



Practical Guide

**FOR THE PREVENTION
OF HEALTHCARE
ASSOCIATED INFECTIONS**



**Our special thanks
go to Professor Didier Pittet and
Doctor Stephan Harbarth,**

Infection, Prevention and Control Department,
Geneva Hospital, Switzerland
for their helpful advice and careful
proof-reading of this booklet.





INTRODUCTION

Healthcare-associated infections (HAI) remain a major cause of morbidity, mortality and excess healthcare cost.

- **USA:** Up to 2 million healthcare-associated infections (HAI) per year, 80,000 of them are lethal or may contribute to death, and generate US \$ 4.5 to 5.7 billion additional expenses per year (WHO figures, 2005).
- **Europe:** 5 million HAI per year 50,000 (1%) are lethal and contribute to death in 135,000 cases (2.7%) (Suetens C, 2006).
- **UK:** 320,000 HAI per year, 5,000 are lethal and generate £1 billion additional expenses per year (WHO figures, 2005).
- **France:** 750,000 HAI per year, 9,000 are lethal (4,200 are directly imputable to HAI) and generate between € 2.4 to 6 billion additional expenses per year (Rapport de l'office parlementaire d'évaluation des politiques de santé, 2006).
- At any time, 1.4 million of people are suffering from HAI (WHO figures, 2005).
- Concerns between 5 and 15% of patients in an acute-care hospital (15-50% in ICUs).
- Up to 70% of organisms causing HAI are resistant to at least one antimicrobial (even if country- and hospital ward-dependant).
- Between 20 and 30% of HAI are considered to be preventable.
- Methicillin Resistant *Staphylococcus aureus* (MRSA) HAI cost (Marchaim, 2005) – data for the USA:
 - Excess mortality: 7.5%
 - Increased length of stay: 8.5 days
 - US \$: 2,4888 per infection.



The **objective of this booklet** is to provide practical recommendations to healthcare workers to prevent HAI and especially those involving Multidrug Resistant Organisms (MDRO). Measures mentioned in this booklet are in alignment with the following recommendations:

- Hospital Infection Society (HIS), published in Journal of Hospital Infection, 2006.
- Society for Healthcare Epidemiology of America (SHEA), 2003.
- WHO guidelines on Hand Hygiene, 2005.
- CDC guidelines (HICPAC) 2006.
- Protecting 5 Million lives from Harm – a campaign by the IHI, USA: Getting Started Kit: Reduce Methicillin-Resistant *Staphylococcus aureus* (MRSA) Infection, 2006.
- International Scientific Forum on Home Hygiene, 2006.
- Best Infection Control Practices for patients with Extended Spectrum Beta-Lactamase *Enterobacteriaceae* (International Infection Control Council).



RECOMMENDATIONS

- Measures adopted in a hospital to prevent the spread of MDRO should be adapted **by the local Infection Control team, after assessment of the local infrastructure and prevalence of MDRO, in agreement with the clinical staff and adapted to local specificities.**
 - Hospitals may have to follow the legal requirements and national guidelines already in place.

To efficiently eradicate MDRO, three points are mandatory:

- **Administrative support and involvement of hospital management**, providing financial and human resources.
- **Combination of multiple actions in a comprehensive MDRO Management approach.**
 - < Hand hygiene.
 - < Active surveillance cultures and targeted screening.
 - < Patient isolation.
 - < Antibiotic stewardship.
 - < Disinfection of the healthcare equipment.
 - < Environmental control.
 - < Carrier decolonization.
 - < Information management (surveillance and feedback).
 - < Targeted educational programs.
 - **Impact reassessment of adopted action plan.**



Information Management (= administrative procedures)	Patient / Relatives	Care Delivery Procedures
Alert function p.26	Screening p.4	Hand hygiene p.12
Surveillance p.26	Educational programs p.28	Patient isolation p.16
		Carrier decolonization p.18
		Pre-operative management of MRSA carriers p.20
		Antibiotic stewardship p.24
		Reinforced measures to prevent MDRO transmission p.30



PREVENTION
OF HEALTHCARE INFECTIONS
RELIES ON INFECTION PREVENTION
AND CONTROL PROGRAMS
COVERING 6 DIFFERENTS AREAS:

Healthcare Workers	Equipment	Environment
 <p>Educational programs p.28</p>	<p>Healthcare equipment disinfection p.22</p>	<p>Environmental control p.23</p>
<p>Screening p.4</p>		

SCREENING

Why?



- **Recognize asymptomatic** carriers, among patients, Healthcare workers (HCW) .
- **Stop cross-transmission** through applying strict barrier precautions (contact isolation and targeted hygiene measures).

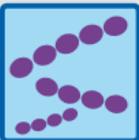
Other facts:

- Transmission is a major driver of MDRO increase.
- Cross transmission between patients in the ICU setting can be reduced up to 16 times with effective preventive measures (isolation + screening) (Jernigan JA, 1995).
- Up to 30 % of patients colonized with MRSA will become infected.
- In North European countries (e.g. Denmark, the Netherlands and Finland), the development and implementation of strict control programs, based on screening policies and antibiotic control, significantly reduced the emergence and spread of bacterial resistance.

Diagnosis of clinical cultures fail to detect 35 to 85% of colonized patients.

In contrast, active surveillance culture identify 80% of colonized patients (IHI Campaign, 2006).

Which microorganisms should be detected ?

Pathogens	Screening context
MRSA 	Highly recommended in areas of endemic cross-infection and high risk of infection (e.g. ICUs).
ESBL* 	Highly recommended in areas of endemic cross-infection and high risk of infection (e.g. ICUs).
VRE** 	According to local epidemiology and in case of epidemics. Annual point prevalence studies in high-risk units may be useful even in settings with sporadic occurrence of VRE.
Multi-R <i>Acinetobacter spp</i>	Highly recommended in areas of endemic cross-infection and high risk of infection.
Other multidrug resistant pathogens	Depending on local epidemiology.
<i>C.difficile</i>	Depending on seasonal variations, outbreak situations or local epidemiology.

* ESBL: Extended Spectrum Beta-Lactamase (*Enterobacteriaceae* producing)

**VRE: Vancomycin Resistant *Enterococcus*

When MRSA is frequently detected, then consider looking for VISA (or GISA) and VRSA on selected isolates.

- **VISA (or GISA):** *Staphylococcus aureus* with decreased susceptibility to vancomycin (MIC = 4 or 8 mg/L)
- **HeteroVISA (or hetero GISA):** *Staphylococcus aureus* with decreased susceptibility to vancomycin (MIC = 2 mg/L) but contains sub-populations of cells, at a frequency $> 10^{-6}$, that exhibits intermediate susceptibility to vancomycin (MIC = 4 to 16 mg/L).
- **VRSA:** *Staphylococcus aureus* fully resistant to vancomycin (MIC > 16 mg/L).

SCREENING

Who?

< At risk patients



High-risk patients
(Gram-positive bacteria)

- Previous carriage or infection with MDRO.
- Older age groups.
- Hospital stay within the last year.
- Antibiotic exposure within the last year (fluoroquinolones to control MRSA, cephalosporins 2nd and 3rd generation, to control VRE).
- Specific patient characteristics (variable on the patient population studied):
 - < Transferred from another institution.
 - < Being hospitalized in a department with a high MDRO rate.
 - < Having open cutaneous wounds.
 - < Poor chronic health status (chronical disease, diabetes...).
 - < Invasive devices (e.g. hemodialysis).
 - < High risk surgery.
 - < Immuno-suppressed.

The selection and profile of patients to be screened should be defined locally by the infection control team, after considering the local epidemiology of MDRO within the facility.

High-risk patients
(Gram-negative bacteria)

- Previous carriage or infection with MDRO.
- Older age groups.
- Hospital or ICU stay within the last year.
- Exposure to certain antibiotic classes.
(e.g. cephalosporins)
- Chronic disease score.
- Specific risk factors for ESBL producing organisms:
 - ◁ Length of stay in the hospital.
 - ◁ Increased length of stay in the intensive care unit.
 - ◁ Increased illness severity.
 - ◁ Use of a central venous or arterial catheter.
 - ◁ Use of urinary catheter.
 - ◁ Ventilatory assistance.
 - ◁ Hemodialysis.
 - ◁ Emergency abdominal surgery.
 - ◁ Use of a gastrostomy or jejunostomy tube.
 - ◁ Gut colonization.
 - ◁ Prior administration of an oxyimino-beta-lactam antibiotic.
 - ◁ Prior administration of any antibiotic.
(Jacoby GA, 2005).

Using a **risk score approach** for targeted on-admission screening, based on epidemiological methods, can be a good way to decrease MDRO infection rates (Harbarth S, 2006).

◁ Other patients



- During outbreaks.
- Depending on local prevalence and epidemiology:
 - ◁ in facilities where there is a high prevalence of MDRO.
 - ◁ point prevalence studies to detect unknown carriers, particularly in rehabilitation and long-term care institutions.
- In case of legal constraints or frequent malpractice suits (to prove the patient's colonization status when he/she is admitted to a hospital).
- In settings with a stringent Search & Destroy strategy: patients coming from abroad should be systematically screened at hospital admission (applied in the Netherlands, for example).

SCREENING

< Staff

MRSA



Screening is not routinely recommended in settings with endemic MRSA, but should be considered:

< **If transmission continues** despite an active infection control program.

< **In case of unusual clusters** suggesting possible staff carriage and involvement in transmission.

< **In case of contact with colonized/infected patients, HCW with chronic skin lesions** may benefit from regular screening.

Screening specimens should be collected at the beginning of the duty period (eliminate transient carriage) and from the same sites as those for the patients.

A previously positive carrier is considered negative when 3 screening tests at weekly intervals are negative.

Local policies should guide post-clearance sampling of staff.

ESBL



Screening is generally not recommended (except in the case of ESBL-producing *Salmonella* and if there is epidemiological evidence of transmission from a suspected source (e.g. ICUs).

Patients from which units?

ICUs may consider implementing on-admission screening for MRSA depending on the local epidemiology.

Usually recommended	ICU	MRSA, ESBL, VRE
	Clean surgery	MRSA
	Transplantation units	MRSA, ESBL, VRE
	Cardio-vascular surgery	MRSA, ESBL, VRE
Optional	Orthopedic surgery	MRSA
In case of outbreaks	Geriatrics	MRSA, ESBL
	Long-term care facilities	MRSA, ESBL

When?

< At what time?

 <p>On hospital admission or during pre-operative visits to outpatient clinics in case of elective surgery</p>	<ul style="list-style-type: none"> < For high-risk patients. < When the Search & Destroy strategy is in use (in the Netherlands for example).
 <p>During hospitalization</p>	<ul style="list-style-type: none"> < Once a contact with carriers has been documented. < For patients hospitalized for a long time. < For patients in high prevalence units (ICU). < When there are changes in risk factors.
 <p>On hospital discharge</p>	<ul style="list-style-type: none"> < When patients are transferred to an institution with low MDRO prevalence.

SCREENING

< How frequently?

Once a week for patients:

- Hospitalized for extended time periods and exposed to broad-spectrum antibiotic agents.
- Hospitalized in critical units with high prevalence and a great risk of cross-infection (e.g. ICUs).

How?

< Which specimens?

Microorganism	Specimens
MRSA 	Nasal specimen (anterior vestibule of the nose). < Other specimen (to increase diagnostic yield): perineal, inguinal, or throat... A multisite specimen can be pooled on the same plate which will increase detection sensitivity. < If present, areas of skin breakdown (wounds, eczema) and foreign body insertion sites (e.g. catheter) should be collected. < Sputum if productive cough.
ESBL 	Rectal/perirectal specimen alone or in combination with oro-pharyngeal, endotracheal, inguinal or wound cultures, urine.
VRE 	Stool specimen or rectal/perirectal specimen .

< Sensitivity of the different sites ?

For MRSA, the most common reservoir is the nose ; axillae for 15-25% of patients, perineum (30-40%); hand and arms (40%) (IHI Campaign, 2006).

Which microbiological techniques ?



- **Culture methods** for MRSA, ESBL, and VRE, (chromogenic media).
- **Molecular methods** for MRSA, and VRE.



The choice between rapid molecular methods (enabling more rapid isolation) and culture tests (easier and less expensive) is still a subject for discussion.

To increase sensitivity, transportation time should be limited as far as possible and inoculation performed immediately. For MRSA and VRE, sensitivity is increased after broth enrichment.

Other biology tests

- **Susceptibility testing** particular for Mupirocin or other drugs used for topical treatment when prescribing antimicrobial therapy for decontamination (SHEA guidelines, 2003).
- **Molecular typing methods** for epidemiological purposes and investigation of epidemics.

Screening result interpretation

A carrier can be considered to be negative and contact precautions can be discontinued if:

- Screening tests are negative 3 times (or 5 times in high risk situations) at weekly intervals (starting at least 48 hours after antimicrobial and/or antiseptic therapy is stopped).
- Or two screening tests are negative for a patient who has not received antimicrobial therapy for several weeks.

HAND HYGIENE

Strict compliance with standard precautions such as hand disinfection and the use of barriers against contact with blood and body fluids could prevent most cases of cross-transmission.

Bedside, alcohol-based antiseptic agents have great potential to increase compliance with hand hygiene recommendations (fast hand hygiene during patient care, rapid microbial killing and improvement of the skin condition of HCWs' hands) and may reduce nosocomial cross-infections (Pittet D, 2000).



General procedures

Guideline for Hand Hygiene in Healthcare settings. WHO guidelines. Extracted/adapted from WHO guidelines on Hand Hygiene in Health Care – Global Patient Safety Challenge, 2005-2006 (<http://www.who.int/patientsafety>).

< Indications for hand washing and hand antisepsis

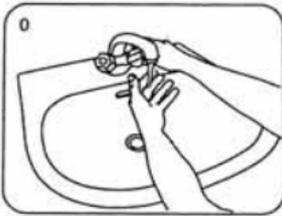
- **Wash hands with soap and water when visibly dirty** or soiled with blood or other body fluids or if exposure with spore-forming organisms or after using restroom.
- Preferably use an **alcohol-based hand rub for routine hand antisepsis** if hand are not visibly soiled.
- **Perform hand hygiene:**
 - < Before and after having direct contact with patients.
 - < After removing gloves.
 - < Before handling an invasive device for patient care, regardless of whether or not gloves are used.
 - < After contact with body fluids or excretions, mucous membranes, non-intact skin or wound dressing.
 - < If moving 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.



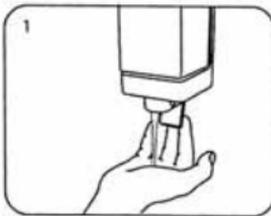
HAND HYGIENE

< Hand hygiene technique

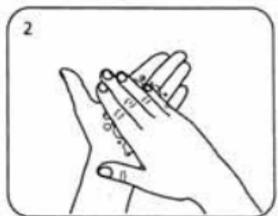
Handwashing technique with Soap and Water



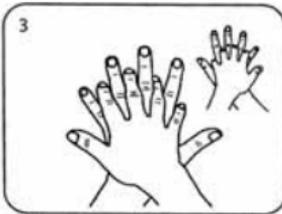
Wet hands with water



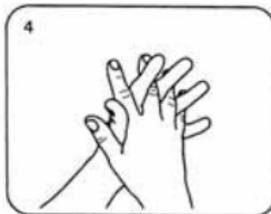
apply enough soap to cover all hand surfaces



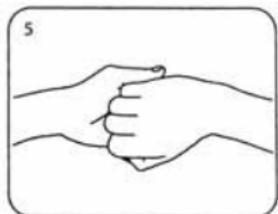
rub hands palm to palm



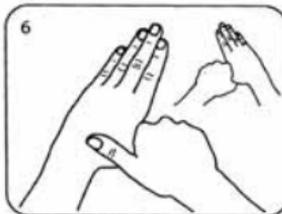
right palm over left dorsum with interlaced fingers and vice versa



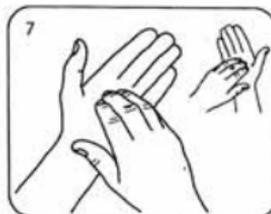
palm to palm with fingers interlaced



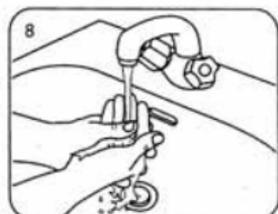
backs of fingers to opposing palms with fingers interlocked



rotational rubbing of left thumb clasped in right palm and vice versa



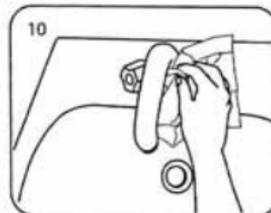
rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa



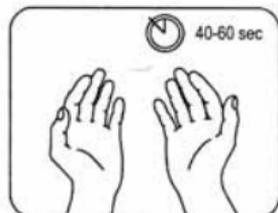
rinse hands with water



dry thoroughly with a single-use towel



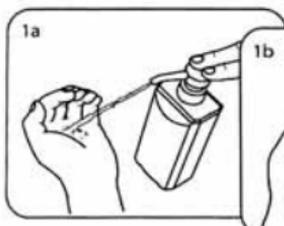
use towel to turn off faucet/tap



...and your hands are safe.

For “surgical hand preparation”, the “selection and handling of hand hygiene agents”, “skin care” and the “use of gloves” see the following site: <http://www.who.int/patientsafety>.

Hand hygiene Technique with Alcohol-Based Formulation



1a Apply a palmful of the product in a cupped hand and cover all surfaces.



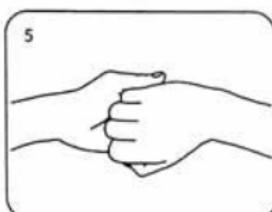
2 Rub hands palm to palm



3 right palm over left dorsum with interlaced fingers and vice versa



4 palm to palm with fingers interlaced



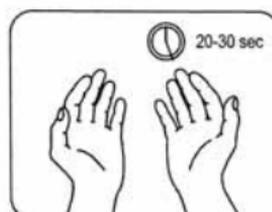
5 backs of fingers to opposing palms with fingers interlocked



6 rotational rubbing of left thumb clasped in right palm and vice versa



7 rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa



...once dry, your hands are safe.

- Apply a palmful of the product and cover all surfaces of the hands. Rub hands until hands are dry.
- When washing hands with soap and water, wet hands with water and apply the amount of product necessary to cover all surfaces. Vigorously perform rotational hand rubbing on both hand palms and backs, interlace and interlock fingers to cover all surfaces. Rinse hands with water and dry thoroughly with a single-use towel. Use running and clean water whenever possible. Use towel to turn off faucet.
- Make sure hands are dry. Use single use towels.
- Liquid, bar, leaf or powered forms of plain soap are acceptable.

PATIENT ISOLATION

How?

< Standard precautions

Who? Any patient without known carriage.

The standard hand hygiene precautions are used. See above “Hand hygiene” chapter.

- Hand washing before and after direct contact with patients.
- Gloves, masks, gowns, glasses wearing when “at risk” care is given (splashing-generating procedures, open tracheostomies or visibly heavily colonized sources) or contact with uncontrolled secretions (draining wounds, stool incontinence).

< Contact isolation (or precautions)

Who? Patients colonized or infected with MDRO (MRSA, ESBL, VRE, VISA/GISA, VRSA...) or suspected to be colonized (in areas where the **Search and Destroy strategy** is in use).

Contact isolation applies for each contact with the patient.

- Patient is placed in a **single room** or geographically separated from other patients.
- **Cohorting** (when individual isolation rooms are not numerous enough). Gathering in the same room of infected/colonized patients with the same organism is possible. Patients with community-acquired MRSA strains should not be cohorted with patients carrying healthcare-associated MRSA. In case of cohorting, hand hygiene is required between 2 patients in order to prevent transmission of other MDRO (IHI Campaign, 2006).
- HCW should wear **gowns, disposable gloves and aprons** to enter the room (masks could be worn to reduce nasal acquisition by HCW) and use disposable masks and glasses for procedures likely to generate aerosols or splashing. They should be discarded before exiting the patient room.
- **Patient charts and records to be placed outside the room.**
- **Non-disposable items** that cannot be easily cleaned should be used **only for a colonized/infected patient.**
- **Linen should be considered as contaminated** (placed in a double bag to go outside the room).
- **Transfers of patients should be avoided** as much as possible. The receiving institution or department should be aware of the patient colonization/infection status.



In some areas where isolation could have a negative psychological effect on patients (nursing homes, geriatric units, psychiatric wards), adaptation of contact precautions may be required (establish ranges of permitted ambulation, socialization, based on their risk to other patients and the ability of colonized/infected patients to observe hand hygiene and recommended precautions).

< Droplet isolation (or precautions)

Who? Patients colonized or infected with MDRO (MRSA, ESBL, VRE, VISA/GISA, VRSA...) with potential respiratory transmission (through droplets).

Patient: use disposable masks and tissue.

Healthcare workers: use contact precautions reinforced with disposable masks

< Air isolation (or precautions)

Who? When there is a risk of air contamination. Use contact precautions reinforced with disposable masks especially designed for respiratory protection and glasses.

Usually does not concern patients colonized or infected with MDRO.

The benefits of pre-emptive precautions (= application of contact precautions until the result of screening tests are available) are a matter of debate: set up isolation earlier can avoid MDRO spread and then reduce the infection risk, especially for higher-risk patients (Harbarth S, 2006), but increases the use of supplies and time-to-care patients (IHI Campaign, 2006).

Transfer of colonized/infected patients

- Should be minimized to reduce the risk of spread.
- Lesions should be occluded.

MRSA decolonization



MRSA decolonization is still a matter of debate (several controversial studies exist). Active decolonization should be:

- Considered as **an additional measure** for patients and HCW to be implemented when appropriate (e.g. CA-MRSA, outbreaks, high-risk patients, pre-operative decontamination, special-care units).
- Systematically **associated with susceptibility testing** to the decontamination agents as well as follow-up culture to ensure eradication.

The broad use of Mupirocin is discouraged as it may lead to the development of resistance (IHI Campaign, 2006).

Different protocols are used worldwide, but most of them include nasal decolonization:

- ◁ **Intranasal mupirocin ointment 2% twice** (SHEA guidelines, 2003) **or three times** (HIS guidelines, 2006) **daily for 5 days**.
- ◁ Eradication in 25% of patients receiving **intranasal mupirocin twice daily for 5 days** and a **daily bath with chlorhexidine 4%** for 7 days (versus 18% with placebo ointment and chlorhexidine bath) (SHEA guidelines, 2003).
- ◁ Better performance when associating **intranasal mupirocin three times daily, daily chlorhexidine bath** and systematic **therapy with rifampicin and another drug effective against MRSA** (minocycline or trimethoprim-sulfamethoxazole) **during 2 weeks**, removal/replacement of devices (endotracheal tubes, endoscopic gastrostomy tubes, catheters...) (SHEA guidelines, 2003).
- **Skin decolonization with 4% chlorhexidine** body-wash/shampoo, **7.5% povidone iodine or 2% triclosan:** daily bath **for 5** (HIS guidelines, 2006) **or 7 days** (SHEA guidelines, 2003). The skin should be moistened and the antiseptic agent applied thoroughly before rinsing in the bath or a shower. Special attention to the axilla, groin and perineal area.
- Wash hair with an antiseptic detergent.
- Throat decolonization is an unresolved issue.

ESBL decolonization



There is a low success rate for decolonization therapy and it leads to the development of resistance. As a consequence, in case of:

- **Low risk of transmission or infection** --> **no decolonisation.**
- **ESBL carrier patients with high risk** of becoming infected (accommodation with other patients with ESBL producing organisms, ICU ...): some authors have recommended the administration of **antibiotics active against ESBL for gastrointestinal decontamination**, with polymyxin B, neomycin + nalidixic acid or colistin plus tobramycin (Livermore, 2006). However this type of decolonization is still a matter of debate.

VRE decolonization



Not commonly carried out and decolonization successes are very limited.

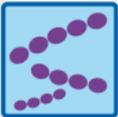


PRE-OPERATIVE MANAG OF MRSA CARRIERS

There is no firm recommendation for other MDRO.

Preparation

- **Bath/shower the patient with an antiseptic detergent active** against MRSA (e.g. chlorhexidine gluconate), applied directly on the skin and rinsed off.
- **Cover affected lesions** with an impermeable dressing.
- **Clean the area adjacent to the lesion with alcoholic chlorhexidine.**
- **Apply mupirocin to the nose at least 3 days** before the operation if the patient is a nasal carrier.
- Before or after surgery, avoid as far as possible carrier patients being in a room with non-carrier patients and ensure dedicated HCW are allocated to their care.

Patient infected/ colonized with	Type of surgery
MRSA 	Clean surgery Clean contaminated surgery
ESBL 	Clean contaminated surgery
VRE 	Unresolved issue



Antibiotic surgical prophylaxis of carriers

- Use peri-operative antibiotic prophylaxis only for patients justifying antibiotic surgical prophylaxis and respect the correct dosage, timing and duration of antimicrobials.

Antibiotics	Protocols (when, duration...)
<p>Vancomycin</p> <p>Add Vancomycin to standard regimen</p>	<p>1 hour before incision Single dose</p> <p>1 hour before incision Single dose</p>
<p>If susceptible isolate: Cephameycins (i.e. cefoxitin, cefotetan, flomoxef)</p> <p>Otherwise for very high risk abdominal procedures, consider carbapenems (imipenem, meropenem, ertapenem),</p>	<p>Max. 24 hours</p>

HEALTHCARE EQUIPMENT DISINFECTION

Healthcare or patient equipment (stethoscopes, wheelchairs...) can become contaminated and vectors of pathogens. They must be disinfected before use by another patient. Disinfection with 70% isopropyl alcohol significantly decreases bacterial counts. Routine disinfection between patients prevents transmission.



ENVIRONMENTAL CONTROL

Appropriate cleaning and disinfection procedures are essential to decrease the microbial burden in the close patient environment and to minimise the likelihood of MDRO cross-infection (Harbarth S, 2006).

MRSA and VRE can be isolated from various devices and environmental surfaces in patient's rooms: 70% of the rooms of colonized or infected patients have some environmental contamination (Boyce J, 1997). They can persist several months on dry surfaces (SHEA guidelines, 2003).



Consider the amount of contacts between patient and environment: frequently-touched surfaces are cleaned and disinfected more frequently than surfaces with minimal contact.

MRSA and VRE are susceptible to low-level and intermediate-level disinfectants, quaternary ammonium compounds, phenolics and iodophors (with proper dilutions).

Routine terminal disinfection with quaternary ammonium compounds is not sufficient. It is better to use a "bucket" method: cleaning rag dipped in bucket with disinfectant, drenching all surfaces, leaving surfaces wet for 10 minutes and then wiping dry with clean towels (SHEA guidelines, 2003).

Even if routine environmental cultures are not recommended, they can help in validating the effectiveness of cleaning procedures and to monitor adherence to recommended environmental cleaning practices.

ANTIBIOTIC STEWARDS

According to different studies, between 20 to 50% of all antimicrobial use in the hospital setting is either unnecessary or not appropriate. **Appropriate antimicrobial use is commonly defined as the use of an antimicrobial agent that is correct on the basis of all available clinical, pharmacological and microbiological evidence.**

It includes:

- Narrowing the spectrum when culture and susceptibility testing results are available.
 - Using appropriate dosages and dosing intervals.
- Respecting additional principles of the judicious prescription of antibiotics.

Recommended Strategies:

- Education and training of physicians.
- Written guidelines with treatment recommendations.
- Surveillance of antimicrobial consumption and resistance with regular feedback to prescribers.
- Formulary interventions with restriction of specific antimicrobial agents.
- Prior approval of certain antimicrobial agents by the Infectious Diseases service.
- Cycling/rotation of antibiotic agents, especially in units with high antibiotic use and resistance.
- Streamlining and automatic stop orders.
- Decision support by computer-assisted programs.

The following measures may further reduce the selective pressure that favours proliferation of MDRO:

- Use antibiotics only when infection has been proved (treat infection and not contamination).
- Avoid excessive duration of treatment.
- Limit the use of broad-spectrum antibiotics when the pathogen is unknown or when other effective agents are unavailable.
- Restrict the use of anti-anaerobic agents in patients with known VRE colonization.

To prevent the spread of:

MRSA



◀ Reduce the use of fluoroquinolones and 3rd generation cephalosporins

ESBL



◀ Reduce the use of 3rd generation cephalosporins

VRE



◀ Reduce 3rd generation cephalosporins and anti-anaerobic agents

Alert function with the main computer = administrative procedure

Flagging previously known patients with MDRO.

The computerized patient database should:

- Keep long term information on MDRO status and be able to perform electronic flagging of patients when they are known to be colonized/infected by MDRO.
- Alerts are generated when the patient comes back to hospital.
- Notify the transfer of colonized/infected patients to/from other institutions before patient admission.

Surveillance

By analyzing laboratory results (identification and susceptibility testing) as well as screening results, surveillance will then:

- **Detect outbreaks** (in this case, typing and strain comparison is important).
- **Alert on new emerging MDRO.** Immediately notify clinicians and infection control staff as well as the relevant national organization in case of VISA/GISA and VRSA.
- **Establish a baseline** (e.g., incidence) for targeted MDRO by reviewing results of clinical cultures, distinguishing colonization from infection.
- **Alert on rare or virulent microorganisms** (e.g. CA MRSA).
- **Detect abnormal events.** Identification of increases above certain thresholds can enable the early detection of possible abnormal events (e.g. incidence increases).
- **Assess the effectiveness of prevention and corrective measures.**

Surveillance should be implemented on-site and ideally consolidated on a local, regional or national level to combat emerging or growing MDRO problems.

National surveillance networks are important for notification of unusual resistant organisms (eg: VISA/GISA, VRSA).

Routinely use data management software to analyze laboratory results (routine clinical cultures or surveillance specimens) which are able to perform epidemiological studies and generate alerts in real-time.

Implement systems to communicate information about MDRO in the institution (provide HCW and administrators with trends in MDRO infections as well as results of infection control practice failures) or to health authorities as required.

Regularly:

- **Perform incidence measures** on clinical culture results.
- **Define infection rates** in certain populations or units.
- In large tertiary care centers, **perform molecular typing** to better understand transmission routes, delineate the epidemiology of MDRO within the healthcare setting and assess the effect of interventions (subject of controversy).



Organization

- **Written policies** should be available.
- **Regularly audit** infection control procedures.
- Plan **appropriate nurse staffing** (with grades and experience) as clinical workload pressure reduces time for appropriate routine infection control measures and hand hygiene.

Healthcare Worker Education

- Emphasize the **importance of hand hygiene and adhering all precautions** and proper barrier techniques. This guarantees better compliance.
- **Review surface disinfection protocols**, disinfecting agent dilution, contact time and effectiveness.
- Provide education on **MDRO risks and prevention** as well as feed back on current practices.
- Present **surveillance data** (charts) to hospital staff routinely, at least annually.
- Ensure that isolated patients have the same care standard than non-isolated patients.

Patient and Relatives Education

- **Involve patients and visitors** in good infection control measures and compliance.
- **Keep patients and visitors informed.**
- **Educate on contact precautions.**
- Prepare dedicated patient and visitor **information leaflets.**

Key points for success

- Teamwork.
- Example from management.
- Use the Plan Do Study Act (PDSA) model for improvement: plan a change in a small scale, observe the result, with positive and negative points and then correct as appropriate and spread on a larger scale (IHI Campaign, 2006).

Key barriers

- Lack of support by leadership.
- Uneven physician acceptance of new practice.



When?

- When the above-mentioned interventions did not succeed in decreasing incidence or prevalence of MDRO infections, intensified actions are required.
- When the first **outbreak of an epidemiologically important MDRO** has been identified (MRSA, VRE, VISA, VRSA, ESBL, or another Gram-negative MDRO ...) in an institution or unit.

What to do?

The following list is not exhaustive and may give hints on additional measures to consider when conventional infection control measures have failed:

- **Evaluate healthcare system** factors in creating/perpetuating transmission of MDRO and potential failures (staffing level, education, training, procedures, adherence to infection control measures...).
- **Intensify educational interventions.**
- **Control and improve antimicrobial use.**
- Surveillance: analyze **prevalence and incidence rates of targeted MDRO infection/colonization** in "at risk population", distinguishing infection and colonization.
- **Reinforce active surveillance cultures:**
 - ◁ Multiply the number of specimen sites (e.g. for MRSA: anterior nares + throat + perineal culture; for VRE: stool + rectal + perirectal; for Gram-negative bacilli: endotracheal tube aspirates or sputum if respiratory tract reservoir is suspected).
 - ◁ Multiply active surveillance cultures: room mates, patients or HCW potentially in contact with colonized/infected patients.

ES TO PREVENT

- **Conduct culture surveys** to assess the efficacy of the reinforced MDRO control program.
- **Implement contact precautions until the surveillance culture is reported negative.**
- Assign **dedicated nursing staff** to care for patients with MDRO
- **Stop new admissions** to the unit or facility if transmission continues.
- Assign **patient-dedicated or single-use disposable equipment** (e.g. blood pressure cuff, stethoscope...).
- **Enhance cleaning/disinfection performance** in areas close to colonized/infected patients.
- Obtain **environmental surveillance cultures** of the targeted MDRO.
- **Close the unit for environmental cleaning/disinfection if previous efforts have failed.**
- **Consider more frequent decolonization**, on a case-by-case basis.
- **Re-assign colonized HCWs** if decolonization is not successful and transmission persists.



BURDEN OF DISEASE AND ECONOMIC IMPACT

Medical impact

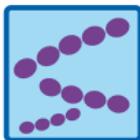
< MRSA



- **In low prevalence countries:**
 - < In the Netherlands, the Search and Destroy strategy has been applied for several years. It has enabled the *S.aureus* resistance rate to be maintained at < 0.5 %.
 - < The frequency of MRSA transmission is 38-fold lower if patients are identified and isolated (Vriens MR, 2002).
- **In medium prevalence countries:** 52.4 HAI / 1,000 patient/days without prevention; 34 HAI / 1,000 patient/days with prevention (Eggimann P, 2000).
 - < MRSA rate is reduced by 50 % with a systematic screening (Harbarth S, 2000).
 - < MRSA Blood Stream Infections (BSI) are reduced by 60 % with effective prevention program (Adeyemi-Doro FA, 1997).
- **In outbreak situations:**

Patient to patient transmission of MRSA was reduced 16-fold by surveillance culture in order to identify colonized patients and place newly detected cases in contact isolation (Jernigan JA, 1995).
- **In endemic situations:**

Even with a high MRSA prevalence rate, screening and fighting are justified (Rubinovitch B, 2001).

< VRE

The most important risk factor for acquiring VRE during an outbreak is the proximity to un-isolated patients (Byers KE, 2001).

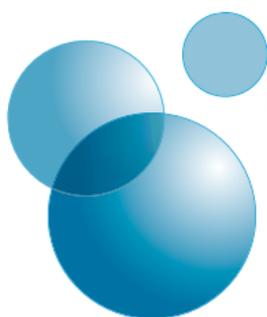
Active Surveillance Cultures decrease VRE transmission 39% (versus no culture) and pre-emptive isolation plus Active Surveillance Culture decrease transmission by 65% (Perencevitch EN, 2004).

Economic impact

8 M € savings through reduction of 6-9 % of HAI number, with a 60,000 € program (x 133) (Durand-Zaleski I, 2001).

The excess cost of VRE BSI was estimated to be 3-fold more than the cost of active surveillance culture and contact isolation (Muto CA, 2002).

A comparison between 2 comparable hospitals during 51 months resulted in 75 MRSA BSI less in the hospital having implemented surveillance culture and contact precautions and exceeded the cost of prevention by 19-27-fold (Karchmer T.B., 2002).



BIBLIOGRAPHY

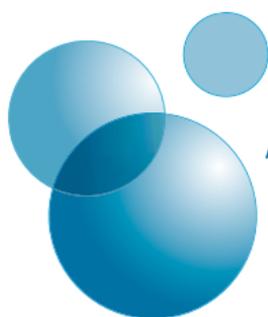
Guidelines

- Coia JE, Duckworth GJ, Edwards DI, Farrington M, Fry C, Humphreys H, Mallaghan C, Tucker DR for the Joint Working Party of the British Society of Antimicrobial Chemotherapy, the Hospital Infection Society and the Infection Control Nurses Association. Guidelines for the control and prevention of methicillin-resistant *Staphylococcus aureus* (MRSA) in healthcare facilities. *J Hosp Infect* 2006; 63S: S1-S44.
- Friedman C, Callery S, Jeanes A, Piaskowski P. Best Infection Control Practices for patients with Extended Spectrum Beta-Lactamase *Enterobacteriaceae*. International Infection Control Council. <http://www.apic.org/Content/NavigationMenu/PracticeGuidance/Reports/Reports.htm>
- Mangram A.J., Horan T.C., Pearson M.L., Silver L.C., Jarvis W.R. Guideline for prevention of surgical site infection, *Infect Control Hosp Epidemiol* 1999; 20:247-278.
- Muto CA, Jernigan JA, Ostrowsky BE, Richet HM, Jarvis WR, Boyce JM, Farr BR. SHEA Guideline for preventing nosocomial transmission of multidrug-resistant strains of *Staphylococcus aureus* and *Enterococcus*. *Infect Control Hosp Epidemiol* 2003; 24:362-386.
- Siegel JD, Thinehart E, Jackson M, Chiarello L, the Healthcare Infection Control Practices Advisory Committee. Management of Multidrug-Resistant Organisms in healthcare settings, Center for Disease Control and Prevention 2006. <http://www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf>
- Protecting 5 Million lives from Harm – a campaign by the Institute for Healthcare Improvement (IHI), USA: Getting Started Kit: Reduce Methicillin-Resistant *Staphylococcus aureus* (MRSA) Infection, 2006 <http://www.ihl.org>.
- Methicillin resistant *Staphylococcus aureus* (MRSA), *Clostridium difficile* and ESBL-producing *Escherichia coli* in the home and community: assessing the problem, controlling the spread, International Scientific Forum on Home Hygiene, 2006. <http://www.ifh-homehygiene.org>.
- WHO guidelines on Hand Hygiene in Health Care – Global Patient Safety Challenge, 2005-2006. <http://www.who.int/patientsafety>.
- http://www.hpa.org.uk/infections/topics_az/esbl/ESBLguidelines.htm

Articles

- Adeyemi-Doro FA, Scheel O, Lyon DJ, Cheng AF. Living with methicillin-resistant *Staphylococcus aureus*: a 7-year experience with endemic MRSA in a university hospital. *Infect Control Hosp Epidemiol* 1997; 18:765-767.
- Boyce, 1997 Boyce JM, Potter-Bynoe G, Chenevert C, King T. Environmental contamination due to methicillin-resistant *Staphylococcus aureus*: possible infection control implications. *Infect Control Hosp Epidemiol*. 1997;18:622-627.
- Byers K E, Anglim AM, Anneski CJ, Germanson TP, Gold HS, Durbin LJ, Simonton BM, Farr BM. A hospital epidemic of vancomycin-resistant *Enterococcus*: risk factors and control. *Infect Control Hosp Epidemiol* 2001; 22:140-147.
- Cox RA, Conquest C. Strategies for the management of healthcare staff colonized with epidemic methicillin-resistant *Staphylococcus aureus*. *J Hosp Infect* 1997; 35:117-127.
- Durand-Zaleski I, Chaix C, Brun-Buisson C. Impact de la résistance bactérienne sur les coûts des soins. 21e Réunion Interdisciplinaire de Chimiothérapie anti-infectieuse , 41-49. 2001.
- Eggimann P, Harbarth S, Constantin MN, Touveneau S, Chevolet JC, Pittet D. Impact of a prevention strategy targeted at vascular-access care on incidence of infections acquired in intensive care. *Lancet* 2000; 355:1864-1868.
- Harbarth S, Martin Y, Rohner P, Henry N, Auckenthaler R, Pittet D. Effect of delayed infection control measures on a hospital outbreak of methicillin-resistant *Staphylococcus aureus*. *J Hosp Infect* 2000; 46:43-49.
- Harbarth S. Control of endemic methicillin-resistant *Staphylococcus aureus*-recent advances and future challenges. *CMI* 2006; 12:1154-1162.
- Jacoby GA, Munoz-Price LS. The new beta-lactamases. *N Engl J Med* 2005; 352:380-391.
- Jernigan JA, Clemence MA, Stott SA, Titus MG, Alexander CH, Palumbo CM, Farr BM. Control of methicillin-resistant *Staphylococcus aureus* at a university hospital: one decade later. *Infect Control Hosp Epidemiol* 1995; 16:686-696.
- Karchmer TB, Durbin LJ, Simonton BM, Farr BM. Cost-effectiveness of active surveillance cultures and contact/droplet precautions for control of methicillin-resistant *Staphylococcus aureus*. *J Hosp Infect* 2002; 51:126-132.
- Livermore DM, Paterson DL. Pocket Guide to Extended-Spectrum beta-Lactamases in Resistance. Current Medicine Group Ltd 2006.

- Marchaim D, Schwaber M, Kaye K, Cosgrove S, Harbarth S, Carmeli Y. The burden of methicillin-resistant *Staphylococcus aureus* infections on patients hospitalized in the US. 46th ICAAC meeting, San Francisco (USA), September 28, 2006. Abstract K-791.
- Muto CA, Giannetta ET, Durbin LJ, Simonton BM, Farr BM. Cost-effectiveness of perirectal surveillance cultures for controlling vancomycin-resistant *Enterococcus*. *Infect Control Hosp Epidemiol* 2002; 23:429-435.
- Perencevich EN, Fisman DN, Lipsitch M, Harris AD, Morris JG Jr, Smith DL. Projected benefits of active surveillance for vancomycin-resistant enterococci in intensive care units. *Clin Infect Dis*. 2004; 38:1108-1115.
- Pittet D, Hugonnet S, Harbarth S, Mourouga P, Sauvan V, Touveneau S, Perneger TV. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Infection Control Programme*. *Lancet*. 2000;14:1307-1312.
- Office parlementaire d'évaluation des politiques de santé. Rapport de l'Office parlementaire d'évaluation des politiques de santé, Vasselle A. 2006. <http://senat.fr/rap/r05-421/r05-421.html>
- Rubinovitch B, Pittet D. Screening for methicillin-resistant *Staphylococcus aureus* in the endemic hospital: what have we learned? *J Hosp Infect* 2001; 47:9-18.
- Suetens C. Healthcare associated infections in Europe: Burden and surveillance strategies, IPSE, 2006. <http://helics.univ-lyon1.fr>.
- Vriens MR, Fluit AC, Troelstra A, Verhoef J. Is methicillin-resistant *Staphylococcus aureus* more contagious than methicillin-susceptible *S. aureus* in a surgical intensive care unit? *Infect Control Hosp Epidemiol* 2002; 23:491-494.
- WHO figures. <http://www.who.int/patientsafety>.



ABBREVIATIONS DEFINITIONS

In this booklet, the term Healthcare Associated Infections (HAI) has been preferred to nosocomial infection or Hospital Acquired Infections as it is more global and concerns all types of healthcare settings.

- **CA-MRSA:** Community Acquired MRSA

- **ESBL:** Extended Spectrum Beta-Lactamase (*Enterobacteriaceae* producing)

- **MDRO:** Multidrug Resistant Organism

- **HAI:** Healthcare Associated Infection

- **HCW:** Healthcare Workers

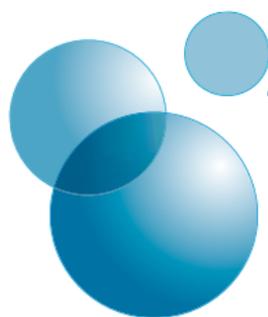
- **MRSA:** Methicillin Resistant *Staphylococcus aureus*

- **GISA:** Glycopeptide Intermediate *Staphylococcus aureus*

- **VRE:** Vancomycin Resistant *Enterococcus*

- **VISA:** Vancomycin Intermediate *Staphylococcus aureus*

- **VRSA :** Vancomycin Resistant *Staphylococcus aureus*



THE BIOMÉRIEUX PRODUCT OFFER*



Screening media:

chromID™ MRSA, chromID™ ESBL,
chromID™ VRE.

Environmental monitoring:

Count-Tact™, airIDEAL®3P.

Identification/Susceptibility testing:

API®, mini API®, VITEK® 2 and VITEK® 2 Compact.

Identification of main organisms responsible for HAI:

VIDAS® CDAB, VIDAS Rotavirus, VIKIA® Rota Adeno,
NucliSENS EasyQ® RSV.

Strain typing:

DiversiLab™.

Surveillance software:

Vigi@ct™, STELLARA™.

* Consult your local bioMérieux representative for further information and availability

09-11 / 010GB99018A / This document is not legally binding. bioMérieux S.A. reserves the right to modify specifications without notice / BIOMÉRIEUX, the blue logo, VITEK, VIDAS, VIKIA, API, miniAPI, VITEK 2, VITEK 2 Compact, chromID, NucleoSens, DiversiLab, STELLARA, Count-Tact, aiiDEAL and VIGlact are used, pending and/or registered trademarks belonging to bioMérieux S.A. or one of its subsidiaries / bioMérieux SA RCS Lyon 673 620 399 / Photos : C. GANET, Getty Images / Printed in France / **THERA Conseil** / RCS Lyon B 398 160 242

Empowering clinical decisions in the fight against HAI*

bioMérieux S.A.
69280 Marcy l'Etoile
France
Tel. : 33 (0)4 78 87 20 00
Fax : 33 (0)4 78 87 20 90

www.biomerieux.com



* Healthcare-Associated Infection