseliflavus* and *E. flavescens*. These species rarely cause clinically significant infections, and are not considered to be of importance to infection control.

Most VRE (especially *E. faecium*) are multiresistant to other antimicrobials, including β-lactams, high-level aminoglycosides, fluoroquinolones, erythromycin and tetracyclines.

Table 1.1: Vancomycin resistance in enterococci

Phenotype	VanA	VanB	VanD	VanE	VanG	VanC
	Acquired					Intrinsic
Vancomycin MIC (mg/L)	≥64	4–1024	64–256	16	16	2–32
Teicoplanin MIC (mg/L)	16–512	≤0.5	4–32	0.5	0.5	≤0.5
Species	*E. faecalis* and *E. faecium*	*E. faecalis* and *E. faecium*	*E. faecium*	*E. faecalis*	*E. faecalis*	*E. gallinarum* *E. casseliflavus* *E. flavescens*

Compared with other developed countries, antimicrobial resistance has often emerged later and more slowly in New Zealand and generally resistance rates are relatively low. While the number of ESBL-producing organisms is increasing in New Zealand, VRE remain uncommon. See Appendix 1 for information on ESBLs and VRE in New Zealand.

New Zealand's relatively low rates of antimicrobial resistance may provide a window of opportunity to implement measures to minimise the risk of emergence and spread of resistances that are still uncommon here. The greatest benefit from efforts to control MDRO transmission in New Zealand is likely to be achieved while the prevalence of MDROs is relatively low.

1.3 Antibiotic stewardship

As well as infection control measures, using antibiotics prudently (antibiotic stewardship) is essential to the control of MDROs because the selective pressures associated with antibiotic use lead to and maintain antibiotic resistance. Minimising adverse events associated with antibiotics is a further stimulus to prudent use (eg, Mazzeo 2005, Sanford Guide to Antimicrobial Therapy 2006).

Some general principles for antibiotic control are to use:

- knowledge of common pathogens and local laboratory data on cumulative susceptibility to guide empiric therapy
- broad-spectrum antibiotics only when necessary
- perioperative antibiotic prophylaxis appropriately (ie, avoid giving for longer than 24 hours) (www.cdc.gov/drugresistance/healthcare/).

The data on the role of antibiotic formulary changes in MDRO outbreak control are mixed. Some evidence suggests that it helps to use ticarcillin/clavulanate or amoxicillin/clavulanate as a replacement for third generation cephalosporins (Bantar et al 2004, Lan et al 2003, Patterson et al 2000, Rice et al 1996). Antibiotic cycling is not recommended (Bergstrom et al 2004, Brown and Nathwani 2005).

In addition, it may be helpful to impose limitations on the use of antibiotics associated with increased prevalence of a target MDRO.

1.3.1 ESBL

To prevent the establishment of ESBL colonisation:

- decrease the use of third generation cephalosporins (Bantar et al 2004, Lan et al 2003, Patterson et al 2000, Rice et al 1996).

1.3.2 VRE

To prevent the establishment of VRE colonisation:

- decrease the use of agents with little or no activity against enterococci, especially cephalosporins
- control the use of glycopeptides
- decrease the use of anti-anaerobic agents (Padiglione et al 2003).

1.4 Summary

- MDROs are organisms resistant to several antimicrobial agents to which they would normally be susceptible.
- These Guidelines focus on ESBL and VRE. Control of MRSA is covered in *Guidelines for the Control of Methicillin-resistant Staphylococcus aureus in New Zealand* (Ministry of Health 2002).
- ESBL-producing enterobacteriaceae produce extended-spectrum β-lactamases. Internationally these enzymes are the most common mechanism of bacterial resistance to β-lactam antibiotics, such as the penicillins and cephalosporins.
- The number of ESBL-producing organisms is increasing in New Zealand.
- Most vancomycin-resistant enterococci (especially *E. faecium*) are multiresistant to other antimicrobials, including β-lactams, high-level aminoglycosides, fluoroquinolones, erythromycin and tetracyclines.
- VRE remain uncommon in New Zealand.
- Infection control measures, including environmental cleaning and antibiotic stewardship are important for controlling MDROs.

2 Modes of Transmission and Risk Factors

2.1 Source and mode of MDRO infection

2.1.1 Mode of MDRO transmission

The most common mode of MDRO transmission is via the hands of health care workers. Hands become transiently contaminated by contact with infected or colonised patients, or by contact with environmental surfaces in close proximity to the patient.

2.1.2 Source of MDROs

Infected or colonised patients are the major reservoir of MDROs.

The gastrointestinal tract is the major reservoir for VRE, *C. difficile* and multidrug-resistant gram-negative bacilli (MDR-GNB), including ESBL-producing bacteria (Donskey 2004; Lucet et al 1996; Lemmen et al 2004).

While human sources are usually responsible for transmission of micro-organisms during health care, inanimate environmental sources may also be involved. Colonisation can be prolonged and is not always recognised.

Environmental contamination can lead to transmission especially when patients have diarrhoea or faecal incontinence and the reservoir of the MDRO is the gastrointestinal tract.

The inanimate environment and equipment may serve as a secondary source for MRSA, VRE and *C. difficile*, but are generally less likely to do so for gram-negative bacteria. MRSA or VRE can survive for weeks to several months on various surfaces (Neeley and Maley 2000) and *C. difficile* spores may remain viable for prolonged periods (Koneman et al 1997). A common environmental source of ESBL-producing organisms has only occasionally been discovered (eg, contaminated ultrasound gel, a bronchoscope and thermometers) (Paterson and Bonomo 2005). Unlike other gram-negative bacteria, *Acinetobacter* can survive for many days on both moist and dry surfaces (bed linen, curtains, floor, etc) (Bergogne-Berezin and Towner 1996).

Consistently following the recommended procedures for cleaning and disinfecting the environment should be adequate to keep rooms of MDRO patients clean (see also section 4.7 on environmental cleaning).

Advice on environmental sources of MDROs can be obtained from a table produced by the World Health Organization (Nicolle 2001, see Annex). The table in this WHO publication presents a list of outbreaks reported in the literature, and includes information on whether an environmental source and/or a reservoir or carrier was implicated in each outbreak.

2.2 Risk factors for acquiring MDROs

The patient risk factors associated with colonisation and infection are often the same for MRSA, VRE, MDR-GNB, *C. difficile* and *Candida* spp (Safdar and Maki 2002, Pfaller and Segreti 2006). The following risk factors have been identified:

- contact with colonised or infected patients
- severity of illness
- transfer of the patient between institutions
- prolonged hospital stay
- gastrointestinal surgery
- transplantation
- presence of medical devices (eg, central venous catheter or urinary catheters)
- prolonged exposure to broad-spectrum antimicrobial drugs
- admission to health care facility with suspected or known MDRO transmission (both in New Zealand and overseas).

2.3 Summary

- The most common mode of MDRO transmission in health care facilities is via the hands of health care workers.
- The major reservoir of MDROs is infected or colonised patients.
- The same factors often predispose patients to acquire MRSA, VRE, MDR-GNB, *C. difficile* and *Candida* spp.

3 Administrative Support for Infection Control

In general, inadequate numbers of ward or unit staff, inadequate staff training, overcrowding of patients, lack of isolation facilities, frequent relocation of patients and staff, and poor attention to infection control processes increase the risk of nosocomial infection (Vicca 1999).

Management support for infection control activity (including adequate staffing of the infection control team and access to epidemiological support and information technology services) enables the baseline level of MDRO control activity required for MDROs to be recognised.

Direct reporting of the infection control team to the clinical governance structure within the organisation helps recognition of the priority of infection control activities (including MDRO control).

Hospitals and other health care facilities need to adhere to Acts and regulations relating to compliance in the areas of infection control and antibiotic use. Hospitals must have a documented policy on antibiotic use. The Health and Disability Services (Safety) Act 2001 requires all hospitals and residential care facilities (RCFs) to be audited by a designated audit agency and to be certified by the Director-General of Health.

Hospitals and RCFs are audited at least three yearly against the Standards New Zealand Health and Disability Sector Standard (NZS 8134: 2001) and the Infection Control Standard (NZS 8142: 2000).

3.1 MDROs and infection control programmes

The detection and/or transmission of MDROs provides an opportunity to assess the effectiveness of infection control programmes, as they often act as an easily recognised marker of infection acquired through hospital or other health care services.

The infection control programme for each health care facility provides the foundation for controlling infection associated with health care. The programme should be actively managed by the infection control team and supported by hospital managers in all New Zealand hospitals and health care facilities (NZS 8142 2000).

The following general infection control measures should be in place.

- Apply standard precautions, particularly with respect to hand hygiene and the use of alcohol-based product (gels, rubs, rinses, foams).
- Provide a clean uncluttered environment.
- Ensure staff are properly trained, have a good understanding of infection control principles and have time to practise effective hygiene.
- Establish appropriate antibiotic prescribing guidelines, reinforcing and auditing them periodically.

- Conduct surveillance of organisms significant to infection control, including MDROs. Surveillance data that provide no evidence of transmission of resistant organisms in a particular unit or setting may allow a more proportional and targeted approach to MDROs.

The infection control team, together with relevant management and clinical staff must at times assess the need for additional infection control measures. Such multi-disciplinary assessment may be facilitated by a systematic consideration of risk factors with associated controls (for example, see matrix in Appendix 2).

3.2 Summary

- The infection control programme, including the antibiotic policy, for each health care facility provides the foundation for controlling infection associated with health care.
- The individual institution's response to MDROs should be integrated with other aspects of its infection control programme.
- Periodic assessments of the need for additional infection control measures must involve relevant management and clinical staff, as well as the infection control team.

4 Management of Patients with MDROs in Health Care Facilities

When a MDRO is detected, the laboratory should notify the infection control team immediately, so that relevant infection control measures can be implemented. Community laboratories are encouraged to advise the infection control practitioners for private surgical hospitals and RCFs when they isolate a MDRO.

4.1 Response appropriate to risk

The management of MDRO infection in individual patients can be assessed and adjusted using a risk based approach that includes institutional as well as patient specific risk factors.

This approach seeks to balance the rights of the patient with the desire to protect others. The following factors are important in achieving this balance.

- The epidemiology of the infection (the emergence of a new MDRO or the spread of an epidemic strain). Epidemics are best prevented early, rather than controlled late, and the discovery of an organism known to cause outbreaks in other situations should provoke a more vigorous control response.
- The range of antibiotics available to treat the particular MDRO. Some MDRO are resistant to nearly all antibiotics. In such situations the only control strategies available is infection control with prevention of colonisation and infection.
- Patients with conditions associated with a high risk for dissemination, for example, the presence of urinary catheter or urinary incontinence, faecal incontinence (eg, toddlers in nappies), or draining wounds.
- The patient's ability and willingness to comply with hygiene instructions. Patients unable or unwilling to control their interactions with vulnerable others may need to be cared for in a more restricted environment.
- The vulnerability of affected or potentially affected groups, such as patients in an intensive care unit (ICU) and transplant, burns, or cancer patients.
- The availability of single rooms with en suite bathroom facilities, which affects decisions whether to isolate or cohort affected patients.
- General state of hygiene in the unit or facility. This is a generic issue, and the discovery of a person with a MDRO in a clinical area with poor standards of cleanliness should be used as a reason to improve cleaning. Other patients in that service should be viewed as being at higher risk for acquiring the MDRO.

Some organisations may adopt a 'search and destroy' approach to all MDROs; others may take a more targeted or risk-based approach.

The differences in approach may be illustrated with two examples. First, where a person is infected or colonised with ESBL in a rehabilitation ward, contact precautions may not be necessary if there is no evidence that ESBL-producing organisms have been transmitted, wounds are covered and the patient is able and willing to practise effective hand hygiene. This approach is supported by the literature which suggests that finding patients colonised with ESBLs does not necessarily imply a transmission risk in all settings (Gardam 2002; Manitoba Health 2002; Rodriguez-Bano 2006).

On the other hand, where ESBL emerges in an ICU or burns unit where there are a number of very susceptible patients, a more vigorous approach using contact precautions would be warranted. The introduction of contact precautions would reflect the level of risk that the patient and the organism pose to the organisation as a whole.

In addition to institutional and patient factors, risk is also influenced by epidemiology and organism specific factors. Assessing the extent of cross-transmission and the success of any control measures requires an understanding of time/place/person considerations and the molecular epidemiology of the MDRO.

4.2 Patient placement

Where patients are known or suspected to have epidemiologically important MDRO infection or colonisation:

- place in a single room
- implement contact precautions.

If there are limited facilities for isolation, give priority to isolating those patients with conditions that may facilitate transmission (eg, uncontained drainage, stool incontinence) – see 4.1.

Patients with the same MDRO can be cohorted in the same room, especially when single rooms are not available. As far as possible, assign dedicated nurses to care for a particular cohort.

When cohorting patients with the same MDRO is not possible, place the MDRO patients with little risk of dissemination (eg, colonised only, continent) in rooms with non-MDRO patients who are at low risk of acquiring MDROs and are likely to have a short stay (eg, patients without indwelling devices or neutropenia).

4.3 Standard precautions

Standard precautions are a set of precautions used to protect patients and staff by reducing the risk of transmission of infectious agents from both recognised and unrecognised sources of infection or colonisation (see Appendix 3, and *http://www.cdc.gov/ncidod/dhqp/gl_isolation_standard.html*).

Use standard precautions for all patient contacts when dealing with blood, body fluid (including secretions and excretions), non-intact skin and mucous membranes.

Hand hygiene is an essential element of standard precautions.

Standard precautions may involve the use of gloves, gowns, aprons, masks, eye protection, and/or face shields.

See Appendices 3–6.

4.4 Hand hygiene

Effective hand hygiene is the most important measure to prevent and control the spread of MDROs.

The term **hand hygiene** includes both handwashing with liquid soap (plain or antimicrobial) and water (see Appendix 6) and the use of alcohol-based products (gels, rubs, rinses, foams).

If hands are not visibly soiled, approved alcohol-based products for hand disinfection are suitable alternatives to soap and water (HICPAC Advisory Committee et al 2002).

The type and length of fingernails and the wearing of jewellery can affect hand hygiene. Artificial fingernails and extenders may promote long-term carriage and have been associated with transmission of gram-negative bacillus and candidal infections (Gupta et al 2004).

Practise hand hygiene:

- before and after direct contact with each patient
- after contact with blood, body fluids, mucus membranes, non-intact skin, or wounds
- if moving hands from a contaminated body site to a clean body site during patient care
- after contact with inanimate objects (including medical equipment) in the immediate vicinity of the patient
- after removing gloves or other protective gear (HICPAC Advisory Committee et al 2002).

4.5 Contact precautions

Contact precautions are designed to reduce transmission through direct or indirect contact. Contact precautions are used in addition to standard precautions when caring for patients who are infected or colonised with a MDRO.

See Appendices 7 and 8 for examples of information sheets for staff caring for patients with MDRO.

4.5.1 Gloves

If contact with the patient, environmental surfaces or the items in the room is likely, wear single-use disposable gloves when entering the patient's room.

Remove gloves and perform hand hygiene before leaving the patient's room.

4.5.2 Gown or apron

If contact with the patient, environmental surfaces or the items in the room is likely, wear a disposable gown or apron when entering the patient's room.

Remove gown or apron and perform hand hygiene procedure before leaving the patient's room.

After removing gown or apron, do not allow clothing and skin to make contact with potentially contaminated environmental surfaces.

4.5.3 Surgical masks

Surgical masks are not recommended for routine use by staff entering a room of an infected/colonised patient. There is little evidence for transmission of MDROs by droplets from most patients to staff. However, surgical masks should be used as part of standard precautions to prevent the face being exposed to body fluids when procedures that might generate droplets (eg, wound irrigation) are being performed.

Use surgical masks when the patient is infected/colonised in the respiratory tract with a MDRO and is coughing and sneezing or aerosol generating procedures are being performed (eg, suctioning, intubation, nebuliser respiratory therapy treatments, tracheostomy cares, bronchoscopy).

4.5.4 Patient equipment

Dedicate equipment involved in patient care to use with a single patient (or a single cohort of patients) to avoid sharing between patients. If use of common equipment or items is unavoidable, then adequately clean and disinfect them before use with another patient.

4.5.5 Staffing of the isolation room

To decrease the risk of transmission to other patients within the wards, it is important to include the following in planning the care of a MDRO patient.

- The number of staff allocated to the patient should be as low as possible while meeting the health care needs of the patient.
- Wherever possible, care should be provided by permanent ward/unit staff.
- If casual/pool staff are allocated, the nurse providing care must have the skills and knowledge to care for a MDRO patient.

- Ideally, the nurse working in contact precautions should have a 'helper nurse' or 'buddy' to assist with delivering and removing items to and from the isolation room. Effort should be made to group nursing cares so that exposure times can be practically controlled.

4.5.6 Patient movement

- Limit the transport of a patient in contact precautions to essential purposes such as diagnostic and therapeutic procedures that cannot be performed in the patient's room.
- When transport is necessary, contain and cover infected or colonised areas of the patient to avoid disseminating the MDRO. Examples include the following.
  - Impermeable dressings should be used to cover unhealed skin wounds or lesions.
  - If appropriate, measures to contain possible incontinence.
  - During transport, cover the wheelchair, trolley or stretcher with a clean sheet which is discarded into a soiled linen container at the completion of transportation.
  - Avoid transporting the patient on their bed from a contact precautions room.
- If the patient's respiratory tract is known to be colonised/infected with a MDRO and they are coughing or sneezing it is recommended that the patient wears a surgical mask during transport.
- Inform the receiving department of the transport before it occurs so that the department can implement infection control measures.
- All people in direct contact with the patient should maintain contact precautions.
- Ensure transporting staff (eg, orderlies) are aware of the patient's MDRO status. While transporting staff need not wear protective apparel during transportation, hand hygiene and cleaning and disinfecting equipment are paramount.
- Where appropriate, consider supplying the patient with their own alcohol-based hand hygiene product and instruct patient to use frequently (before leaving and re-entering their room).

4.6 Surgery

Operating room staff should be aware of the patient's MDRO status. All people in direct contact with the patient should maintain contact precautions, including hand hygiene.

There are no data suggesting that MDRO positive patients should be placed last on an operating list. Standard operating room precautions, including decontaminating items the patient touches, are sufficient. Operating attire worn by the theatre team is made to meet the challenges of operating theatre procedures. The barrier fabrics are impervious and strike-through proof and can be disposable.

4.6.1 Surgical antibiotic prophylaxis

If antibiotic prophylaxis is required for someone colonised with MDROs selection of an appropriate agent should be made in consultation with a clinical microbiologist or infectious diseases physician.

4.7 Environmental cleaning

Follow recommended routine cleaning and disinfection procedures for maintaining patient care areas and equipment.

Pay meticulous attention to surfaces in close proximity to the patient as well as those surfaces likely to be touched by the patient and staff (eg, bedrails, bedside commodes, doorknobs, tap handles).

Consistently following the routine recommendations for the amount, dilution and contact time of disinfectants, will generally suffice for cleaning of rooms of patients with MDRO. Most often it is the failure to follow the recommended procedures rather than the failure of the procedures that helps to create an environmental reservoir of pathogens during outbreaks.

4.8 Discontinuation of contact precautions

These Guidelines do not recommend testing for clearance. Colonisation with MDRO may persist for years (Baden et al 2001; Arpin et al 2005).

Contact precautions should be stopped only following case-by-case consideration by a multidisciplinary team. The team must assess the risk of MDRO transmission from an infected or colonised patient to others.

The decision to remove someone from isolation should be based on the same principles by which decisions are made to isolate people (refer to section 4.2).

4.9 Eradication of carriage

Decolonising patients with VRE or MDR-GNB is not recommended. The efficacy of decolonisation protocols for VRE and MDR-GNB has not been established (www.cdc.gov/drugresistance/healthcare/).

4.10 Communication

The successful management and control of MDROs requires co-operation and communication among all the disciplines and facilities involved in patient care. All DHBs and health care facilities should also have access to expert advice and policies. The entire control effort is generally co-ordinated and overseen by infection control practitioners and the institutional infection control team.

The infection control team should take responsibility for communication with all the relevant services.

4.10.1 Medical warning regarding MDRO status on patient database

Establish a way to identify patients previously colonised or infected with a MDRO (as a patient medical warning) to enable the screening and/or use of appropriate infection control precautions for previously positive patients.

4.10.2 Patient and caregiver information

Provide patients and caregivers with appropriate information on MDROs and the local MDRO policy.

Educate patients on the importance of hand hygiene, particularly when they are required to leave the isolation room. Where appropriate, ambulatory patients should be encouraged to perform hand hygiene if they need to leave the isolation room to use ward facilities.

Where patients colonised or infected with a MDRO in the respiratory tract are coughing and sneezing, teach them to follow appropriate coughing and sneezing hygiene etiquette (see Appendices 4 and 7).

The use of PPE is not usually required for carers but they should be encouraged to wash their hands before leaving the room.

Ask caregivers also to limit their visit only to the patient infected with MDROs.

4.10.3 Visitor information

Provide visitors with appropriate information (preferably both written and verbal) on MDROs prior to entering the patient's room. Visitors require education, in particular regarding hand hygiene and the importance of washing their hands thoroughly after the visit.

If visitors wish to visit more than one patient, ask them to visit the patient with MDROs last.

See Appendix 9 for an example of patient and visitor information. See also Section 3 on administrative support.

4.10.4 Communication between laboratory and clinicians

Maintain systems to provide feedback to clinicians and administrators on facility trends in resistance, adherence monitoring, and system failures.

When a MDRO is isolated, the clinical microbiologist, infection control nurse or laboratory scientist should notify the ward immediately so that the patient can be managed appropriately.

When increased incidence of a targeted MDRO is observed, the infection control team can consider intensive monitoring of selected indicators.

4.10.5 Communication between health care facilities

Colonisation or infection with a MDRO should not prevent the transfer of patients between health care institutions, including RCFs.

Advise the receiving institution of the patient's MDRO status in advance of the transfer to enable the receiving institution to put in place appropriate precautions (see Section 7 transfer of patients between institutions). See Appendix 10 for an example letter to the doctor accepting the patient's care in the community or facility.

4.10.6 Communication between pharmacy and clinicians

A pharmaceutical formulary (including restrictions for use of certain antibiotics) can be introduced. A further option, applicable to therapy guided by culture results, is to implement systems to prompt prescribers to verify that prescribed antibiotics are active against the patient's clinical isolates.

In hospitals and RCFs, a multidisciplinary committee should review antibiotics utilisation patterns. Utilisation and resistance patterns must be considered to minimise selective pressure and to ensure appropriate antibiotics coverage.

4.11 Education

4.11.1 Education of staff and patients

Conduct staff educational programmes to ensure that staff understand why antibiotic-resistant pathogens are important, why prevention of spread is critical for control, and which measures for preventing spread have proven to be effective.

In staff orientation and periodic educational updates, include education on MDRO transmission and how to prevent transmission. Also include MDRO education in the required curriculum of all staff professional training programmes.

Make information available to patients (see Appendix 9 for an example of a patient and visitor information sheet).

4.12 Patient discharge

The patient's MDRO status should be communicated to the general practitioner, district nurse and other community health agencies involved in their care, before a MDRO patient is discharged from hospital.

If the patient is being transferred to another institution, advise the receiving institution of the patient's MDRO status in advance of the transfer to enable the receiving institution to put in place appropriate precautions (see section 4.10.5 and section 7 Transfer of patients between institutions). See Appendix 10 for an example letter to the doctor accepting the patient's care in the community or facility.

4.13 Summary

- Appropriate isolation and cleaning procedures should be maintained by all people in direct contact with the patient.
- Effective hand hygiene is the most important measure to prevent and control the spread of MDROs.
- If possible, place in a single room patients known or suspected to have epidemiologically important MDRO infection or colonisation.
- Decolonising patients with VRE or MDR-GNB is not recommended.
- Educate staff, patients and visitors on the precautions to be followed.
- Before a MDRO patient is discharged from hospital, provide information about their MDRO status to the general practitioner, district nurse, receiving health care facility and other community health agencies involved in their care.
- Clean the patient environment thoroughly with approved disinfectant.
- All the disciplines and facilities involved in patient care must co-operate and communicate for the successful management and control of MDROs.

5 Screening

Routinely identifying patients colonised with MDROs (screening) is not recommended.

Methods used to detect colonisation with a MDRO may not be 100% sensitive. However, in specific situations, measures to actively identify patients who are colonised with MDROs should be considered.

When a screening programme is instituted, collection and periodic review of data obtained from screening is essential. These data may be used to re-evaluate the screening programme over time and assist other regions, hospitals, and health care facilities with similar programmes.

5.1 When is screening appropriate?

- During an outbreak (≥2 new isolates of a MDRO identified from clinical specimens and related in time and place) screening for surveillance purposes (active surveillance cultures) is recommended (see section 8.1).
- As part of an investigation of a MDRO that is new to New Zealand, screening may be appropriate.
- Screening may be used as part of an infection control programme to control an endemic MDRO.
- Active surveillance cultures (see 10.1.2) may be appropriate as a method of confirming the absence or presence of a MDRO locally. For example, there may be periodic surveys for MDROs that are uncommon or that have not been identified among clinical isolates in the region, or screening for VRE and ESBLs in faeces samples submitted for *C. difficile* testing.

5.2 Which patients should be screened at the time of admission?

Candidates for screening for MDROs when admitted to an acute care hospital or private surgical hospital are those patients who:

- have been admitted, within the previous six months, to an overseas hospital
- have received outpatient health care in an overseas facility (eg, for dialysis; screen the patient on return to a New Zealand dialysis centre)
- have been admitted previously to a ward/unit within New Zealand (including own facility) where recent MDRO transmission was suspected
- are being admitted from a RCF where transmission of a MDRO is suspected
- are involved in an outbreak investigation and control programme (see below).

The decision to implement isolation using contact precautions pending the results of screening is influenced by the number of patients being screened, number of isolation beds and the likelihood of finding a MDRO. Contact precautions may be used for patients in the categories above, although facilities will need to decide what is appropriate within their available resources.

If knowledge of a patient's MDRO status makes no difference to the infection control precautions planned, there may be little value in screening. For example, if contact precautions are employed at each readmission of a patient previously identified as having VRE, then screening on these occasions is unnecessary. Similarly, if patients in a RCFs will continue to be cared for with standard precautions regardless of whether they have been colonised with ESBL, identifying colonised patients through screening will have little impact on their care.

A review of risks and available control measures using the risk matrix in Appendix 2 can inform the infection control approach, including screening for MDRO.

5.3 Screening in an outbreak situation

During an outbreak, screening of other patients exposed to the same conditions (ie, who were present in the same room and/or ward at the same time as identified cases) provides information on the extent of transmission and assists with cohorting of patients.

A 'traffic light' system is an example of an outbreak control tool used to establish screening and cohorting of exposed patients (see section 8.2, and also Appendix 11).

5.4 Screening specimens

To detect colonisation with VRE or ESBL-producing organisms, a faeces sample or rectal swab is needed (sensitivity of each sample is not known). If the patient has chronic skin ulcers or a surgical wound, these areas should also be swabbed. If the patient has a permanent indwelling urinary catheter, a urine sample should be submitted. Other sites may need to be sampled depending on the MDRO in question.

In contrast to screening for MRSA, a nasal swab need not be collected for VRE or ESBLs.

The laboratory request form accompanying these specimens must state that these samples are specifically for **screening** for VRE and/or ESBL (or an alternative MDRO of interest) in order to be processed correctly. A clinical specimen processed routinely may **not** identify colonisation with VRE or ESBL.

5.5 Summary

- Screening (routine laboratory testing for MDROs) of well people admitted from the community is not recommended.
- Screening may be considered:
  - where there is an outbreak or reason to suspect that the patient being admitted is infected/colonised
  - where a risk assessment suggests screening is appropriate.
- To detect colonisation with VRE or ESBL-producing organisms, a faeces sample or rectal swab (clearly labelled as VRE and/or ESBL screening samples) is needed.

6 Management of Staff

Screening of staff is not recommended for ESBL organisms or VRE.

The literature indicates that staff practices for infection control (eg, hand hygiene) are more important than the possibility that they may carry MDROs. In addition, it is believed that achieving clearance of VRE and ESBL colonisation is impossible.

If it is found incidentally that staff are colonised with MDROs, no work restrictions for these staff are required. Instead staff should receive education on standard precautions, particularly hand hygiene.

However, if epidemiological evidence shows a staff member has a role in the spread of a MDRO, review that staff member's infection control practices as well as factors that may increase the risk of transmission (eg, paronychia). If the predisposing factors cannot be remedied and concerns about transmission persist, then it may be necessary to reallocate the staff member to other tasks. Irrespective of their MDRO status, staff should not work if they are experiencing acute diarrhoea.

If individual staff members are concerned about their health, they may liaise with an occupational health representative for further advice. The occupational health service should have a policy for dealing with such instances, developed in conjunction with the infection control team.

6.1 Summary

- Routine screening of staff is not recommended.
- If staff are epidemiologically linked to the transmission of a MDRO, review infection control practices and predisposing factors.

7 Transfer of Patients Between Institutions

Colonisation or infection with a MDRO should not prevent the transfer of patients between health care institutions, including RCFs.

There is no evidence that restricting admission of colonised patients to RCFs is beneficial to either the patient or the institution. A facility's infection rate does not appear to increase when a resident with a MDRO is present.

Moreover, when transfer is delayed due to a RCFs' reluctance to admit a patient with a MDRO, it can place significant burdens on tertiary and secondary hospital resources.

Advise the receiving institution of the transfer in advance so that it can implement contact precautions. Transfer information should include information on current management of the patient.

See also *Guidelines for the control of methicillin-resistant Staphylococcus aureus in New Zealand* (Ministry of Health 2002).

7.1 Summary

- Colonisation or infection with a MDRO should not prevent the transfer of patients between health care institutions.
- Advise the receiving institution in advance of the transfer of any MDRO infected/ colonised patient.

8 Additional Measures in the Event of an Outbreak

The detection of the first MDRO isolate signals the potential for the MDRO to spread in the facility concerned. Where several epidemiologically linked MDRO isolates, or an increase in numbers of cases over a baseline, are detected, it may indicate cross-transmission and this situation may constitute an outbreak.

8.1 Investigation of transmission/outbreak

If two or more patients within a defined clinical area have the same MDRO, an investigation may be undertaken for a potential common source and mode of transmission, depending on the prevalence of the MDRO and the nature of the institution.

Such investigations usually involve formulating a case definition, determining timelines and common factors associated with colonised or infected patients.

Identification of the index patient may be difficult because of subclinical spread of the organism before it is first detected.

Active surveillance cultures of potentially exposed patients (eg, patients in the same room) can help estimate the degree of spread once transmission of the MDRO has been identified (see section 10.1.2). Interpretation of results must take account of the limited sensitivity of screening cultures and the effect of time of exposure relative to cultures being taken.

If other patients are found to harbour the MDRO, establish an outbreak management plan which includes implementing control measures to prevent further spread.

Where transmission continues for some time, periodic surveillance of patients for MDRO carriage in the unit may be performed to check on persistence of the organism.

Normally, surveillance cultures of staff or of the environment are not necessary unless epidemiological evidence implicates them in transmission.

8.1.1 Assessing risk to institution

A multidisciplinary assessment of risk may be needed to respond to the isolation of a MDRO in a particular setting. Relevant management and clinical staff, together with the infection control team, will need to assess the risk and determine the need for, and type of, escalation in response.

A multidisciplinary assessment of risk may be facilitated by a systematic consideration of risk factors with associated controls (for example, see matrix in Appendix 2).

8.2 Controlling transmission/outbreak

Focus control efforts on interruption of transmission in identified areas.

Implement policies for patient placement and staffing to prevent transmission. Intensified infection control measures can include the following.

- Place MDRO positive patients in single rooms (when available) or place the cohort patients with the same MDRO in the same room.
- Implement contact precautions for all patients colonised or infected with MDRO. Consider routine use of gowns and gloves.
- Reinforce standard precautions for all other patients in the unit.
- If transmission continues despite cohorting patients, consider assigning dedicated nursing staff (and other staff where possible) to the care of MDRO patients only.
- Cohort exposed patients (but not proven culture positive for the MDRO) if necessary to control an outbreak of a MDRO. Implement contact precautions initially for these patients until assessment (eg, negative cultures) suggests they are a low risk.
- One model that has been used with some success in the management of MRSA and also ESBL-producing organisms is the traffic-light system of cohorting patients. This system cohorts patients in a unit according to whether they are known to carry the MDRO (red), have been exposed to but are not known to carry the organism (orange) or have no known exposure to the organism (green). See Appendix 11 for an example of this system.
- If the environment is implicated in transmission, the following measures can be considered.
  - Increase frequency of scheduled cleaning and improve processes for cleaning and disinfection (eg, assign dedicated staff who have been educated about MDROs, including the role of the environment in transmission, to ensure consistent, correct cleaning and disinfection of the environment).
  - When epidemiological evidence suggests that an environmental source (eg, surfaces, shared equipment) is associated with ongoing transmission of the targeted MDRO, cultures may be obtained. Only undertake environmental sampling in consultation with infection control experts.
  - When previous efforts to eliminate environmental reservoirs have failed, vacate the units concerned, assess their environment and clean them intensively.
- Consider closing the unit or facility to new admissions if transmission continues despite the implementation of the intensified infection control measures. Factors to be considered in this decision include: risk status of patients to be admitted, number of cases, MDRO strain and behaviour, availability of alternative facilities and staffing levels.

In some instances, infection control principles and practices must be applied persistently for a significant period before control is achieved. Occasionally an institution may find it helpful to ask the District Health Boards New Zealand, Ministry of Health and the Institute of Environmental Science and Research (ESR) for specialised skills and resources in investigating and helping control a difficult outbreak.

8.3 Establishing a dedicated outbreak control team

To fully investigate an outbreak epidemiology and to obtain control a dedicated team approach may be needed. To achieve such an approach, there is a need for:

- representation from all stakeholders of a unit, including managerial, infection control and microbiology staff
- commitment of the necessary resources to gain control.

8.4 Facility-wide education in outbreak setting

In an outbreak setting, education programmes should:

- be targeted at intensified MDRO control interventions
- be provided to staff throughout the facility and/or in high-risk units
- include relevant information on MDRO trends, system failures, action plans and their outcomes.

8.5 Summary

- In an investigation of a MDRO outbreak, the degree of spread and mode of transmission are assessed.
- Commitment of staff and management for months or years may be required to control outbreaks due to MDRO.
- To control the outbreak, it may be necessary to intensify control measures and conduct periodic active surveillance cultures over a significant period.
- To achieve control, it may be necessary to establish a dedicated team and tailored measures, perhaps with specialised help recruited from outside the institution.

9 Management in the Community

Patients colonised or infected with MDROs may be cared for in many different community settings. These settings include residential care facilities (RCFs), general practice and hospices, as well as the patients' own homes, where they are cared for by either district nurses or other community health care providers.

All health and disability care organisations must have an infection control programme as outlined in the Standards New Zealand Infection Control Standard (NZS 8142: 2000). The programme should include formulation of policies and procedures for the management of MDROs and the use of antibiotics, education and surveillance. A designated staff member should be appointed to deal with infection control issues.

9.1 Residential care facilities

RCFs are ideal settings for MDROs to persist and spread. Although MDROs are often first introduced to RCFs from acute care facilities, they persist more strongly in RCFs that lack effective infection control. As in hospitals, prudent antibiotic use in the community setting is an essential element in the control of antibiotic resistance.

The following recommendations are made for RCFs (Strausbaugh et al 1996).

- Hand hygiene is the single most effective means of preventing the spread of MDROs.
- Individuals colonised with a MDRO should not be denied entry to RCFs. It appears that entry of resistant bacteria into an RCF does not increase its infection rates, nor does it necessarily lead to excess morbidity or mortality.
- Decolonisation therapy should not be required prior to transfer.
- RCF residents colonised with MDRO should not be restricted from participation in social or therapeutic group activities unless there is a reason to think they are shedding large numbers of bacteria and infecting other residents.

There is no evidence that colonised residents must be excluded from dining rooms or limited in their rehabilitation group activities to prevent the spread of MDROs in these settings. Such restrictions deprive affected residents of social contact and rehabilitation opportunities, which may in turn impair their convalescence or quality of life.

Reserve contact precautions and other restrictions of movement for residents who both:

- may be shedding large numbers of organisms into the environment (eg, where they have large wounds not contained with dressings, or tracheostomies with frequent coughing, or are incontinent) **and**
- are linked epidemiologically with other residents who acquired infections with the same strain of MDRO.

Isolate residents with acute infection, rather than colonisation, appropriately.

9.1.1 RCFs without infection

For RCFs without infections caused by MDROs in the preceding year and with few, if any, colonised residents, the following control measures are advocated.

- Before a resident who is infected or colonised with a MDRO is transferred to an RCF, inform the RCF.
- Routine precautions in all RCFs should include adequate handwashing facilities, and education as to the need for precautions. Incentives and other resources may be used to maintain contact precautions when it is required.
- Minimise use of invasive devices such as urinary catheters and feeding tubes. Offer ongoing education that emphasises measures most likely to prevent cross-transmission.
- Implement control measures for MDROs that reflect the incidence of MDROs in the facility.

9.1.2 RCFs with low endemic infection rates

For RCFs with a low endemic infection rate (eg, <1 per 1000 resident days), the following additional control measures are recommended.

- Analyse surveillance data monthly to identify cross-transmission.
- Do not place residents infected or colonised with a MDRO in rooms with debilitated, non-ambulatory residents, who are at greatest risk of becoming infected or colonised.

Use single rooms, if available, and cohorting strategies judiciously to minimise dissemination of MDROs from residents shedding large numbers of organisms into the environment (eg, residents with colonised wounds not fully covered with dressings, incontinent residents with urinary or faecal carriage, or colonised residents with tracheostomies and difficulty handling respiratory secretions).

9.1.3 RCFs with high rates of infection

Consultation with an experienced infection control expert is recommended for RCFs with either:

- high rates of endemic infection (eg, > 1 per 1000 resident days)
- an outbreak (eg, > 3 infections in a week, or twice the number of infections in a month than has been observed in the previous three months).

9.2 Other settings

Carriage of MDRO is asymptomatic and therefore many carriers go undetected. This means that appropriate infection control practices, must be employed for all patients, not just for those known to be infected or colonised with MDRO.

9.2.1 Outpatient clinics

If a patient is known to be infected, it is important to inform the department to ensure that procedures are in place to further reduce the risk of spread.

9.2.2 General practice and other community based services

Infection control programmes are also necessary for general practices and other community-based services such as ambulance services and district nursing.

If a patient is known to be infected or colonised with a MDRO, it is important to notify other health care providers caring for the patient so that optimal infection control precautions are taken.

9.3 Summary

- All health and disability care organisations must have an infection control programme as outlined in the Standards New Zealand Infection Control Standard (NZS 8142: 2000).
- Hand hygiene is the single most effective means of preventing the spread of MDROs.
- People who are colonised with a MDRO should not be denied entry to RCFs.
- RCF residents colonised with a MDRO should not be restricted from participation in social or therapeutic group activities unless there is a reason to think they are shedding large numbers of bacteria and infecting other residents.

10 Surveillance

10.1 Local surveillance

10.1.1 Analysis and reporting of routine clinical cultures

Laboratories should regularly analyse and report their antimicrobial susceptibility test results so that local resistance data are available to:

- detect and investigate trends and emerging resistances
- evaluate the effectiveness of infection control measures to prevent the spread of resistance
- formulate and evaluate local antibiotic treatment guidelines.

Laboratories should have computer systems that facilitate these analyses. Analysis protocols should follow the Clinical and Laboratory Standards Institute (CLSI) guidelines for the analysis and presentation of cumulative antimicrobial susceptibility test data (CLSI 2005). The analyses should investigate multiresistance as well as the prevalence of resistance to individual antibiotics. In addition to institute-wide data, there should be analysis and reporting of antimicrobial resistance in specific units, especially units with patients at high risk of having or acquiring MDROs.

Laboratories should have protocols to notify infectious diseases and infection control personnel of the identification of any novel (eg, VRE) or targeted MDROs (eg, ESBL). The prevalence and frequency of a MDRO that would initiate an increase in control efforts should be defined. These definitions may vary according to the specific MDRO and its local prevalence.

10.1.2 Active surveillance cultures

Active surveillance cultures may be appropriate to determine the extent of any spread of a MDRO or as part of an outbreak investigation. Identifying patients colonised with MDROs (screening) may be considered to determine the source of a resistant organism or to quantify the risk associated with certain patient groups (see section 5). All isolates should be stored so that they are available for further testing, such as typing, if required.

Each institution needs to consider establishing active surveillance culture programmes to periodically monitor the prevalence of resistances that are still uncommon in their institution or area. Such programmes are especially important for monitoring VRE, as routine culture of diagnostic specimens is likely to detect only a small proportion of patients who are colonised (see section 11.2.2). Periodic screening will be most sensitive if focused on patients at risk of being colonised with the target organism.

10.2 National surveillance

At the national level, ESR operates several surveillance systems to monitor antibiotic resistance, including ESBL-producing enterobacteriaceae, VRE and other MDROs. All data from these surveillance systems are published on ESR's surveillance website at http://www.surv.esr.cri.nz/antimicrobial/antimicrobial_resistance.php.

10.2.1 Web-based surveillance of MRSA, ESBL-producing enterobacteriaceae and other resistant organisms

This system allows health care facilities to regularly report the prevalence of MRSA and ESBL-producing enterobacteriaceae in their facility. Health care facilities can also record significant transmission and outbreaks of any resistant organism and provide qualifying comments. The prevalence and transmission data reported is available to all participating health care facilities to assist them operate appropriate screening and isolation protocols for patients being transferred between facilities. To register to participate in this surveillance, email NIL@esr.cri.nz.

10.2.2 Surveillance of uncommon and emerging resistances

Uncommon and emerging resistances include VRE, vancomycin-resistant and intermediate *S. aureus*, β-lactamase positive *E. faecium* and *E. faecalis*, and multiresistant organisms associated with nosocomial spread or outbreaks.

Laboratories are requested to refer all isolates of any of these organisms to ESR for confirmation and further analyses.

10.2.3 Annual survey of ESBL-producing enterobacteriaceae

From 2007, ESR will conduct annual one-month surveys of ESBL-producing enterobacteriaceae. During this month, laboratories will be asked to refer all ESBL-producing enterobacteriaceae isolated to ESR. These surveys will be similar to the annual MRSA surveys that have been conducted since 2000.

The isolates will be characterised at ESR. Appropriate epidemiological data will be collected with each isolate to provide additional information on the epidemiology of ESBLs in New Zealand, such as geographic distribution and the prevalence of ESBLs in the community.

10.2.4 Point-prevalence surveys

In addition to the regular ongoing surveillance of particular resistances, ESR undertakes, usually annually, point-prevalence surveys of resistance. These surveys focus on a particular species or group of organisms collected from diagnostic laboratories throughout the country.

Data from these surveys provide national estimates of the prevalence of resistance, including multiresistance, among a species. Geographic variations in resistance can be identified and investigated. Resistant isolates are often further investigated to determine if resistance is clonal or sporadic.

10.3 Summary

- Laboratories should regularly analyse and report their local or institution's susceptibility data. This reporting should include both the current prevalence of resistance and recent trends.

- Laboratories should have protocols for reporting novel and targeted MDROs to relevant infectious disease and infection control personnel.
- A national surveillance and reference service is available to provide national data on the prevalence of resistance and trends, to confirm resistance and to assist in outbreak investigations.

11 Microbiological Methods

All laboratories should use standardised antimicrobial susceptibility testing methods such as the CLSI methods (CLSI 2006a, 2006b, 2007). They should follow the current version of the standard methods, including the recommended quality control procedures.

Reference and confirmatory antimicrobial susceptibility testing services are available from ESR. These services include identifying ESBL types and *van* genotypes, and epidemiological typing to assist in the investigation of outbreaks and the clonal spread of resistance. The full range of ESR's communicable disease reference services is available at http://www.esr.cri.nz/competencies/communicabledisease.

11.1 Detection of ESBL-producing enterobacteriaceae

The detection of ESBL-producing organisms is complicated by their potential to test as susceptible to third- and fourth-generation cephalosporins and monobactams when standard susceptibility testing breakpoints are applied. In addition, the sensitivity and specificity of tests to detect ESBLs can vary with the cephalosporin tested. Detection of ESBLs in members of the enterobacteriaceae that commonly possess AmpC β-lactamase, such as *Enterobacter*, *Citrobacter freundii*, *Serratia*, *Morganella morganii* and *Providencia,* can be particularly problematic.

Supplementary susceptibility testing is necessary to confirm that an isolate produces an ESBL. Urine is the most common clinical specimen from which ESBL-producing Enterobacteriaceae are isolated in New Zealand. For example, 73 percent of the clinical isolates of ESBL-producing Enterobacteriaceae referred to ESR in 2004 were urinary isolates. Therefore, limiting supplementary testing to sterile site isolates will limit detection to only a fraction of ESBL-producing enterobacteriaceae.

A recent ESR survey assessed the most common methods used by New Zealand laboratories to identify ESBL-producing organisms. Its results provide useful information on the relative sensitivity of different screening and confirmatory test methods (Heffernan et al 2005). They are available at http://www.surv.esr.cri.nz/PDF_surveillance/Antimicrobial/ESBLMethods_2005.pdf.

11.1.1 Selecting candidate isolates for supplementary testing for ESBLs

The selection of isolates for supplementary testing for ESBLs depends on the routine susceptibility testing methods used by individual clinical laboratories. Indicator antibiotics are used to select isolates for further testing. The indicator antibiotics recommended by CLSI are one or more of the following: cefotaxime, ceftriaxone, ceftazidime, cefpodoxime and aztreonam.

Laboratories that routinely include third-generation cephalosporins when a clinical isolate warrants susceptibility testing

For laboratories that use the **CLSI disc antimicrobial susceptibility testing method** (CLSI 2006), candidate isolates for further testing to confirm ESBL production are isolates with a cefotaxime, ceftriaxone, ceftazidime, cefpodoxime or aztreonam zone diameter that is smaller than CLSI's ESBL screening breakpoint. An algorithm for selecting isolates for confirmatory testing, and for reporting penicillin, cephalosporin and aztreonam susceptibility, is given in Table 11.1 using ceftriaxone disc testing as an example.

Table 11.1: Interpretation of ceftriaxone zone diameters according to the CLSI standard and ESBL screening interpretive criteria

Ceftriaxone 30 µg disc			
ESBL screening breakpoints	≤25 mm: positive screen Confirmatory testing needed.		>25 mm: negative screen
Standard breakpoints	≤13 mm: resistant	14–20 mm: intermediate	≥21 mm: susceptible
Reporting of penicillin, cephalosporin and aztreonam susceptibility	Report as resistant **and** confirm ESBL.	Withhold result until ESBL confirmatory test result is known.	>25 mm: report as susceptible unless other indicator antibiotics have a positive screen. 21–25 mm: withhold result until ESBL confirmatory test result is known.

Note: Based on 2007 CLSI interpretive standards (CLSI 2007).

The sensitivity of the various indicator antibiotics in the CLSI screening tests depends on the locally prevalent ESBL types and may change over time with a change in the prevalent types. As advised by CLSI, the sensitivity of the ESBL screening tests is improved with the use of more than one indicator antibiotic. In the ESR survey using CLSI's ESBL disc screening test, the percentages of ESBL-producing isolates that screened positive were:

- 98.7 percent with cefotaxime
- 98.7 percent with ceftriaxone
- 97.1 percent with cefpodoxime
- 94.9 percent with aztreonam
- 78.1 percent with ceftazidime
- 100 percent with either cefotaxime or ceftazidime (Heffernan et al 2005).

For laboratories that use the **CLSI dilution antimicrobial susceptibility testing method** (CLSI 2006a), either agar or automated systems, candidate isolates for confirmatory testing are isolates that grow at CLSI's ESBL screening breakpoint concentrations for cefotaxime, ceftriaxone, ceftazidime, cefpodoxime or aztreonam.

The ESR survey found that, as with the disc screening test, in CLSI's ESBL microbroth screening test, more ESBL-producing isolates screened positive with cefotaxime (97.2 percent) than with ceftazidime (92.7 percent). All isolates screened positive with either cefotaxime or ceftazidime. Ceftriaxone, cefpodoxime and aztreonam were not tested (Heffernan et al 2005).

The SENTRY Antimicrobial Surveillance Program (SENTRY) provides data for the Asia–Pacific region. Using microbroth minimum inhibitory concentrations (MICs) and ceftazidime, ceftriaxone and aztreonam as indicator antibiotics, SENTRY found that:

- aztreonam was the best indicator for *E. coli*
- ceftazidime was the best indicator for *K. pneumoniae*
- no single antibiotic detected all isolates (Hirakata et al 2005).

Laboratories that do not routinely test third-generation cephalosporins on some or all specimen types

The results of second-generation susceptibility testing cannot be relied on to screen for possible ESBL producers. In the ESR survey, 30 percent of the ESBL-producing *Klebsiella* and 2.7 percent of *E. coli* appeared susceptible to cefuroxime (Heffernan et al 2005).

To avoid inappropriate cephalosporin therapy for infections due to ESBL-producing organisms, include at least one of CLSI's ESBL screening indicator antibiotics in routine susceptibility testing of isolates from sterile sites.

For isolates from other (non-sterile) sites – for example, urines and superficial swabs – it is recommended that at least one of the indicator antibiotics is included as part of routine susceptibility testing. Alternatively, consider periodic surveys to monitor the current prevalence of ESBL-producing bacteria in the local community. The United Kingdom guidelines for laboratory detection and reporting of bacteria with ESBLs recommend including an indicator cephalosporin in the first-line panel for all community urinary tract infection (UTI) isolates (Livermore and Woodford 2004).

A susceptible result for an indicator antibiotic – for example, cefotaxime, ceftriaxone or ceftazidime – need not be reported if the antibiotic is inappropriate for the patient group being tested. However, where any isolate meets CLSI's ESBL screening criteria, no cephalosporin should be reported as susceptible or intermediate until a confirmatory test produces a negative result, thereby excluding the presence of an ESBL.

Resistance features typical of ESBL-producing bacteria

If a CLSI screening test is not used routinely, other features typical of ESBL-producing bacteria should prompt supplementary testing. However, relying on these features alone will miss some ESBLs.

ESBLs are inhibited by clavulanic acid and sulbactam – a feature used to advantage in confirmatory tests. Supplementary testing is warranted for *E. coli* and *Klebsiella* that are susceptible/intermediate to amoxicillin/clavulanate yet resistant to second-generation cephalosporins. But note that ESR's survey found that 31 percent of ESBL-producing *E. coli* and 18 percent of ESBL-producing *Klebsiella* were resistant to amoxicillin/clavulanate (Heffernan et al 2005).

Perform confirmatory testing if an area of inhibition or extension of inhibition is seen between second-generation cephalosporins and amoxicillin/clavulanate using the routine spacing of a disc dispenser (approximately 20 mm) used to perform first-line susceptibility tests. This phenomenon is unlikely to be seen among Enterobacteriaceae other than *E. coli* and *Klebsiella*.

ESBL-producing organisms are often resistant to a number of other antibiotic classes, for example, cotrimoxazole/trimethoprim, quinolones, gentamicin and tetracyclines. Supplementary testing is warranted if an isolate is:

- amoxicillin resistant **and**
- resistant to two or more of the following: cotrimoxazole/trimethoprim, norfloxacin/ ciprofloxacin, gentamicin or tetracycline.

11.1.2 ESBL confirmatory testing

In the clinical microbiology laboratory, there are two common ways of performing ESBL phenotypic confirmatory testing. Both depend on demonstrating synergy between clavulanate and cephalosporins – that is, inhibition of the ESBL by clavulanate and therefore increased or restored cephalosporin susceptibility. For those laboratories that perform ESBL confirmatory testing only infrequently, the CLSI combination disc test may be easier to interpret than the double-disc synergy test.

CLSI combination disc test

The CLSI combination disc test uses cefotaxime and ceftazidime discs with and without clavulanic acid (CLSI 2007). An isolate is ESBL positive if the zone diameter around the cefotaxime disc with clavulanic acid and/or ceftazidime disc with clavulanic acid is ≥5 mm larger than the zone diameter around the corresponding disc without clavulanate. Only one of the cephalosporins needs to demonstrate this difference for the isolate to be ESBL positive. Currently CLSI recommends this test for the confirmation of ESBLs only in *E. coli*, *K. pneumoniae*, *Klebsiella oxytoca* and *Proteus mirabilis.*

Extending the test to include discs of an AmpC β-lactamase stable fourth-generation cephalosporin, such as cefpirome or cefepime, with and without clavulanic acid may aid the detection of ESBLs in enterobacteriaceae that produce AmpC β-lactamase, such as *Enterobacter*, *C. freundii*, *Serratia*, *M. morganii* and *Providencia.* AmpC β-lactamases, plasmid-mediated, are also uncommonly found in *E. coli* and *Klebsiella*. An increase of ≥4 mm in cefpirome zone diameter in the presence of clavulanic acid has been proposed as indicative of ESBL production (De Gheldre et al 2003).

Double-disc synergy test

The double-disc synergy (Jarlier) method involves detecting an expansion of the zone of inhibition (synergy) around third-generation cephalosporin discs (eg, cefotaxime and ceftazidime) on the side adjacent to an amoxicillin/clavulanate disc placed 20–30 mm away (Jarlier et al 1988).

As with the CLSI combination disc test, extending this test to include a fourth-generation cephalosporin may aid the detection of ESBLs in enterobacteriaceae that produce AmpC β-lactamase.

The ESR survey found that 20 mm spacing between discs in this test was better than 30 mm for detecting synergy (Heffernan et al 2005). However, isolates that are moderately susceptible to third-generation cephalosporins – for example, *P. mirabilis* – may need a larger distance of separation in order to observe extension of the zone of inhibition. The use of both cefotaxime and ceftazidime confirmed the presence of ESBL in all ESBL-producing *E. coli* and *Klebsiella* tested in the ESR survey. The addition of the fourth-generation cefepime confirmed all ESBL-producing Enterobacteriaceae tested, including those species with AmpC β-lactamase.

K. oxytoca that hyperproduce K1 chromosomal β-lactamase may give positive clavulanate synergy tests with cefotaxime and cefpirome or cefepime, but never with ceftazidime. Suspect K1 hyperproduction if a *Klebsiella* isolate is indole-positive, resistant to cefuroxime and piperacillin/tazobactam, but susceptible to ceftazidime.

If a *Stenotrophomonas* is inadvertently tested, synergy may be seen because of inhibition of the clavulanate-susceptible chromosomal L2 β-lactamase. False positive results are also seen with *Acinetobacter* in clavulanate synergy tests due to *Acinetobacter*'s inherent susceptibility to clavulanate. Identification to the genus level is necessary before the result of an ESBL confirmatory test is reported.

Other ESBL confirmatory methods

Other ESBL confirmatory methods are also available. These include Etest ESBL strips and automated system panels that contain an ESBL confirmatory test, for example, Vitek GNS424 and ASTN041 cards.

Quality control

Test a negative and positive control organism routinely. Refer to the CLSI performance standards for the currently recommended quality control strains and protocols (CLSI 2007).

11.1.3 Reporting isolates for which an ESBL confirmatory test has been performed

If the ESBL confirmatory test is negative

It is often useful for the laboratory, clinical or infection control staff to know that earlier isolates from the same patient have or have not been tested for the production of an ESBL. Therefore it is suggested that when an ESBL confirmatory test has been performed, negative results are also reported. For example, 'combination disc test for ESBL: negative or 'double-disc synergy test for ESBL: negative.

If the ESBL confirmatory test is positive

Identify the isolate to genus and species level.

Indicate on the report that the isolate produces an ESBL. Regardless of the in vitro results, report all penicillins, cephalosporins (including the fourth-generation) and aztreonam as resistant.

The in vitro susceptibility of ESBL-producing organisms to β-lactamase inhibitor combinations (eg, amoxicillin/clavulanate, piperacillin/tazobactam) varies. The decision to report susceptible results may depend on the specimen site. There is a lack of clinical data to support the use of inhibitor combinations for the treatment of serious infections due to ESBL-producing organisms.

ESBLs do not confer resistance to the cephamycins, such as cefoxitin. However, Enterobacteriaceae may be resistant to cefoxitin via some other mechanism, for example, AmpC β-lactamase production, or may develop resistance during therapy. The decision to report a susceptible cephamycin result may depend on the specimen site. As for β-lactamase inhibitor combinations, there is a lack of clinical data to support the use of cephamycins for the treatment of serious infections due to ESBL-producing organisms.

Test and report one or more carbapenems (ertapenem, imipenem, meropenem). Which agents are tested may depend on the local formulary and the prescribing preferences of the local clinical microbiology and infectious diseases teams.

Notify the local infection control team of the identification of every new ESBL-producing isolate as soon as possible.

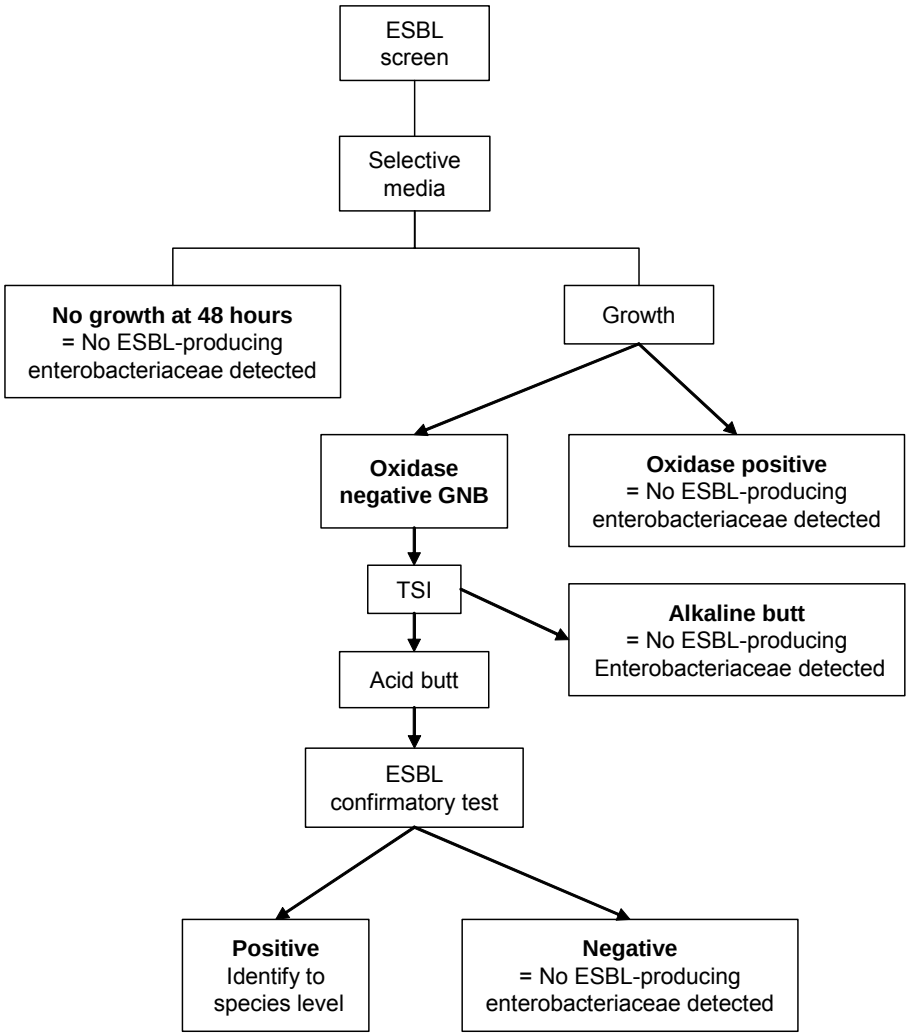
11.1.4 Screening clinical specimens for ESBL-producing bacteria

A variety of selective media has been used to screen for ESBL-producing organisms directly from clinical specimens, predominantly faecal samples. Most media include one or more of ceftazidime, cefotaxime, cefpodoxime or aztreonam added to MacConkey or blood agar. Concentrations of the selective antibiotic vary. There are no studies evaluating which selective medium or combination of media is optimal. It would seem logical that any selective medium should not contain cephalosporins or aztreonam at concentrations greater than CLSI's ESBL screening breakpoints (CLSI 2007).

The ESR survey found that aztreonam (6 mg/L) blood agar was the selective medium most commonly used by New Zealand laboratories to directly screen clinical specimens. This medium failed to detect over one-third of ESBL-producing *E. coli* and nearly one-half of *Klebsiella* tested (Heffernan et al 2005).

An example of a protocol for direct screening of clinical specimens for ESBL-producing organisms is shown in Figure 11.1. It has been used at Middlemore Hospital to detect ESBL-producing organisms from faeces submitted for specific 'ESBL screening' and Clostridium difficile toxin testing. The selective medium used is a modification of that described by Hacek et al (2001). A split plate with 1 mg/L ceftazidime on one side and 1 mg/L aztreonam on the other, as well as vancomycin and amphotericin B but without the clindamycin originally described, has been used.

Figure 11.1: Example of a protocol for screening clinical specimens for ESBL-producing enterobacteriaceae



11.2 Detection of VRE

11.2.1 Susceptibility testing of enterococci

Whenever susceptibility results are reported for an enterococcal isolate, test and report amoxicillin and vancomycin susceptibility as a minimum. Also test isolates from blood and sterile sites for high-level gentamicin resistance.

Use a standardised vancomycin susceptibility testing method. Although there are methods of performing vancomycin testing by disc diffusion, proficiency surveys indicate that an MIC method is more likely to detect low-level vancomycin resistance. Where a laboratory's primary method of susceptibility testing is disc diffusion, it is recommended that the laboratory uses an alternative method for detecting vancomycin resistance. One such method is the CLSI vancomycin agar screen which uses brain heart infusion (BHI) agar containing 6 mg/L of vancomycin (CLSI 2006a). This agar has the advantage of also being used for the detection of reduced vancomycin susceptibility among staphylococci.

When using the CLSI disc method, CLSI vancomycin agar screen, other CLSI dilution method, or Etest, a full 24 hours incubation is required, unless vancomycin resistance is evident within a shorter time. Examine zones of inhibition and Etest ellipses using transmitted light for any faint growth. Similarly, on the vancomycin agar screening plates and other dilution tests, any faint growth indicates resistance. Use a reference MIC method to test isolates with equivocal results.

Identify any vancomycin-intermediate or -resistant isolate to genus level in order to establish that the isolate is an *Enterococcus* rather than another intrinsically resistant gram-positive organism. If the isolate is an *Enterococcus*, also try to identify it to species level in order to differentiate those species with acquired vancomycin resistance from those with intrinsic low-level vancomycin resistance (eg, *E. gallinarum* and *E. casseliflavus*). *E. gallinarum* and *E. casseliflavus* may be differentiated from *E. faecalis* and *E. faecium* by their ability to acidify methyl-α-D-glucopyranoside (MGP). In addition, the former two species are usually motile and *E. casseliflavus* usually has a yellow pigment.

If the isolate is *E. faecalis* or *E. faecium* with a vancomycin MIC >4 mg/L, refer it to ESR for detection of vancomycin resistance genes. There have been occasional reports of acquired high-level vancomycin resistance among *E. gallinarum*, so also refer any enterococcal species with a vancomycin MIC >16 mg/L to ESR.

Test and report the following additional susceptibilities for a VRE, regardless of the site: amoxicillin, β-lactamase production, detection of high-level gentamicin resistance, teicoplanin MIC, linezolid and, for *E. faecium*, quinupristin/dalfopristin. These tests are available at ESR if they are not performed locally.

11.2.2 Screening clinical specimens for VRE

Patients who have been admitted to an overseas hospital in the previous six months should be screened for VRE on admission to a hospital in New Zealand. Dialysis patients who have received dialysis in an overseas facility should also be screened for VRE on their return to New Zealand.

Periodic screening for VRE colonisation should be undertaken by tertiary and secondary care hospitals. As *C. difficile*-associated diarrhoea and VRE colonisation share several common risk factors, faecal specimens submitted for *C. difficile* toxin testing are appropriate and useful for VRE surveillance. In the absence of clinical isolates of VRE, it is suggested that periodic surveys occur at least every three to five years. Once clinical isolates are detected from patients at health care facilities within the DHB, more frequent surveys may be warranted.

Inoculate surveillance specimens onto a selective medium, for example, bile-esculin-azide (BEA) agar containing 6 mg/L of vancomycin. A broth enrichment step with BEA broth and vancomycin before subculture onto selective agar may increase the detection of VRE from faeces or rectal swabs. However, enrichment broths may also increase the detection of motile enterococci. Incubate directly inoculated agar for up to 72 hours in air at 35^{o}C. Broth cultures are examined at 24 and 48 hours; only those that turn black need subculturing. Subculture onto BEA agar containing vancomycin and incubate for 24 hours. Subculture any esculin positive, gram-positive cocci onto blood for further identification and susceptibility testing.

11.3 Summary

- In routine susceptibility testing of enterobacteriaceae, include at least one sensitive indicator cephalosporin, such as cefotaxime or ceftriaxone, to detect possible ESBL producers.
- Identify any confirmed ESBL producers fully, and report ESBL-producing enterobacteriaceae as resistant to all penicillins, cephalosporins and monobactams.
- In routine susceptibility testing of enterococci, include a reliable method of detecting vancomycin resistance.
- Identify vancomycin-intermediate and -resistant isolates fully.
- Refer vancomycin-resistant *E. faecalis* and *E. faecium* to ESR for confirmation and further investigation.
- Hospitals should conduct VRE screening for all patients who have been in an overseas hospital. In addition, secondary and tertiary care hospitals should undertake periodic surveys for VRE colonisation among high-risk patients.

12 Treatment of MDROs Causing Infections

Seek expert advice from an infectious diseases physician or microbiologist for treatment of these organisms. As with non-MDROs, the isolation of a MDRO from a particular site should prompt an assessment as to whether it represents colonisation or infection. Address any predisposing condition, such as by removing a catheter or draining an abscess.

12.1 ESBL-producing organisms

ESBLs, including their treatment, have been reviewed recently (Paterson and Bonomo 2005; Ramphal and Ambrose 2006).

The most reliable agents for treatment of serious infections are the carbapenems. Most experience has been gathered with the use of imipenem but meropenem and ertapenem have also been used.

There is no evidence that combining another class of antibiotic (eg, amikacin) with a carbapenem is superior to using a carbapenem alone.

For less serious infection such as UTI, other agents such as nitrofurantoin, quinolones or ß-lactam/ß-lactamase inhibitor (eg, amoxycillin/clavulanate) may be attempted if the organism is susceptible in vitro. Do not use cephalosporins. Cephamycins (ie, cefoxitin) may be considered in less serious infections such as UTI but rapid emergence of resistance has been observed.

Again, seek expert advice.

12.2 VRE

VRE remains a rare problem in New Zealand in 2006. For nearly all strains of *Enterococcus faecalis* resistant to glycopeptides, penicillin/amoxycillin remains effective. For *Enterococcus faecium* resistant to glycopeptides, obtain expert advice. Susceptibility testing will guide treatment options including antibiotic combinations. Tetracyclines, chloramphenicol, rifampicin, streptogramins, linezolid and high dose amoxicillin are candidates.

Glossary

ASC	Active Surveillance Cultures – laboratory testing to identify patients colonised with MDROs for surveillance purposes.
BHI	brain heart infusion
CLSI	Clinical and Laboratory Standards Institute
Contact precautions	precautions designed to reduce transmission through direct or indirect contact (eg, with dry skin or contaminated surfaces). There are two other types of transmission-based precautions: droplet and airborne precautions, intended to prevent droplet and airborne transmission.
DHB	District Health Board
ESBL	extended-spectrum ß-lactamase; ESBL-producing gram-negative bacteria are often referred to as 'ESBLs'
ESR	Institute of Environmental Science and Research
GRE	glycopeptide-resistant enterococci; also referred to as vancomycin-resistant enterococci (VRE) in areas where vancomycin is the glycopeptide drug in widespread clinical use
HICPAC	Healthcare Infection Control Practices Advisory Committee
MDR-GNB	multidrug-resistant gram-negative bacilli; also referred to as MDR-GNO – gram-negative organisms
MDRO	multidrug-resistant organism; also abbreviated as MRO
MGP	methyl-α-D-glucopyranoside
MIC	minimum inhibitory concentration
MRSA	methicillin-resistant *Staphylococcus aureus*
RCF	residential care facility
SENTRY	SENTRY Antimicrobial Surveillance Program, designed to monitor antimicrobial resistance among the predominant pathogens causing nosocomial and community-acquired infections globally by using reference quality identification and susceptibility testing methods performed in a central laboratory
SHEA	Society for Healthcare Epidemiology of America
Standard precautions	Standard Precautions – precautions designed for the care of all patients in hospitals, regardless of their diagnosis or presumed infection status. Standard Precautions may include use of handwashing; gloves; mask, eye protection, and face shield, and gowns; respiratory hygiene and cough etiquette.
UTI	urinary tract infection
VRE	vancomycin-resistant *Enterococcus faecium* or *faecalis* (see GRE)
VRSA	vancomycin-resistant *Stapholococcus aureus*

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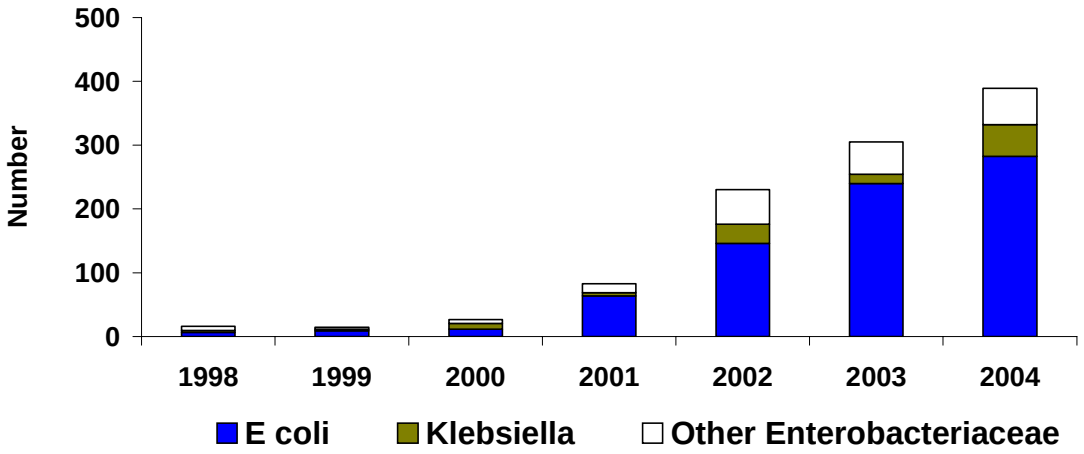
Appendix 1: ESBLs and VRE in New Zealand

1 ESBL-producing enterobacteriaceae

ESBL-producing organisms are increasing in New Zealand, particularly in the Auckland area. Until August 2005 diagnostic laboratories were requested to refer all probable ESBL-producing Enterobacteriaceae to the Institute of Environmental Science and Research (ESR). Between 1996 and 2000 a maximum of 35 ESBL-producing enterobacteriaceae were referred and confirmed in any one year. From 2001, when there were 83 confirmed isolates, numbers started to increase markedly, reaching 389 in 2004 (Figure A1.1) (ESR 2004a). The majority of the isolates have been *E. coli* from urinary sites.

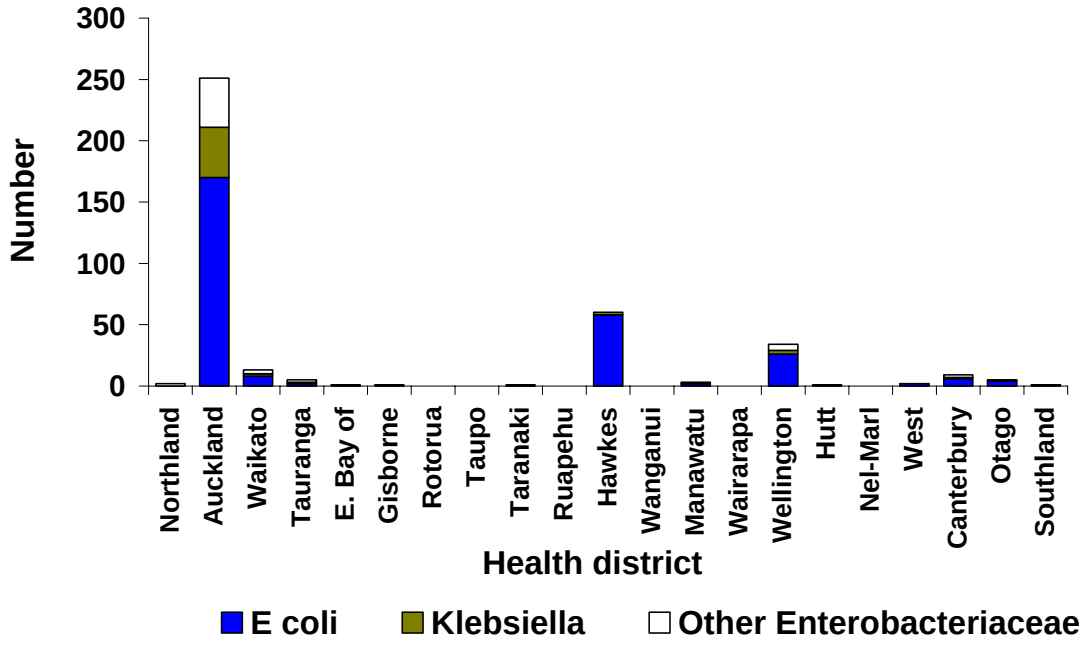
Susceptibility data collated from hospital and community laboratories throughout New Zealand indicate that, in 2004, 1.3% of *E. coli* from bacteraemias, 0.9% of urinary *E. coli* and 2.8% of *Klebsiella* from bacteraemias were resistant to cefotaxime or ceftriaxone (ESR 2004b). It is likely that the majority of these resistant isolates were ESBL producers. These rates suggest that overall ESBLs are still relatively uncommon among *E. coli* and *Klebsiella* in New Zealand.

Figure A1.1: ESBL-producing enterobacteriaceae referrals to ESR, 1998–2004



There are wide geographic variations in the incidence of ESBL-producing enterobacteriaceae (Figure A1.2). Most ESBL-producing organisms are isolated in the Auckland and Hawkes Bay areas. There has been an ongoing outbreak of an ESBL-producing *E. coli* strain in Hawkes Bay Hospital since 2001 (ESR 2004a, 2002). There have also been outbreaks of strains of ESBL-positive *E. coli* and *K. pneumoniae* in the Auckland area. Screening policies and microbiological testing methods may affect the reported rates.

Figure A1.2: Geographic distribution of ESBL-producing enterobacteriaceae, 2004



E. coli and *K. pneumoniae* outbreak strains in both Hawkes Bay and Auckland have the CTX-M15 type ESBL. CTX-M15 ESBL is common in the United Kingdom and is often associated with community-acquired infections.

The majority of ESBL-producing enterobacteriaceae are multiresistant to ≥3 antibiotic classes in addition to cephalosporins. Resistance to gentamicin, tobramycin, co-trimoxazole, trimethoprim and tetracycline is common. Most ESBL-positive *E. coli* are also resistant to fluoroquinolones (Table A1.1).

Table A1.1: Rates of resistance among ESBL-positive enterobacteriaceae isolated in New Zealand

	Percentage resistance		
	E. coli (n = 75)	***Klebsiella* species** (n = 33)	**Other enterobacteriaceae** (n = 29)
Meropenem	0	0	0
Aminoglycosides	72.0	69.7	86.2
Amikacin	0	0	0
Tobramycin	65.3	39.4	72.4
Gentamicin	60.0	69.7	82.8
Ciprofloxacin	81.3	21.2	17.2
Folate pathway inhibitors	73.3	66.7	93.1
Co-trimoxazole	70.7	66.7	89.7
Trimethoprim	73.3	66.7	93.1
Nitrofurantoin	1.3	24.2	20.7
Co-amoxiclav	30.7	18.2	93.1
Tetracycline	82.7	51.5	69.0
Multiresistant ≥3 antibiotic classes	82.7	54.5	89.7

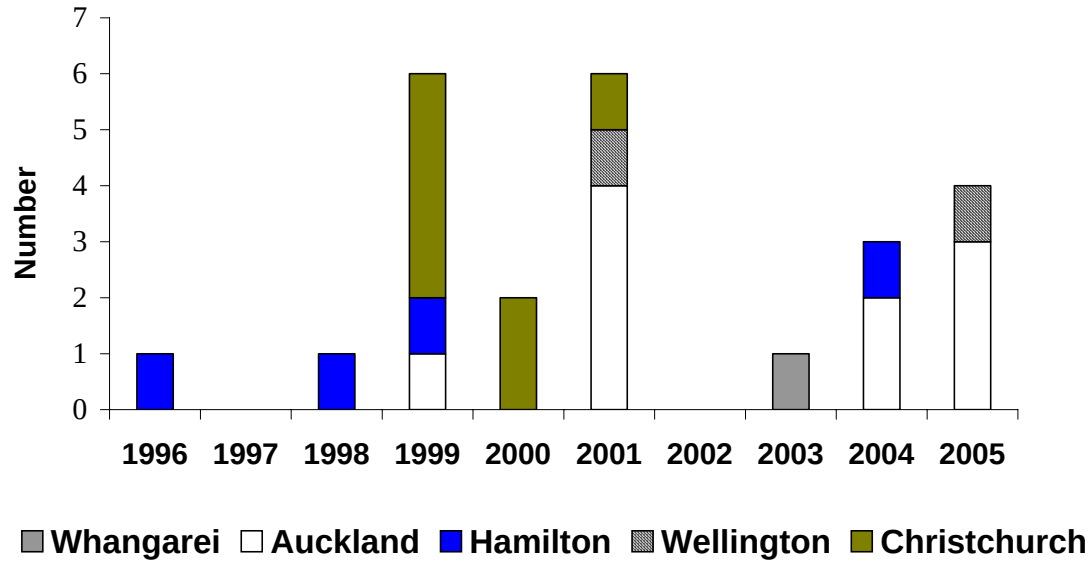
Note: Based on the susceptibility of isolates confirmed at ESR in 2003.

2 Vancomycin-resistant enterococci

VRE remain uncommon in New Zealand. Diagnostic laboratories are requested to refer all possible VRE to ESR for confirmation and further investigation.

Between 1996, when the first VRE was identified, and 2005, VRE from only 24 people have been confirmed (Figure A1.3). Results from periodic screening studies also indicate that the incidence is very low. No study isolated VRE until 2001, when an Auckland-based study isolated two vancomycin-resistant *E. faecalis* from 686 patients screened – a prevalence rate of 0.3% (Briggs et al 2002).

Figure A1.3: VRE referrals to ESR, 1996–2005



Approximately half of VRE isolates represented in Figure A1.3 were reported to be isolated from colonised rather than infected patients.

There has been no evidence of any VRE transmission within New Zealand hospitals. The VRE isolated to date have come from patients throughout the country (Figure A1.3), and from both community and hospital patients.

Until 2003 the majority of VRE isolated in New Zealand were *E. faecalis* with the VanA phenotype. Molecular typing identified that most of these VanA *E. faecalis* were the same strain, although no links among the patients were evident. The same VanA *E. faecalis* strain was common among poultry sampled in 2000–2001 (Manson et al 2003). Since 2003 *E. faecium* has predominated among the VRE isolated and most affected patients have had a history of hospitalisation overseas.

The majority (83% or 20 out of 24 cases) of the VRE have had VanA type resistance, and therefore were resistant to both vancomycin and teicoplanin. All vancomycin-resistant *E. faecalis* (n = 16) were susceptible to ampicillin and 75% were susceptible to high-level gentamicin. In contrast, all vancomycin-resistant *E. faecium* (n = 8) were ampicillin resistant and 88% were resistant to high-level gentamicin.

Regular updates of referred isolates and surveillance for VRE and ESBL producing organisms are posted on the ESR website (www.surv.esr.cri.nz/antimicrobial/antimicrobial_resistance.php).

Appendix 2: Example of a Risk Matrix for MDROs

Ongoing control of MDROs requires occasional collaborative assessments of risk and need for further action by relevant hospital or RCF managers, relevant clinicians, and the infection control team. The risk matrix in Table A2.1 is an example of a list of risk factors with associated controls that may facilitate such multi-disciplinary assessments.

The matrix is not quantitative because there is insufficient data to support it. The matrix is, however, based on expert opinion and experience. As far as possible, it also follows a standard risk assessment matrix, meaning that each risk may be mitigated by control measures.

Following isolation of a MDRO, a meeting of the infection control team, clinical staff, and management can be convened. The matrix supports a consistent and systematic approach to identifying residual risks that may need to be managed. Residual risk can be identified by taking account of the organisation's pre-existing control measures, as well as measures that have recently been taken or planned prior to the convening of the multidisciplinary meeting.

Each new situation should be assessed by the local infection control team, as neither MDROs nor health care institutions are homogeneous. The matrix may assist discussion about the need for escalation, and determining what could be the most appropriate response commensurate with the perceived risk and culture of that institution.

For example, after detecting the first patient with vancomycin-resistant *E. faecium* (VRE) of the ST17 clonal type, the response should be swift and uncompromising. This kind of response is warranted because this organism has caused major outbreaks in Australia and other countries and cost millions of dollars to control. On the other hand, a patient colonised with an ESBL-producing *E. coli*, who is not on antibiotics, has no diarrhoea or incontinence and is fully conversant with the need to practise good hygiene, is unlikely to be a source of dissemination.

Table A2.1: Example of a risk matrix tool for MDRO control

Factor	Estimated size of risk	Suggested controls	Residual risk
Patient (with MDRO)			
1. Longer stay: more sick and more opportunity for transmission events	↑	Isolate patient and discharge as soon as possible	
2. Understands and is compliant with IC recommendations	↓↓	Patient is provided with information, and then becomes advocate for good infection control practice	
3. Unable or unwilling to comply with IC recommendations	↑↑↑↑	It may be necessary to limit patient movement around the hospital or health care facility	
4. Incontinent of faeces	↑↑↑	Correct medical or surgical conditions as possible	
5. Uncovered wounds	↑↑	Implement staff training	
6. Urinary catheter	↑	Implement training of staff on emptying catheter bags; provide well designed sluices and sanitisers	
7. Mobile: consider along with other factors listed above	↑↑	It may be necessary to limit patient movement around hospital or health care facility	
Epidemiology			
8. Recently acquired MDRO – making an easily transmitted strain more likely	↑	Introduce a screening policy; this may reduce time to detection	
9. Part of a known outbreak in current hospital/health care facility – pointing to an easily transmitted organism or suboptimal infection control practice	↑↑	Assess general hygiene and infection control practice in relevant clinical areas	
10. Molecular typing shows relatedness to other organisms – possibly clarifying sites and patterns of transmission within an organisation	↑↑↑	May allow more targeted interventions	

Factor	Size of risk	Suggested controls	Residual risk
Organism			
11. Identified as being of international or national significance	↑↑↑	Nil	
12. High ratio of infection to colonisation, suggesting a highly virulent organism	↑↑	Nil	
13. Resistant to other antibiotics as well as β-lactams, reducing therapeutic options	↑↑	Implement antibiotic stewardship	
Institution/environment			
14. Poor general cleanliness and hygiene	↑	Increase level and frequency of cleaning	
15. Good access to hand rub and sinks	↓↓		
16. Area cluttered and hard to clean	↑	Remove unnecessary or hard-to-clean objects as much as possible	
17. High staff workload	↑	Work with management to reduce workload, by closing beds if necessary	
18. Vulnerable patients in unit	↑↑↑		
19. Insufficient isolation beds	↑↑	Consider cohorting patients colonised with MDRO	

Staff			
20. Short staffed	↑↑	Increase staff numbers or close beds	
21. Training provided in both clinical area practice and infection control practice	↓↓	Hold training sessions	
22. High staff turnover, making it hard to educate staff and monitor infection control practices	↑↑	Problem solve with management of clinical area	

Footnotes to individual factors

1. The length of stay applies both before and after detection of the MDRO. Brief admissions and day stays obviously reduce the opportunity for transmission.
2. The patient can be the best advocate for infection control. It is suggested that written information is provided to the patient, who can then show it to others.
3. Demented, agitated and other patients who cannot or will not comply with infection control recommendations can be a major risk, particularly if they mix and interact with other patients.
4. Many MDROs are carried in the bowel so incontinence is a major risk for uncontrolled shedding and environmental contamination by MDROs, including VRE and ESBL.
5. Uncovered wounds would be of greatest significance in the burns and plastic surgery units.
6. Urinary catheters are a risk for acquiring some MDROs. Consider enhanced care of catheters, as well as care when transporting and disposing of used catheter bags.
7. Mobility mainly applies in conjunction with factor 3.
8. If samples have been received in the laboratory during a patient's stay, then the detection of a MDRO is more likely to represent recent acquisition and hence transmission. Active surveillance cultures may help assess the extent of transmission and identify sources and direct activity.
9. This factor is similar to factor 8, but describes the situation when there is a known outbreak.
10. Molecular typing may support 'time, place and person' epidemiology. It may either rule out cross infection or refine knowledge about what is already thought to be occurring.
11. As noted above, the first detected occurrence of a 'problem' organism, such as *E. faecium* or imipenem-resistant *Acinetobacter*, should lead to decisive infection control action.
12. Increased virulence is suggested if a MDRO is being detected from clinical isolates and is causing infection rather than colonisation – eg, finding ESBL-E in the urine of patients with symptomatic UTI as opposed to swabs from ulcers without surrounding cellulitis.
13. Organisms that are resistant to almost all classes of antibiotic, such as carbapenem-resistant *Acinetobacter*, require highly effective infection control interventions because antibiotic therapy may not be possible.
14. An unclean or poorly maintained clinical area greatly increases the risk of environmental contamination and transmission.
15. See factor 14.
16. See factor 14.
17. Busy people may not have time to wash hands.

18. Immunocompromised patients, especially in haemodialysis, intensive care, oncology vascular surgical and neonatal units, are extremely vulnerable and require extra control measures.
19. Single rooms with en suite bathrooms are critical for controlling the spread of MDROs.
20. This factor is similar to factor 17, but refers to staffing shortages at time of normal unit activity.
21. Good infection control training and support are critical steps in the control of hospital-acquired infection of all types.
22. High staff turnover works against factor 21.

Appendix 3: Recommendations for Standard Precautions from Centers for Disease Control and Prevention

Source: Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee, 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings, June 2007. URL: *http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf*.

Assume that every person is potentially infected or colonized with an organism that could be transmitted in the healthcare setting and apply the following infection control practices during the delivery of health care.

A. Hand Hygiene

1. During the delivery of healthcare, avoid unnecessary touching of surfaces in close proximity to the patient to prevent both contamination of clean hands from environmental surfaces and transmission of pathogens from contaminated hands to surfaces.
2. When hands are visibly dirty, contaminated with proteinaceous material, or visibly soiled with blood or body fluids, wash hands with either a nonantimicrobial soap and water or an antimicrobial soap and water.
3. If hands are not visibly soiled, or after removing visible material with nonantimicrobial soap and water, decontaminate hands in the clinical situations described in IV.A.2.a-f. The preferred method of hand decontamination is with an alcohol-based hand rub. Alternatively, hands may be washed with an antimicrobial soap and water. Frequent use of alcohol-based hand rub immediately following handwashing with nonantimicrobial soap may increase the frequency of dermatitis. Perform hand hygiene:
    a. Before having direct contact with patients.
    b. After contact with blood, body fluids or excretions, mucous membranes, nonintact skin, or wound dressings.
    c. After contact with a patient's intact skin (e.g., when taking a pulse or blood pressure or lifting a patient).
    d. If hands will be moving from a contaminated-body site to a clean-body site during patient care.
    e. After contact with inanimate objects (including medical equipment) in the immediate vicinity of the patient .
    f. After removing gloves.
4. Wash hands with non-antimicrobial soap and water or with antimicrobial soap and water if contact with spores (e.g., *C. difficile* or *Bacillus anthracis*) is likely to have occurred. The physical action of washing and rinsing hands under

such circumstances is recommended because alcohols, chlorhexidine, iodophors, and other antiseptic agents have poor activity against spores.

5. Do not wear artificial fingernails or extenders if duties include direct contact with patients at high risk for infection and associated adverse outcomes (e.g., those in ICUs or operating rooms).

    a. Develop an organizational policy on the wearing of non-natural nails by healthcare personnel who have direct contact with patients outside of the groups specified above.

B. Personal protective equipment (PPE)

1. Observe the following principles of use:

    a. Wear PPE, as described in IV.B.2-4,when the nature of the anticipated patient interaction indicates that contact with blood or body fluids may occur.

    b. Prevent contamination of clothing and skin during the process of removing PPE .

    c. Before leaving the patient's room or cubicle, remove and discard PPE.

2. Gloves

    a. Wear gloves when it can be reasonably anticipated that contact with blood or other potentially infectious materials, mucous membranes, nonintact skin, or potentially contaminated intactskin (e.g., of a patient incontinent of stool or urine) could occur.

    b. Wear gloves with fit and durability appropriate to the task.

        i. Wear disposable medical examination gloves for providing direct patient care.

        ii. Wear disposable medical examination gloves or reusable utility gloves for cleaning the environment or medical equipment.

    c. Remove gloves after contact with a patient and/or the surrounding environment (including medical equipment) using proper technique to prevent hand contamination. Do not wear the same pair of gloves for the care of more than one patient. Do not wash gloves for the purpose of reuse since this practice has been associated with transmission of pathogens.

    d. Change gloves during patient care if the hands will move from a contaminated body-site (e.g., perineal area) to a clean body-site (e.g., face).

3. Gowns

    a. Wear a gown, that is appropriate to the task, to protect skin and prevent soiling or contamination of clothing during procedures and patient-care

activities when contact with blood, body fluids, secretions, or excretions is anticipated.

i. Wear a gown for direct patient contact if the patient has uncontained secretions or excretions.

ii. Remove gown and perform hand hygiene before leaving the patient's environment.

b. Do not reuse gowns, even for repeated contacts with the same patient.

c. Routine donning of gowns upon entrance into a high risk unit (e.g., ICU, NICU, HSCT unit) is not indicated.

4. Mouth, nose, eye protection

a. Use PPE to protect the mucous membranes of the eyes, nose and mouth during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions and excretions. Select masks, goggles, face shields, and combinations of each according to the need anticipated by the task performed.

5. During aerosol-generating procedures (e.g., bronchoscopy, suctioning of the respiratory tract [if not using in-line suction catheters], endotracheal intubation) in patients who are notsuspected of being infected with an agent for which respiratory protection is otherwise recommended (e.g., *M. tuberculosis*, SARS or hemorrhagic fever viruses), wear one of the following: a face shield that fully covers the front and sides of the face, a mask with attached shield, or a mask and goggles (in addition to gloves and gown).

C. Respiratory Hygiene/Cough Etiquette

1. Educate healthcare personnel on the importance of source control measures to contain respiratory secretions to prevent droplet and fomite transmission of respiratory pathogens, especially during seasonal outbreaks of viral respiratory tract infections (e.g., influenza, RSV, adenovirus, parainfluenza virus) in communities.

2. Implement the following measures to contain respiratory secretions in patients and accompanying individuals who have signs and symptoms of a respiratory infection, beginning at the point of initial encounter in a healthcare setting (e.g., triage, reception and waiting areas in emergency departments, outpatient clinics and physician offices).

a. Post signs at entrances and in strategic places (e.g., elevators, cafeterias) within ambulatory and inpatient settings with instructions to patients and other persons with symptoms of a respiratory infection to cover their mouths/noses when coughing or sneezing, use and dispose of tissues, and perform hand hygiene after hands have been in contact with respiratory secretions.

b. Provide tissues and no-touch receptacles (e.g., foot-pedal operated lid or open, plastic-lined waste basket) for disposal of tissues.

c. Provide resources and instructions for performing hand hygiene in or near waiting areas in ambulatory and inpatient settings; provide conveniently-located dispensers of alcohol-based hand rubs and, where sinks are available, supplies for handwashing.

d. During periods of increased prevalence of respiratory infections in the community (e.g., as indicated by increased school absenteeism, increased number of patients seeking care for a respiratory infection), offer masks to coughing patients and other symptomatic persons (e.g., persons who accompany ill patients) upon entry into the facility or medical office and encourage them to maintain special separation, ideally a distance of at least 3 feet, from others in common waiting areas.

    i. Some facilities may find it logistically easier to institute this recommendation year-round as a standard of practice.

D. Patient placement

1. Include the potential for transmission of infectious agents in patient placement decisions. Place patients who pose a risk for transmission to others (e.g., uncontained secretions, excretions or wound drainage; infants with suspected viral respiratory or gastrointestinal infections) in a single-patient room when available.

2. Determine patient placement based on the following principles:

- Route(s) of transmission of the known or suspected infectious agent
- Risk factors for transmission in the infected patient
- Risk factors for adverse outcomes resulting from an HAI in other patients in the area or room being considered for patient placement
- Availability of single-patient rooms
- Patient options for room-sharing (e.g., cohorting patients with the same infection)

E. Patient-care equipment and instruments/devices

1. Establish policies and procedures for containing, transporting, and handling patient-care equipment and instruments/devices that may be contaminated with blood or body fluids.

2. Remove organic material from critical and semi-critical instrument/devices, using recommended cleaning agents before high level disinfection and sterilization to enable effective disinfection and sterilization processes.

3. Wear PPE (e.g., gloves, gown), according to the level of anticipated contamination, when handling patient-care equipment and instruments/devices that is visibly soiled or may have been in contact with blood or body fluids.

F. Care of the environment

1. Establish policies and procedures for routine and targeted cleaning of environmental surfaces as indicated by the level of patient contact and degree of soiling.

2. Clean and disinfect surfaces that are likely to be contaminated with pathogens, including those that are in close proximity to the patient (e.g., bed rails, over bed tables) and frequently-touched surfaces in the patient care environment (e.g., door knobs, surfaces in and surrounding toilets in patients' rooms) on a more frequent schedule compared to that for other surfaces (e.g., horizontal surfaces in waiting rooms).

3. Use EPA-registered disinfectants that have microbiocidal (i.e., killing) activity against the pathogens most likely to contaminate the patient-care environment. Use in accordance with manufacturer's instructions.

    a. Review the efficacy of in-use disinfectants when evidence of continuing transmission of an infectious agent (e.g., rotavirus, *C. difficile*, norovirus) may indicate resistance to the in-use product and change to a more effective disinfectant as indicated.

4. In facilities that provide health care to pediatric patients or have waiting areas with child play toys (e.g., obstetric/gynecology offices and clinics), establish policies and procedures for cleaning and disinfecting toys at regular intervals.

    - Use the following principles in developing this policy and procedures:
    - Select play toys that can be easily cleaned and disinfected
    - Do not permit use of stuffed furry toys if they will be shared
    - Clean and disinfect large stationary toys (e.g., climbing equipment) at least weekly and whenever visibly soiled
    - If toys are likely to be mouthed, rinse with water after disinfection; alternatively wash in a dishwasher
    - When a toy requires cleaning and disinfection, do so immediately or store in a designated labeled container separate from toys that are clean and ready for use.

5. Include multi-use electronic equipment in policies and procedures for preventing contamination and for cleaning and disinfection, especially those items that are used by patients, those used during delivery of patient care, and mobile devices that are moved in and out of patient rooms frequently (e.g., daily).

    a. No recommendation for use of removable protective covers or washable keyboards. *Unresolved issue*

G. Textiles and laundry

1. Handle used textiles and fabrics with minimum agitation to avoid contamination of air, surfaces and persons.

2. If laundry chutes are used, ensure that they are properly designed, maintained, and used in a manner to minimize dispersion of aerosols from contaminated laundry.

H. Safe injection practices

The following recommendations apply to the use of needles, cannulas that replace needles, and, where applicable intravenous delivery systems

1. Use aseptic technique to avoid contamination of sterile injection equipment.

2. Do not administer medications from a syringe to multiple patients, even if the needle or cannula on the syringe is changed. Needles, cannulae and syringes are sterile, single-use items; they should not be reused for another patient nor to access a medication or solution that might be used for a subsequent patient.

3. Use fluid infusion and administration sets (i.e., intravenous bags, tubing and connectors) for one patient only and dispose appropriately after use. Consider a syringe or needle/cannula contaminated once it has been used to enter or connect to a patient's intravenous infusion bag or administration set.

4. Use single-dose vials for parenteral medications whenever possible.

5. Do not administer medications from single-dose vials or ampules to multiple patients or combine leftover contents for later use.

6. If multidose vials must be used, both the needle or cannula and syringe used to access the multidose vial must be sterile.

7. Do not keep multidose vials in the immediate patient treatment area and store in accordance with the manufacturer's recommendations; discard if sterility is compromised or questionable.

8. Do not use bags or bottles of intravenous solution as a common source of supply for multiple patients.

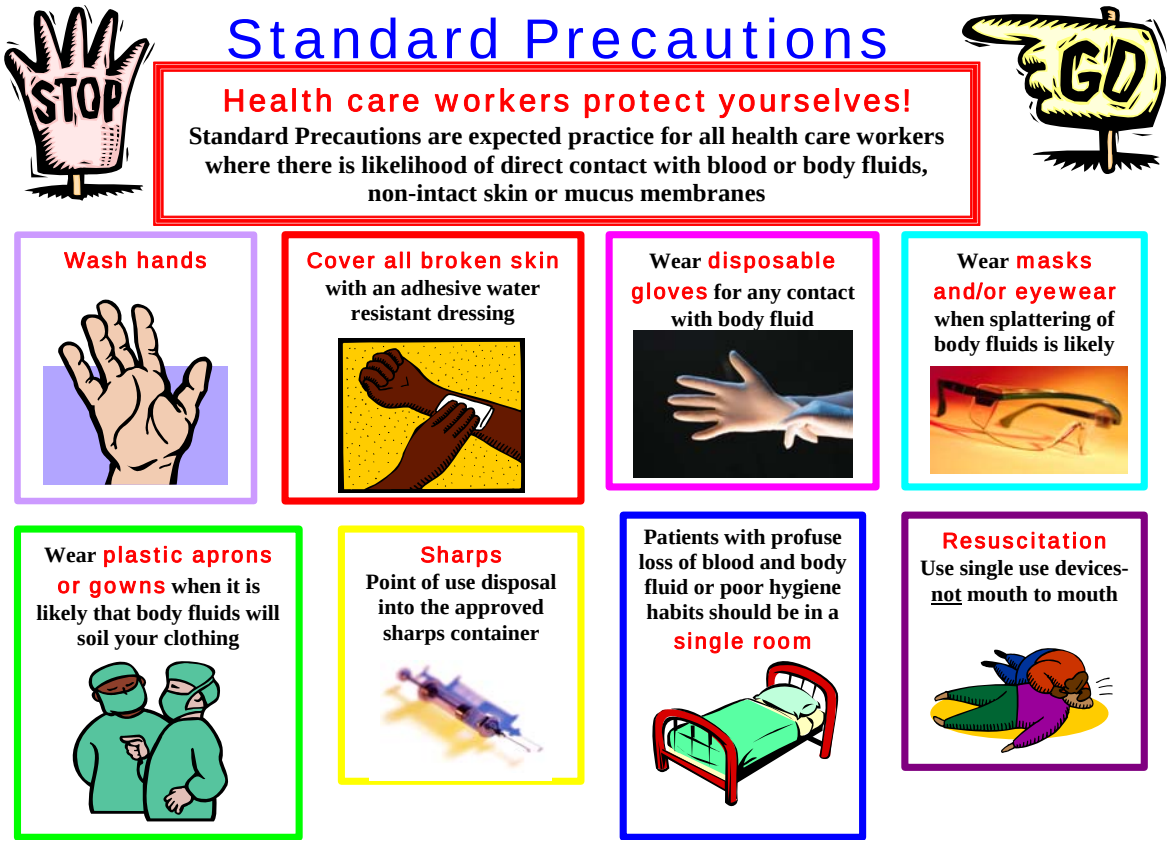
I. Infection control practices for special lumbar puncture procedures

Wear a surgical mask when placing a catheter or injecting material into the spinal canal or subdural space (i.e., during myelograms, lumbar puncture and spinal or epidural anesthesia.

J. Worker safety

Adhere to federal and state requirements for protection of healthcare personnel from exposure to bloodborne pathogens.

Appendix 4: Example of Standard Precautions Poster



Appendix 5: Example of Respiratory Hygiene and Cough Etiquette Poster

Cough and Sneeze Hygiene

Coughs and sneezes spread diseases!!

- **Cover your mouth and/or nose when coughing or sneezing**
- **Use tissues to contain the respiratory secretions**
- **After use, place tissues immediately into a waste bin**
- **Wash your hands. There are plenty of hand basins and alcohol-based hand gel for you to use in this hospital**
- **Staff please use gloves to handle used patient tissues at all times**

In winter months, viruses which cause infection can be easily spread on the hands as well as in the air- so please don't forget to wash your hands!!

Visitors - Please do not visit your loved ones if you have a cold – they will not thank you for it!!

Appendix 6: Example of Handwashing Poster

How Clean are Your Hands ...?

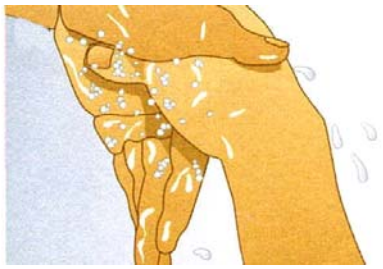
Turn on the taps and wet hands
Add liquid soap to hands
Follow these steps:

1. Palm to palm

2. Backs of hands

3. Between fingers

4. Fingertips



5. Thumbs and wrists

6. Nails

- **Use a paper towel and dry well-pat dry is best.**
- **Turn off the taps with elbows or a paper towel.**

Use the same technique when using alcohol based hand rub so that you cover all areas of the hands. Let alcohol dry before touching anything!

Protect yourself and your patients!

Appendix 7: Example of Information for Staff

ESBL producing organisms

Extended-spectrum β-lactamase (ESBL) producing gram-negative organisms

Description

Enterobacteriaceae, eg, *Escherichia coli, Klebsiella, Enterobacter, Proteus* produce many different β-lactamase enzymes. Some have activity against only penicillins and 1st and 2nd generation cephalosporins. However, in recent years, β-lactamase enzymes capable of hydrolysing extended-spectrum cephalosporins, eg, cefotaxime, ceftriaxone, ceftazidime and the monobactam aztreonam have been detected in numerous countries. These organisms frequently carry genes encoding resistance to other classes of antibiotics, eg, aminoglycosides, quinolones and to cotrimoxazole, thus limiting treatment options.

These are classified as multidrug-resistant organisms (MDROs).

The resistance gene is carried on a plasmid that can be passed to other gram negative bacilli (GNB). Infections caused by ESBL-producing GNB include urinary tract infection, wound infection, blood stream infection, meningitis, endocarditis, ventilator-associated pneumonia, osteomyelitis and septic arthritis.

Causative agents

- ESBLs have been found in most species belonging to the family *Enterobacteriaceae*, however they are most commonly found among *Klebsiella pneumoniae, Escherichia coli* and *Enterobacter cloacae.*

Epidemiology

- ESBL producing GNB are usually associated with wide spread use of broad-spectrum antibiotics (third generation cephalosporins) and the resulting selection pressure.
- They have been identified as a cause of health care associated infection around the world.
- Infections occur more frequently in hospitalised, severely ill patients.
- Mortality and morbidity are increased with infection with these organisms.

Risk factors for colonisation or infection

- Inadequate health care worker compliance with hand decontamination, asepsis.
- Prolonged length of hospital stay.
- Admission to a high-risk unit, eg, ICU, burns.
- Severe underlying disease.
- Exposure to antibiotics.

- Presence of invasive medical devices (in particular indwelling urinary catheters).
- Inadequate environmental cleaning.
- Exposure to contaminated respiratory equipment.

Reservoir

- Humans. GNB reside on the skin, in the upper respiratory tract, genito-urinary tract and intestinal tract.
- Environmental reservoirs (eg, contaminated liquids, respiratory equipment). Most GNB survive in damp, moist environments.

Transmission

- Transmission most often occurs from person-to-person on the hands of health care personnel who have been transiently contaminated by contact with infected or colonised patients, or equipment contaminated with these organisms.
- *Hand hygiene is one of the most important measures in preventing spread of multiresistant organisms, including ESBL-producing GNB, in hospitals.*
- *Hands should be decontaminated, either by handwashing or using an alcohol-based hand gel, after examining any patient (ie, this includes those recognised and not yet recognised to be colonised with ESBLs).*

Prevention

- Judicious antibiotic prescribing practices.
- Compliance with standard precautions, particularly handwashing or using an alcohol-based hand gel before and after patient contact, and attention to aseptic technique.
- Contact precautions will be required for patients colonised or infected with ESBL producing GNB.
- Routine cleaning of the environment and removal/control of environmental reservoirs and sources.

Treatment

- Antibiotics need only be prescribed if the ESBL-producing GNB is contributing to an infection, eg, UTI, bacteremia.
- Therapeutic options are usually limited. Please discuss treatment with the Infectious Diseases and Clinical Microbiology Team.
- Colonisation (or carriage) with an ESBL-producing GNB should not be treated with antibiotics. This is a pointless exercise and exposes the patient to additional, unnecessary broad-spectrum antibiotics.
- It may not be possible to clear colonising ESBL-producing GNB from a patient.

Isolation requirements

- ESBL positive patients (either colonised or infected) require **contact isolation**. Masks may be required however this should be determined on the basis of the individual organism characteristics and the site of infection.
- For information on contact isolation policy at [*name*] refer to the [*relevant manual*] or discuss with the infection control practitioner covering your area.

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Appendix 8: Example of Information for Staff

Infection control advice: to whom it may concern

Isolation patient

A multidrug resistant organism (VRE) has been cultured from this patient.

All staff please note

In addition to standard precautions, please institute contact precautions:

- Single room and ensuite or designated bathroom facilities and if dialysis is required treatment is to be in the isolation area.
- Personal protective equipment (PPE): gloves and plastic apron (single use items) or gown are required by all staff entering this patient's room/area to give patient care or to touch equipment or environmental surfaces.
- Dispose of protective clothing in the containers in the area and cleanse hands by Alcohol Gel or antimicrobial hand wash before leaving the area.
- Masks are not required.
- Dedicate blood pressure cuff for duration of stay.
- Do not use any communally used equipment (blood pressure machine, tympanic thermometer etc). Dedicate specific equipment to the patient for the duration of their stay. Where this is not possible equipment must be thoroughly wiped over with a clean damp cloth dried and then wiped over with a Superwipe (see VRE isolation guidelines).
- Please do not bring patient charts, notes or pens into the isolation area.
- Where appropriate provide gel on the patient's locker. This can be used by visitors.
- Transportation: advise orderly of PPE requirements and any area where investigations or treatment are being carried out of the patient's isolation status. Cover chair or trolley with a cloth so cleaning is reduced.
- Ensure any leakage from wounds is contained and does not leak through dressing. Redress if required.
- The ward phone can be used by the patient but should be contained in a plastic bag which is removed in the room after it has been used. Ward staff should check if a cell phone can be used by the patient for her convenience.

For further details of isolation care, contact an Infection Control Officer ext/page [x].

Appendix 9: Example of Patient and Visitor Information Sheet

Extended-Spectrum Beta-Lactamase Producing Organisms ("ESBL")

Information for patients and visitors

What is an ESBL?

ESBLs are enzymes produced by a variety of bacteria that can break down certain types of antibiotics. The bacteria making these enzymes usually reside in the bowel. Bowel organisms may contaminate wounds and cause infection.

ESBL-producing bacteria have been around for a number of years and were first reported in Europe in the early eighties.

Bacteria able to produce this enzyme include some *Klebsiella pneumoniae*, *Escherichia coli* and *Enterobacter cloacae*.

ESBL-producing bacteria are resistant to some of the common antibiotics used to treat infection. This resistance means there are fewer options for antibiotic treatment if an infection develops.

Although ESBL-producing bacteria can infect your urine, wounds, or the bloodstream, more commonly, these bacteria come to reside in the bowel without making you sick. This is called colonisation (or carriage) instead of infection, as you are well and have no signs or symptoms of infection.

ESBL producing bacteria are often found on patients who have been in hospital. They may also be found on patients who have not been near a hospital.

How are these bacteria spread?

By direct or indirect contact with others already carrying the bacteria, usually via hands.

Can I spread it to other people?

If you are in hospital you are more at risk of infection as your body's normal defence mechanisms are weakened by illness, surgery, drugs and procedures.

Healthy people are probably at no greater risk of developing infection from antibiotic-resistant bacteria (eg, ESBLs) than they are from the other bacteria which normally live in their bowels.

You will be placed in a single room and staff will wear gowns and gloves while in your room.

The best way to prevent spread is by encouraging staff, visitors and patients to maintain good hand washing practices.

As people in hospital are often at risk of infection you will be asked not to visit patients in other parts of the ward or in other wards in the hospital.

There are no special precautions that you or your family need to take when you return home. Healthy people in the community are not a particular risk from ESBLs. Health-care professionals who visit you at home should clean their hands before and after visiting you (standard precautions) as they would for any patients they visit.

The doctors can discuss this with you.

It is not necessary for you to stay in hospital until the ESBL is cleared. Once your general condition allows, you can go home even if you are still carrying the ESBL-producing bacteria.

Can I have visitors in hospital?

Visitors will be asked to wear a gown and sometimes gloves and asked to wash their hands when they enter and leave your room.

Visitors should not sit or lie on your bed.

Please ask any of your potential visitors to not enter the ward if they have coughs and colds, diarrhoea, vomiting, open wounds or weeping skin lesions.

How do I know when I am no longer carrying the ESBL-bacteria?

People may have ESBL-bacteria living with other bacteria in, for example, their gut for months and possibly years without any problems. Tests to check for the continued presence of the bacteria are not usually necessary, but if you have further contact with a health care facility you may be retested to see if the bacteria are still present. While it is reassuring if no ESBL-bacteria are detected, infection control precautions may still be used as no test is completely accurate.

What happens when I go home?

It is possible that you will be discharged from the hospital before your infection is completely healed. The district nurses may be asked to attend to your dressing and medications or assist you with activities in your home.

The infection won't affect your family or friends when you are at home. Usual personal hygiene and household cleaning is adequate. You do not need to restrict your activities or visitors.

If your wound becomes red, swollen or oozes, or if you developed a fever, please contact your usual family doctor or return to the hospital emergency department.

Please do not hesitate to ask the staff if you have any further questions.

Appendix 10: Example of Letter to Patient's Doctor

This patient is colonised with a multi-resistant gram-negative bacillus (ESBL-producing organism).

An ESBL-producing [*details*] was isolated from the following site(s): [*details*]

You should assume that the patient remains colonised since antibiotics given to clear an ESBL infection do not necessarily eradicate carriage.

Standard precautions are used to prevent transmission of such bacteria via health-care workers in primary health care settings. Standard precautions include hand hygiene (eg, alcohol hand gel or hand washing) before and after any contact and wearing of gloves for contact with for example wounds, urine, faeces or other secretions.

Antibiotics that may be a risk factor for later infection with an ESBL include cephalosporins and quinolones.

Previous colonisation with an ESBL is relevant if this patient is referred to hospital. The hospital; should be notified of their history as part of the referral. Your assistance in this is very much appreciated.

Should there be any questions about ESBLs, please contact the infection Prevention and Control Service, through the operator ph: [*number*].

Yours sincerely

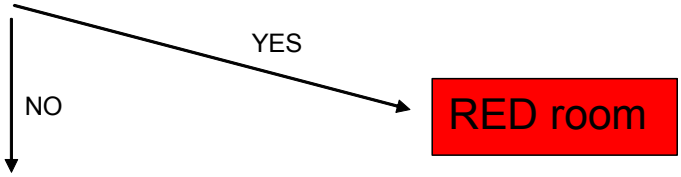
Infection Control Service

Appendix 11: Example of the 'Traffic Light System'

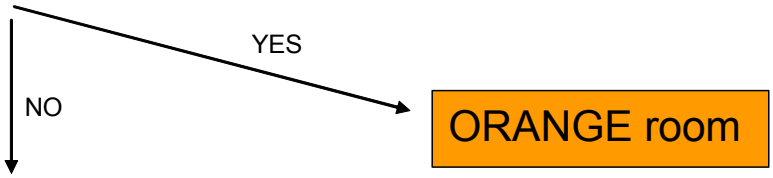
The following information for staff shows how to operate a 'traffic light system' for cohorting patients.

Red/Orange/Green (ROG) outbreak control: Admissions to [*define outbreak area*]

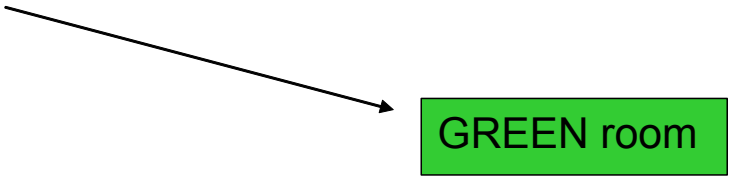
Has the patient
Ever been colonised/infected with defined MDRO?



Been a patient in [*X*] between defined period of outbreak [*Y*]
eg, 01/01/06 to 31/01/06 (later date usually when ROG begins)



Never been an patient in [*X*] during [*Y*]



RED room patient

- Contact precautions throughout admission (in addition to standard precautions).
- Not removed from contact precautions unless discussed with infection control team.

ORANGE room patient

- Gloves and standard precautions throughout admission.
- Not removed from ORANGE rooms unless discussed with infection control team.
- Consider need for screening or active surveillance cultures (ASC) for MDRO on admission:
  - One set on admission.
  - If already on antibiotics, repeat the screen 48 hours after stopping all antibiotics.
  - Depending on the MDRO in question, specimens may include rectal swab/faecal spec, urine, any skin lesions, surgical wounds, IV sites.
  - If MDRO screen positive, moves to red room. If MDRO screen negative, remains in orange room for duration of admission.

GREEN room patient

- Standard precautions throughout admission.
- Not removed from GREEN rooms without discussion with infection control team.
- Consider need for screening or ASC for MDRO on admission:
  - One set on admission.
  - If already on antibiotics, repeat the screen 48 hours after stopping all antibiotics.
  - Depending on the MDRO in question, specimens may include rectal swab/faecal spec, urine, any skin lesions, surgical wounds, IV sites.
  - If MDRO screen positive, moves to red room. If MDRO screen negative, remains in green room for duration of admission.

Clinical staff

- Nursing
  - Where possible to look after either red/orange room or green room in the same shift.
  - May look after another colour room on the next shift.
- Medical/nurse practitioners/phlebotomists/physiotherapists/occupational therapists etc
  - When doing a ward round, to visit rooms in order of green then orange then red.

Patients

- To use green or orange or red bathrooms appropriate to status.

Equipment

- No equipment to be shared between red or orange or green rooms.

Cleaning

- When any red or orange room vacated, full MDRO clean to occur. Then room is able to be used as a green room.

Patients transferring from another "alert" area

- Patients admitted to [*specify ward*] from another cross infection area [*specify the ward or hospital*]. Need contact precautions and possibly screening for organism implicated in cross-infection in [*specify the ward or hospital*]. Once results are known, and if negative, can be moved to orange or green room depending on whether they were ever in [specify the ward or hospital] during [*specify period*].

Patients transferring out of [X]

- For patients not known to be colonised or infected with the defined MRO, consider screening before transfer, inform receiving area or institution.

What to do if the laboratory contacts the ward with a positive ESBL result while the green/orange/red room system is in place in the ward

If the patient is already in isolation?

- This should continue as per normal multidrug-resistant organism (MDRO) policy.

If the patient is in an "orange" room with other patients

- Isolate the positive patient as per normal MDRO policy – into a red room.
- The room the positive patient shared with other patients, remains orange as do the remaining patients, and can still be used to admit other orange patients.
- The patients that shared the orange room with the positive patient could still be considered for active surveillance cultures.

If the patient is in a green room with other patients:

- Isolate the positive patient as per normal MDRO policy – into a red room.
- The room the positive patient shared with other patients remains green as do the remaining patients, and can admit new patients. Contact the infection control team so that infection control can further assess the situation and give advice where necessary (eg, screening of patients).