
FRENCH SOCIETY FOR HOSPITAL HYGIENE

www.sfhh.net

# NATIONAL GUIDELINES

# CROSS-CONTAMINATION PREVENTION: ADDITIONAL CONTACT PRECAUTIONS

## A FORMAL EXPERT CONSENSUS

## APRIL 2009

# SOMMAIRE / TABLE OF CONTENTS

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| Ab | *Acinetobacter baumannii* |
| ANAES | French National Agency for Accreditation and Evaluation in Health / *Agence nationale d'accréditation et d'évaluation en santé* |
| AN / *AS* | Auxiliary Nurse / *Aide-soignant(e)* |
| MDRO / *BMR* | Multi-Drug Resistant Organisms / *Bactéries multi-résistantes aux antibiotiques* |
| C-CLIN | Regional Nosocomial Infection Control Coordinating Centres / *Centres de coordination de la lutte contre les infections nosocomiales* |
| CLIN | A term which, in this document, designates the Committee for nosocomial infection control or the CME sub-committee in charge of NI control |
| CME | Hospital Medical Committee / *Commission médicale d'établissement* |
| CTINILS | Technical Committee for Nosocomial and Healthcare-Associated Infections / *Comité technique des infections nosocomiales et des infections liées aux soins* |
| NIHW / *DAOM* | Non-Infectious Hospital Waste / *Déchets assimilables aux ordures ménagères* |
| IW / *DASRI* | Infectious Waste / *Déchets d'activités de soins à risque infectieux* |
| ESBL / *EBLSE* | Extended-Spectrum BetaLactamase-Producing Enterobacteria / *Entérobactéries productrices de bétalactamase à spectre étendu* |
| EHPAD | Nursing Home for Dependent Elderly / *Établissement d'hébergement pour personnes âgées dépendantes* |
| ICT / *EOH* | Infection control team / *Équipe opérationnelle d'hygiène* |
| PPE / *EPI* | Personal Protective Equipment / *Equipements de protection individuels* |
| GRE / *ERG* | Glycopeptide Resistant Enterococci / *Entérocoques résistants aux glycopeptides* |
| ABHR / *FHA* | Alcohol-based handrub / *Friction hydro-alcoolique* |
| GISA / VISA | Glycopeptide/vancomycin intermediate S. Aureus / *Staphylocoques dorés intermédiaires aux glycopeptides/à la vancomycine* |
| HAS | French National Authority for Health (formerly ANAES) / *Haute autorité de santé* |
| RN / *IDE* | Registered Nurse / *Infirmier(ère) diplômé(e) d'état* |

| | |
|---|---|
| NI / *IN* | Nosocomial Infections or more formally, Healthcare-Related Infections / *Infections nosocomiales* |
| InVS | French Institute for Public Health / *Institut de veille sanitaire* |
| MO / *MO* | Microorganism / *Microorganisme* |
| MSO / *MCO* | Medicine-Surgery-Obstetrics (short term) / *Médecine chirurgie obstétrique* |
| Pa | *Pseudomonas aeruginosa* |
| ABP / *PHA* | Alcohol-based products (gel or solution) / *Produits hydro-alcoolique* |
| MRSA / *SARM* | Methicillin resistant *Staphylococcus Aureus* / *Staphylococcus aureus résistant à la méticilline* |
| CC / *SC* | Continuing care / *Soins continus* |
| IC / *SI* | Intensive care / *Soins intensifs* |
| LTC / *SLD* | Long-term care / *Soins de longue durée* |
| ECR / *SSR* | Extended care and rehabilitation / *Soins de suite et de réadaptation* |
| SU / *UU* | Single use / *Usage unique* |
| UV | Ultraviolet |

# GLOSSARY

| | |
|---|---|
| Invasive procedure | A procedure which requires penetrating into the body (by means of an incision, injection, or via natural orifices) |
| Cohorting | Grouping patients (geographically or spatially) or grouping health care delivered to a type or group of patients, who may sometimes require dedicated or minimally identified staff (organization) |
| Colonization | Presence of microorganisms with no clinical symptoms |
| Contaminant | Is said of a microorganism which has contaminated the sample or the culture medium |
| Invasive device | A device which partially or fully penetrates into the body; either through a natural orifice or through the body's surface<br>French Public Health Code (CSP), Annexes, Book 5bis: provisions pertaining to medical devices, Article, Annex IX to articles R665-1 to R665-47, I. definitions |
| Close patient environment | Relates to an environment susceptible to contamination by hand transmission: via the patient, care givers or visitors (e.g. bed, bedside table, overbed table, armchair, etc.) |
| Open anatomical site | Is said of an infected or colonized site in direct commun-ication with the open air |
| Closed anatomical site | Is said of an infected or colonized site when it is not in direct communication with the open air |
| Healthcare-related infection | An infection occurring during hospitalization or after patient discharge (for diagnosis, therapeutic, palliative, preventive or educational purposes) if it was neither present nor incubating at the beginning of hospitalization<br>CTINILS May 2007 - http://www.sante.gouv.fr |
| Infection | Illness/inflammatory process caused by a microorganism |
| Biological fluids | Blood or any other material of human origin (resulting e.g., from aspiration, endoscopy, operating procedures, autopsy, manipulation of soiled equipment or linen, etc.) |
| Surgical mask | For standardization purposes, medical masks such as "healthcare" masks and "surgical masks" will all be referred to as "surgical masks". These are class-1 medical devices which must fulfill the EN 14663 normative standard - http://www.sante.gouv.fr |
| Pathogen | A microorganism liable to cause an illness |

| | |
|---|---|
| Carriage | The presence of microorganisms with or without any clinical symptoms (with the patient being colonized or infected) - independent of the pathogen's power |
| MRSA-risk patients | Long-term central catheter carriers, liver-graft patients, etc. |
| Intensive care unit | A structure or unit for dispensing care to patients having or likely to have multiple acute circulatory, renal and respiratory organ failures, which may be life threatening and require the implementation of long-lasting replacement therapies such as mechanical ventilation, hemodynamic support, renal support therapy<br>Decree No 2002-465 of April 5th, 2002 pertaining to public and private health care institutions providing intensive care, which amends the public health code<br>DHOS/SDO Circular No 2003-413 of August 27th, 2003 pertaining to public and private health institutions with a critical care, intensive care and continuous care units |
| Protected units | A patient care unit in which the architecture, admission processes, organization, supplies and air processing systems contribute to the protection of patients from "hospital flora", or to the reduction of so-called "environmental" risks |
| Care with the risk of splattering and splashing | Care or manipulations, which expose to a splash and splatter risk or aerosolization of blood or any other material of human origin (resulting e.g., from aspiration, endoscopy, surgical procedures, autopsy, manipulation of soiled equipment or linen, etc.)<br>Circular No DGS /DH/98/249 of April 20th, 1998 pertaining to the prevention of contamination by infectious agents borne by blood or biological fluids to patients in health care institutions |
| Attentive care unit | A structure or unit for treating patients whose condition and treatment are likely to cause one or more life-threatening failures which require monitoring, or whose condition, following one or several life-threatening failures, is too severe or unstable to allow return to a conventional hospitalization unit<br>Decree No 2002-465 of April 5th, 2002 pertaining to public and private health care institutions with intensive care units, which amends the public health code<br>DHOS/SDO Circular No 2003-413 of August 27th, 2003 pertaining to public and private health care institutions with critical care, intensive care and attentive care units |
| Direct care | Patient care implying direct contact between the patient and the health care worker, independently of any "protection" (gloves, apron, over garments, etc.) |

| | |
|---|---|
| Critical care unit | A structure or unit for treating organ failures related to only one organ specialty<br>Decree No 2002-465 of April 5th, 2002 pertaining to public and private health care institutions with intensive care units, which amends the public health code<br>DHOS/SDO Circular No 2003-413 of August 27th, 2003 pertaining to public and private health care institutions critical care, intensive care and chronic care units |
| Clean care | Health care relating to intact skin other than in areas deemed to be contaminated (inter-digital spaces, armpits, perineum, etc.) |
| Serial care | A care organization method, whose principle is to repeat the same type of procedure (e.g., measuring constants, measuring capillary glycemia, morning samplings, preventative anticoagulant injection, etc.) |
| Health care involving wet / soiled linen | Dispensation of care, which considerably exposes the clothes of health care workers (e.g., during bed toilet, change of dependent patients or patients who suffer from profuse diarrhea, or have a surgical pack, etc.) |

# INTRODUCTION

At the same time as he was putting the final touches to the theory of spontaneous generation, in the XIXth century, Louis Pasteur showed that microorganisms were sources of infection, and that cross-contamination was one of their main modes of carriage: "What causes infection is none of this; it is the physician and his staff who carry the germ from a sick woman to a healthy one" (referring to causes of puerperal fever).

Vaccination and the discovery of antibiotics may have led to the illusion that the battle against microorganisms was won. This assumption did not take the ingeniousness of microbes into account, as was confirmed by the first penicillin-resistant staphylococci pandemic in the sixties ... just a few years after this treatment had become part of the therapeutic arsenal.

Because of the continuing misuse of antibiotics, bacteria have become multi-resistant, that is, sensitive to only a small number of antibiotics, which are normally active therapeutic agents. France thus faces an endemic situation regarding bacterial resistance to antibiotics, that of methicillin-resistant *Staphylococcus aureus* (MRSA) being at the forefront. In the nineties, various studies showed that this multi-resistance also concerned other bacteria: extended-spectrum betalactamase-producing enterobacteria, betalactamine-resistant enterococcus. Cross-transmission of micro-organisms (via the hands of health care workers or medical equipment) may thus originate from a patient infected by an infectious agent, which is not spontaneously contagious but may disseminate throughout the environment or from a patient who carries or excretes an infectious agent multi-resistant to antibiotics, and is known for its risk of epidemic dissemination.

The nosocomial infection control policy, launched already in 1998, established the fight against bacterial resistance to antibiotics as a priority. Programs have been established, whose two fundamental lines of action are the reduction in selective pressure through a rational use of antibiotics, and the prevention of cross-contamination.

In 1998, under the auspices of the Technical Committee on Nosocomial Infections (CTIN) and in cooperation with the French Society for Hospital Hygiene (SFHH), guidelines were published, under the title *Septic Isolation*[1], aimed at avoiding the transmission of an infectious agent, whether known or assumed, to non-infected and non-carrying but receptive individuals. These guidelines combine two levels of precaution: "standard precautions", to be applied whatever the patient's infectious condition, and "specific precautions" defined according to the infectious agent (sources of infectious agents, their transmission modes and resistance to the environment) and the infection itself (location and seriousness).

[1] CTIN-SFHH - Septic Isolation; recommendations for health care institutions. Ministry of employment and social affairs, 1998, 51 p. [http://www.sante-sports.gouv.fr/ IMG//pdf/recommandations_isolement _septique.pdf] (01/04/2009)

Application of these measures by professionals in health care settings with the help of the infection control teams has resulted, at least for MRSA, in an improvement in the situation, as shown by the results of the 2006 national prevalence survey (with more than 2300 responding institutions and nearly 400,000 patients surveyed, showing a 38% decrease in the prevalence of MRSA infected patients[2]).

Various factors prompted the National Technical Committee for Nosocomial and Healthcare-Associated Infections (CTINILS) to revise these cross-contamination prevention guidelines at the end of 2004, to include:

- a development of the basic measures, reflected in particular by the emphasis placed by the CTIN (Notice dated December 5th 2001[3] which takes the SFHH's guidelines on this matter into account [4]) on alcohol-based hand rubbing (ABHR) for hand hygiene;
- a change in patient management (development of ambulatory care, reduction in lengths of stay, increase in the number of patients at risk, and older patients requiring high-density healthcare, etc.);
- successive changes between different types of hospitalization for the same patient;
- referral to the French Institute for Public Health (InVS), as a consequence of emerging drug-resistant or highly virulent microorganisms, which could lead to the development of epidemics throughout the national territory.

The CTINILS commissioned the SFHH to update these guidelines and designated two of its members to participate in the working group in charge of this revision, whose task was to organize communication on the CTINILS' recommendations or guidelines on standard and "contact" precautions. It should be recalled that, at the same time, a similar reflection was initiated in the United States, leading to the publication of the North American guidelines in 2007[5], after more than two years of maturation.

The commissioning of this dossier with the SFHH is one aspect of the fight against healthcare-associated infections, which has now evolved:

- an increasing number of professionals now work in structures which specialize in the on-site management of infectious risks within health care settings, but more and more frequently they provide technical support in medical-social institutions

---

[2] THIOLET JM *et al.* Prévalence des infections nosocomiales (Prevalence of nosocomial infections), France, 2006. Bull Epidemiol Hebd 2007; (52-52): 429-431

[3] Notice of the National Technical Committed on Nosocomial Infections (CTIN) of December 5th, 2001, on "The role of hydro-alcoholic rubbing in hand hygiene when dispensing health care". Bull Epidemiol Hebd 2002; (8):35.

[4] FRENCH SOCIETY FOR HOSPITAL HYGIENE. Recommendations for hand hygiene. Paris, 2002, 22 p.

[5] Siegel JD *et al.* Guideline for isolation precautions: preventing transmission of infectious agents in health care settings 2007. CDC ed, Atlanta, 219 p. [http://www.cdc.goc/ncidod:dhqp/pdf/guidelines/ Isolation2007.pdf] (01/04/2009)

(through inter-institutional agreements): they must now foster these recommendations while providing information and training, a major challenge to their application;

- regional and inter-regional coordinating organizations (ARLIN and CCLIN) have become involved: they ensure that these guidelines reach their targets and provide them with the required methodological support.

SFHH's Guidelines Committee has defined the following principles for the actual conception of these guidelines:

- A Formal Expert Consensus should be organized (including the use of a DELPHI method) because of the large number of issues to be addressed and the limited number of studies providing a high level of evidence. This is a known methodology which, in particular, has been accepted by the French National Authority for Health (HAS);
- there should be a willingness to form the widest possible partnership with learned societies and professional groups, involved in the delivery of health care associated with high cross-contamination potential;
- the working method should be as "cross-disciplinary" as possible at each step (steering committee, work group, reading group), and should involve professionals from the hospital, medical-social and general practitioner worlds, whilst involving the CTINILS throughout the entire process.

These guidelines are intended to upgrade, on one hand the standard precautions, in view of the now prominent position of ABHRs in hand hygiene and, on the other hand, the additional contact precautions (including screening policy and decontamination strategies). One of the major turning points in the concept of cross-contamination prevention resides in the fact that the CLIN or the specialized sub-committee of the Hospital Medical Committee can now establish a prevention strategy by choosing between "standard precautions" only, and "standard precautions plus additional contact precautions", provided a given set of conditions is met.

The scope of these guidelines excludes recommendations specific to the "droplet" and "air" transmission modes, and those aimed at controlling the environment, which will be the subject of later documents whose drafting by the SFHH has just begun. Interventional procedures were left aside, since specific guidelines have been designed for these (Consensus Conference on the *Preoperative Infection Management* [*Gestion préopératoire du risqué infectieux*], SFHH, 2004[6] and Formal Expert Conference on *Air Quality in the Operating Theater* [Qualité de l'air au bloc opératoire], SFHH 2004[7]).The same was done for the microorganisms which are the subject of published or prevailing national guidelines, and for other pathogens such as *Clostridium difficile*.

---

[6] SFHH Preoperative infection management. Consensus Conference, March 5th 2004. [http://www.sfhh.net/telechargement/cc_risqueinfectieux_long.pdf] (01/04/2009)

[7] SFHH. Air quality in the operating theater. Experts Guidelines. [http://www.sfhh.net/telechargement/ recommandations_grair.pdf] (01/04/2009)

The drafting of this document, which ultimately has been entirely funded by the SFHH, has been completed thanks to the involvement of a representative group of motivated contributors (which is a factor in favor of optimal assimilation of these guidelines), and to the integration of a wide range of accumulated knowledge (this is the added value of the expert consensus).

# METHODOLOGY

The French Society for Hospital Hygiene (SFHH), which has promoted these guidelines, organized a formal expert consensus as part of a broad partnership, since the selected topics were essentially multidisciplinary. The Learned Societies, Federations, or Associations listed below were solicited in order to incorporate private practitioners and homecare services. Some of these institutions could not actively participate in this effort, but have confirmed their interest in the work performed so far.

**PARTNERS**

| | |
|---|---|
| AFC | Association Française de Chirurgie / *French Surgical Association* |
| BICS | *Belgian Infection Control Society* |
| CRM | Centres de Référence de la Mucoviscidose/*Cystic Fibrosis Reference Centres* |
| CRCM | Centres de Ressources et de Compétences de la Mucoviscidose (fédération nationale)/ *Cystic Fibrosis Reference Centres Resource and Competence Centres (National Federation)* |
| CTINILS | Comité Technique des Infections Nosocomiales et des Infections Liées aux Soins / *Technical Committee for Nosocomial and Healthcare-Associated Infections* |
| FNI | Fédération Nationale des Infirmières libérales / *National Federation of Private Nurses* |
| FNCLCC | Fédération Nationale des Centres de Lutte Contre le Cancer / *National Federation of Cancer Centres* |
| GPIP | Groupe de Pathologie Infectieuse Pédiatrique / *Paediatric Infectious Diseases Group* |
| ORIG | Observatoire du Risque Infectieux en Gériatrie / *Observatory for Infectious Risks in Geriatrics* |
| SFGG | Société Française de Gériatrie et Gérontologie / *French Society for Geriatrics and Gerontology* |
| SFM | Société Française de Microbiologie / *French Society for Microbiology* |
| SFP | Société Française de Pédiatrie / *French Society for Paediatrics* |
| SFAR | Société Française d'Anesthésie-Réanimation / *French Society for Anaesthesia-Critical Care* |
| SFR | Société Française de Radiologie / *French Society for Radiology* |
| SIHHF | Société des Infirmières et Infirmiers en Hygiène Hospitalière Française / *French Society of Hospital Hygiene Nurses* |
| SPILF | Société de Pathologie Infectieuse de Langue Française / *French Speaking Society for Infectious Diseases* |
| SRLF | Société de Réanimation de Langue Française / *French Speaking Intensive Care Society* |

The work as a whole was coordinated by Dr. Marie-Louise Goetz, President of the Steering Committee, Hervé Blanchard, Vice-President of the Organizing Committee, and Bruno Grandbastien, expert group Coordinator.

The literature search was conducted by Jacinthe Foegle (PH), Céline Hernandez (PH), Thierry Lavigne (MCU-PH), Gilles Nuemi (Intern) and Montaine Soulias (AHU).

The SFHH would like to thank the members of the Steering Committee, the expert group, the literature search group and the reading group, whose names are given in the following.

## STEERING COMMITTEE

| | | | | |
|---|---|---|---|---|
| Gilles Beaucaire | CTINILS | Physician, infectious diseases specialist | Pointe à Pitre | |
| Hervé Blanchard | SFHH | Physician, hygienist | Paris | Vice-President |
| Martine Erb | SIIHHF | Health care manager, hygienist | Lille | |
| Gaëtan Gavazzi | SFGG | Physician, geriatrician | Grenoble | |
| Marie-Louise Goetz | SFHH | Physician, hygienist | Strasbourg | President |
| Bruno Grandbastien | SFHH | Physician, hygienist | Lille | Expert group coordinator |
| Benoît Guery | SPILF | Physician, infectious diseases specialist | Lille | |
| Nadine Hesnart | FNI | Nurse | Paris | |
| Francis Joffre | SFR | Physician, radiologist | Toulouse | |
| Olivier Mimoz | SFAR | Physician, anesthetist | Poitiers | |
| Anne-Marie Rogues | SFHH | Physician, hygienist | Bordeaux | |
| Claude-James Soussy | SFM | Physician, microbiologist | Créteil | |
| Marie Thuong-Guyot | SRLF | Physician, resuscitator | Saint-Denis | |

## EXPERT GROUP

| | | | |
|---|---|---|---|
| Martine Cacheux | FNI | Private Nurse | Maignelay-Montigny |
| Corinne Coclez-Meyer | SIIHHF | Nurse, hygienist | Compiègne |
| Matthieu Eveillard | SFHH | Pharmacist, microbiologist and hygienist | Angers |
| Emmanuelle Girou | SFHH | Pharmacist, epidemiologist and hygienist | Créteil |
| Christine Lawrence | SFHH | Pharmacist, microbiologist and hygienist | Garches |
| Alain Lepape | SFAR | Physician, anesthetist | Lyon |
| Jean-Christophe Lucet | CTINILS | Physician, hygienist | Paris |
| Marie-Reine Mallaret | SFHH | Physician, hygienist | Grenoble |
| Nicole Marty | SFM | Physician, microbiologist | Toulouse |
| Didier Neau | SPILF | Physician, infectious diseases specialist | Bordeaux |
| Franck Raschilas | SFGG | Physician, geriatrician | Montpellier |
| Jean Sarlangue | GPIP and SFP | Physician, pediatrician | Bordeaux |
| Anne Simon | SFHH and BICS | Physician, hygienist | Brussels |
| Bertrand Souweine | SRLF | Physician, resuscitator | Clermont-Ferrand |
| Daniel Talon | SFHH | Physician, hygienist | Besancon |
| Danielle Velardo | FNCLCC | Health care manager, hygienist | Villejuif |
| Benoît de Wazières | SFGG and ORIG | Physician, geriatrician | Nîmes |

## LITERATURE GROUP

| | | |
|---|---|---|
| Jacinthe Foegle | Physician, hygienist | Strasbourg |
| Céline Hernandez | Biologist doctor and hygienist | Strasbourg |
| Thierry Lavigne | Physician, hygienist | Strasbourg |
| Gilles Nuemi | Physician, public health | Dijon |
| Montaine Soulias | Physician, hygienist | Dijon |

## READING GROUP

| | | | |
|---|---|---|---|
| Serge Alfandari | | Physician, hygienist and infectious diseases specialist | Tourcoing |
| Odile Arimane | SIIHHF | Health care manager, hygienist and risk manager | Lille |
| Pascal Astagneau | CCLIN Paris-North | Physician, hygienist | Paris |
| Gabriel Bellon | CRM, French Society for Cystic Fibrosis | Physician, pediatrician | Lyon |
| Chloé Bernard | | Health care manager in pediatrics | Paris |
| Philippe Berthelot | SFHH | Physician, hygienist | Saint-Étienne |
| Stéphanie Bordes-Couecou | | Physician, hygienist | Bayonne |
| Christian Brun-Buisson | | Physician, resuscitator | Creteil |
| Anne Carbonne | CCLIN Paris-North | Physician, hygienist | Paris |
| Pascale Chaize | SIIHHF | Health care manager, hygienist | Montpellier |
| Catherine Chapuis | CCLIN South-East | Physician, hygienist | Lyon |
| Lénaïg Daniel | CCLIN West | Nurse, hygienist | Brest |
| Véronique Denizot | CCLIN East | Health care manager, hygienist | Besancon |
| Evelyne Gaspaillard | SIIHHF | Health care manager, hygienist | Saint-Brieux |
| Hervé Haas | GPIP and SFP | Physician, pediatrician | Nice |
| Joseph Hajjar | SFHH | Physician, hygienist | Valence |
| Fabienne d'Halluin | SIIHHF | Health care manager, hygienist | Lille |
| Vincent Jarlier | | Physician, microbiologist | Paris |
| Olivier Jonquet | SRLF | Physician, resuscitator | Montpellier |
| Benoist Lejeune | CCLIN West | Physician, hygienist | Brest |
| Didier Lepelletier | SFHH | Physician, hygienist | Nantes |
| Jacques Merrer | | Physician, hygienist | Poissy-Saint-Germain en Laye |
| Christian Meyer | AFC | Surgeon | Strasbourg |
| Claudine Mocco | | Health care manager, hygienist | Pointe-à-Pitre |
| Etienne Nerzic | | User representative | Nantes |
| Pierre Parneix | CCLIN South-West | Physician, hygienist | Bordeaux |
| Bruno Pozzetto | | Physician, microbiologist | Saint-Étienne |
| Christian Rabaud | CCLIN East | Physician, infection diseases specialist | Nancy |

The drafting of expert recommendations, similarly to the Consensus Conferences, requires that a strict methodology be followed, as described below. The selected methodology is similar to that used by the French Speaking Critical Care Society (SRLF) in its work to establish "formal expert recommendations"[8], itself largely inspired by the "Adapted Nominal Group" technique developed by the *Rand Corporation* and the California University in the United States[9]. This methodology was adapted, to bring it in line with the "Formal Expert Consensus" method designed by the French National Authority for Health[10].

A multidisciplinary steering committee, involving each partner learned society, which oversees the proper implementation of the project until the guidelines are published, nominated the project's coordinator (Marie-Louise Toetz) and the senior expert for the expert groups (Bruno Grandbastien). The steering committee's task was to delineate the topic, to define the relevant fields, to designate and assign experts into three subgroups, ascribing one field to each of these, and to designate their group leaders; it also defined their work schedule.

The experts designated by the steering committee were also members of the various partnering learned societies. They were assigned to work subgroups, and were assigned the task of addressing, whenever possible, the issues raised by the steering committee for each of the relevant fields. This step took place in a plenary session.

Groups were organized as follows:

- The "**Definition and scope of standard precautions"** Group

  Martine Cacheux, Corinne Coclez-Meyer, Christine Lawrence, Anne Simon (group leader), Benoît de Wazières.

- The "**Screening"** group

  Matthieu Eveillard, Jean-Christophe Lucet (head person), Nicole Marty, Franck Raschilas, Daniel Talon.

- The "**Modalities and scope of additional precautions"** group

  Emmanuelle Girou, Alain Lepape, Marie-Reine Mallaret (head person), Didier Neau, Bertrand Souweine, Danielle Velardo.

---

8 SAULNIER F, BONMARCHAND G, CHARBONNEAU P *et al.* Méthodologie pour l'élaboration des recommandations d'experts. [Methodology for drafting expert recommendations]. Rea Urg 2000; 9: 398-403.

9 Jones J, Hunter D. Consensus methods for medical and health services research. Br Med J 1995; 311: 376-380.

10 Bases méthodologiques pour l'élaboration de recommandations professionnelles par consensus formalisé : Guide méthodologique [Methodological basis for establishing professional recommendations through formal consensus: a methodology guide]. HAS, January 2006, 37 p.

## SCOPE OF THE RECOMMENDATIONS

The work conducted for drafting these recommendations examined the status of contact and additional precautions in any given health care institution or setting, including homecare.

The targeted microorganisms *a priori* exclude those which are emerging (glycopeptide-resistant Enterococci...), since these microorganisms are subject to national recommendations already published or in use, and were thus excluded from the scope of the present recommendations. The same comment applies to other pathogens such as *Clotridium difficile*.

- General policy for cross-contamination control
- Status of standard precautions and hand hygiene
    - What measures should be taken to prevent transmission of a microorganism to a patient under all circumstances, whatever his/her infectious condition and whether or not the latter is known?
    - And how can patient / caregiver transmission be avoided?

This aspect integrates the organization of care provision as well as the assimilation of hygiene rules by all professionals and health care workers who come into contact with patients.

- A specific policy for cross-transmission of certain microorganisms is established for patients with identified infectious risks, taking into account the epidemiology and the transmission modes of the MO.
    - What are the screening methods, depending on the microorganism, its transmissibility and the hospitalization unit?
    - What is the status and what are the methods to be used when decontamination is performed?
    - What are the auxiliary measures to be introduced, in addition to standard precautions? For which germs (including multidrug-resistant organisms (MDRO)), and under what circumstances?
    - When can these additional precautionary measures be lifted?

These points account for all aspects applicable to any hospital setting, together with the occasional application specificities of certain types of institution or specialty (psychiatry, extended care and rehabilitation, long-term care, pediatrics, nursing homes for dependent elderly, ...), and include the specificities of certain sectors (conventional hospitalization, ambulatory care, accommodation, pre-hospital care...).

## LITERATURE SEARCH

A literature search was conducted, following the formation of a literature search group. The results were made available to the experts and the steering committee members. The literature search strategy is provided in an annex.

## METHODOLOGY

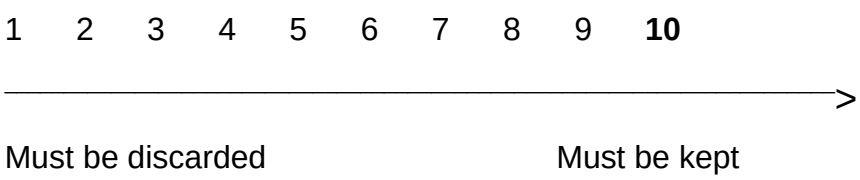
The experts analyzed data found in the literature using analysis tools and recommendation levels, and tried to identify, for each article, any conflict of interest (such as industry-backed studies).

The recommendation rating system described by the French National Agency for Accreditation and Evaluation in Health (ANAES) was selected for this work[11].

Based on this analysis, the experts drafted a list of principles (together with the relevant bibliographical references) for each issue raised in a given field. Each part of this list was accompanied by recommendations, which were rated by all of the experts.

A group manager, who is a person skilled in the art and recognized by his peers, coordinated each sub-group of experts, who worked independently. The group manager was responsible for, and managed each sub-group. Each subgroup manager sent his/her list of principles and final recommendation proposals to the project coordinator and the senior expert. The results of this work was presented, enriched and validated in a plenary session before any further rating.

On the basis of this data, the senior expert and project coordinator formally drafted a "global questionnaire" which was then sent to all experts of each sub-group, for an initial individual rating. This took place outside any plenary session. All experts used the Delphi method[12] with the same rating scale.




The analysis involved three intervals: 1 to 3 = negative agreement, 4 to 6 = uncertain, 7 to 9 = positive agreement. The proposed recommendations, rated between 1 and 3, or between 7 and 9, by nearly all experts (with a 10% margin with respect to the expressed

[11] National Agency for Evaluation in Health. Guidelines for analyzing literature and rating recommendations [Agence nationale pour l'évaluation en santé. Guide d'analyse de la littérature et gradation des recommandations]. ANAES, Paris, 2000.

[12] Dalkey NC. The Delphi method: an experimental study of group opinion. RM-5888-PR. Santa Monica:Rand Corp, 1969.

ratings), were selected as being indicative of a **strong positive agreement** (7 to 9) or a **strong negative agreement** (1 to 3). All other recommendations were discussed in a plenary meeting of the expert group, in the presence of the steering committee members, in order to clarify the arguments contributed by the relevant subgroups. It was then possible to reformulate and finalize these recommendations.

A second rating round was then proposed, which was restricted to the latter recommendations only.

The same rating tool was used for each step. Similarly, the analysis identified those recommendations leading to a **strong negative agreement** or a **strong negative agreement**. The recommendation proposals whose median rating fell in the range between 1 and 3 or 7 and 9 were retained as being indicative of a **moderate positive agreement** (7 to 9) or a **moderate negative agreement** (1 to 3), respectively. All other recommendations were classified as "non-consensual".

During the drafting work, negative recommendations were formulated positively each time it was possible and their meaning was not changed.

The statistical treatment of the ratings as a whole was supported by the Public Health Department of Lille University (Bruno Grandbastien).

### RATED RECOMMENDATIONS

Three hundred and seventy seven initial drafts were rated in the first round. Sixty of these were retained immediately (strong agreement from the outset). Among the 317 drafts needing reassessment, grouping, splitting and reformulations were used to improve their content. Thus, 326 recommendation proposals were sent for a new rating. Among these, 161 were rated as corresponding to a "strong agreement", and 110 to a "moderate agreement". All of the elementary rated recommendations leading to agreement (either strong or moderate) were grouped into 118 final recommendations.

These are presented in combination with the experts' agreement level (SA for strong agreement, and MA for moderate agreement). The 55 proposals which did not lead to any consensus have been grouped at the end of each chapter, in a section entitled "Aspects for which no consensus could be found".

It should be recalled that:

- a "moderate agreement" reflects a lack of unanimity between experts, but does not invalidate the recommendation itself;
- certain recommendations are formulated negatively, in which case they relate to measures considered to be unnecessary.

## THE READING GROUP

The draft of the 118 final recommendations (and non-consensual matter) was sent to a reading group.

Thirty eight readers were proposed by the partner learned societies, as well as by other learned societies, federations or institutions acting as representatives of those professionals who did not wish to participate in the upstream part of the process (French National Federation of Associations of Managers of Homes and Services for the Elderly [FNADEPA / *Fédération nationale des associations des directeurs d'établissements et de services pour personnes âgées*]) ... the five C-CLINs (managers, medical and paramedical professionals who they had designated in each of the five inter-regions), and opinion leaders. Twenty-eight of them actively participated in this reading step. Their reading, which focused on the understandability and feasibility of the recommendations, was synthesized in the form of a rating tool with scores ranging from 1 (no) to 9 (yes), with supportive references when available. This step was accompanied by a methodology notice. From the 28 responding readers, 26 used the tool provided.

During specific drafting meetings, the leaders of the expert sub-groups were able to discuss issues, and to choose whether or not to integrate comments made by the reading group in view of the final drafting step.

To facilitate reading, a glossary of technical terms is provided. When a word from the glossary is used in this document it is marked with an asterisk.

## PERSPECTIVE

While this expert conference answered many of the issues raised, uncertainties still remain, which will require either further research or further development.

# RECOMMENDATIONS

## PREAMBLE

Because of the emerging microorganism strains which are resistant to antibiotics or highly virulent, leading to epidemics across the national territory, on request from the InVS, the CTINILS commissioned the SFHH to update the existing recommendations related to the prevention of cross-transmission of infectious agents in health care settings.

The object of these recommendations is both to update the standard precautions, which must now account for the place occupied by ABHRs in hand hygiene, and the additional contact precautions.

In the text of these recommendations, “CLIN” refers to the Committee for the Nosocomial Infection (NI) Control of private institutions, and to the sub-commission of the Hospital Medical Committee (CME) responsible for controlling NI in public institutions. Similarly, the term “Infection-Control Team” (ICT/*EOH*) refers to the structure (Department, Functional unit...) in charge of the operational implementation of the healthcare-associated infection control policy.

Those words followed by an asterisk (*) can be found in the Glossary.

For each recommendation listed below, an agreement level is specified (strong agreement-SA, moderate agreement-MA) after each recommendation, or after each item contained by the same recommendation when each of the items has been rated separately. Those aspects for which no expert consensus could be reached are grouped at the end of each chapter.

The following aspects should be recalled:

- A “moderate” agreement reflects a lack of expert unanimity, but does not invalidate the recommendation itself;
- Certain recommendations are formulated negatively, in which case they relate to measures considered to be unnecessary.

## 1 GENERAL POLICY

**R1:** Standard precautions always apply to all patients; additional precautions are complementary to these.

It is thus highly recommended to use the term “additional contact precautions” (**SA**).

**R2:** It is highly recommended to adjoin additional contact precautions to the standard precautions for patients who carry emerging microorganisms with a high cross-contamination potential, typically Glycopeptide-Resistant Enterococci (GRE/*ERG*),

*Clostridium difficile*, and Extended-Spectrum BetaLactamase-Producing Enterobacteria (ESBLPE/*EBLSE*) ... (**SA**). Certain microorganisms are subject to national recommendations.

**R3:** The CLIN may define the strategy for preventing cross-contamination in the range between "standard precautions" only and "standard precautions plus additional contact precautions", provided all of the following conditions are met:

- close proximity of alcohol-based hand rub products (ABP) to health care provision,
- high hand hygiene compliance, as measured by a large number of observations,
- high ABP consumption level, with product availability in each service,
- high proportion of ABP hand rubbing and hand hygiene practice,
- extensive use of gloves,
- strong expertise/experience of the ICT/*EOH* and CLIN,
- sound knowledge of microbial epidemiology, based on screening samples (notion of prevalence). (**MA**)

→ There is no consensus on any given strategy which relies on "standard precautions" only, or which combines "standard precautions with additional contact precautions", whether the whole institution, or only one or more units of this institution are concerned.

---

With regard to, and as an example of quantitative values, a high ABP consumption level could be chosen as the customized objective of at least attaining the specified national index of ABP consumption.

# 2 STANDARD PRECAUTIONS

**R4:** It is highly recommended to use an ABHR (Alcohol-Based Hand Rub) instead of hand washing (using a mild or antiseptic soap) when there is no visible soiling of the hands. (**SA**)

**R5:** It is highly recommended to perform an ABHR (**SA**):

- immediately before any direct contact with a patient,
- immediately before providing any clean care or beginning any invasive procedure,
- inbetween contaminating care and clean care, or an invasive procedure with the same patient,

- following the last direct contact or care provided to a patient,
- before putting on gloves for the purpose of providing care,
- immediately after health care gloves are removed,
- after any accidental contact with biological fluids* (blood, feces, urine, ...); in such a situation, ABHR should be preceded by washing with a mild soap.

In case of BBFE, specific recommendations apply.

**R6:** It is highly recommended to choose non-powdered, latex-free health care gloves. (**SA**)

**R7:** It is highly recommended (**SA**):

- not to wear gloves when in contact with intact skin,
- to wear gloves for procedures which expose the user to a risk of contact with blood, biological fluids*, mucosa or non-intact skin,
- to change gloves between patients,
- to remove gloves after use and before touching surrounding objects,
- to remove gloves when moving from a contaminated site to a clean site of the body, or when moving from one contaminated site to another, in a sequence of procedures carried out on the same patient.

**R8:** There is a strong agreement between experts in considering that entering a patient's room is not in itself an indication for applying a hand hygiene procedure (**SA**).

**R9:** It is highly recommended to suggest making use of ABHR in the circumstances listed under R5: (**SA**)

- in any health care setting (hospital and accommodation wards, technical support centers, private practices of all types of health care workers, home or home staff substitute...),

**and**

- for all health care workers,
- for internal and external health care providers in hospital or accommodation settings, whether voluntary or other professionals (assistant housekeeper, care assistant, ...),
- for visitors and families when they are involved (or associated) with the care provided.

**R10:** It is highly recommended that patients admitted to an hospitalization or collective accommodation institution should apply a hand hygiene procedure before entering a public room (restaurant, rest area, technical center and rehabilitation room, games room, ...) (**SA**)

**R11:** It is highly recommended to wear short-sleeved professional clothing for care given in a hospital setting or when providing care in an institution.

For care given in civilian dress (home, ambulatory, ...), it is highly recommended to keep the forearms free (except for care with the risk of fluid splashing*). (**SA**)

**R12:** It is highly recommended, in order to efficiently perform a hand hygiene procedure: (**SA**)

- not to wear any false fingernails or jewelry (including watches and wedding rings) when in direct contact with patients,
- to keep fingernails short (with a free nail tip of less than 5 mm),
- to keep fingernails free of nail polish.

**R13:** It is highly recommended, when the hands are visibly soiled, to perform simple hand washing followed by ABHR once the hands have been properly dried. (**SA**)

**R14:** It is highly recommended to no longer use antiseptic scrubs (antiseptic soaps) in the context of standard precautions. (**SA**)

**R15:** It is highly recommended not to perform glove rubbing or glove washing. (**SA**)

**R16:** It is highly recommended that all rooms, whatever the hospitalization or accommodation unit (critical care, general medicine, surgery, ECR, LTC, Nursing Homes for the Dependent Elderly [*EHPAD*]...) be provided with a water outlet, to allow, *inter alia*, washing of the hands. (**SA**) This water outlet should then comprise: (**SA**)

- a sink,
- a mild liquid soap dispenser,
- a disposable paper towel dispenser,
- a lidless rubbish container.

**R17:** It is highly recommended to provide ABPs within easy access. If the dispensers are installed too far away, it is highly recommended to install an additional dispenser as close to the care location as possible. (**SA**)

**R18:** It is highly recommended that access to ABPs be adapted to the various situations encountered, with pocket flasks made available for: (**SA**)

- health care workers who must provide care in several units of a given institution, (physiotherapists, radiology technicians ....),
- other persons who are required to meet several patients (religious ministers, voluntary workers, ...),
- visits and care given at home,

and in any other place where care is dispensed: (**SA**)

- workstations in technical support centers (imagery, dialysis, ...),
- private care and consulting practices,
- emergency cubicles,
- rehabilitation rooms (in close proximity to hardware and equipment),
- health care transport.

**R19:** It is highly recommended to assess situations in which the provision of ABPs could present a risk, if these were accessible to patients, and to use individual flasks (or pocket flasks) of ABP intended for health care workers tending patients at risk of devious or accidental use of these products (alcohol addiction, dementia patients, pediatrics...). (**SA**)

**R20:** It is highly recommended, in the context of standard precautions, not to discard flasks of ABP, which were opened at the time of a patient's discharge from the ward where he/she was hospitalized or accommodated. (**SA**)

**R21:** It is highly recommended to include practical training to reduce the risk of dermatitis, irritation and other skin lesions related to hand hygiene procedures in the curriculum of health care professionals. (**SA**)

In case of a declared intolerance to substances usually employed in the institution, it is highly recommended to investigate the conditions under which the ABHR procedure was performed and provide alternative ABPs. (**SA**)

It is highly recommended to make protective lotions or creams available to the relevant professionals. (**SA**)

**R22:** It is highly recommended to actively promote the use of ABPs in any health care setting. (**SA**)

**R23:** It is highly recommended to encourage the involvement of patients and families in order to promote hand hygiene during health care provision. (**SA**)

**R24:** It is highly recommended for health care workers to systematically wear an anti-splash mask with safety goggles, or a face piece intended for care with a risk of blood or biological fluid splashing*. (**SA**)

The same applies to visitors who are involved with care dispensing. (**SA**)

**R25:** When a patient suffers from a supposedly infection-related cough, it is highly recommended to have him/her wear a surgical mask*: (**SA**)

- at the time of admission to a health establishment or when moving around in his/her hospital room while care is provided,
- in the case of home care,

when he/she is in close proximity (less than 1 meter) to other people not wearing an appropriate mask.

**R26:** It is highly recommended to wear a over-gown to protect one's clothing when providing care likely to: (**SA**)

- involve soiling*,
- involve splattering and splashing*,
- lead to exposure to blood or biological fluids*.

**R27:** It is highly recommended, for the protection of professional clothing, to choose: (**SA**)

- a disposable plastic apron (without sleeves) when dispensing care leading to body fluid splatter or splashing,
- a disposable long-sleeve and impervious gown for major exposures to biological fluids.

It is highly recommended to change this protection: (**SA**)

- after a care provision sequence,
- before tending to another patient.

It is highly recommended not to use a disposable gown. (**SA**)

**R28:** It is highly recommended not to use overshoes, in any hospital unit (including critical care, IC, CC and protected units). (**SA**)

This recommendation does not apply to interventional units such as the operating theaters (outside the scope of all recommendations disclosed here).

**R29:** It is highly recommended not to use adhesive mats, in any hospital unit (including critical care, IC, CC* and protected units*). (**SA**)

**R30:** It is highly recommended that visitors and family perform ABHR gestures: (**SA**)

- before entering high risk hospitalization units (critical care, intensive care, continuous care* and protected units*),
- after visiting high risk hospitalization units (critical care, intensive care, continuous care* and protected units*).

**R31:** It is highly recommended that visitors do not wear any protection over their civilian clothes when visiting patients in any hospital unit (including critical care, intensive care, and continuous care*). (**SA**)

This recommendation does not apply to protected units* where immunosupressed patients are hospitalized under protective isolation.

"Visitor" includes voluntary workers, service providers, and the like, which are likely to be involved with several patients and whose status is equivalent to that of health care workers (see R9).

**R32:** It is highly recommended to: (**SA**)

- favor a globalized organization of health care for the same patient and to avoid any serial care*,
- prioritize care provided to the same patient, from the cleanest to the most contaminating.

**R33:** It is highly recommended to favor the use of equipment dedicated to a single patient. (**SA**)

**R34:** It is highly recommended to reduce the amount of stored equipment and not to systematically discard consumables that are not used and stored in rooms at the time of patient discharge, including disposable equipment kept in sealed packages in the context of standard precautions. (**SA**)

**R35:** It is highly recommended to: (**SA**)

- make a protocol available, describing the alcohol-based hand rubbing (ABHR) technique,

- teach this protocol during the initial training of health care professionals, as well as in continuous education programs, with particular focus being placed on the technical and time compliance aspects,
- assess the ABHR technique whilst respecting each of the steps involved.

**R36:** For training/awareness purposes, it is highly recommended to use a system to verify, on users' hands, that the ABHR technique has been correctly implemented. (**SA**)

For example, it is possible to use devices equipped with a UV lamp, following the use of an ABP to which a fluorescent chemical has been added.

**R37:** It is highly recommended, in each institution, to organize a strategy enabling the appropriate adaptation of hand hygiene, to the level of risk, to be verified through: (**SA**)

- regular assessments (preferably annually) in which the observance of hand hygiene and the observance of the correct use of gloves are audited,
- regular assessments (preferably annually) in which the quality of the hand hygiene procedures is audited,
- regular assessments (if possible, annually) of the personnel's knowledge of the indications for hand hygiene procedures,
  - to be associated with feedback to the health care teams.

**R38:** It is highly recommended, in addition to the alcohol-based solution consumption index (ICSHA index), for all health care institutions: (**SA**)

- to measure the consumption of ABPs in medical-social institutions (Nursing homes for the dependent elderly ...),
- to organize the ABP procurement/distribution system in order to monitor and prepare indicators adapted to the size of each team (unit, service, center,...),
  - whilst providing feedback to the institution (authorities,...) and to the teams (unit, service, center,...) on the ABP consumption level.

→ The following aspects did not lead to any consensus:

---

- Systematically performing an ABHR after removal of a mask,
- Performing an ABHR after any contact with the patient's immediate environment*,
- Provide a ABP dispenser close to the water outlet,
- Provide water outlets with indirectly controlled taps (activated by the elbow, knee, or a photoelectric cell ...).

# 3 SPECIFIC POLICY FOR THE CONTROL OF THE CROSS-CONTAMINATION OF CERTAIN MICROORGANISMS:

There are numerous situations, which can lead to the implementation of additional measures and which are often entwined with standard precautions. As a result of their pathogenic capability, some microorganisms must be considered in the same manner, whether or not they are found to be multi-resistant to antibiotics.

Amongst bacteria which are multi-resistant to antibiotics (MDRO), some have already been identified in national or local programs to combat nosocomial infections, as a result of their frequency, their commensal nature, consequences in terms of morbidity, or even mortality in the case of infection, and the potential risk of the spreading of resistance in the community, as in the case of MRSA and extended-spectrum betalactamase-producing enterobacteria (ESBLPE). They have been used as a model for cross-contamination control policies in many countries.

Other purely hospital, or health care related MDRO, such as *Pseudomonas aeruginosa* and *Acinetobacter baumannii* are essentially saprophytic species, which thus do not play a significant role in community infectiology. Their role is limited to hospitals and certain patients. It is occasionally amplified by difficulties in controlling the local environment. In addition, the selective pressure exerted by antibiotics plays a major role in the emergence and dissemination of *P. aeruginosa* resistance.

Certain MDROs can be responsible for infections that are difficult, if not impossible, to treat with antibiotics. Moreover, they are also taken into account in cross-contamination control policies. MDROs include mainly emerging microorganisms such as *Staphylococcus aureus* GISA/VISA and *Klebsiella pneumoniae* ESBLPE, resistant to carbapenems through the production of enzymes, and glycopeptide-resistant enterococci (GRE/*ERG*) … These microorganisms are dealt with by national recommendations, already published or in-print, and have been excluded from the domain of these recommendations. The same applies to other pathogenic agents such as *Clostridium difficile.*

## 3.1 Specific policy for the control of the cross-contamination of certain microorganisms: screening

### 3.1.1 Screening policy

**R39:** It is highly recommended that an epidemiological surveillance of infectious agents with a “high potential for cross-contamination”, including antibiotic multi-resistant bacteria (MDRO), be established. It is thus highly recommended that the occurrence of these microorganisms be regularly monitored, on the basis of clinical samples only. (**SA**)

**R40:** It is highly recommended that, in the context of the general policy for hospitals (cf. R3), the CLIN should:

- define those microorganisms justifying additional contact precautions (according to the prevalence of these microorganisms, hand hygiene compliance, and the type of activity … ),
- define a screening policy for these microorganisms, including MDROs, in agreement with national recommendations,
- regularly revise local screening policies.

**R41**: It is highly recommended to establish a screening strategy adapted to each health care unit. (**SA**)

The epidemiological situation in a service or a unit can justify a specific screening strategy. (**SA**)

In epidemic situations, it is highly recommended that the responsible microorganism be targeted by a screening strategy, no matter what its resistance phenotype. (**SA**)

**R42**: It is highly recommended to privilege the screening of infectious agents with a "strong potential for cross-contamination", including MDROs for which cross-contamination plays an essential role; the best example is methicillin resistant *Staphylococcus aureus* (MRSA). (**SA**)

Conversely, it is highly recommended not to privilege the screening of MDROs which are mainly dependent on selective pressure; the first examples of this type are, cephalosporinase hyper-producing enterobacteria (EBCASE). (**SA**)

**R43**: The screening of bacteria with multi-resistance to antibiotics (MDRO) is useful for the implementation of additional contact precautions. (**SA**)

**R44**: With the exclusion of epidemic situations, for all units (intensive care, ECR-LTC or MSO), weekly screening will be considered only if screening was carried out at the time of admission. (**SA**)

### 3.1.2 Microbiological screening targets

#### 3.1.2.1 MRSA SCREENING

The principle of screening (screening strategies, whatever their modalities) of patients for MRSA at the time of admission is important for all hospital units (intensive care, non-critical MSO, ECR and long-term stays). Its specific applications are itemized in the following, in the form of recommendations.

#### 3.1.2.1.1 MRSA IN INTENSIVE CARE UNIT

**R45**: At the time of admission to intensive care, it is recommended that:

- patients with a high risk of infection (in particular for chronic dialysis patients, long duration catheter wearers, and liver graft recipients) be screened for MRSA (**SA**)
- systematic screening for MRSA be used for patients:
  - in a recent epidemic situation, (**SA**)
  - in an established epidemic situation (endemo-epidemic situation); (**MA**)
- MRSA not be screened for:
  - in units with a low rate of MRSA incidence, in the absence of an epidemic or endemoepidemic situation, (**MA**)
  - in units where the bacterial ecology, known from a previous evaluation of carriage rate through the use of screening, has a low incidence rate, (**MA**)

**R46**: During their stay in the intensive care unit, provided screening was carried out at the time of admission (cf. R45), it is recommended that patients be regularly screened for MRSA. (**MA**)

**R47**: It is recommended that patients not be screened just before leaving intensive care. **(MA)**

#### 3.1.2.1.2 MRSA IN NON-CRITICAL MEDICINE-SURGERY-OBSTETRICS (MSO), INTENSIVE CARE UNIT EXCLUDED

If a screening policy were to be ordained by the CLIN, the conditions under which it would be executed are described in the following.

**R48**: In the absence of a recent or established epidemic situation (endemoepidemic situation) or if it has been established that the carriage rate is low, the principle of screening for MRSA in non-critical care MSO is not recommended. (**SA**)

**R49**: At the time of admission to non-critical MSO, screening of patients for MRSA is recommended in the following types of epidemic situations:

- recent, (**SA**)
- established (endemoepidemic situation). (**MA**)

This screening must be restricted to only those patients at risk of carrying MRSA*. (**MA**)

**R50**: During a stay in non-critical MSO, it is recommended not to regularly screen patients for MRSA. (**MA**)

**R51**: Just before discharge from non-critical MSO, in the absence of any recent epidemic situation, it is highly recommended not to screen patients for MRSA. (**SA**)

#### 3.1.2.1.3 MRSA IN EXTENDED CARE AND REHABILITATION (ECR)

If a screening policy were to be ordained by the CLIN, the conditions under which it would be executed are described in the following.

**R52**: It is recommended that patients be screened for MRSA upon admission to extended care and rehabilitation (ECR), in recent epidemic situations. (**SA**)

**R53**: At the time of admission to extended care and rehabilitation, it is recommended not to screen patients for MRSA:

- if it has been determined that the carriage rate is low, (**SA**)
- in the absence of a recent epidemic situation. (**MA**)

**R54**: It is recommended that screening for MRSA be restricted to only those patients at risk of carrying MRSA*. (**MA**)

**R55**: It is recommended not to screen patients for MRSA: (**MA**)

- who are still in the hospital,
- before their discharge from extended care and rehabilitation.

#### 3.1.2.1.4 MRSA IN LONG-TERM CARE (LTC)

If a screening policy were to be ordained by the CLIN, the conditions under which it would be executed are described in the following.

**R56**: It is recommended not to screen LTC patients for MRSA: (**MA**)

- at the time of their admission, (**MA**)
- during their stay, (**SA**)
- before their transfer to MSO. (**MA**)

#### 3.1.2.1.5 MRSA SCREENING TECHNIQUES

**R57**: It is recommended to screen for MRSA using a nasal swab and chronic cutaneous wounds. (**SA**)

#### 3.1.2.2 SCREENING FOR EXTENDED-SPECTRUM BETA-LACTAMASE PRODUCING ENTEROBACTERIA (ESBLPE)

The principle of screening (screening strategies, whatever their modalities) of patients for ESBLPE at the time of admission is important for all hospital units (intensive care, non-critical MSO, extended care and rehabilitation, and LTC). Its specific applications are itemized in the following, in the form of recommendations.

These may evolve in the future; specific recommendations for ESBLPE are being prepared under the auspices of the ***high council for public health***. It is planned to publish these in 2010.

**R58**: It is recommended not to screen patients for ESBLPE at the time of admission, for units in which it has been established that the carriage rate is low:

- in intensive care, (**MA**)
- in non-critical MSO, (**SA**)
- in extended care and rehabilitation, and LTC. (**MA**)

##### 3.1.2.2.1 ESBLPE IN INTENSIVE CARE UNITS

**R59**: At the time of admission to an intensive care unit, it is recommended:

- to screen patients for ESBLPE: (**SA**)
  - in situations of a recent epidemic,
  - in situations of an established epidemic, (endemoepidemic situation) involving an epidemic species or strain;
- not to screen patients for ESBLPE in situations other than those described above. (**MA**)

**R60**: It is recommended not to screen patients for ESBLPE just before their discharge from intensive care, or in the absence of, or as a complement to, prior screening. (**MA**)

##### 3.1.2.2.2 ESBLPE IN NON-CRITICAL MSO, INTENSIVE CARE UNIT EXCLUDED

**R61**: At the time of admission to MSO, it is highly recommended:

- to screen patients for ESBLPE: (**SA**)
  - in situations of a recent epidemic,
  - in situations of an established epidemic, (endemo-epidemic situation) involving an epidemic species or strain;
- not to screen patients for ESBLPE in situations other than those described above. (**SA**)

**R62**: It is recommended not to systematically screen patients for ESBLPE: (**MA**)

- during their stay,
- before their discharge.

#### 3.1.2.2.3 ESBLPE IN ECR UNITS

**R63**: At the time of admission to a ECR unit, it is recommended to screen all patients for ESBLPE:

- in situations of a recent epidemic, (**SA**)
- in endemoepidemic situations (established epidemic) involving an epidemic strain. (**MA**)

In the absence of such situations it is highly recommended not to screen ECR patients for ESBLPE: (**SA**)

- at the time of admission,
- during their stay
- before their discharge

#### 3.1.2.2.4 ESBLPE IN LTC UNITS

**R64**: it is recommended not to screen for ESBLPE:

- at the time of admission to LTC, (**MA**)
- during a patient's stay in LTC, (**SA**)
- before a patient's transfer to MSO. (**MA**)

#### 3.1.2.2.5 ESBLPE SCREENING TECHNIQUES

**R65**: It is highly recommended to screen for ESBLPE using a rectal swab. (**SA**)

It is not recommended to screen for ESBLPE using chronic cutaneous wounds. (**SA**)

### 3.1.2.3 SCREENING FOR *PSEUDOMONAS AERUGINOSA* (PA)

The principle of screening (screening strategies, whatever their modalities) of patients for *Pseudomonas Aeroginosa* at the time of admission is important in intensive care units. Its specific applications are itemized in the following, in the form of recommendations.

#### 3.1.2.3.1 SCREENING FOR *PSEUDOMONAS AERUGINOSA* IN INTENSIVE CARE UNITS

**R66**: It is recommended not to screen patients for PA in intensive care if it has been established that the carriage rate is low. (**SA**)

**R67**: It is recommended to screen patients for PA upon admission to intensive care:

- in situations of a recent epidemic (with the notion of clonality), (**SA**)
- in established epidemic or "endemoepidemic" situations involving an epidemic strain (with the notion of clonality). (**MA**)

**R68**: With the exception of epidemic situations, it is recommended not to proceed with regular PA screening of patients during their stay in intensive care. (**MA**)

**R69**: It is recommended not to screen patients for PA before their discharge from intensive care. (**MA**)

#### 3.1.2.3.2 SCREENING FOR *PSEUDOMONAS AERUGINOSA* IN NON CRITICAL MSO, INTENSIVE CARE UNIT EXCLUDED

**R70**: With the exclusion of characteristic epidemic situations, there is no indication for the PA screening of patients in non-critical MSO. (**SA**)

#### 3.1.2.3.3 *PSEUDOMONAS AERUGINOSA* TECHNIQUES

**R71**: It is recommended to screen for PA using a throat swab or tracheal aspiration (intra-tracheal device), and a rectal swab. (**SA**)

### 3.1.2.4 SCREENING FOR *ACINETOBACTER BAUMANNII* (AB)

The principle of screening (screening strategies, whatever their modalities) of patients for *Acinetobacter Baumannii* at the time of admission is important in intensive care and in non-critical MSO. In the absence of sufficient data and the low rate of incidence outside the intensive care units and some MSO units, the experts have not drawn up screening recommendations for ECR, and Long Term Care. The conditions for this type of screening are itemized in the following, in the form of recommendations.

**R72**: It is highly recommended not to screen patients for *Acinetobacter Baumannii* at the time of their admission to units in which the carriage rate is low. (**SA**)

- in intensive care units,
- in non-critical MSO units.

#### 3.1.2.4.1 SCREENING FOR *ACINETOBACTER BAUMANNII* IN INTENSIVE CARE UNIT

**R73**: It is highly recommended to screen patients for *Acinetobacter Baumannii (AB)* at the time of their admission to intensive care: (**SA**)

- in recent epidemic or endemoepidemic (established epidemic) situations, involving an epidemic species or strain,
- for patients with the risk of carriage (services, hospitals or countries in an epidemic or endemic situation),

Outside such situations (units with a low incidence of AB), it is recommended not to systematically screen patients for AB at the time of admission to intensive care. (**MA**)

**R74**: When screening has been carried out at admission, or for a patient with a risk of carrying *Acinetobacter Baumannii (AB)* (services, hospitals or countries in an epidemic or endemic situation), it is recommended to follow such patients during their stay in intensive care, by means of regular screening. (**MA**)

Outside such situations, it is highly recommended not to regularly screen patients for AB during their stay in intensive care. (**SA**)

**R75**: It is highly recommended not to screen patients for *Acinetobacter Baumannii (AB)*, in addition to weekly screening, just before their discharge from intensive care. (**SA**)

#### 3.1.2.4.2 SCREENING FOR *ACINETOBACTER BAUMANNII* IN NON-CRITICAL MSO, INTENSIVE CARE UNIT EXCLUDED

**R76**: It is recommended:

- not to systematically screen patients for AB at the time of admission to MSO, (**SA**)
- to restrict screening for AB in MSO to situations of a recent epidemic (**SA**), or only to those patients presenting a carriage risk (services, hospitals or countries in an epidemic or endemic situation). (**MA**)

**R77**: It is recommended not to regularly screen patients for AB during their stay in MSO units. (**MA**)

#### 3.1.2.4.3 *ACINETOBACTER BAUMANNII* SCREENING TECHNIQUES

**R78**: It is recommended to screen for PA using a rectal swab (**SA**), or a throat swab (**MA**).

→ The following aspects did not lead to any consensus:

---

- concerning fast screening techniques
  - from the current state of the art, there is insufficient data related to the use of fast screening methods for conclusions to be drawn on their usefulness;
- concerning specific indications for MRSA screening
  - restriction of MRSA screening to the admission to intensive care of patients with a MRSA carriage risk,
  - screening for MRSA at the time of admission to non-critical MSO, with the exclusion of situations listed in R49 (a recent or established epidemic);
- concerning the MRSA screening technique
  - use of rectal, throat, axilla or perineum swab;
- concerning the specific screening indications for extended-spectrum beta-lactamase producing enterobacteria (ESBLPE)
  - use ESBLPE screening at the time of admission to intensive care, limited to only those patients with a risk of ESBLPE carriage;
  - use regular ESBLPE screening of patients during their stay in intensive care
- concerning the ESBLPE screening technique
  - screening for ESBLPE using urinary or feces samples;
- concerning the Pseudomonas aeruginosa (Pa) screening technique
  - specific search for Pa in chronic wounds;
- concerning the Acinetobacter Baumannii (Ab) screening technique
  - specific search for Ab with an axilla or perineum swab;

### 3.1.3 Microbial decontamination

#### 3.1.3.1 MRSA DECONTAMINATION

The principle of collective decontamination of MRSA carriers (to prevent its dissemination) remains an unresolved issue, as to whether it should be based on indications, on the unit (intensive care, MSO, ECR, LTC), on the time (admission or discharge from the service), or even the context (in the case of a recent or established epidemic situation).

**R79**: It is highly recommended not to make use of antibiotics used in systemic treatments for the eradication of MRSA carriers. (**SA**) When the decision has been made to proceed with the eradication of MRSA carriers, it is recommended:

- in the first instance to use mupirocin, by means of a nasal application, (**SA**)
- to associate the patient's ablutions, using an antiseptic soap, with nasal decontamination. (**MA**)

**R80**: It is highly recommended to restrict decontamination to only those patients colonized by MRSA, in other words in the absence of positive clinical samples (wounds, cutaneous lesions, urine, tracheae … ). (**SA**)

**R81**: It is highly recommended to use individualized decontamination in patients carrying MRSA with a high risk of infection (in particular for chronic dialysis patients, long duration central catheter wearers, and liver graft recipients). (**SA**)

#### SCREENING FOR *ACINETOBACTER BAUMANNII* IN INTENSIVE CARE UNIT

**R82**: On the basis of current data, it is recommended not to attempt to eradicate ESBLPE from digestive carriage, through the use of non-absorbable or systemic antimicrobial agents, in a recent or established epidemic situation, in intensive care, or outside the intensive care units. (**MA**)

**R83**: It is highly recommended not to collectively treat (in order to prevent its dissemination) a ESBLPE urinary tract colonization (asymptomatic bacteriuria) through the use of systemic antibiotics.

## 3.2 Specific policy for the control of cross-contamination of certain microorganisms: additional contact precautions

It is important to recall the role of standard precautions and their implementation whenever additional contact precautions are recommended; these are supplementary to the standard precautions. The following recommendations must then be implemented in the principles described in R2 and R3.

### 3.2.1 Strategy

**R84**: Among the microorganisms described above, it is recommended that the following bacteria be considered to require contact precautions:

- Methicillin-resistant *Staphylococcus aureus* (MRSA), (**SA**)
- Imipenem-resistant *Acinetobacter baumannii* (IPM) (**SA**)
- *Acinetobacter baumannii* remaining sensitive only to imipenem (IPM), (**SA**)
- Extended-spectrum betalactamase producing enterobacteria (ESBLPE), (**SA**)
- Cephalosporinase-hyperproducing enterobacteria in neonatology, (**MA**)
- Imipenem-resistant *Pseudomonas aeruginosa* associated with other resistances. (**MA**)

However, it is not recommended to consider the following bacteria as requiring contact precautions:

- Negative coagulase staphylococcus (white staphylococcus) resistant to methicillin, (**SA**)
- Wild-type *Acinetobacter baumannii*, (**SA**)
- *Acinetobacter baumannii* (resistant to ticarcillin or to broader spectrum beta-lactamines), (**MA**)
- Cephalosporinase hyper-producing enterobacteria, outside neonatology, (**MA**)
- Wild-type, or isolated imipenem-susceptible *Pseudomonas aeruginosa*, (**MA**)

**R85**: It is highly recommended that the laboratory should explicitly mention (or notify) the identification of these prioritized bacteria (**SA**) and that a policy, for the reporting of patients carrying a bacterium justifying additional contact precautions, be defined by the CLIN or the institution (logo …). (**SA**)

**R86**: It is highly recommended to link the screening, if any, of prioritized microorganisms with the return of the analyses to the teams, and the implementation of additional contact precautions. (**SA**)

**R87**: Whenever microorganisms are identified, justifying additional contact precautions (cf. R84), it is highly recommended to apply these to intensive care and non-critical MSO patients. (**SA**)

**R88**: Whenever a decision is made to implement additional contact precautions, it is highly recommended to apply the same additional contact measures to the patient, whether he/she is infected or colonized:

- in intensive care, (**SA**)
- in non-critical MSO, (**MA**) or
- in ECR. (**MA**)

**R89**: When the implementation of additional contact precautions is envisaged, it is highly recommended to modulate these measures in ECR / LTC / Dependent Elderly Care patients, taking into account the psychological and social impact they may produce. (**SA**)

**R90**: If a patient with a microorganism justifying additional contact precautions is readmitted, it is highly recommended to implement: (**SA**)

- an immediate alert system,
- the same screening and additional contact precautions.

**R91**: It is highly recommended to inform the patient, the family, and the medical and paramedical correspondents of the positive outcome of a sample concerning a microorganism justifying additional contact precautions (including cases of carriage). (**SA**)

### 3.2.2 Measures to be implemented

#### 3.2.2.1 HAND HYGIENE

**R92**: In the context of additional contact precautions, it is recommended to apply 'alcohol-based hand rubbing' (ABHR):

- in all indications for hand hygiene, (**SA**)
- just before any contact with the patient, (**SA**)
- just before any sterile care or any invasive procedure, (**SA**)
- after any contact with the patient, (**SA**)
- after any accidental contact with biological fluids* (blood, feces, urine … ); in this situation 'ABHR' must be preceded by washing with a mild soap, (**SA**)

- following any contact with the close patient environment (**MA**)
- before leaving the room. (**MA**)

**R93**: As for the case of standard precautions (cf. R8), it is highly recommended to consider the fact that entering the room of a patient requiring additional contact precautions does not, alone, represent an indication for the use of a hand-cleaning procedure. (**SA**)

#### 3.2.2.2 WEARING OF GLOVES

**R94**: It is recommended not to systematically wear non-sterile gloves. (**SA**)

- when entering the room, (**SA**)
- before treating intact skin, (**SA**)
- before touching the immediate environment, (**MA**)

of a patient for whom additional contact precautions are applicable.

This recommendation does not take the specific problems related to the care of certain microorganisms into account, such as toxigenic *Clostridium difficile*, glycopeptide-resistant enterococci (GRE/*ERG*) … as indicated within the scope of these recommendations.

#### 3.2.2.3 PROTECTION OF CLOTHING

**R95**: It is highly recommended not to systematically wear specific protective clothing when entering the room of a patient requiring additional contact precautions. (**SA**)

**R96**: It is recommended to systematically wear a plastic disposable apron, as a specific form of protective clothing, whenever direct care of a patient is initiated requiring additional contact precautions. (**MA**)

#### 3.2.2.4 WEARING OF A MASK

The following recommendations relative to the wearing of a mask are fully justified in this chapter, which deals with additional contact precautions. They may, or course, be supplemented by specific recommendations for the prevention of “droplet” or “air” types of transmission.

**R97**: It is recommended that health care workers wear a disposable protective mask (surgical type) when tending to patients with a respiratory infection involving a microorganism, MRSA in particular, requiring additional contact precautions: (**MA**)

- when near to the patient, inside his/her room,
- in the case of direct treatment.

However, it is recommended not to wear such a mask:

- when entering the room,
- when the patient does not present with a symptomatic respiratory infection (**SA**), including the involvement of MRSA. (**MA**)

**R98**: It is highly recommended to have patients with an MRSA respiratory infection systematically wear a disposable protective mask (surgical type) whenever they leave their room. (**SA**)

It is recommended for patients, with a microorganism respiratory infection other than MRSA, and requiring additional contact precautions, to systematically wear a disposable protective mask (surgical type) whenever they leave their room. (**MA**)

#### 3.2.2.5 OTHER "BARRIER" PRECATIONS

**R99**: Whenever it has been decided to implement additional contact precautions, it is recommended to: (**MA**)

- systematically place patients carrying MDROs in a single room,
- group patients carrying the same MDRO in the same room or unit of a given service.

**R100**: It is recommended to assign dedicated health personnel to the care of a patient, for whom additional contact precautions are applicable, only in an epidemic situation not controlled by the initial measures, as for example defined for the control of GREs. (**MA**)

**R101**: It is recommended not to systematically confine to his room a patient able to walk, for whom additional contact precautions are applicable. (**MA**)

#### 3.2.2.6 ORGANIZATION OF TREATMENT BETWEEN PATIENTS, TAKING THE RISK OF INFECTION INTO ACCOUNT

For the purposes of preventing cross-contamination, and excluding all other considerations (privacy, quietness, personal choice of the patient … ), the closing of a patient's door does not contribute towards the efficiency of additional contact precautions.

**R102**: It is recommended to organise a patient's care, taking into account the risk of transmitting a microorganism justifying additional contact precautions. (**MA**)

**R103**: It is recommended to organise sectorized (cohorting) care for the paramedical teams (PN, AN … ) in an epidemic situation. (**MA**)

**R104**: It is highly recommended to systematically inform all actors, even occasionally involved in the care of a patient, for whom additional contact precautions are applicable. (**SA**)

**R105**: It is highly recommended to systematically inform the technical support centers which are involved (even occasionally) with, and units which provide care to a patient for whom additional contact precautions are applicable at the time of a transfer. (**SA**)

**R106**: It is not recommended to plan for the end of a health care sequence, or to use specific time slots for the surgical intervention, diagnostic or therapeutic examination in a medico-technical unit, of a patient for whom additional contact precautions are applicable, whenever appropriate cleaning and disinfection can be ensured following this intervention or examination. (**MA**)

**R107**: It is recommended not to forbid the use of collective toilets or showers to patients for whom additional contact precautions are applicable, including those who are carriers excreting microorganisms in their feces, whenever appropriate cleaning and disinfection can be carried out. (**MA**)

#### 3.2.2.7 MANAGEMENT OF MEDICAL DEVICES AND OTHER EQUIPMENT

**R108**: It is highly recommended to promote the individualization of reusable material in the room of a patient for whom additional contact precautions are applicable. (**SA**)

**R109**: As for the case of the recommendation concerning standard precautions (R34), it is highly recommended to restrict the storage of medical equipment, and not to systematically discard of the unused consumable items in the room of a patient, including any patient carrying a MDRO, for whom additional contact precautions are applicable. (**SA**)

**R110**: It is highly recommended not to make use of a specific treatment for the crockery, utensils and clothes used by a patient for whom additional contact precautions are applicable. (**SA**)

**R111**: Although it is required by the regulations, it is highly recommended not to consider as potentially infectious hospital waste (**PIHW**), material which can be likened to domestic waste (**NIHW**) produced by a patient for whom additional contact precautions are applicable. (**MA**)

It is recommended to eliminate from the room, several times a day, the NIHW of patients who are carriers of MDRO. (**MA**)

As a consequence of the nature of the microorganism involved, it is sometimes justified to eliminate certain NIHWs via the PIHW circuit; this is the case for example with the recommendations specific to *Clostridium difficile* infections.

**R112**: It is highly recommended not to decontaminate urine infected by MDRO, before its evacuation into the collective waste circuit. (**SA**)

**R113**: It is highly recommended not to carry out other (maintenance) treatments than those usually recommended for reusable medical devices, when these are used with a patient for whom additional contact precautions are applicable. (**SA**)

**R114**: It is highly recommended to remove any individual protective equipment before leaving the room of a patient justifying additional contact precautions. (**SA**)

#### 3.2.2.7 MANAGEMENT OF VISITS, MOVEMENT OF PEOPLE

**R115**: As for all patients (context of standard precautions), it is highly recommended that visitors of a patient, for whom additional contact precautions are applicable, apply a hand hygiene procedure (ABHR). (**SA**)

Apart from this hand-cleaning procedure, it is recommended not to request the visitors to apply the other precautions required of the health care workers. (**MA**)

**R116**: It is recommended not to forbid patients justifying additional contact precautions with respect to an open infectious site, access to the physiotherapy service and public living areas, but rather to accompany such access with specific hygienic measures. (**MA**)

This recommendation does not apply to hydrotherapy activities.

### 3.2.3 Lifting of additional contact precautions

**R117**: It is highly recommended to maintain the additional contact precautions throughout a patient's stay in a MSO unit. (**MA**)

If decontamination has been carried out, its efficiency must have been demonstrated (for example in the case of MRSA by means of at least two successive negative samples), before the additional contact precautions can eventually be lifted. (**SA**)

**R118**: During a stay in ECR-LTC units, it is highly recommended not to lift the additional contact precautions until such time as several negative screenings (for example in the case of MRSA, by means of at least two negative samples), have been carried out. (**SA**)

→ The following aspects did not lead to any consensus:

---

- concerning the definition of targets for additional precautions
  - whether to consider ceftazidime-resistant *Pseudomonas aeruginosa* to be a bacteria requiring additional contact precautions,
  - whether to apply additional contact precautions in the case of the identification of a microorganism corresponding to these indications, in LTC, nursing homes for the dependent elderly, or ambulatory or home healthcare.
- concerning the technical aspects of the implemented measures
  - whether, in the context of additional contact precautions, to make use of ABHR between two clean health care procedures with the same patient,
  - whether to make use of a disposable long-sleeved over-gown for the protection of clothing.
- concerning the organization of health care
  - whether to organize sectorized (cohorting) care for the medical and paramedical teams in non epidemic situations,
  - whether to restrict the number of visits to a patient for whom additional contact precautions are applicable.

# RATIONALE

Control strategies for the prevention of cross-contamination have evolved substantially in recent years. Numerous lessons-learned, new approaches, and new tools and techniques, such as the implementation of ABHR, and also new approaches to health monitoring (reporting of nosocomial infections) have led to progress in practices and perceptions.

The new national recommendations "Prevention of cross-contamination: contact precautions", produced in 2009 under the auspices of the French Society for Hospital Hygiene (SFHH = *Société française d'hygiène hospitalière)*, are based on the method of a formalized expert consensus, and rely on searching the literature for the analysis of risks, and on the evaluation and lessons-learned from the control of cross-contamination in health or medical institutions, or at the scale of transversal programs. Established scientific rationales are successively addressed, in support of the choice of a policy for the control of this cross-contamination, the justification of preventative measures in their "standard precautions" format and of organizational as well as technical measures, adapted to certain microorganisms, such as the screening strategy or the requirement (or not) to implement additional contact precautions.

## 1 PREVENTION OF CROSS-CONTAMINATION: "STANDARD PRECAUTIONS" VERSUS A "STANDARD AND ADDITIONAL PRECAUTIONS" STRATEGY

### 1.1 EPIDEMIOLOGICAL ASPECTS

The scientific data concerning the efficiency of measures used for the control of MDRO, and as a corollary the recommendations for the control of their dissemination, are imprecise for several reasons. In terms of hospital hygiene, the analysed unit is the hospital service and not the patient. As a consequence, it is difficult to conduct randomized studies, and impossible to make double-blind studies, as opposed to the case of the evaluation of a molecule. Most of the available studies are "quasi-experimental" or "before and after" studies, measuring the impact of a specific measure. These studies are difficult to conduct over periods of several years. Whenever the study is of short duration, i.e. less than two or three years, variations in the incidence of an infectious phenomenon can be attributed to the effects of the measure, but also to chance (notion of mean regression, in particular in the case of an epidemic phenomenon) or to causes external to the studied phenomenon, for example for cross-contamination, changes in the frequency of imported cases, of the environment (premises, infrastructure, …), of the health care workload, or even the use of antibiotics.

Although it is thus theoretically necessary to take these phenomena into account in the statistical analysis and adjustments, this is in fact rarely the case [1].

Some epidemiological methods (use of a control group), and in particular statistical methods (segmented linear regressions, chronological series) allow these uncertainties to be at least partially taken into account [2]. To offset such potential biases, more complex methods are proposed, in particular clustered multicentered trials, with cross-over. However these are expensive, difficult to implement, and are also not exempt from biases. Other factors make it difficult to conclude on the interest of a preventative measure:

- the epidemiological situation varies from one service to the other, and limits the generalization of a study's conclusions. These are often carried out in intensive care units, and do not enable conclusions to be drawn relevant to short-stay units, and even less for ECR or LTC.
- the preventative measures are rarely studied one by one, but are generally bundled, such that it is not possible to determine the individual impact of a measure. In addition, if a measure is tested individually, it may be efficient in itself, but can also modify the behaviour of the health care workers with regard to the other measures [3, 4];
- Above all, it is less the recommendations themselves than their observance, which is of importance: to take this phenomenon into account, poorly reproducible and time-consuming audits of practices would be needed. In respecting the measures, the impact of management and leadership is also crucial, although its measurement is difficult [5, 6];
- The audit of practices does not always assess the reality of the measures' observance. It is well known that the observation of a practice induces a change in the health care personnel's behaviour, which can vary from one audit to the next.

These uncertainties are at the origin of a heated debate between the supporters of a strategy for the control of MDRO, based partly on screening and contact precautions, and the defenders of a strategy based on standard precautions only [7-12]. These are also responsible for unharmonized recommendations [13,14].

## 1.2 IMPLICATIONS

The 1998 national recommendations for septic isolation, followed in 1999 by those for the control of cross-contamination [15], proposed to implement control strategies for risks of infection and available resources, as a function of the epidemiological situation. However, the recommended isolation precautions (now referred to as additional contact precautions) were identical for all services, with some adaptations for ECR or LTC. The introduction, in each healthcare institution, of personnel dedicated to the prevention of infections, and the improvement of expertise in infection control teams and the Nosocomial Infection Control Committee, over the past 10 years, should allow more flexibility in strategic trade-offs, adapted to each specific health care establishment.

A further aspect to be considered is the impact of additional precautions on the safety of patients. Some papers observe the occurrence of undesirable events in patients placed under additional contact precautions, with no possibility to eliminate factors other than the precautions themselves, for example the existence of comorbidities, to explain some of these events [16]. Finally, it is well established in the literature that the patient-staff ratio, as well as the staff's qualification level, are significant factors in terms of risk of infection [17,18]. This aspect lies outside the framework of these recommendations, but may be taken into account in the choice between “Standard precautions alone” and “Standard precautions + Contact precautions”. One could indeed imagine, although it has not been demonstrated, that precautions targeting certain bacteria might lead to limitations in the standard precautions applied to other patients [19]. Conversely, it would appear that, in other circumstances, the choice of precautions targeted at certain MDRO could contribute towards improvements in the general level of hygiene [20]. The choice between one strategy and another must take into account the eventuality of effects, which are induced, complex, and probably variable, from one health care establishment or service to another.

## 1.3 DATA FROM THE LITERATURE

In a literature review published in 2004 [21], Cooper listed 4382 abstracts dealing with efficiency and additional precautions in the control of methicillin-resistant *Staphylococcus aureus* (MRSA). This author analysed 245 studies in greater detail, thereby retaining only 46, published between 1996 and 2000: none of these were randomized, and only four of them were prospective, including the application of preventative measures during phases predefined at the beginning of the study. Six studies formulated clear conclusions (Table 1).

Following this analysis, Cooper concluded on the global methodological inadequacy of studies dedicated to the efficiency of additional precautions for the prevention of the dissemination of MRSA: presence of numerous biases, absence of an evaluation of the observance of the implemented hygiene measures, influence of additional precautions, which is difficult to differentiate from that resulting from other simultaneously implemented measures (screening, cohorting …). He recommended that further studies be conducted, with more robust methodologies, and that the implemented recommendations continue to be applied, until such time as the results of more rigorous studies become available.

Since this study, several papers have enhanced this view of the situation. Some of these are described in detail in the introduction to the chapter concerning screening (see Chapter 3).

Nijssen found no case of MRSA acquired over a period of 10 weeks, in an intensive care unit, whereas the prevalence of carriers at the time of admission was 6% [28]. The proposed explanations attributed this to appropriate compliance with cohorting (77%), hand hygiene (53%), and the wearing of gloves (68%). A questionnaire-based inquiry in

164 intensive care units in Germany found that 34% of these units did not implement the additional precautions for patients carrying MRSA [29]. The rate of nosocomial MRSA infections was significantly lower in those units, which implemented additional precautions or cohorting.

Cepeda [30] concludes on the non-superiority of additional precautions or cohorting with respect to standard precautions, in the prevention of MRSA transmission in intensive care. This study is rather delicate to interpret: the prevalence of MRSA was high at the time of admission, as were the rates of MRSA acquisition (greater than 10%), and the rates of hygiene observance were very low, leading to the impression that the recommended measures were not really applied (21% observance of hand hygiene), although the nursing staff ratio was high.

**Table 1 Efficiency of additional precautions in the control of the dissemination of *Staphylococcus aureus* according to a review of the literature by Cooper & col.[a] [21]**

| Studies | Target of the study | Type of study | Authors' main conclusions |
|---|---|---|---|
| 1988 Duckworth [22] | Hospital | Retrospective | Usefulness of: isolation unit + screening + decolonization |
| 1992 Faoagali [23] | Hospital | Retrospective | Efficiency of stricter measures |
| 1998 Farrington [24] | Hospital | Retrospective | Efficiency of measures in phase 1, then 'escape' |
| 1994 Coello [25] | Hospital | Retrospective | Usefulness of: single room, contact precautions, cohorting, screening and decolonization of carriers |
| 1998 Cosseron [26] | Pediatric intensive care unit | Retrospective and prospective | Usefulness of: single room, contact precautions, cohorting, screening and decolonization of carriers, feedback, hand hygiene awareness |
| 2000 Harbarth [27] | Hospital | Retrospective and prospective | Usefulness of: single room, contact precautions, cohorting, screening and decolonization of carriers associated with feedback, hand hygiene awareness |

Other uncontrolled factors in this study could explain such results: carriage of MRSA by the staff, and contamination of the environment.

Pan [31] concluded on the efficiency of the "search and isolate" strategy, to reduce the cross-contamination of MRSA in services where there was a high level of endemic disease. A 62% observance of the preventative program was thus associated with a significant 89% reduction in MRSA bacteremia in intensive care, whereas the percentage

reductions in general medicine and surgery were not significant (respectively 39% and 59%). Similar results were found by Huang [32] in a study conducted over a period of 9 years, with the introduction, one after the other, of various preventative measures: only the introduction of nasal screening at the time of admission, followed by the implementation of additional precautions in the case of a positive outcome, led to a significant reduction in MRSA bacteremia, whereas the other measures had no significant effect.

Gillespie [33] retained above all the efficiency of ABHR in reducing the cross contamination of MRSA in intensive care. The frequency of MRSA acquisition decreased in effect from 15.2/1000 hospital days to 3.2 per 1000 hospital days, after the introduction of ABHRs and the active promotion of its use by professionals, whereas other measures (in particular screening and additional precautions) had remained identical prior to and after this introduction.

Mangini implemented additional precautions in two types of intensive care unit: some with a high MRSA infection rate, others with a low rate [34]. In the intensive care units with a high MRSA rate, the incidence of MRSA infections decreased significantly (10.0 *vs* 4.3 / 1000 hospital days), with the simultaneous introduction of additional droplet and contact precautions. Despite the withdrawal of the droplet precautions, the MRSA infection rate continued to decrease, although at a non-significant rate. In intensive care units with a low MRSA rate, the introduction of these measures had no effect. In other services with a high incidence rate (excluding intensive care), the introduction of additional precautions also significantly reduced the incidence of MRSA infections, although this reduction was only moderate (between 1.3 and 0.9 cases per 1000 hospital days).

Raineri evaluated the prevention of MRSA cross-contamination in intensive care over a period of 10 years [35]. The "*search and destroy"* (SD) strategy proved efficient in reducing MRSA cross-contamination in intensive care: the addition of complementary precautions to the SD strategy further reduced the incidence of nosocomial MRSA infections.

# 2 STANDARD PRECAUTIONS

## 2.1 HAND HYGIENE

### 2.1.1 PRODUCT, PUBLIC CONCERNED, INDICATIONS

The hygienic act of hand cleaning is one of the fundamental rules of hygiene. This is observed in situations involving the care of all patients, and is thus included in the framework of "Standard precautions" [36-40]. The prioritized hand-cleaning technique is alcohol-based hand rubbing (ABHR) [36-38]. In December 2001, the CTIN (French Technical Committee on Nosocomial Infections) reiterated that hand hygiene is to be based on hand rubbing with an alcohol-based product (ABP), *"instead of hand washing"* [41].

In the interests of health care, the indications for hand hygiene are well defined; Pittet *et al.* recall these in their review [42]. These are related to the care at his/her bedside of a hospitalized patient [43], but also, by extension, to technical support centers (imaging, … ) and rehabilitation services. During consultations, whatever the structure (in a health care establishment, private practice, or ambulatory care) [44], the risks of microorganism cross-contamination, and thus the indications for a hand hygiene procedure, can be extrapolated to situations involving hospitalization, and should include a patient's relatives and friends whenever they are involved in his/her care. The risk of transmission via hospital visitors or staff involved in community child-care is considered to be non negligible [36, 45]. Cases of the transmission of *Staphylococcus aureus* from mother to child, or between twins, have been described in neonatalogy [46]. The wearing of non-sterile gloves is one measure for the prevention of cross-contamination, and has precise indications. Although the recommendation to use a hand hygiene procedure before putting gloves on is not found in several international recommendations [36, 38], it is used in Australia [47]. The logic is to prevent the risk of contaminating the other gloves in the box [48]. The use of a hand hygiene procedure is recommended after removal of the gloves [49-51].

### 2.1.2 THE ALCOHOL-BASED HAND RUBBING (ABHR) TECHNIQUE

All of the recommendations for hand hygiene [36-40] describe the same indispensable pre-requirements and steps needed for an appropriate procedure. A precise protocol is needed; this can then be used as a basis for evaluation [37]. The upper garment should have short sleeves in order to permit a hygiene procedure including the wrists. The occurrence of epidemics has been associated with deviations from these recommendations. Amongst the hypotheses put forward, some have incriminated long fingernails [52]; others their decoration or nail-varnish [53]. The wearing of false fingernails has been clearly associated with epidemics [54, 55]. These accessories reduce the efficiency of hand cleaning [56]. The wearing of jewelry, including a smooth wedding ring, wrist-watches and bracelets, has also been associated with persistent contamination of the hands [57].

For it to be efficient ABHR requires the absence of organic soiling, which could hinder its active principle [58]. In addition, alcohols, the main active ingredients of ABHR products, have no or little detergent efficiency [59] with the risk of cross-contamination whenever ABHR has been used in the presence of organic soiling. The use of ABHR on wet hands could also dilute the active ingredient, and thus reduce the quantity available for rubbing, a factor which can influence its efficiency [60]. When applied to a situation of hand rubbing for surgical disinfection, the use of hand washing before the ABHR reduces the efficiency of the latter, as a result of the absence of complete drying, when compared with protocols without washing [61]. Finally, the tolerance of ABHR is lower when the hands have been washed beforehand.

In situations involving exposure to certain pathogens, such as *Clostridium difficile* [62] and the scabies vector, it is recommended to use simple hand-washing followed by ABHR once the hands have been correctly dried.

The efficiency of a preventative strategy based on ABHR is related to the accessibility of the product. A correlation between accessibility (for example one dispenser per bed in a room with several beds) and the use of ABHR has thus been demonstrated [63]. Doctors are also more inclined to use these products when they have individual (pocket) flasks [64].

Diverted uses of ABHR products have been described, involving ingestion in particular [65]. Exposure to these products in care units with alcohol withdrawal patients can also be a potential problem [66].

French law restricts to 3 liters per room the stored volume of products, with a flash point in the range between and including 21°and 55°C (fire safety regulations); this is the case for ABHR products. This requirement has often been referred to by safety commissions. Boyce [67] has shown, through an inquiry involving North-American hospitals, that the fire hazard observed with respect to ABHR dispensers is very low (none of the 798 ABHR product users had noted a fire).

Although the risk of contamination of bottles of ABHR products has not yet been documented, the contamination of liquid soap dispensers is a reality [68].

The cutaneous tolerance of ABHR has consistently been judged as better than that of other hand hygiene products (mild soap and *a fortiori* antiseptic scrubs [69, 70]. The management of a possible intolerance is based essentially on the teaching of risk reduction [71], with the use of protective creams during periods outside health care activities [72, 73-75], or even alternative ABHR products (no allergy to alcohol has been described, leading to the preference for the use of a different product). The transcutaneous or pulmonary migration of the active ingredient of ABHR products is low [76-78].

The hand hygiene procedure is carried out with bare hands; the washing or rubbing of gloves has been associated with cases of microorganism transmission [36, 49, 79].

### 2.1.3 PROMOTION OF HAND HYGIENE

Educational and promotional campaigns have shown their efficiency in terms of observance [42, 80]. The experience from the University Hospitals of Geneva [81] is constantly quoted. The large number of observational experiences reported concurrently with an increase in the use of alcohol-based products, and a decrease in the isolation of MDRO, or the prevalence of nosocomial infections, contribute to the range of arguments in favor of a causal relationship [81-84].

## 2.2 INDIVIDUAL PROTECTIVE EQUIPMENT AND BARRIER PRECAUTIONS

### 2.2.1 WEARING OF GLOVES

The indication for the wearing of gloves is part of the standard precautions, having been defined in the framework of universal precautions, and of the recommendations for the prevention of BBFE [85, 86]. It is concerned with preventing the risk of contamination resulting from the presence of a pre-existing cutaneous lesion, or of reducing the risk in the case of an accident resulting in a cutaneous lesion. The choice of latex-free glove types is justified by the ever increasing incidence of allergic problems. They must not be powdered, in order to enable their use conformant with ABHR after their removal (no reduction in ABHR efficiency if the hands have been soiled by non-organic products with a visually unclean appearance).

Gloves are to be disposable (single use) [40, 87], and must be removed immediately after treating a patent, or changed between two patients [50, 51, 88]. Between two treatments of the same patient, changing of gloves can be recommended, according to the typology of the treatment [89]. They must also be changed whenever they are damaged.

### 2.2.2 WEARING OF A MASK / GOGGLES

As for the wearing of gloves, the indication for the wearing of a mask is part of the universal precautions [85, 86], and procedures for the prevention of BBFEs through exposure of the mucosa. The wearing of a mask by the care-giver is thus designed to protect the care-giver, the patient [39, 40], and occasionally other people in the immediate vicinity. In this sense, this measure is part of the standard precautions.

The transmission of pathogenic microorganisms to a care-giver, involving “community” microorganisms such as meningococcus [90] or highly transmissible viruses (SARS virus [91, 92]), have been documented.

The wearing of a mask by a patient with a suspected infectious cough can be justified by analogy with the evaluation of the risks underlying the additional “droplet” precautions [93-95]. Coughing can thus be assimilated to an exposure to biological fluids.

### 2.2.3 PROTECTION OF PROFESSIONAL CLOTHING

The protection of professional clothing is recommended in the “universal precautions” [96], which themselves are derived from the recommendations for the prevention of HIV transmission [97] in the context of standard precautions. The choice of method used for the protection of clothing is considerably less well justified; the actual observation of its “one-time use”, the extent of forearm protection, or the possibility of achieving efficient ABHR during a sequence of treatments (problem associated with long-sleeved over-garments), and the “waterproof” qualities of this protection under hospital care circumstances involving wet conditions, or the risk of splashing or splattering, should be

taken into account. The use of over-shoes unnecessarily exposes the hands to the risk of contamination, at the moment when they are put on or removed. There is no study showing their usefulness in preventing infections. Adhesive mats have also failed to prove their efficiency.

## 2.3 PRECAUTIONS FOR NON HEALTH CARE PERSONS

Visitors have been identified as potential sources of transmission of nosocomial infections [98], including those occurring in neonatology [46]. In view of this, it appears essential to inform visitors of the importance of respecting the cleanliness of their hands before and after direct contact with a patient [39, 40, 99]. The wearing of gloves and over-gowns by visitors has not been well documented in the literature. Although certain protocols associating these means of protection for visitors are considered to be efficient in the prevention of certain resistant microorganisms, in parallel with other preventative measures (including hand hygiene) [100], and with some specific protocols such as those for protected hematology units or obstetric operating theaters, they appear to be relatively unjustified as standard precautions.

## 2.4 ORGANIZATION OF CARE

By analogy with measures which have demonstrated their efficiency in epidemic situations, whatever the microorganism and its resistance phenotype [101-104], it would seem reasonable to prefer globalized hospital treatment to care in series, and to organize the sequence of treatments starting from the cleanest and ending with the most soiled. In view of the potential risk, during treatment, of contamination of the immediate environment with microorganisms likely to survive for a long time [105], and in view of the difficulties of decontaminating reusable or available (one-time use) material, it would appear reasonable to restrict, as far as possible, the storage of such material in the treatment areas themselves. This purposeful management of stock permits the material, kept under seal in the patient's room, not to be discarded at the time of the patient's discharge.

## 2.4 EVALUATION OF STANDARD PRECAUTIONS

On the basis of a standardized protocol, the indications and procedures used with ABHR are to be submitted to several qualitative and quantitative evaluations. The impact of an educational approach relative to a program [81] or a technique [106] is clearly positive. The quality of the procedures can be evaluated by using a UV lamp to view the areas, disinfected with ABHR products to which fluorescein has been added [106]. This evaluation must also take into account the duration of the ABHR, which itself depends on the ABHR product [107]. Moreover, the degree of hand cleanliness observance is incorporated into the national evaluation policies [108, 109]. International

recommendations favor accompanying this evaluation with the wearing of gloves [36, 38]. The monitoring of the level of consumption of ABHR products / solutions is officially an indicator of the performance of health establishments in the control of nosocomial infections [110, 111]. Information feedback from all of these indicators is important; it drives improvements in intensive care performance [112], and its impact on the frequency of infections contributes towards the efficiency of policies for the control of nosocomial infections [81, 113, 114].

# 3 SCREENING POLICIES

## 3.1 MRSA SCREENING

### 3.1.1 EPIDEMIOLOGICAL DATA

The epidemiology of MRSA varies from one country to another. In some countries, in particular the Netherlands and Scandinavia, there are sporadic cases, with the occurrence of small epidemic outbreaks in hospitals, which are rapidly brought under control. The increase in the number of real community-acquired MRSA cases is responsible for an increase in the MRSA rate, but does not appear to modify the hospital epidemiology of such strains. The success with which MRSA has been controlled in these countries can clearly be attributed to an aggressive and long-lasting screening policy of admitted patients, associated with personnel screening, decontamination of carriers, implementation of contact precautions, and sometimes the closure of services affected by an uncontrolled epidemic. In most other countries, the MRSA rates are stable or increasing, with the significant exception of a few countries, including France. In Slovenia, where the situation is endemic, the MRSA rate is decreasing thanks to a policy associating screening, decontamination of carriers and contact precautions [115]. In Great Britain, where the MRSA rates are amongst the highest in Europe, a decrease is currently observed, through the initiation of an active policy over recent years. It would seem that a stabilization, or even a decrease in MRSA rates, is appearing in some European countries [116]. MRSA rates are decreasing in France, as shown by data from the European surveillance network EARSS, which collects MRSA rates in *S. aureus* bacteremia: they decreased from 34% in 2001 to 26% in 2007 [116]. This reduction is corroborated by other data sources. National inquiries into the prevalence of nosocomial infections identify a *S. aureus* MRSA rate in nosocomial infections, varying from 57% in 1996, to 64% in 2001, and 52% in 2006. Regional or inter-regional surveillance data also indicate the same trend, with a reduction in APHP (Assistance Publique - Hôpitaux de Paris = *Public Assistance – Paris Hospitals*) MRSA rates from 39% to 22% for short-term stays (55% to 20% in intensive care), and a reduction, although less significant, in the CCLIN (*Regional Coordinating Centre for Nosocomial Infection Control*) for North and Paris.

### 3.1.2 CONTROL STRATEGY

It is difficult to attribute this reduction in France to one single measure. All studies reporting success in the control of MRSA dissemination have used several control measures, implemented simultaneously or successively, thereby underlining, for the control of MDRO, as for that of other care-related infections, the importance of a bundle of measures. The relative success achieved in France also appears to be related to the initiation of a nation-wide policy, initially steered by leaders of opinion, taken up by the CCLIN and most health establishments, and now supported by national indicators: MRSA, ICSHA (French Indicator for the consumption of hydro-alcoholic solutions or products). The importance of a coordinated strategy within a health care network has been well established for MRSA [117] or GRE in the United States [118], and in a mathematical model [119]. In addition, it is clear – although this point has not been fully studied – that the success of a strategy depends as much on the way in which the recommended measures are applied by the care personnel, as on the measures themselves. A well observed measure can thus be efficient in one service, and less efficient in another where it is less well observed. These evaluations would require a methodologically complex, poorly reproducible, and time-consuming audit of practices. Nevertheless, those studies reporting efficiency in the control of MRSA have all implemented contact precautions associated with screening. Some of these have shown that the association of contact precautions with screening was efficient, whereas standard precautions were inefficient [120]. These uncertainties are well illustrated by two recent publications. The first of these evaluated the impact of initially screening at the time of admission, followed by daily screening, of patients kept in intensive care for a period of ten weeks, whose results were not returned [28]. Whereas the imported MRSA rate was 5.7%, no acquisition was observed, which led the authors to the conclusion that screening is not useful in controlling an epidemic. However the colonization pressure (number of MRSA days / total number of days during a given period) was low, at 10.5%, and the average length of patients' short-stays was four days. In addition, the observance rate for the wearing of gloves and hand cleaning was high (78%), which favors the absence of transmission. The other study made use of before-after analysis, to evaluate whether the geographic isolation of MRSA carrier patients could allow its dissemination to be limited in two intensive care units [30]. No difference was observed between two populations in terms of MRSA acquisition. This study has been criticized, in particular for the fact that the hand hygiene observance rates were only 21%, thereby rendering the use of additional measures inefficient. The inter-relationships between dissemination prevention measures are complex: it is possible that screening and contact precautions are less useful if, in the context of standard precautions, the hand hygiene observance rates are already very high.

On the other hand, the introduction of additional measures, when the "basic" hygiene measures are not respected, will certainly be inefficient. It is in intermediate observance zones (40% to 60%) that screening and contact precautions could have the greatest

efficiency in limiting the dissemination of hand-carried MDROs. A suitable balance between “standard precautions” and “additional precautions” thus needs to be defined, which may not be identical in all health care structures. The main elements which could cause this strategy to vary are:

- the type of MDRO: an emerging epidemic would in all cases justify targeted measures,
- the prevalence of carrier patients at the time of admission,
- the nursing staff ratio, together with the staff’s care workload,
- the seriousness and length of the patients’ stay,
- knowledge of the health care staff’s culture in terms of hygiene,
- the degree to which “standard precautions” are respected,
- the environmental conditions (for example the number of single rooms, the availability of protective material, the number of hand-washing areas and ABHR dispensers … ).

Numerous interventions, during recent or established MRSA epidemic situations, have shown that the association of screening and contact precautions with carrier patients has enabled infection-colonization rates to be reduced [27, 31, 115, 120-124], or has even led to its eradication [126]. This control, when prolonged in certain hospitals [121] or countries [124, 127], contrasts sharply with the situation prevailing in other establishments, which have not applied screening. Several publications underline the importance of associating screening with “additional precautions”. In neonatal intensive care, imported cases are rare and the control of an epidemic depends essentially on the hindrance of transmission within the service. A “bundled” set of measures, together with a reorganization of health care, have permitted MRSA to be eradicated [126]. Several tens of publications have, over the last 25 years, reported on the efficiency of such measures [13, 128]. All of these studies are uncontrolled, and make use of a method based on “quasi-experimental” historical controls, which are sometimes made over a period of several years, or after the failure of an active “standard precautions” strategy. For example, Thompson [120] observed that a strategy involving contact precautions “for patients identified by clinical samples as MRSA carriers” was not efficient over a period of three years, as the rates continued to increase. They decreased as soon as screening was added to the previous methods. Although these successes provide a significant argument in favor of the implementation of a screening policy in association with additional “contact” precautions, there is a publication bias in the sense that successful experiences tend to be published more often than failures.

In the literary review published by Cooper [21] in 2004, on the basis of six methodologically robust studies, of which five involved the use of screening and contact precautions, it was concluded that this policy should remain applicable in endemic

situations, unless new data should indicate the opposite. Since the time of this publication, several studies carried out in intensive care and over a period of several years have suggested that these measures are efficient [32, 129]. In the first of these references, the MRSA acquisition rates progressively decreased over a period of five years. This decrease accelerated following the introduction of ABHR [129], and a low acquisition rate was maintained after this period. In the second study, several preventative measures were successively implemented in eight intensive care units, over a period of nine years: “sterile” insertion of central venous catheters (“surgically” aseptic conditions), introduction of ABHR, a hand cleanliness campaign, and finally screening at the time of admission, on a weekly basis. The latter was at first poorly respected, and then well adhered starting in September 2003. The increase in the incidence of MRSA bacteria continued from 1996 until July 2002, whereas the simple introduction of screening with additional precautions was sufficient to progressively reduce the rate of incidence over a period of two years. The interesting aspects of this study are its duration over a period of nearly ten years, and its inclusion of eight intensive care units. It suggests that the most efficient measure is the introduction of screening, whereas other measures, introduced one by one, did not have the same long-term effect.

### 3.1.3 SCREENING IN INTENSIVE CARE

The MRSA surveillance data in France shows that:

- the MRSA rates, taken from clinical samples and combining acquired and imported cases, decreased from 55% in the APHP in 1993, to 20% in 2006. The rates of occurrence decreased in the MDRO surveillance networks operated by the CCLIN, from approximately 3 cases / 1000 hospital-days in 1998-2000 to approximately 2 to 2.5 cases / 1000 hospital-days in 2005 and 2006.
- The MRSA rate for *S. aureus* responsible for nosocomial infections is also on the decline, decreasing from 47-48% in 2004-2005 to 40% in 2006, in the data from the REA RAISiN network [130].

The prevalence of MRSA carriage at the time of admission to intensive care varies from one country to another and from one service to another. In the USA, it varies between 10% and 15%, but can be as high as 20% [28, 32, 131]. In France, it varies between 5% and 10% [123, 132-135]. The data is more sparse in other countries, varying between 3% and 18% [30, 136, 137]. These rates come from services, which are often affected by MRSA epidemics, university hospitals and intensive care units. Admission prevalence is probably lower in the intensive care units of non-university health establishments. In the absence of screening samples, between one third and more than half of carriers would not have been identified at the time of admission [123, 131, 135, 138]. Weekly screening allows the number of identified, acquired case to be increased by approximately one third [129, 131]. The ratio between cases identified by clinical sampling and those identified

only by screening sampling varies considerably from one service to another, for both admission and acquired prevalence [131]. Screening thus increases the number of detected acquired cases from 7% to 137%, depending on the service concerned. In view of the higher risk of dissemination from a non-isolated carrier [124, 139], an active MRSA screening strategy thus appears to be justified. The population which should be screened at the time of admission is also discussed. Some countries recommend the targeted screening of patients presenting risk factors, these being of two types: those with MRSA carriage at the time of admission to intensive care, but also those with MRSA acquisition during a hospital stay. In the second case, screening at the time of admission will allow acquired cases to be differentiated from those which are imported, which is useful if the risk of acquisition is high, for example in a intensive care unit. At admission, there is a relatively good consensus on the view that patients who were previously MRSA carriers, from services in an epidemic situation (ECR and LTC in particular) or having frequently been hospitalized, represent a risk. Other studies have identified an advanced age, the consumption of antibiotics or the presence of cutaneous lesions to be factors associated with carriage at the time of admission [135, 140, 141]. This strategy could be sufficient, and have a favorable cost-effectiveness [123, 142, 143]. The use of carriage risk factors for the screening of patients is however not an optimal approach. In several studies, the presence of risk factors leads to the detection of approximately one third of admitted patients, with a sensitivity between 80% and 90% [135, 141]. A systematic admission screening policy could also be proposed, and would be simpler since it would not require risk factors to be identified at the time of admission [135]. The studies are in agreement, in suggesting that screening is economically profitable [121, 144, 145]. They compare the cost of screening, and occasionally those of preventatively introduced “additional precautions”, with those incurred by the transmission of MRSA between patients, and the resulting acquisition and infection in a patient. Some authors have carried out sensitivity analyses, suggesting that their conclusions remained correct for a wide range of hypotheses. However, the hypotheses used are derived from studies which are often monocentric, and whose conclusions cannot be generalized to all circumstances.

### 3.1.4 INDICATIONS OR ROLE OF SCREENING IN NON-CRITICAL CARE SHORT-STAYS

The situation in non-critical care short-stay units varies from one study to another. It however appears that it is higher in general medicine services (lying between 5.5% and 14.6% in internal medicine, dermatology and internal geriatrics) [146-148] than in vascular surgery, general medicine and orthopedic services (around 5%) [149, 150]. However, this prevalence varies with the patients. In a British study [151], the prevalence of MRSA carriage at the time of admission in a vascular surgery unit was ten times higher in patients admitted *via* the emergency department or transferred from another establishment, than in patients admitted for a planned surgical intervention (20% vs 2%, $p < 0.0001$). Similarly, in a study carried out in Germany, the prevalence rates in

programmed surgery, emergency surgery, and in patients transferred from another establishment were respectively 0.5%, 2.5% and 8.6% [152]. Most of these studies were carried out in university hospital structures, and are not representative of the general situation.

The studies carried out in surgery services [149, 150] show that in the absence of screening by sample taking, 60% of carrier patients would not have been identified. According to the studies carried out in general medicine [148] or for a complete establishment [153, 154], this proportion could be as high as 85%. By systematically screening all patients admitted to the Geneva hospitals over a period of 7 months, Harbarth *et al.* showed that when a medical history of identified carriage at the time of previous hospitalizations were not taken into account, the proportion of patients not identified without the use of screening was 96%. By using the information related to their medical history, this proportion fell to 40% [141]. Finally, Shitrit *et al.* [155] have shown that the introduction of screening, targeted at certain high risk patients, was accompanied by an increase in the frequency of MRSA carrier patient identification, from 0.9 to 15.8/1000 admissions in general medicine services, and from 0.16 to 3.8/1000 admissions in surgery units. There is not a full consensus on the sensitivity of screening, targeted at patients with a risk of carriage at the time of admission. According to Girou *et al.* [146], more than 90% of patients who are effectively carriers are identified in this way, whereas another study has shown that this type of strategy would allow less than half of all carriers to be identified [148]. However, for reasons of cost efficiency, it appears to be far more difficult to envisage systematic screening than in the case of intensive care. This shows the importance of identifying carriage risk factors at the time of admission, in order to target specific populations for sampling, in non-critical care, short-stay services. In this type of service, or in an entire hospital, the most commonly identified risk factors are: transfer or recent hospitalization [147, 149, 150, 153, 156], age (more than 70, 75 or 80 years according to various studies) [141, 149, 153, 156] and the presence of wounds or chronic cutaneous lesions [147, 153]. Other risk factors such as recent antibiotherapy with broad spectrum antibiotics (fluoroquinolones or cephalosporins), presence of a urinary tract catheter at the time of admission [141, 147] or home nursing [157] are less frequently identified. A carriage risk score ranging from 0 to 13 was proposed by Harbarth *et al.* [14]. The risk of carriage was 8% in patients with a low score, 19% in patients with an intermediate score, and 46% in patients with a high score. The screening of patients with an intermediate or high score would allow 30% of sample taking to be avoided, whilst maintaining a sensitivity of 86% when compared to generalized screening. The rate of MRSA acquisition during short stays is poorly known, with most studies being devoted to carriage at the time of admission. In a recent study in hospital services with a certain risk of acquisition (high prevalence at the time of admission, long hospital stays), the rate of acquisition was 3.1%, but 95% of these acquisitions were identified only through screening at the time of discharge [158]. The efficiency of the use of screening has been poorly

studied with respect to the specific cases of short, non-critical care stays. At the scale of an entire establishment, Wernitz *et al.* [159] have shown that the implementation of a policy including screening and the use of additional precautions was followed by a 48% reduction in the incidence of MRSA infections. In the aforementioned study of SHITRIT [155], the introduction of a screening program for high risk patients was accompanied by a significant reduction in the incidence of nosocomial MRSA bacteremias (from 0.74 to 0.37 / 1000 admissions). However, as previously indicated, the evaluation of screening efficiency is delicate, as a consequence of the difficulty in organizing controlled studies, and the multifactorial nature of most procedures.

### 3.1.5 ROLE OF SCREENING IN ECR AND LTC

Strong variations can be found in the types of structure used in ECR and LTC, in the pathologies which are cared for, in the lengths of stay, in the nursing staff ratio and workload, and in the patients' comorbidities. This heterogeneous situation, and the relatively small number of publications related to these types of unit do not allow a global view of the epidemiology of multiresistant bacteria, nor a single control strategy, to be established for such units. As for the case of short-stay services, the epidemiological situation of MRSA in ECR, and LTC services or establishments, varies considerably from one study to another. However, the incidence of MRSA infections is always very much lower in these services than that observed in the full range of short-stay services (intensive care, general medicine, and surgery) [160-163], even though carriage at the time of admission may be very high [147, 164]. The inter-relationships between, on the one hand, the use of measures to prevent dissemination, including screening and additional precautions, and, on the other hand, the observance of hand hygiene in the context of standard precautions, are very strong. Thus, the implementation of screening can lead to a reduction in cross-contamination only when the basic hygienic precautions (hand hygiene in particular) are already widely respected [115, 129, 135, 144]. In these services (ECR, and LTC), the introduction of screening, together with the additional precautions which are required in the case of a positive result, can be difficult: cost of screening, unfavorable nursing staff ratio, necessary "re-socialization" of patients [165]. In addition, the application of additional precautions can have a negative impact on the global care of patients (occurrence of undesirable incidents) [16]. In elderly persons, the prevalence of MRSA carriage is particularly high in those who have been recently hospitalized (6 months to one year) in MSO, and/or who within this same period have received one or more antibiotic treatments [147, 153, 164]. Some studies report that the frequency of carriage is higher in men than in women [166].

### 3.1.6 SCREENING METHODS

#### 3.1.6.1 SCREENING SITES

Many studies have tried to identify an anatomical sampling site or a combination of anatomical sampling sites, providing a good compromise between sensitivity and screening feasibility in patients carrying MRSA. According to which study is considered, the sensitivity of only nasal samples varies between 66% and 93% [167, 168]. According to Manian *et al.* [169], 16.7% of patients presenting with cutaneous wounds have a negative nasal screening outcome and a positive wound screening outcome. Since cutaneous wounds have been identified in numerous studies as being MRSA carriage risk factors at the time of admission [135, 147, 153], this site should in all likelihood be taken into account if any wounds are present. In a recent study [170], a screening strategy associating nasal samples and cutaneous ulcer or bedsore samples had a sensitivity of 91%, with respect to a more thorough strategy associating these sites with urine, scar (if present) and armpit samples, at a 2.5 times lower cost. Other sites have been identified as being important for screening. A Finnish study [168] has shown that the use of throat samples in addition to nostril samples allowed a non-negligible improvement in sensitivity to be achieved (from 66% to 85%). In another Scandinavian study [171], 55% of identified MRSA patients had a positive throat sample. For 17% of new cases of identified MRSA carriage, the only positive site found was the throat. Several studies emphasize the small gain in sensitivity obtained by sampling the armpits [148, 170]. A recent study [148] has shown that rectal sampling allowed 20% more carriers to be identified than by nasal screening alone. However, these patients' cutaneous wounds were not sampled, which makes it difficult to evaluate the real usefulness of rectal sampling. Finally, according to Manian *et al.* [169], perineal screening is positive in only 2% of patients presenting with negative nasal screening. It thus appears that a reasonable approach would involve a strategy including nasal sampling, together with sampling of at least one other site [172], preferably wounds or cutaneous lesions.

#### 3.1.6.2 FAST SCREENING METHODS

An important aspect in the rapid implementation of contact precautions, in patients identified as carriers at the time of admission, is the rapidity of the return of a positive result. Conventional culture techniques do not all have the same sensitivity, nor the same speed of response [173]. Chromogenic media are now widely used: they normally contain cefoxitin, which enables methicillin-resistant strains to be differentiated [174]. The response time with such media ranges from 24 hours (negative sample) to 48 hours. Fast screening methods are now available, using immunological or molecular techniques. Their sensitivity and specificity are good [175-177], but are not always reproducible [178]. The use of fast techniques has not yet been shown to be efficient, as is the case for other

MRSA testing techniques. In two intensive care units, the introduction of fast screening allowed the average response time to be reduced from 4 days to one day, and a reduction to be achieved in the number of preventative isolation days spent waiting for the results of admission screening [179]. Fast screening was not accompanied by a reduction in MRSA acquisitions in one service. In another service, a reduction was obtained, only after preventative isolation had been introduced in addition to fast screening. Another publication also suggests that fast screening can be efficient, although several actions may have been initiated simultaneously, which limits the impact of this study [180]. Several publications contributed to this debate in 2008. In an initial study [181] carried out in a chain of three hospitals, three periods were compared: the first (12 months and nearly 40 000 admitted patients), with neither screening nor decontamination of MRSA carriers, using contact precautions only for patients having MRSA positive clinical samples; the second (12 months with the same number of admissions) in which fast screening was carried out at the time of admission, in intensive care units only; and the third involving universal screening of all patients admitted to the hospital, and decontamination of carriers (18 months and screening of 73 000 admitted patients !). A fast PCR screening technique was used. With respect to the first period, a non-significative reduction in MRSA infections was achieved in the hospital during the second period (a change from 0.89 to 0.74 cases per 1000 hospital days), whereas a significative change was achieved (0.39 cases per 1000 hospital days) during the third period of universal screening. The second study [182] was carried out in the surgeries of the Geneva Hospital in which a *"cross-over"* scheme was used: during 9 months, fast screening at the time of admission was used in half of the surgical services, followed by the transposition of the same strategy during a second 9 month period in the other services. Screening was carried out for all patients admitted to these services. Once carriage had been identified, the patients were reported and treated using contact precautions, an adaptation of the surgical antibioprophylaxis was recommended for MRSA carriers, and decontamination was initiated for all carriers, if possible before surgical intervention. No other action was taken, which could have influenced the risk of MRSA acquisition. More than 10 000 patients were included in each of the two groups, with similar results concerning the consumption of ABPs and antibiotics. These measures were well respected, since approximately 95% of admitted patients were screened, with a MRSA carriage rate at the time of admission of approximately 5%. Despite a median return delay of a little less than 24 hours, this information was available only after the operation in 31% of cases, and only 30% of operated MRSA carrying patients received an antibioprophylaxis taking their MRSA carriage into account. There was no difference in MRSA infection rate, nor in MRSA acquisition rate (1.59 to 1.69), between the control group and the screened group (0.91 and 1.1 per 1000 hospital days). For patients with an MRSA infection at the operating site, 41% from the screened group and 25% from the control group were known to be carriers before the operation (P = 0.05), 27% received a suitably adapted antibioprophylaxis (15% in the control group), and 17% received at least one day of decontamination treatment before surgery (*vs* 7% in the

control group). The latter two differences are not significative. Finally, 57% of patients infected with MRSA had a negative screening result in the screened group. The third study [183] compared two MRSA screening strategies at admission and discharge in ten health care services “at risk”, in two hospitals. During two successive 5-month periods, 8971 patients were screened, either using the conventional method (enrichment followed by streaking onto a chromogen agar), or using a fast PCR technique, by means of a cross-over technique identical to that described in the preceding study. The patients found to be MRSA carriers were cared for using contact precautions, and were decolonized. The patients at risk of carrying MRSA were preventatively isolated until the screening result was returned. The prevalence of carriage at the time of admission was 6.6%. The response times were 46 hours for the conventional method and 22 hours for the fast technique. On the basis of screening made at the time of discharge, 3.2% of patients acquired MRSA in the conventional screening group, as opposed to 2.8% in the fast screening group (non-significative difference). Although fast screening allowed the time spent without contact precautions to be significantly reduced, from 389 to 213 days, these durations represent only a small proportion of the number of hospital days spent by patients who were MRSA carriers. Despite the excellent methodological quality and the large number of patients included in these three studies, their results are discordant. As for the case of previous studies, there are numerous explanations for this: before-after historical studies, numerous confusing factors some of which were not taken into account, other actions applied simultaneously to the described measures, level of observance of contact precautions. Concerning the application of conventional or fast screening, the usefulness of preventative isolation, i.e. its implementation at the time of a patient’s admission, until the screening results become available, should be examined. This could concern all admitted patients (sometimes to intensive care), or high carriage risk patients in intensive care and in some cases in short stay services. Its effectiveness has not been demonstrated [179].

### 3.1.7 MRSA DECONTAMINATION

The results of MRSA decontamination vary, according to different studies. In the case of nasal carriage, there was a high rate of eradication associated with mupirocin taken for 5 to 7 days in some studies, approximately 80% in intensive care [132] or short stay care [184], and even 93% in ECR-LTC [124, 185]. The only randomized double-blind study revealed the eradication of carriage, in nasal and all other sites, respectively in only 44% and 25% of patients receiving mupirocin (associated with aseptic ablutions), and in only 23% and 18% of those receiving a placebo [186]. Another randomized double-blind study in Extended Care and Rehabilitation revealed, quite to the opposite, that mupirocin was efficient in decontaminating MRSA carriage [185]. The impact on the infection rate is thus uncertain [132, 186], except in a surgical intensive care unit, in which mupirocin was used for all patients, whether or not they were *S. aureus* carriers [133]. The reasons for these

failures appear to be numerous: absence of cutaneous decontamination associated with nasal decontamination [132], persistence of cross contamination in the absence of efficient contact precautions in established epidemic situations [132], multiple MRSA reservoir sites other than nasal and cutaneous [186], or intercurrent curative antibiotherapies, in particular those using fluoroquinolones, favoring carriage persistence [186]. A decontamination associating topical decontamination with mupirocin, ablutions using chlorhexidine, and systemic decontamination using doxycycline-rifampicin appears to be effective, but is based on the assumption that the MRSA strains are sensitive to systemic antibiotics, and also incurs the risk of developing a resistance to these antibiotics [187]. Since decontamination is a measure, which runs the risk of a resistance emerging to the products used, those antibiotics normally used for systemic treatments must not be used for this indication. Mupirocin resistance is also a cause for concern. It can arise preferentially if mupirocin is used for cutaneous decontamination [188]. The clonal dissemination of mupirocin resistant strains could then become a real threat [189]. In the context of the prevention of MRSA infections, two main objectives can be identified: as has been discussed, the collective interest in preventing the horizontal dissemination of these MRSA, but also the individual interest procured by preventing self-infection in carrier patients [190]. The situation in terms of MRSA resistance to mupirocin is poorly known. In 1997, a European multi-center study evaluated the hospital prevalence of MRSA resistance to mupirocin at 6.2% [191]. In a study carried out in 57 hospitals in 2000, the resistance rate was 13.8% [192]. In Canada, the high-level resistance increased to 7% over the period from 2000 to 2004 [193].

## 3.2 ESBLPE SCREENING

### 3.2.1 EPIDEMIOLOGICAL SITUATION

Initially described in West Germany (1983) and in France (1985), the enterobacteria which produce ESBL can be found throughout the world. In the second half of the 1990's, there was a widespread TEM-24 type ESBL producing *Enterobacter aerogenes* epidemic in France [194, 195]. Today, the most commonly encountered ESBL producing enterobacteria are CTX-M type enzyme producing *Escherichia coli*. Among the countries affected, we cite Canada, Spain, the United Kingdom and Portugal [196, 197]. In France, progress is also being made on the isolation of the *E. coli* strains which produce CTX-M-15 [198]. According to the study carried out in 2004, in the Champagne-Ardennes region [199], 26.5% of ESBL produced by enterobacteria were of the CTX-M-15 type, and 0.9% were of the TEM-3 type. In order to appreciate the evolution in the implication of different enzymes, it is interesting to note that a study made in Auvergne, three years beforehand, had identified a TEM-3 type enzyme in 51.2% of the isolated strains [200]. Classically, these ESBL producing *E. coli* strains of community origin are preferentially found in a patient's urine. However, ESBL producing *E. coli* represented nearly 9% of the *E. coli* strains isolated in the case of bacteremias in a Sevilla hospital [201], which implies the possibility of therapeutic treatment problems in the case of serious infections, and underlines the serious implications of the dissemination capabilities of these strains. This dissemination capability remains however a topic of controversy. A study carried out in the Sevilla hospital, on the *E. coli* strains isolated in 49 patients, did not reveal a clonal relationship between the different strains; this does not favor horizontal transmission, without however excluding the possibility of plasmid epidemics [202]. Nevertheless, in the same hospital, a study dealing with ESBL producing *E. coli* bacteremias from June 2001 until March 2005 showed the existence of nosocomial acquisition in half of all cases [203]. Similarly, more recent studies have shown the existence of clusters of strains, closely related to the hospital as in the community. Pitout *et al.* demonstrated the clonal diffusion of CTX-M-14 producing strains, responsible for a widespread epidemic in the region of Calgary [204]. From 151 strains studied in a Madrid hospital, a cluster of 103 CTX-M-14 producing and genetically related strains was highlighted [205]. Finally, a Portuguese study dealing with 119 CTX-M-14 producing strains showed that 76% of these belonged to the same epidemic cluster. From the 47 nosocomial strains, 41 belonged to this cluster, and had been disseminated primarily in three hospital services [206]. The epidemiological situation with regard to ESBL producing enterobacteria is thus particularly complex. The French epidemic at the beginning of the 1990's affected mainly intensive care units and ECR-LTC units, with an oligoclonal strain dissemination, most often involving *Klebsiella pneumoniae*. It was controlled using measures designed to prevent cross-contamination. The situation observed in France in recent years is, on the contrary, poorly understood and rapidly changing:

- ubiquitous epidemics, often affecting general medicine and surgery units of a hospital, and no longer intensive care units only,
- diversity of the enterobacterial strains carrying the genetic basis of the resistance,
- diversity of the enzymes, of the conventional SHV and TEM types, but also of the CXT-M type,
- probable urban acquisitions of ESBLPE (CTX-M *E. coli*),
- and also circulation of strains within hospitals, in services where measures applied for the control of MRSA appear to be efficient,
- impression of a variable dissemination capability of some strains of ESBLPE.

For these reasons, it is difficult to propose uniform and definitive recommendations for the control of ESBLPE dissemination. More than other MDROs, MRSA in particular, it is possible that actions designed to achieve the best (least) utilization of antibiotics may be determinant in limiting an epidemic. In addition, the difficulty in establishing the profile of patients at risk of ESBLPE carriage, who would represent a population to be screened under certain circumstances, suggests that as much importance should be placed on standard, as on additional precautions. The digestive decontamination of ESBLPE carriers was proposed at the end of the 1990's, with initially positive results [207]. On the other hand, subsequent data suggested that the decontamination was not always efficient, could mask carriage without ensuring its eradication, and could even increase the risk of dissemination if the topical antibiotics included erythromycin, which sometimes leads to diarrhea [208].

### 3.2.2 SCREENING

Several studies appear to demonstrate the efficiency of the association of a screening policy, with the introduction of contact precautions in epidemic ESBLPE enterobacteria situations [20, 209]. On the other hand, according to different authors, in the absence of an epidemic situation, either as a consequence of weak cross-contamination [210], or as a result of very low prevalence (< 1%) at the time of admission [210], the same screening policy is not useful. These studies were carried out in intensive care units. As far as non-intensive care short-stay patients are concerned, data is virtually inexistent. It was possible to control the dissemination of a *K. pneumoniae* ESBLPE epidemic in the general medicine and intensive care surgery units of the Aberdeen hospital, following enhancement of standard precautions and decontamination of the environment, without the introduction of a screening policy [212]. Finally, most authors are in agreement over the ineffectiveness of screening for asymptomatic carriage in LTC [213]. However, all of these studies were prior to the emergence of CTX-M producing *E. coli*. As a result of the absence of reliable data concerning the dissemination capability of these bacteria [214], it

is difficult to recommend one procedure or another, for non-epidemic situations in which screening appears necessary. The consideration of carriage risk factors at the time of admission could be useful in cases where targeted screening is adopted. These risk factors refer mainly to a recent antibiotherapy, an age over 60 years, or a high chronic pathology score [201, 203, 215].

### 3.2.3 ANATOMICAL SITES

Contrary to MRSA, the sensitivity of screening for ESBLPE enterobacteria has seldom been studied. However, rectal screening is the most commonly used method in studies of asymptomatic carriage [20, 210, 211].

## 3.3 SCREENING FOR OTHER MDROS

### 3.3.1 *ACINETOBACTER BAUMANNII*

*Acinetobacter baumannii* is involved in epidemics mainly in intensive care, or in immunosuppressed patients, and is subjected to strong selective pressure by antibiotics. For several reasons, its epidemiology is rather specific when compared with that of MRSA or ESBLPE:

- It is a commonly saprophytic, weakly pathogenic, but occasionally commensal species in hot and humid climates, and in this case is involved in community pathologies;
- Although this species is the first pathogen responsible for healthcare related infections in intensive care in certain countries of the Mediterranean rim, it is the cause of only 1.6% of such infections in French intensive care units [130];
- Hospital *A. baumannii* is very often multi-resistant to antibiotics, since this bacterium has acquired resistance to all available antibiotics, in some cases including colimycin;
- *A. baumannii* is responsible for “explosive” epidemics in intensive care, justifying the introduction of aggressive control measures, which can go as far as limiting admissions in order to restrict the health care load, or even closure of the service [216];
- This species has a long survival capability in the environment, which thus represents a secondary reservoir for its transmission. Control measures must include specific actions in order to limit environmental contamination.

Two aspects are thus used to guide the control strategies used for *A. baumannii* epidemics:

- Specific measures targeted essentially at intensive care: as this species is not generally found in other health care units, the factors which can promote epidemic dissemination (under antibiotic pressure) are: patient confinement, density of treatment, invasive procedures [216, 217];
- An aggressive control strategy, if the responsible strain is multi-resistant, even more so if it is pan-resistant [218]. There has been little research into potential screening sites. In France it is customary to sample two (throat and rectum) or three (skin) sites, although this practice has not been systematically evaluated. A recent publication suggests that the sensitivity of single-site sampling is insufficient [219]. A study by Ayats suggests that three sites should be sampled (throat, rectum, armpits), indicating that the first two of these are more sensitive [220].

### 3.3.2 *PSEUDOMONAS AERUGINOSA*

*Pseudomonas aeruginosa* is an opportunistic pathogen, which is highly significant in terms of the number and gravity of infections it causes [221-223]. *P. aeruginosa* is an uncommon commensal organism in humans, found in 4% to 10% of hospitalized patients, with the main carriage sites being the digestive tract, the upper airways and the skin [224-226]. This bacterium is highly endemic in intensive care units, and plays a predominant role in broncho-pulmonary, and to a lesser degree in urinary, surgical site infections and bacteremias [227]. Although it currently seems that most colonisations / infections find their origin in the endogenous flora of the patient, numerous epidemics involving cross-contamination between patients have been described [228, 229]. The relative significance of an endogenous origin or of cross-contamination is thus not clear, and can vary considerably as a function of health care service. The differences observed between services can be explained by differences in the application of general hygiene measures and antibiotherapies, and differences in the recruitment of patients [19, 221, 230]. In intensive care units, *P. aeruginosa* generally evolves in limited epidemic bursts, against a sporadic background. Widespread epidemic phenomena can add to this picture. In this type of situation, all epidemiological surveillance must therefore include the taking of screening samples [223, 225]. In other services, the endogenous origin of *P. aeruginos* is frequently observed with a generally lower cross-contamination rate than in intensive care units. Globally, the epidemiology of *P. aeruginosa* in hospitals is highly variable as a function of time and service. It is thus difficult to propose generally applicable screening measures, outside the context of clearly epidemic situations.

### 3.3.3 *OTHER MDROS*

#### *3.3.3.1 BURKHOLDERIA CEPACIA*

*Burkholderia cepacia* is responsible for lung colonizations or infections, mainly in patients who are immunosuppressed or affected by cystic fibrosis. With regard to the transmission of these microorganisms, numerous epidemics have been described. The origin and mode of transmission are often difficult to determine [232]. An environmental origin has been clearly identified in some cases (salbutamol solutions, ultrasonography gels … ) and this hypothesis must always be envisaged. However, cross-contaminations related (or not) to contaminated material have been identified [231, 232]. In such cases, the reinforcement of standard precautions, or the introduction of contact precautions, have allowed epidemics to be controlled. Nevertheless, even though all strains do not have the same ability to disseminate, a recent literary review concerning patients affected by cystic fibrosis has shown that patients colonized by *B. cepacia* were frequently isolated [233]. However, no study has clearly reported the introduction of systemic screening during an epidemic.

#### *3.3.3.2 STENOTROPHOMONAS MALTOPHILIA*

The contamination of a hospital environment is recognized as being a potential source of *Stenotrophomonas maltophilia* epidemics. However, recent studies have also shown the possibilities of cross-contamination from one patient to another, or via contaminated material, in some non immunocompetent patients (in neonatology for example). The main risk factors for infection by this bacterium are treatments based on carbapenems, some bronchial pathologies, or the association of diarrhea and mucitis in oncology. In general, the measures introduced to control epidemics are the tightening of standard precautions, and the reinforcement of procedures for the cleaning and disinfection of material. According to a review of the literature concerning *S. maltophilia* infections in children affected by cystic fibrosis, it was not possible to prove that the isolation practices used in certain cases played a determinant role in controlling epidemics [223]. However, if, contrary to the case of *B. cepacia*, the authors do not recommend systematic isolation, they recommend not to hospitalize a *S. maltophilia* colonized or infected patient next to another fragile (immunosuppressed or affected by cystic fibrosis) patient. On the other hand, no screening of carrier patients appears to have been implemented to control epidemics.

#### *3.3.3.3 CEPHALOSPORINASES HYPERPRODUCING ENTEROBACTERIA*

It is generally accepted that the emergence of these enterobacteria is associated with the use of broad-spectrum antibiotics, including third generation cephalosporins. Moreover, epidemics of proven environmental origin have been described. The sources can be certain antiseptic solutions [234], contaminated injectable solutes favoring the development of infections related to catheters, bacteremias, or surfaces. However, hand-

transmission has also certainly been involved in *Enterobacter cloacae* [234], or in *Serratia marcescens* epidemics [235]. At the time of one of these epidemics in a neonatology service, the systematic screening and isolation (associated with a sensitization, information and education program) of colonized new-born infants, enabled the epidemic to be controlled. It should however be noted that these epidemics, whether they be of environmental origin and/or associated with hand-transmission, are most often concerned with neonatal, and in exceptional cases adult, intensive care units. In conclusion, the epidemiology of these three types of multi-resistant bacteria involves several factors. Thus, even if its existence has been clearly proven on several occasions, hand-transmission does not appear to be predominant with respect to other factors, in particular environmental reservoirs or selective pressure through the use of broad-spectrum antibiotics. Although the isolation of colonized or infected patients is recommended, in particular with respect to contact with immunosuppressed patients, the screening of patients is not used outside epidemic situations.

#### *3.3.3.4 EMERGING MDROS (ERG, IMIPENEM-R ESBLPE … )*

Several types of even more resistant MDRO have appeared recently in France. The prevalence of Glycopeptide resistant enterococci (GREs) has been at an epidemic level in the USA for 20 years. Several widespread epidemics have been described in French university hospitals in recent years. National recommendations were given by the CTINILS in the autumn of 2005, and were refined in December 2006 [237]. They recommend a “search and isolate” strategy, similar to the Dutch MDRO control recommendations, as soon as the first case is detected. An identical strategy appears to have been recommended for other highly resistant MDROs, for example carbapenemasis producing, imipenem-resistant ESBLPE. An epidemic risk factor is the importation of these strains, by patients returning from countries in an epidemic situation, for example multi-resistant *A. baumannii* [238] or imipenem-resistant ESBLPE [239].

# 4 ADDITIONAL CONTACT PRECAUTIONS

## 4.1 MICROBIOLOGICAL TARGETS OF ADDITIONAL CONTACT PRECAUTIONS

Several MDRO have been studied and additional precautions have been recommended, in particular for MRSA and GRE. For the case of *Acinetobacter baumannii,* essentially in epidemic situations, numerous studies have been made [218]. Very little data is relevant to extended spectrum beta-lactamase producing enterobacteria (ESBLPE). Kola recommended additional contact precautions for ESBLPE infected or colonized patients in view of the frequency of these microorganisms in hospitalized patients and of the long duration of their carriage. ESBLPEs could be eradicated in only 6.8% of carrier patients in this German study. Cross-contamination was observed in 7 patients out of 96 [214]. Lucet reported the control of a prolonged ESBLPE epidemic after the introduction of screening and contact precautions, the latter having been efficient only following an audit and improvements in the observance of these precautions [20]. One program including additional precautions reduced the incidence of MRSA as well as ESBLPE [240].

## 4.1 MEASURES FOR ADDITIONAL CONTACT PRECAUTIONS

These precautions include measures, which are additional to standard precautions: single rooms or grouping of carriers, and communication to staff of a patient's condition. Cleanliness of the hands, the wearing of gloves or a mask, and of over-gowns/aprons, under conditions where a patient is being treated, are comparable with standard precautions.

### 4.2.1 SINGLE ROOMS

The use of single rooms, or grouping of MRSA carriers is one of the recommended measures [15, 39, 40, 241, 242]. These recommendations are based more on common sense than on solid scientific findings. However, one of the risk factors in the acquisition of glycopeptide-resistant enterococci (GREs), a MDRO whose hospital epidemiology is close to that of MRSA, was associated with the fact that a patient could be placed in the same room as a known carrier [243]. A recent publication from the German network of intensive care surveillance (KISS) has suggested that putting a patient in a single room represents a form of protection against MRSA [29]. Even if "technical" isolation precautions are taken in a double room, it is known that contamination of the environment can play the role of an auxiliary reservoir. It is possible that the observance of additional contact precautions (technical measures in particular) between two patients hospitalized in the same room is less well respected. This observation thus argues in favor of placing patients in individual rooms. However, the extension of screening, and the identification of a greater number of MRSA carriers, leads to the question of the availability of single rooms. The recommendations of the Society for Hospital Epidemiology of America (SHEA), which

advocates an active screening policy, does not however deal with the question of single rooms or patient grouping [13]. When the number of single rooms is insufficient, it is proposed to group carrier patients together in the same room, and occasionally to group carriers together in dedicated units. The aim is to achieve “cohorting” of the staff, who then deal only with MRSA carriers, thereby limiting the risk of dissemination. Although such units are common in Great Britain, their usefulness has not been demonstrated. This is again a recommendation based on common sense. Talon nevertheless suggested that the use of an aseptic orthopedic surgery unit allowed colonization pressure to be restricted to this unit, thereby reducing the dissemination of MRSA [244]. It should be noted that this data has been validated for short-stay patients.

### 4.2.2 COMMUNICATION

The recommendations normally include the indication of MDRO carriage on the door of a patient’s room. This is again a measure based on common sense, to help in the application of additional measures, but whose scientific rationale is uncertain. In an experiment, the observance of hand hygiene upon entry and exit from a room was greater when the patient was identified as being a MDRO carrier [20]. The national audit coordinated by the South-West CCLIN is in agreement with this finding [245]. Another study leads to the opposite outcome, although the audit took all hygienic patient-contact procedures into account, including those made between two treatments [246].

### 4.2.3 HAND HYGIENE

In view of an insufficient level of observance, the primary measure for the control of MRSA is certainly an improvement in hand hygiene. However, data from mathematical models is sparse, with one study indicating that suitable control of GRE would require an 80% observance, which has until now never been achieved [247], and the other indicating that an increase of 12% in observance could compensate for the effects of work overload and/or lack of personnel [136]. Just one published study has suggested that an improvement in hospital observance, from 48% to 66%, would lead to a reduction in the rates of nosocomial infection (16.9% to 9.9%) and MRSA (2.16 to 0.93 cases per 1000 hospital days) [81]. However, other actions taken to control the risk of infection or nosocomial infection had been introduced simultaneously. Thereafter, MRSA acquisitions increased again in this hospital, despite an increase in the use of ABHR [248]. In Lucet’s experiment, the introduction of screening and additional contact precautions allowed a progressive reduction in MRSA acquisitions to be achieved over five years, in three intensive care units. The introduction of ABHRs led to an additional 50% reduction in MRSA acquisitions, after adjustment for acquisition risk factors [129]. As for the other measures included in the contact precautions, the impact of ABHR use has not been demonstrated by methodologically robust studies. However, convergence of the data – improvement in hand hygiene observance and better microbiological efficiency of ABHRs,

clinical studies (including many, which have not yet been published) – is such that the usefulness of these products can no longer be doubted.

### 4.2.4 WEARING OF NON-STERILE DISPOSABLE GLOVES

Several studies have shown that contamination of the hands was reduced by wearing gloves [49, 249, 250]. This issue is however not so simple, as has been shown by Tenorio: the wearing of gloves prevents the presence of GREs on the wearer's hands in 71% of cases, but this protection is incomplete since the GREs are found on the hands of 29% of professionals after removal of the gloves [49]. Three factors increase significantly: the presence of GREs on the gloves: contact with a patient presenting with diarrhea, presence of several colonized sites in a patient, and contact duration. This study summarizes the problematic issues of wearing gloves: the need for hand hygiene before any contact, the guarantee of protection whilst the gloves are worn, countered by frequent contamination of the hands inside poorly used gloves, or at the time of their removal. Several audits indicate that poorly used gloves lead to more risks than the expected benefit [246, 251]. In the first of these studies, gloves were worn in 98% of cases, but were justified in only 27% of contacts involving biological fluids. The gloves were changed in only 3% (in general medicine) and 19% (in intensive care) of cases, prior to those aseptic contacts, which would in theory have required a pair of clean gloves [246]. In this same study, gloves were worn in rehabilitation, in 82% of observations, but were changed in only 16% of cases between two treatments [251]. A study carried out in intensive care suggests that, on the contrary, gloves were worn correctly, thus leading to correct hand hygiene, and to improved observance during treatment of patients [6]. With the introduction of ABHRs, it is nevertheless possible that the wearing of gloves is more of an obstacle to cleanliness of the hands, in particular during a sequence of treatments for the same patient. These uncertainties were expressed in the expert recommendations of the French Speaking Intensive Care Society (SRLF) in 2002 [252, 253], which give a reserved opinion concerning the wearing of gloves, whereas the SRLF consensus on MDROs in 1996 [254], and the North American recommendations on GRE and MRSA [13, 39, 40] advocate the wearing of gloves for any form of contact with a MDRO carrying patient and his immediate environment, and even for contact with non MDRO carrying patients [123, 254]. In a literary review, Kirkland summarized the systematic wearing of gloves and concluded that the dogma of systematic glove wearing needed to be revisited in the context of additional contact precautions [255].

### 4.2.5 PROTECTION OF CLOTHING

It has been suggested that clothing could constitute a MRSA transmission vector, thus justifying the use of professional clothing protection. The clothing of nurses is thus contaminated in 65% of cases, after morning treatment of a MRSA-carrying patient. The wearing of an over-gown or protective clothing in addition to gloves and hand washing

allowed a GRE epidemic to be controlled, whereas hand washing and the wearing of gloves alone were not efficient [243]. Five studies have evaluated the relevance of wearing an over-gown or an apron in order to control the dissemination of GRE. If those studies in which only the wearing of an over-gown was introduced, with no other associated additional measure, two out of three studies found a reduction in the rates of acquisition: the wearing of an over-gown was accompanied by an improvement in the observance of glove wearing or washing of the hands. In a non-contributive study, the GRE acquisition rate was very high in both groups (24% and 26%), and the observance of precautionary measures was low. This dataset thus suggests that contamination of clothing can contribute to the transmission of MDROs, and leads to the recommendation of wearing an over-gown for all treatments which could potentially contaminate clothing (extended contact … ). In addition, two studies suggest that the wearing of an over-gown is beneficial for the observance of hand hygiene, and favors compliance with the other measures. The near environment of a patient is frequently and lastingly contaminated after its exposure to infected or colonized patients, in particular those with MDROs (MRSA, *A. baumannii*) but also other microorganisms (viruses, *Candida …* ) [256]; the precise role of the environment in the transmission of microorganisms remains difficult to clarify because it is intertwined with other hygiene practices (hand hygiene, wearing of gloves, protection of clothing, care of surfaces) the level of application of which often remains unknown. Professionals can acquire a GRE on their gloves through simple contact with a patient's environment [49]. The microorganisms for which the environment appears to play an indisputable role are: *Clostridium difficile, Enterococcus species, MRSA* and *A. baumannii* [217, 256, 257]. MDROs have been found in the near environment of patients: *A. baumannii* was thus found on beds, mattresses, pillows, bedpan, syringe dispensers, and critical care devices [217]. An excess in MRSA (5.8%) and in GRE (6.8%) acquisition risk is found in intensive care patients staying in a room previously occupied by a patient colonized or infected by one of these MDROs; this appears to play only a secondary role when compared to the full set of means by which MDRO can be acquired [258].

### 4.2.6 WEARING OF A MASK

The prevalence of nasal carriage of MRSA by hospital personnel is highly variable, sometimes null [122], sometimes very high in some units (severe burn treatment) [259]. This prevalence depends on the MRSA reservoir in the unit [260]. Masks are recommended for treatments involving the risk of contaminated aerosols [15]. They are in fact rarely worn in the context of contact precautions. In intensive care units with a high rate of nosocomial MRSA infection, the withdrawal of additional droplet precautions did not increase the incidence of MRSA infections, thus suggesting that the mask is not a priority measure, outside the scope of standard precautions, in the control of MRSA cross-contamination in intensive care [34].

# BIBLIOGRAPHICAL REFERENCES


**1-** Cooper BS, Stone SP, Kibb ler CC, *et al*. Isolation measures in the hospital management of methicillin resistant *Staphylococcus aureus* (MRSA): systematic review of the literature. Bmj 2004; 329(7465):533.

**2-** Shardell M, Harris AD, El-Kamary SS, Furuno JP, Miller RR, Perencevich EN . Statistical analysis and application of quasi experiments to antimicrobial resistance intervention studies. Clin Infect Dis 2007; 45(7): 901-907.

**3-** Slaughter S, Hayden MK, Nathan C, *et al*. A comparison of the effect of universal use of gloves and gowns with that of glove use alone on acquisition of vancomycin-resistant enterococci in a medical intensive care unit. Ann Intern Med 1996; 125(6): 448-456.

**4-** Golan Y, Doron S, Griff ith J, *et al*. The impact of gown-use requirement on hand hygiene compliance. Clin Infect Dis 2006; 42(3): 370-376.

**5-** Muto CA, Sistrom MG, Farr BM. Hand hygiene rates unaffected by installation of dispensers of a rapidly acting hand antiseptic. Am J Infect Control 2000; 28(3): 273-276.

**6-** Lankf ord MG, Zemb ower TR, Trick WE, Hacek DM, Nosk in GA, Peterson LR . Influence of role models and hospital design on hand hygiene of healthcare workers. Emerg Infect Dis 2003; 9(2): 217-223.

**7-** Strausb augh LJ, Siegel JD, Weinstein RA. Preventing transmission of multidrug-resistant bacteria in health care settings: a tale of 2 guidelines. Clin Infect Dis 2006; 42(6): 828-835.

**8-** Muto CA, Jarvis WR, Farr BM. Another tale of two guidelines. Clin Infect Dis 2006; 43(6): 796-797; author reply 7-8.

**9-** Farr BM. Doing the right thing (and figuring out what that is). Infect Control Hosp Epidemiol 2006; 27(10): 999-1003.

**10-** Farr BM. What to think if the results of the National Institutes of Health randomized trial of methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant enterococcus control measures are negative (and other advice to young epidemiologists): a review and an au revoir. Infect Control Hosp Epidemiol 2006; 27(10): 1096-1106.

**11-** Farr BM. Political *versus* epidemiological correctness. Infect Control Hosp Epidemiol 2007; 28(5): 589-593.

**12-** Talbot TR. Two studies feed the debate on active surveillance for methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant enterococci carriage: to screen or not to screen? J Infect Dis 2007; 195(3): 314-317.

**13-** Muto CA, Jernigan JA, Ostrowsk y BE, *et al*. SHE A guideline for preventing nosocomial transmission of multidrug-resistant strains of *Staphylococcus aureus* and enterococcus. Infect Control Hosp Epidemiol 2003; 24(5): 362-386.

**14-** Hospital Infection Control Practices Advisory Committee (HICPAC). Management of Multidrug-Resistant Organisms in Healthcare Settings. 2006 [consulté le 01/09/2008]. http://www.cdc.gov/ncidod/dhqp/pdf/ar/mdro Guideline2006.pdf

**15-** Comité technique national des infections nosocomiales. Maîtrise de la diffusion des bactéries multirésistantes aux antibiotiques. Recommandations pour les établissements de santé. Documentation du Ministère de l'Emploi et de la Solidarité, 1999.

**16-** Stelfox HT , Bates DW , Redelmeier DA . Safety of patients isolated for infection control. Jama 2003; 290(14): 1899-1905.

**17-** Needleman J, Buerhaus P, Mattke S, Stewart M, Zelevinsk y K. Nurse-staffing levels and the quality of care in hospitals. N Engl J Med 2002; 346(22): 1715-1722.

**18-** Hugonnet S, Harbarth S, Sax H, Duncan RA, Pittet D. Nursing resources: a major determinant of nosocomial infection? Curr Opin Infect Dis 2004; 17(4): 329-333.

**19-** Thuong M, Arvaniti K, Ruimy R, *et al*. Epidemiology of *Pseudomonas aeruginosa* and risk factors for carriage acquisition in an intensive care unit. J Hosp Infect 2003; 53(4): 274-282.

**20-** Lucet JC, Decre D, Fichelle A, *et al*. Control of a prolonged outbreak of extended-spectrum beta-lactamase-producing enterobacteriaceae in a university hospital. Clin Infect Dis 1999; 29(6): 1411-1418.

**21-** Cooper BS, Stone SP, Kibb ler CC, *et al*. Isolation measures in the hospital management of methicillin resistant *Staphylococcus aureus* (MRSA): systematic review of the literature. BMJ 2004, 2004; 329(7465): 533-540.

**22-** Duck worth GJ, Lothian JL, Williams JD. Methicillin-resistant *Staphylococcus aureus*: report of an outbreak in a London teaching hospital. J Hosp Infect 1988; 11(1): 1-15.

**23-** Faoagali JL, Thong ML, Grant D. Ten years' experience with methicillin-resistant *Staphylococcus aureus* in a large Australian hospital. J Hosp Infect 1992; 20(2): 113-119.

**24-** Farrington M, Redpath C, Trundle C, Coomb er S, Brown NM. Winning the battle but losing the war: methicillin-resistant *Staphylococcus aureus* (MRSA) infection at

a teaching hospital. Qjm 1998; 91(8): 539-548.

**25-** Coello R, Jimenez J, Garcia M, *et al*. Prospective study of infection, colonization and carriage of methicillin-resistant *Staphylococcus aureus* in an outbreak affecting 990 patients. Eur J Clin Microbiol Infect Dis 1994; 13(1): 74-81.

**26-** Cosseron-Zerbib M, Roque Afonso AM, Naas T, *et al*. A control programme for MRSA (methicillin-resistant *Staphylococcus aureus*) containment in a paediatric intensive care unit: evaluation and impact on infections caused by other micro-organisms. J Hosp Infect 1998; 40(3): 225-235.

**27-** Harbarth S, Martin Y, Rohner P, Henry N, Auck enthaler R, Pittet D. Effect of delayed infection control measures on a hospital outbreak of methicillin-resistant *Staphylococcus aureus*. J Hosp Infect 2000; 46(1): 43-49.

**28-** Nijs en S, Bonten MJ, Weinstein RA . Are active microbiological surveillance and subsequent isolation needed to prevent the spread of methicillin-resistant *Staphylococcus aureus*? Clin Infect Dis 2005; 40(3): 405-409.

**29-** Gastmeier P, Schwab F, Geff ers C, Ruden H. To isolate or not to isolate? Analysis of data from the German Nosocomial Infection Surveillance System regarding the placement of patients with methicillin-resistant *Staphylococcus aureus* in private rooms in intensive care units. Infect Control Hosp Epidemiol 2004; 25(2): 109-113.

**30-** Cepeda JA, Whitehouse T, Cooper B, *et al*. Isolation of patients in single rooms or cohorts to reduce spread of MRSA in intensive-care units: prospective two-centre study. Lancet 2005; 365(9456): 295-304.

**31-** Pan A, Carnevale G, Catenazz i P, *et al*. Trends in methicillin-resistant *Staphylococcus aureus* (MRSA) bloodstream infections: effect of the MRSA "search and isolate" strategy in a hospital in Italy with hyperendemic MRSA. Infect Control Hosp Epidemiol 2005; 26(2): 127-133.

**32-** Huang SS, Yokoe DS, Hinrichsen VL, *et al*. Impact of routine intensive care unit surveillance cultures and resultant barrier precautions on hospital-wide methicillin-resistant *Staphylococcus aureus* bacteremia. Clin Infect Dis 2006; 43(8): 971-978.

**33-** Gillespie EE, ten Berk de Boer FJ, Stuart RL, Buist MD, Wilson JM. A sustained reduction in the transmission of methicillin resistant *Staphylococcus aureus* in an intensive care unit. Crit Care Resusc 2007; 9(2): 161-165.

**34-** Mangini E, Segal-Maurer S, Burns J, *et al*. Impact of contact and droplet precautions on the incidence of hospital-acquired methicillin-resistant *Staphylococcus aureus* infection. Infect Control Hosp Epidemiol 2007; 28(11): 1261-1266.

**35-** Raineri E, Crema L, De Silvestri A, *et al*. Meticillin-resistant *Staphylococcus aureus* control in an intensive care unit: a 10 year analysis. J Hosp Infect 2007; 67(4): 308-315.

**36-** Centers for Disease Control and Prevention. Guideline for Hand Hygiene in Health-Care Settings: Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HI CPAC/SHE A/APIC/IDSA Hand Hygiene Task Force. MM WR 2002; 51(N° RR-16):1-56 - http://www.cdc.gov/mmwr/PDF/rr/rr5116.pdf.

**37-** Société française d'hygiène hospitalière. Recommandations pour la désinfection des mains. 2002 [consulté le 01/09/2008]; http://sfhh.net/telechargement/recommandations_hygienemain.pdf

**38-** World Health Organization. World Alliance for Patient Safety. WHO Guidelines on hand hygiene in health care (Advanced Draft).2006 [consulté le 01/01/2008]; http://www.who.int/patientsafety/information_centre/guidelines_hhad/en/index.html

**39-** Siegel JD, Rhinehart E, Jacks on M, Chiarello L, Healthcare Infection Control Practives Advisory Comm ittee (HI CPAC). 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Health Care Settings. Am J Infect Control 2007; 35(10 Suppl 2): S65-164.

**40-** Siegel JD, Rhinehart E, Jacks on M, Chiarello L, Healthcare Infection Control Practives Advisory Comm ittee (HI CPAC). Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. 2007 [consulté le 01/09/2008]; http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/Isolation2007.pdf

**41-** Comité technique national des infections nosocomiales. Avis du5 décembre 2001 sur la place de la friction hydro-alcoolique dans l'hygiène des mains lors des soins. Bull Epidemiol Hebdo 2002(8): 35.

**42-** Pittet D, Allegranzi B, Sax H, *et al*. Evidence-based model for hand transmission during patient care and the role of improved practices. Lancet Infect Dis 2006; 6(10): 641-652.

**43-** Pronovost P, Needham D, Berenholtz S, *et al*. An intervention to decrease catheter-related bloodstream infections in the ICU. N Engl J Med 2006; 355(26): 2725-2732.

**44-** Guide de bonnes pratiques pour la prévention des infections liées aux soins réalisés en dehors des établissements de soins. Ministère de la Santé et des Solidarités, Direction générale de la Santé, janvier 2006. 2006 [consulté le 01/09/2008]; http://www.sante.gouv.fr/htm/dossiers/infect_soins/guide.pdf

**45-** Lee GM, Salomon JA, Friedman JF, *et al*. Illness transmission in the home: a possible role for alcohol-based hand gels. Pediatrics 2005; 115(4): 852-860.

**46-** Sax H, Posf ay-Barbe K, Harbarth S, *et al*. Control of a cluster of community-associated, methicillin-resistant *Staphylococcus aureus* in neonatology. J Hosp Infect 2006; 63(1): 93-100.

**47-** DeBug. Infection Prevention Program, Austin Health, Melbourne, Australia. [consulté le 01/09/2008]; http://www.debug.net.au/index.html

**48-** Ross off LJ, Lam S, Hilton E, Borenstein M, Isenberg HD. Is the use of boxed gloves in an intensive care unit safe? Am J Med 1993 Jun; 94(6): 602-607.

**49-** Tenorio AR, Badri SM, Sahgal NB, *et al*. Effectiveness of gloves in the prevention of hand carriage of vancomycin-resistant enterococcus species by health care workers after patient care. Clin Infect Dis 2001; 32(5): 826-829.

**50-** Olsen RJ, Lynch P, Coyle MB, Cumm ings J, Bokete T, Stamm WE. Examination gloves as barriers to hand contamination in clinical practice. Jama 1993; 270(3): 350-353.

**51-** Pess oa-Silva CL, Dharan S, Hugonnet S, *et al*. Dynamics of bacterial hand contamination during routine neonatal care. Infect Control Hosp Epidemiol 2004; 25(3): 192-197.

**52-** Moolenaar RL, Crutcher JM, San Joaquin VH, *et al*. A prolonged outbreak of *Pseudomonas aeruginosa* in a neonatal intensive care unit: did staff fingernails play a role in disease transmission? Infect Control Hosp Epidemiol 2000; 21(2): 80-85.

**53-** Jeanes A, Green J. Nail art: a review of current infection control issues. J Hosp Infect 2001; 49(2): 139-142.

**54-** Foca M, Jakob K, Whittier S, *et al*. Endemic *Pseudomonas aeruginosa* infection in a neonatal intensive care unit. N Engl J Med 2000; 343(10): 695-700.

**55-** Gupta A, Della-Latta P, Todd B, *et al*. Outbreak of extended-spectrum beta-lactamase-producing *Klebsiella pneumoniae* in a neonatal intensive care unit linked to artificial nails. Infect Control Hosp Epidemiol 2004; 25(3): 210-215.

**56-** McNeil SA, Foster CL, Hedderwick SA, Kauffm an CA. Effect of hand cleansing with antimicrobial soap or alcohol-based gel on microbial colonization of artificial fingernails worn by health care workers. Clin Infect Dis 2001; 32(3): 367-372.

**57-** Trick WE, Vernon MO, Hayes RA, *et al*. Impact of ring wearing on hand contamination and comparison of hand hygiene agents in a hospital. Clin Infect Dis 2003; 36(11): 1383-1390.

**58-** Larson EL, Morton HE. Alcohols [Chapter 11]. *In:* SS B, ed. Disinfection, sterilization and preservation 4th ed. Philadelphia, PA: Lea and Febiger, 1991: 642-654.

**59-** Larson E, Bobo L. Effective hand degerming in the presence of blood. J Emerg Med 1992; 10(1): 7-11.

**60-** Larson EL, Eke PI, Wilder MP, Laughon BE. Quantity of soap as a variable in handwashing. Infect Control 1987; 8(9): 371-375.

**61-** Hubner NO, Kampf G, Kamp P, Kohlmann T, Kramer A. Does a preceding hand wash and drying time after surgical hand disinfection influence the efficacy of a propanol-based hand rub? BMC Microbiol 2006; 6: 57-60.

**62-** Haut Conseil de la santé publique. Avis du 20 juin 2008 relatif à la maîtrise de la diffusion des infections à *Clostridium difficile* dans les établissements de santé français. 2008 [consulté le 01/09/2008]; http://www.hcsp.fr/hcspi/docspdf/avisrapports/hcspa20080620_Cdifficile.pdf

**63-** Bisc hoff WE, Reynolds TM, Sess ler CN, Edmond MB, Wenzel RP. Handwashing compliance by health care workers: the impact of introducing an accessible, alcohol-based hand antiseptic. Arch Intern Med 2000; 160(7): 1017-1021.

**64-** Pittet D, Simon A, Hugonnet S, Pessoa-Silva CL, Sauvan V, Perneger TV . Hand hygiene among physicians: performance, beliefs, and perceptions. Ann Intern Med 2004; 141(1): 1-8.

**65-** Tavolacc i MP, Marini H, Vanheste S, *et al*. A voluntary ingestion of alcohol-based hand rub. J Hosp Infect 2007; 66(1): 86-87.

**66-** Roberts HS, Self RJ, Coxon M. An unusual complication of hand hygiene. Anaesthesia 2005; 60(1): 100-101.

**67-** Boyce JM, Pearson ML. Low frequency of fires from alcoholbased hand rub dispensers in healthcare facilities. Infect Control Hosp Epidemiol 2003; 24(8): 618-619.

**68-** Sartor C, Jacomo V, Duvivier C, Tissot-Dupont H, Sambuc R, Drancourt M. Nosocomial *Serratia marcescens* infections associated with extrinsic contamination of a liquid nonmedicated soap. Infect Control Hosp Epidemiol 2000; 21(3): 196-199.

**69-** Boyce JM, Kelliher S, Vallande N. Skin irritation and dryness associated with two hand-hygiene regimens: soap-and-water hand washing *versus* hand antisepsis with an alcoholic hand gel. Infect Control Hosp Epidemiol 2000; 21(7): 442-448.

**70-** Loff ler H, Kampf G, Schmermund D, Maibach HI. How irritant is alcohol? Br J Dermatol 2007; 157(1): 74-81.

**71-** Schwanitz HJ, Riehl U, Schlesinger T, Bock M, Skudlik C, Wulfhorst B. Skin care management: educational aspects. Int Arch Occup Environ Health 2003; 76(5): 374-381.

**72-** Ramsing DW, Agner T. Preventive and therapeutic effects of a moisturizer. An

experimental study of human skin. Acta Derm Venereol 1997; 77(5): 335-337.

**73-** Berndt U, Wigger-Alberti W, Gabard B, Elsner P. Efficacy of a barrier cream and its vehicle as protective measures against occupational irritant contact dermatitis. Contact Dermatitis 2000; 42(2):77-80.

**74-** Kampf G, Ennen J. Regular use of a hand cream can attenuate skin dryness and roughness caused by frequent hand washing. BMC Dermatol 2006; 6: 1-5.

**75-** Kampf G, Loff ler H. Prevention of irritant contact dermatitis among health care workers by using evidence-based hand hygiene practices: a review. Ind Health 2007; 45(5): 645-652.

**76-** Turner P, Saeed B, Kelsey MC. Dermal absorption of isopropyl alcohol from a commercial hand rub: implications for its use in hand decontamination. J Hosp Infect 2004; 56(4): 287-290.

**77-** Brown TL, Gamon S, Tester P, *et al*. Can alcohol-based hand-rub solutions cause you to lose your driver's license? Comparative cutaneous absorption of various alcohols. Antimicrob Agents Chemother 2007; 51(3): 1107-1108.

**78-** Kramer A, Below H, Bieber N, *et al*. Quantity of ethanol absorption after excessive hand disinfection using three commercially available hand rubs is minimal and below toxic levels for humans. BMC Infect Dis 2007; 7: 117-128.

**79-** Patterson JE, Vecc hio J, Pantelick EL, *et al*. Association of contaminated gloves with transmission of *Acinetobacter calcoaceticus* var. anitratus in an intensive care unit. Am J Med 1991; 91(5): 479-483.

**80-** McGuck in M, Taylor A, Martin V, Porten L, Salcido R. Evaluation of a patient education model for increasing hand hygiene compliance in an inpatient rehabilitation unit. Am J Infect Control 2004; 32(4): 235-238.

**81-** Pittet D, Hugonnet S, Harbarth S, *et al*. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. Lancet 2000; 356(9238): 1307-1312.

**82-** MacDonald A, Dinah F, MacKenzie D, Wilson A. Performance feedback of hand hygiene, using alcohol gel as the skin decontaminant, reduces the number of inpatients newly affected by MRSA and antibiotic costs. J Hosp Infect 2004; 56(1): 56-63.

**83-** Johnson PD, Martin R, Burrell LJ, *et al*. Efficacy of an alcohol/ chlorhexidine hand hygiene program in a hospital with high rates of nosocomial methicillin-resistant *Staphylococcus aureus* (MRSA) infection. Med J Aust 2005; 183(10): 509-514.

**84-** Rosenthal VD, Guzman S, Safdar N. Reduction in nosocomial infection with improved hand hygiene in intensive care units of a tertiary care hospital in Argentina. Am J Infect Control 2005; 33(7): 392-397.

**85-** Centers for Disease Control and Prevention. Prevention of HIV transmission. MM WR 1987; 36 suppl 2S: S3-S18.

**86-** US Department of Labor. Occupational Safety and Health Administration 29 CFR Part 1910. 1030 occupational exposure to bloodborne pathogens; needlestick and other sharps injuries; final rule. Federal Register 2001; 66(12): 5317-5325. As amended from and includes Federal Register 1991 29 CFR Part 1910. 1030 occupational exposure to blood-borne pathogens; final rule. 2001, 56(235): 64174-64182.

**87-** Hagos B, Kibwage IO , Mwongera M, Muthotho JN, Githiga IM, Mukindia GG . The microbial and physical quality of recycled gloves. East Afr Med J 1997; 74(4): 224-226.

**88-** Doebb eling BN, Pfaller MA, Houston AK, Wenzel RP. Removal of nosocomial pathogens from the contaminated glove. Implications for glove reuse and handwashing. Ann Intern Med 1988 1; 109(5): 394-398.

**89-** Pittet D, Dharan S, Touveneau S, Sauvan V, Perneger TV . Bacterial contamination of the hands of hospital staff during routine patient care. Arch Intern Med 1999; 159(8): 821-826.

**90-** Gehanno JF, Kohen-Couderc L, Lemeland JF, Leroy J. Nosocomial meningococcemia in a physician. Infect Control Hosp Epidemiol 1999; 20(8): 564-565.

**91-** Scales DC, Green K, Chan AK, *et al*. Illness in intensive care staff after brief exposure to severe acute respiratory syndrome. Emerg Infect Dis 2003; 9(10): 1205-1210.

**92-** Seto WH , Tsang D, Yung RW , *et al*. Effectiveness of precautions against droplets and contact in prevention of nosocomial transmission of severe acute respiratory syndrome (SARS). Lancet 2003; 361(9368): 1519-1520.

**93-** Bridges CB, Kuehnert MJ, Hall CB. Transmission of influenza: implications for control in health care settings. Clin Infect Dis 2003; 37(8): 1094-1101.

**94-** Musher DM. How contagious are common respiratory tract infections? N Engl J Med 2003; 348(13): 1256-1266.

**95-** Bass etti S, Bisc hoff WE, Walter M, *et al*. Dispersal of *Staphylococcus aureus* into the air associated with a rhinovirus infection. Infect Control Hosp Epidemiol 2005; 26(2): 196-203.

**96-** Centers for Disease Control and Prevention. Perspectives in Disease Prevention and Health Promotion Update: Universal Precautions for Prevention of Transmission of Human Immunodeficiency Virus, Hepatitis B Virus, and Other Bloodborne Pathogens in Health-Care Settings. MM WR 1988; 37(24): 377-388.

**97-** Centers for Disease Control and Prevention. Recommendations for Preventing Transmission of Infection with Human T-Lymphotropic Virus Type II / Lymphadenopathy-Associated Virus in the Workplace. MM WR 1985; 34(45): 682-686, 91-95.

**98-** Hall CB. Nosocomial respiratory syncytial virus infections: the "Cold War" has not ended. Clin Infect Dis 2000; 31(2): 590-596.

**99-** Jarvis WR. Handwashing-the Semmelweis lesson forgotten? Lancet 1994; 344(8933): 1311-1312.

**100-** Puzniak LA, Leet T, Mayfield J, Kollef M, Mundy LM. To gown or not to gown: the effect on acquisition of vancomycin-resistant enterococci. Clin Infect Dis 2002; 35(1): 18-25.

**101-** Buff ington J, Chapman LE, Stobiersk i MG, *et al*. Epidemic keratoconjunctivitis in a chronic care facility: risk factors and measures for control. J Am Geriatr Soc 1993; 41(11): 1177-1181.

**102-** Doherty JA, Brookf ield DS, Gray J, McEwan RA. Cohorting of infants with respiratory syncytial virus. J Hosp Infect 1998; 38(3): 203-206.

**103-** Graham PL, 3rd, Morel AS, Zhou J, *et al*. Epidemiology of methicillin-susceptible *Staphylococcus aureus* in the neonatal intensive care unit. Infect Control Hosp Epidemiol 2002; 23(11): 677-682.

**104-** Zawack i A, O'Rourke E, Potter-Bynoe G, Macone A, Harbarth S, Goldmann D. An outbreak of *Pseudomonas aeruginosa* pneumonia and bloodstream infection associated with intermittent otitis externa in a healthcare worker. Infect Control Hosp Epidemiol 2004; 25(12): 1083-1089.

**105-** Kampf G, Kramer A. Epidemiologic background of hand hygiene and evaluation of the most important agents for scrubs and rubs. Clin Microbiol Rev 2004; 17(4): 863-893.

**106-** Widmer AF, Conzelmann M, Tomic M, Frei R, Stranden AM. Introducing alcohol-based hand rub for hand hygiene: the critical need for training. Infect Control Hosp Epidemiol 2007; 28(1): 50-54.

**107-** Kampf G, Ostermeyer C. Intra-laboratory reproducibility of the hand hygiene reference procedures of EN 1499 (hygienic handwash) and EN 1500 (hygienic hand disinfection). J Hosp Infect 2002; 52(3): 219-224.

**108-** Ministère de la Santé et de la Protection sociale. Circulaire DGS /SD5C-DHOS /E2/ 2005-384 du 11 août 2005 relative à la stratégie nationale d'audit des pratiques en hygiène hospitalière. 2005 [consulté le 01/09/2008]; http://nosobase.chu-lyon.fr/legislation/Hygienemains/2005/ci110805.pdf

**109-** Ministère de la Santé et des Solidarités. Circulaire DHOS /E2/ DGS /5C/2006/82 du 24 février 2006 relative aux mesures à envisager pour l'amélioration du niveau d'activités des établissements de santé en matière de lutte contre les infections nosocomiales. 2006 [consulté le 01/09/2008]; http://www.sante.gouv.fr/htm/dossiers/nosoco/tab_bord/documents/06_82t.pdf

**110-** Ministère de la Santé et de la Protection sociale. Programme national de lutte contre les infections nosocomiales 2005-2008. 2005 [consulté le 01/09/2008]; http://www.sante-sports.gouv.fr/IMG//pdf/programme_2005_2008.pdf

**111-** Ministère de la Santé et de la Protection sociale. Circulaire DHOS /E2/DGS /5C/2006/121 du 13 mars 2006 relative au tableau de bord des infections nosocomiales et portant sur les modalités de calcul et de présentation de l'indicateur de volume de produits hydro-alcooliques consommé par les établissements de santé. 2006 [consulté le 01/09/2008];http://www.sante.gouv.fr/htm/dossiers/nosoco/tab_bord/icsha/06_121t0.pdf

**112-** Hugonnet S, Perneger TV, Pittet D. Alcohol-based handrub improves compliance with hand hygiene in intensive care units. Arch Intern Med 2002; 162(9): 1037-1043.

**113-** Conly JM, Hill S, Ross J, Lertzm an J, Louie TJ. Handwashing practices in an intensive care unit: the effects of an educational program and its relationship to infection rates. Am J Infect Control 1989; 17(6): 330-339.

**114-** Dubb ert PM, Dolce J, Richter W, Miller M, Chapman SW. Increasing ICU staff handwashing: effects of education and group feedback. Infect Control Hosp Epidemiol 1990; 11(4): 191-193.

**115-** Tomic V, Svetina Sorli P, Trinkaus D, Sorli J, Widmer AF, Trampuz A. Comprehensive Strategy to Prevent Nosocomial Spread of Methicillin-Resistant *Staphylococcus aureus* in a Highly Endemic Setting. Arch Intern Med 2004; 164(18): 2038-2043.

**116-** EARSS . Annual Report 2007. [consulté le 01/04/2009]; http://www.earss.rivm.nl/

**117-** Nicolle LE, Dyck B, Thompson G, *et al*. Regional dissemination and control of epidemic methicillin-resistant *Staphylococcus aureus*. Manitoba Chapter of CHI CA-Canada. Infect Control Hosp Epidemiol 1999; 20(3): 202-205.

**118-** Ostrowsk y BE, Trick WE, Sohn AH, *et al*. Control of vancomycinresistant enterococcus in health care facilities in a region. N Engl J Med 2001; 344(19): 1427-1433.

**119-** Smith DL, Levin SA, Laxminarayan R. Strategic interactions in multi-institutional epidemics of antibiotic resistance. Proc Natl Acad Sci U S A 2005; 102(8): 3153-3158.

**120-** Thompson RL, Cabezudo I, Wenzel RP . Epidemiology of nosocomial infections caused by methicillin-resistant

*Staphylococcus aureus*. Ann Intern Med 1982; 97(3): 309-317.

**121-** Jernigan JA, Clemence MA, Stott GA, *et al*. Control of methicillinresistant *Staphylococcus aureus* at a university hospital: one decade later. Infect Control Hosp Epidemiol 1995; 16(12): 686-696.

**122-** Jernigan JA, Titus MG, Grosc hel DH , Getchell-White S, Farr BM. Effectiveness of contact isolation during a hospital outbreak of methicillin-resistant *Staphylococcus aureus*. Am J Epidemiol 1996; 143(5): 496-504.

**123-** Girou E, Pujade G, Legrand P, Cizeau F, Brun-Buiss on C. Selective screening of carriers for control of methicillin-resistant *Staphylococcus aureus* (MRSA) in high-risk hospital areas with a high level of endemic MRSA. Clin Infect Dis 1998; 27(3): 543-550.

**124-** Vriens MR, Fluit AC, Troelstra A, Verhoef J, van der Werken C. Is methicillin-resistant *Staphylococcus aureus* more contagious than methicillin-susceptible *S. aureus* in a surgical intensive care unit? Infect Control Hosp Epidemiol 2002; 23(9): 491-494.

**125-** Kotilainen P, Routamaa M, Peltonen R, *et al*. Elimination of epidemic methicillin-resistant *Staphylococcus aureus* from a university hospital and district institutions, Finland. Emerg Infect Dis 2003; 9(2): 169-175.

**126-** Haley RW , Cushion NB, Tenover FC, *et al*. Eradication of endemic methicillin-resistant *Staphylococcus aureus* infections from a neonatal intensive care unit. J Infect Dis 1995; 171(3): 614-624.

**127-** Verhoef J, Beaujean D, Blok H, *et al*. A Dutch approach to methicillin- resistant *Staphylococcus aureus*. Eur J Clin Microbiol Infect Dis 1999; 18(7): 461-466.

**128-** Siegel JD, Rhinehart E, Jacks on M, Chiarello L, Healthcare Infection Control Practives Advisory Comm ittee (HI CPAC). Management of Multidrug-Resistant Organisms In Healthcare Settings, 2006. 2006 [consulté le 01/09/2008]; http://www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf

**129-** Lucet JC, Paoletti X, Lolom I, *et al*. Successful long-term program for controlling methicillin-resistant *Staphylococcus aureus* in intensive care units. Intensive Care Med 2005; 31(8): 1051-1057.

**130-** Réseau d'alerte d'investigation et de surveillance des infections nosocomiales (RAISIN). Surveillance des infections nosocomiales en réanimation adulte. France, résultats 2006. 2007 (decembre 2007) [consulté le 01/09/2008]; http://www.invs.sante.fr/publications/2007/rea_raisin/index.html

**131-** Huang SS, Rifas-Shiman SL, Warren DK, *et al*. Improving methicillin- resistant *Staphylococcus aureus* surveillance and reporting in intensive care units. J Infect Dis 2007; 195(3): 330-338.

**132-** Brun-Buiss on C, Rauss A, Legrand P, Mentec H, Oss art M, Eb F. Traitement du portage nasal de *Staphylococcus aureus* par la mupirocine nasale et prévention des infections acquises en réanimation. Etude multicentrique contrôlée. Med Mal Infect 1994; 24: 1229-1239.

**133-** Talon D, Rouget C, Cailleaux V, *et al*. Nasal carriage of *Staphylococcus aureus* and cross-contamination in a surgical intensive care unit: efficacy of mupirocin ointment. J Hosp Infect 1995; 30(1):39-49.

**134-** Merrer J, Santoli F, Appere de Vecc hi C, Tran B, De Jonghe B, Outin H. "Colonization pressure" and risk of acquisition of methicillin-resistant *Staphylococcus aureus* in a medical intensive care unit. Infect Control Hosp Epidemiol 2000; 21(11): 718-723.

**135-** Lucet JC, Chevret S, Durand-Zaleski I, Chastang C, Regnier B. Prevalence and risk factors for carriage of methicillin-resistant *Staphylococcus aureus* at admission to the intensive care unit: results of a multicenter study. Arch Intern Med 2003; 163(2): 181-188.

**136-** Grundmann H, Hori S, Winter B, Tami A, Austin DJ. Risk factors for the transmission of methicillin-resistant *Staphylococcus aureus* in an adult intensive care unit: fitting a model to the data. J Infect Dis 2002; 185(4): 481-488.

**137-** Ho PL. Carriage of methicillin-resistant *Staphylococcus aureus*, ceftazidime-resistant Gram-negative bacilli, and vancomycin-resistant enterococci before and after intensive care unit admission. Crit Care Med 2003; 31(4): 1175-1182.

**138-** Warren DK, Guth RM, Coopersm ith CM, Merz LR , Zack JE, Fraser VJ. Impact of a methicillin-resistant *Staphylococcus aureus* active surveillance program on contact precaution utilization in a surgical intensive care unit. Crit Care Med 2007; 35(2): 430-434.

**139-** Byers KE, Anglim AM, Annesk i CJ, *et al*. A hospital epidemic of vancomycin-resistant Enterococcus: risk factors and control. Infect Control Hosp Epidemiol 2001; 22(3): 140-147.

**140-** Hidron AI, Kourbatova EV , Halvosa JS, *et al*. Risk factors for colonization with methicillin-resistant *Staphylococcus aureus* (MRSA) in patients admitted to an urban hospital: emergence of communityassociated MRSA nasal carriage. Clin Infect Dis 2005; 41(2): 159-166.

**141-** Harbarth S, Sax H, Fankhauser-Rodriguez C, Schrenzel J, Agostinho A, Pittet D. Evaluating the probability of previously unknown carriage of MRSA at hospital admission. Am J Med 2006 Mar; 119(3): 275 e15-23.

**142-** Furuno JP, McGregor JC, Harris AD, *et al*. Identifying groups at high risk for carriage of antibiotic-resistant bacteria. Arch Intern Med 2006; 166(5): 580-585.

**143-** West TE , Guerry C, Hiott M, Morrow N, Ward K, Salgado CD. Effect of targeted surveillance for control of methicillin-resistant *Staphylococcus aureus* in a community hospital system. Infect Control Hosp Epidemiol 2006; 27(3): 233-238.

**144-** Chaix C, Durand-Zalesk i I, Alberti C, Brun-Buiss on C. Control of endemic methicillin-resistant *Staphylococcus aureus*: a cost-benefit analysis in an intensive care unit. Jama 1999; 282(18): 1745-1751.

**145-** Papia G, Louie M, Tralla A, Johnson C, Collins V, Simor AE . Screening high-risk patients for methicillin-resistant *Staphylococcus aureus* on admission to the hospital: is it cost effective? Infect Control Hosp Epidemiol 1999; 20(7): 473-477.

**146-** Girou E, Azar J, Wolkenstein P, Cizeau F, Brun-Buiss on C, Roujeau JC. Comparison of systematic *versus* selective screening for methicillin-resistant *Staphylococcus aureus* carriage in a high-risk dermatology ward. Infect Control Hosp Epidemiol 2000; 21(9): 583-587.

**147-** Eveillard M, Ernst C, Cuviller S, *et al*. Prevalence of methicillinresistant *Staphylococcus aureus* carriage at the time of admission in two acute geriatric wards. J Hosp Infect 2002; 50(2): 122-126.

**148-** Eveillard M, Mortier E, Lancien E, *et al*. Consideration of age at admission for selective screening to identify methicillin-resistant *Staphylococcus aureus* carriers to control dissemination in a medical ward. Am J Infect Control 2006; 34(3): 108-113.

**149-** Samad A, Banerjee D, Carbarns N, Ghosh S. Prevalence of methicillin-resistant *Staphylococcus aureus* colonization in surgical patients, on admission to a Welsh hospital. J Hosp Infect 2002; 51(1): 43-46.

**150-** Morange-Sauss ier V, Giraudeau B, van der Mee N, Lermusiaux P, Quentin R. Nasal carriage of methicillin-resistant *Staphylococcus aureus* in vascular surgery. Ann Vasc Surg 2006; 20(6): 767-772.

**151-** Muralidhar B, Anwar SM, Handa AI , Peto TE, Bowler IC. Prevalence of MRSA in emergency and elective patients admitted to a vascular surgical unit: implications for antibiotic prophylaxis. Eur J Vasc Endovasc Surg 2006; 32(4): 402-407.

**152-** Diller R, Sonntag AK, Mellmann A, *et al*. Evidence for cost reduction based on pre-admission MRSA screening in general surgery. Int J Hyg Environ Health 2008; 211: 205-212.

**153-** Lucet JC, Grenet K, Armand-Lefevre L, *et al*. High prevalence of carriage of methicillin-resistant *Staphylococcus aureus* at hospital admission in elderly patients: implications for infection control strategies. Infect Control Hosp Epidemiol 2005; 26(2): 121-126.

**154-** Salgado CD, Farr BM. What proportion of hospital patients colonized with methicillin-resistant *Staphylococcus aureus* are identified by clinical microbiological cultures? Infect Control Hosp Epidemiol 2006; 27(2): 116-121.

**155-** Shitrit P, Gottesm an BS, Katzir M, Kilman A, Ben-Niss an Y, Chowers M. Active surveillance for methicillin-resistant *Staphylococcus aureus* (MRSA) decreases the incidence of MRSA bacteremia. Infect Control Hosp Epidemiol 2006; 27(10): 1004-1008.

**156-** Eveillard M, Leroy C, Teiss iere F, *et al*. Impact of selective screening in the emergency department on meticillin-resistant *Staphylococcus aureus* control programmes. J Hosp Infect 2006; 63(4): 380-384.

**157-** Lesc ure FX, Locher G, Eveillard M, *et al*. community-acquired infection with healthcare-associated methicillin-resistant *Staphylococcus aureus*: the role of home nursing care. Infect Control Hosp Epidemiol 2006; 27(11): 1213-1218.

**158-** Rioux C, Armand-Lefevre L, Guerinot W, Andremont A, Lucet JC. Acquisition of methicillin-resistant *Staphylococcus aureus* in the acute care setting: incidence and risk factors. Infect Control Hosp Epidemiol 2007; 28(6): 733-736.

**159-** Wernitz MH, Swidsinsk i S, Weist K, *et al*. Effectiveness of a hospital- wide selective screening programme for methicillin-resistant *Staphylococcus aureus* (MRSA) carriers at hospital admission to prevent hospital-acquired MRSA infections. Clin Microbiol Infect 2005; 11(6): 457-465.

**160-** Bradley SF, Terpenning MS, Rams ey MA, *et al*. Methicillin-resistant *Staphylococcus aureus*: colonization and infection in a longterm care facility. Ann Intern Med 1991; 115(6): 417-422.

**161-** Bradley SF. Methicillin-resistant *Staphylococcus aureus*: longterm care concerns. Am J Med 1999; 106(5A): 2S-10S; discussion 48S-52S.

**162-** Drinka P, Faulks JT, Gauerke C, Goodman B, Stemper M, Reed K. Adverse events associated with methicillin-resistant *Staphylococcus aureus* in a nursing home. BMC Geriatr 2003; 3: 5-10

**163-** Talon DR, Bertrand X. Methicillin-resistant *Staphylococcus aureus* in geriatric patients: usefulness of screening in a chroniccare setting. Infect Control Hosp Epidemiol 2001; 22(8): 505-509.

**164-** Sax H, Harbarth S, Gavazz i G, *et al*. Prevalence and prediction of previously unknown MRSA carriage on admission to a geriatric hospital. Age Ageing 2005; 34(5): 456-462.

**165-** Minary-Dohen P, Bailly P, Bertrand X, Talon D. Methicillin-resistant *Staphylococcus aureus* (MRSA) in rehabilitation and chronic-care-facilities: what is the best strategy? BMC Geriatr 2003; 3: 5.

**166-** O'Sullivan NP, Keane CT. Risk factors for colonization with methicillin-resistant *Staphylococcus aureus* among nursing home residents. J Hosp Infect 2000; 45(3): 206-210.

**167-** Sanford MD, Widmer AF, Bale MJ, Jones RN, Wenzel RP . Efficient detection and long-term persistence of the carriage of methicillinresistant *Staphylococcus aureus*. Clin Infect Dis 1994; 19(6): 1123-1128.

**168-** Meurman O, Routamaa M, Peltonen R. Screening for methicillinresistant *Staphylococcus aureus*: which anatomical sites to culture? J Hosp Infect 2005; 61(4): 351-353.

**169-** Manian FA, Senkel D, Zack J, Meyer L. Routine screening for methicillin-resistant *Staphylococcus aureus* among patients newly admitted to an acute rehabilitation unit. Infect Control Hosp Epidemiol 2002; 23(9): 516-519.

**170-** Tavolacc i MP, Merle V, Dupuis M, *et al*. [Choice of a strategy for screening for methicillin-resistant *Staphylococcus aureus* on admission to rehabilitation units]. Presse Med 2004; 33(22): 1575-1578.

**171-** Ringberg H, Cathrine Peterss on A, Walder M, Hugo Johanss on PJ. The throat: an important site for MRSA colonization. Scand J Infect Dis 2006; 38(10): 888-893.

**172-** Marshall C, Wess elingh S, McDonald M, Spelman D. Control of endemic MRSA-what is the evidence? A personal view. J Hosp Infect 2004; 56(4): 253-268.

**173-** Safdar N, Narans L, Gordon B, Maki DG. Comparison of culture screening methods for detection of nasal carriage of methicillinresistant *Staphylococcus aureus*: a prospective study comparing 32 methods. J Clin Microbiol 2003; 41(7): 3163-3166.

**174-** Felten A, Grandry B, Lagrange PH , Casin I. Evaluation of three techniques for detection of low-level methicillin-resistant *Staphylococcus aureus* (MRSA): a disk diffusion method with cefoxitin and moxalactam, the Vitek 2 system, and the MRSA-screen latex agglutination test. J Clin Microbiol 2002; 40(8): 2766-2771.

**175-** Francois P, Pittet D, Bento M, *et al*. Rapid detection of methicillin- resistant *Staphylococcus aureus* directly from sterile or nonsterile clinical samples by a new molecular assay. J Clin Microbiol 2003; 41(1): 254-260.

**176-** Huletsk y A, Giroux R, Rossb ach V, *et al*. New real-time PCR assay for rapid detection of methicillin-resistant *Staphylococcus aureus* directly from specimens containing a mixture of staphylococci. J Clin Microbiol 2004; 42(5): 1875-1884.

**177-** Huletsk y A, Lebel P, Picard FJ, *et al*. Identification of methicilinresistant *Staphylococcus aureus* carriage in less than 1 hour during a hospitral surveillance program. Clin Infect Dis 2005; 40: 976-981.

**178-** Nguyen Van JC, Kitzis MD, Ly A, *et al*. Detection of nasal colonization methicillin-resistant *Staphylococcus aureus*: a prospective study comparing real-time genic amplification assay vs selective chromogenic media. Pathol Biol (Paris) 2006; 54(5): 285-292.

**179-** Harbarth S, Masuet-Aumatell C, Schrenzel J, *et al*. Evaluation of rapid screening and pre-emptive contact isolation for detecting and controlling methicillin-resistant *Staphylococcus aureus* in critical care: an interventional cohort study. Crit Care 2006; 10(1): R25.

**180-** Cunningham R, Jenks P, Northwood J, Wallis M, Ferguson S, Hunt S. Effect on MRSA transmission of rapid PCR testing of patients admitted to critical care. J Hosp Infect 2007; 65(1): 24-28.

**181-** Robics ek A, Beaumont JL, Paule SM, *et al*. Universal surveillance for methicillin-resistant *Staphylococcus aureus* in 3 affiliated hospitals. Ann Intern Med 2008; 148(6): 409-418.

**182-** Harbarth S, Fankhauser C, Schrenzel J, *et al*. Universal screening for methicillin-resistant *Staphylococcus aureus* at hospital admission and nosocomial infection in surgical patients. Jama 2008; 299(10): 1149-1157.

**183-** Jeyaratnam D, Whitty CJ, Phillips K, *et al*. Impact of rapid screening tests on acquisition of meticillin resistant *Staphylococcus aureus*: cluster randomised crossover trial. Bmj 2008; 336(7650): 927-930.

**184-** Cox RA , Conquest C, Mallaghan C, Marples RR . A major outbreak of methicillin-resistant *Staphylococcus aureus* caused by a new phage-type (EM RSA-16). J Hosp Infect 1995; 29(2): 87-106.

**185-** Mody L, Kauffm an CA, McNeil SA, Galeck i AT, Bradley SF. Mupirocin- based decolonization of *Staphylococcus aureus* carriers in residents of 2 long-term care facilities: a randomized, double-blind, placebo- controlled trial. Clin Infect Dis 2003; 37(11): 1467-1474.

**186-** Harbarth S, Dharan S, Liass ine N, Herrault P, Auck enthaler R, Pittet D. Randomized, placebo-controlled, double-blind trial to evaluate the efficacy of mupirocin for eradicating carriage of methicillin- resistant *Staphylococcus aureus*. Antimicrob Agents Chemother 1999; 43(6): 1412-1416.

**187-** Simor AE , Phillips E, McGeer A, *et al*. Randomized controlled trial of chlorhexidine gluconate for washing, intranasal mupirocin,

and rifampin and doxycycline *versus* no treatment for the eradication of methicillin-resistant *Staphylococcus aureus* colonization. Clin Infect Dis 2007; 44(2): 178-185.

**188-** Kauffm an CA, Terpenning MS, He X, *et al*. Attempts to eradicate methicillin-resistant *Staphylococcus aureus* from a long-term-care facility with the use of mupirocin ointment. Am J Med 1993; 94(4): 371-378.

**189-** Vasquez JE, Walker ES, Franzus BW, Overbay BK, Reagan DR, Sarubb i FA. The epidemiology of mupirocin resistance among methicillin-resistant *Staphylococcus aureus* at a Veterans' Affairs hospital. Infect Control Hosp Epidemiol 2000; 21(7): 459-464.

**190-** Muller A, Talon D, Potier A, Belle E, Cappelier G, Bertrand X. Use of intranasal mupirocin to prevent methicillin-resistant *Staphylococcus aureus* infection in intensive care units. Crit Care 2005; 9(3): R246-250.

**191-** Schmitz FJ, Lindenlauf E, Hofm ann B, *et al*. The prevalence of low- and high-level mupirocin resistance in staphylococci from 19 European hospitals. J Antimicrob Chemother 1998; 42(4): 489-495.

**192-** Deshpande LM, Fix AM, Pfaller MA, Jones RN . Emerging elevated mupirocin resistance rates among staphylococcal isolates in the SEN TRY Antimicrobial Surveillance Program (2000): correlations of results from disk diffusion, Etest and reference dilution methods. Diagn Microbiol Infect Dis 2002; 42(4): 283-290.

**193-** Simor AE, Stuart TL, Louie L, *et al*. Mupirocin-Resistant, Methicillin-Resistant *Staphylococcus aureus* Strains in Canadian Hospitals. Antimicrob Agents Chemother 2007; 51(11): 3880-3886.

**194-** Mamm eri H, Laurans G, Eveillard M, Castelain S, Eb F. Coexistence of SHV -4- and TEM -24-producing *Enterobacter aerogenes* strains before a large outbreak of TEM -24-producing strains in a French hospital. J Clin Microbiol 2001; 39(6): 2184-2190.

**195-** Paterson DL, Bonomo RA. Extended-spectrum beta-lactamases: a clinical update. Clin Microbiol Rev 2005; 18(4): 657-686.

**196-** Livermore DM, Canton R, Gniadkowsk i M, *et al*. CTX-M: changing the face of ES BLs in Europe. J Antimicrob Chemother 2007; 59(2): 165-174.

**197-** Pitout JD, Church DL, Gregson DB, *et al*. Molecular epidemiology of CTX-M-producing *Escherichia coli* in the Calgary Health Region: emergence of CTX-M-15-producing isolates. Antimicrob Agents Chemother 2007; 51(4): 1281-1286.

**198-** Lavigne JP, Marchandin H, Delmas J, *et al*. CTX-M beta-lactamase- producing *Escherichia coli* in French hospitals: prevalence, molecular epidemiology, and risk factors. J Clin Microbiol 2007; 45(2): 620-626.

**199-** Brasm e L, Nordmann P, Fidel F, *et al*. Incidence of class A extended-spectrum beta-lactamases in Champagne-Ardenne (France): a 1 year prospective study. J Antimicrob Chemother 2007; 60(5): 956-964.

**200-** De Champs C, Chanal C, Sirot D, *et al*. Frequency and diversity of Class A extended-spectrum beta-lactamases in hospitals of the Auvergne, France: a 2 year prospective study. J Antimicrob Chemother 2004; 54(3): 634-639.

**201-** Rodriguez-Bano J, Navarro MD, Romero L, *et al*. Clinical and molecular epidemiology of extended-spectrum beta-lactamaseproducing *Escherichia coli* as a cause of nosocomial infection or colonization: implications for control. Clin Infect Dis 2006; 42(1): 37-45.

**202-** Rodriguez-Bano J, Navarro MD, Romero L, *et al*. Epidemiology and clinical features of infections caused by extended-spectrum beta-lactamase-producing *Escherichia coli* in nonhospitalized patients. J Clin Microbiol 2004; 42(3): 1089-1094.

**203-** Rodriguez-Bano J, Paterson DL. A change in the epidemiology of infections due to extended-spectrum beta-lactamase-producing organisms. Clin Infect Dis 2006; 42(7): 935-937.

**204-** Pitout JD, Gregson DB, Church DL, Elsayed S, Laupland KB. Community-wide outbreaks of clonally related CTX-M-14 betalactamase-producing *Escherichia coli* strains in the Calgary health region. J Clin Microbiol 2005; 43(6): 2844-2849.

**205-** Oteo J, Navarro C, Cercenado E, *et al*. Spread of *Escherichia coli* strains with high-level cefotaxime and ceftazidime resistance between the community, long-term care facilities, and hospital institutions. J Clin Microbiol 2006; 44(7): 2359-2366.

**206-** Mendonca N, Leitao J, Manageiro V, Ferreira E, Canica M. Spread of extended-spectrum beta-lactamase CTX-M-producing *Escherichia coli* clinical isolates in community and nosocomial environments in Portugal. Antimicrob Agents Chemother 2007; 51(6): 1946-1955.

**207-** Brun-Buiss on C, Legrand P, Rauss A, *et al*. Intestinal decontamination for control of nosocomial multiresistant gram-negative bacilli. Study of an outbreak in an intensive care unit. Ann Intern Med 1989; 110(11): 873-881.

**208-** Decre D, Gachot B, Lucet JC, Arlet G, Bergogne-Berezin E, Regnier B. Clinical and bacteriologic epidemiology of extendedspectrum beta-lactamase-producing strains of *Klebsiella pneumoniae* in a medical intensive care unit. Clin Infect Dis 1998; 27(4): 834-844.

**209-** Soulier A, Barbut F, Ollivier JM, Petit JC, Lienhart A. Decreased transmission of

Enterobacteriaceae with extended-spectrum betalactamases in an intensive care unit by nursing reorganization. J Hosp Infect 1995; 31(2): 89-97.

**210-** Gardam MA, Burrows LL, Kus JV, *et al*. Is surveillance for multidrug- resistant enterobacteriaceae an effective infection control strategy in the absence of an outbreak? J Infect Dis 2002; 186(12): 1754-1760.

**211-** Thouverez M, Talon D, Bertrand X. Control of Enterobacteriaceae producing extended-spectrum beta-lactamase in intensive care units: rectal screening may not be needed in non-epidemic situations. Infect Control Hosp Epidemiol 2004; 25(10): 838-841.

**212-** Hobs on RP, MacKenzie FM, Gould IM. An outbreak of multiplyresistant *Klebsiella pneumoniae* in the Grampian region of Scotland. J Hosp Infect 1996; 33(4): 249-262.

**213-** Nicolle LE. Infection control in long-term care facilities. Clin Infect Dis 2000; 31(3): 752-756.

**214-** Kola A, Holst M, Chaberny IF, Ziesing S, Suerbaum S, Gastmeier P. Surveillance of extended-spectrum beta-lactamase-producing bacteria and routine use of contact isolation: experience from a three-year period. J Hosp Infect 2007; 66(1): 46-51.

**215-** Harris AD , McGregor JC, Johnson JA, *et al*. Risk factors for colonization with extended-spectrum beta-lactamase-producing bacteria and intensive care unit admission. Emerg Infect Dis 2007; 13(8): 1144-1149.

**216-** Villegas MV, Hartstein AI. *Acinetobacter* outbreaks, 1977-2000. Infect Control Hosp Epidemiol 2003; 24(4): 284-295.

**217-** Fournier PE, Richet H. The epidemiology and control of *Acinetobacter baumannii* in health care facilities. Clin Infect Dis 2006; 42(5): 692-699.

**218-** Naas T, Coignard B, Carbonne A, *et al*. VE B-1 Extended-spectrum beta-lactamase-producing *Acinetobacter baumannii*, France. Emerg Infect Dis 2006; 12(8): 1214-1222.

**219-** Marchaim D, Navon-Venezia S, Schwartz D, *et al*. Surveillance cultures and duration of carriage of multidrug-resistant *Acinetobacter baumannii*. J Clin Microbiol 2007; 45(5): 1551-1555.

**220-** Ayats J, Corbella X, Ardanuy C, *et al*. Epidemiological significance of cutaneous, pharyngeal, and digestive tract colonization by multiresistant *Acinetobacter baumannii* in ICU patients. J Hosp Infect 1997; 37(4): 287-295.

**221-** Bonten MJ, Bergmans DC, Speijer H, Stobb eringh EE. Characteristics of polyclonal endemicity of *Pseudomonas aeruginosa* colonization in intensive care units. Implications for infection control. Am J Respir Crit Care Med 1999; 160(4): 1212-1219.

**222-** Berthelot P, Grattard F, Mahul P, *et al*. Prospective study of nosocomial colonization and infection due to *Pseudomonas aeruginosa* in mechanically ventilated patients. Intensive Care Med 2001; 27(3): 503-512.

**223-** Bertrand X, Thouverez M, Talon D, *et al*. Endemicity, molecular diversity and colonisation routes of *Pseudomonas aeruginosa* in intensive care units. Intensive Care Med 2001; 27(8): 1263-1268.

**224-** Bergmans DC, Bonten MJ, Stobb eringh EE , *et al*. Colonization with *Pseudomonas aeruginosa* in patients developing ventilatorassociated pneumonia. Infect Control Hosp Epidemiol 1998; 19(11): 853-855.

**225-** Blanc DS, Petignat C, Janin B, Bille J, Francioli P. Frequency and molecular diversity of *Pseudomonas aeruginosa* upon admission and during hospitalization: a prospective epidemiologic study. Clin Microbiol Infect 1998; 4(5): 242-247.

**226-** Bertrand X, Thouverez M, Patry C, Balvay P, Talon D. *Pseudomonas aeruginosa*: antibiotic susceptibility and genotypic characterization of strains isolated in the intensive care unit. Clin Microbiol Infect 2001; 7(12): 706-708.

**227-** Rello J, Lorente C, Diaz E, *et al*. Incidence, etiology, and outcome of nosocomial pneumonia in ICU patients requiring percutaneous tracheotomy for mechanical ventilation. Chest 2003; 124(6): 2239-2243.

**228-** Talon D, Mulin B, Rouget C, Bailly P, Thouverez M, Viel JF. Risks and routes for ventilator-associated pneumonia with *Pseudomonas aeruginosa*. Am J Respir Crit Care Med 1998; 157(3 Pt 1): 978-984.

**229-** Bertrand X, Bailly P, Blasc o G, Balvay P, Boillot A, Talon D. Large outbreak in a surgical intensive care unit of colonization or infection with *Pseudomonas aeruginosa* that overexpressed an active efflux pump. Clin Infect Dis 2000; 31(4): E9-E14.

**230-** Paramythiotou E, Lucet JC, Tims it JF, *et al*. Acquisition of multidrug- resistant *Pseudomonas aeruginosa* in patients in intensive care units: role of antibiotics with antipseudomonal activity. Clin Infect Dis 2004; 38(5): 670-677.

**231-** Loukil C, Saizou C, Doit C, *et al*. Epidemiologic investigation of *Burkholderia cepacia* acquisition in two pediatric intensive care units. Infect Control Hosp Epidemiol 2003; 24(9): 707-710.

**232-** Bress ler AM, Kaye KS, LiPuma JJ, *et al*. Risk factors for *Burkholderia cepacia* complex bacteremia among intensive care unit patients without cystic fibrosis: a case-control study. Infect Control Hosp Epidemiol 2007; 28(8): 951-958.

**233-** Vonberg RP, Gastmeier P. Isolation of infectious cystic fibrosis patients: results of a

systematic review. Infect Control Hosp Epidemiol 2005; 26(4): 401-409.

**234-** Harbarth S, Sudre P, Dharan S, Cadenas M, Pittet D. Outbreak of *Enterobacter cloacae* related to understaffing, overcrowding, and poor hygiene practices. Infect Control Hosp Epidemiol 1999; 20(9): 598-603.

**235-** Villari P, Crispino M, Salvadori A, Scarcella A. Molecular epidemiology of an outbreak of *Serratia marcescens* in a neonatal intensive care unit. Infect Control Hosp Epidemiol 2001; 22(10): 630-634.

**236-** Leclercq R, Coignard B. Les entérocoques résistants aux glycopeptides : situation en France en 2005. Bull Epidemiol Hebdo 2006; 13(13): 85-87.

**237-** Comité technique national des infections nosocomiales et des infections liées aux soins. Avis du Comité technique national des infections nosocomiales et des infections liées aux soins relatif à la maitrise de la diffusion des entérocoques résistants aux glycopeptides dans les établissements de santé, 6 octobre 2005. Bull Epidemiol Hebdo 2006; (13): 88-89.

**238-** Davis KA, Moran KA, McAllister CK, Gray PJ. Multidrug-resistant *Acinetobacter* extremity infections in soldiers. Emerg Infect Dis 2005; 11(8): 1218-1224.

**239-** Kass is-Chikhani N, Decre D, Gautier V, *et al*. First outbreak of multidrug-resistant *Klebsiella pneumoniae* carrying blaVIM -1 and blaSHV -5 in a French university hospital. J Antimicrob Chemother 2006; 57(1): 142-145.

**240-** Eveillard M, Eb F, Tramier B, *et al*. Evaluation of the contribution of isolation precautions in prevention and control of multi-resistant bacteria in a teaching hospital. J Hosp Infect 2001; 47(2): 116-124.

**241-** Garner JS. Guideline for isolation precautions in hospitals. The Hospital Infection Control Practices Advisory Committee. Infect Control Hosp Epidemiol 1996; 17(1): 53-80.

**242-** Revised guidelines for the control of methicillin-resistant *Staphylococcus aureus* infection in hospitals. British Society for Antimicrobial Chemotherapy, Hospital Infection Society and the Infection Control Nurses Association. J Hosp Infect 1998; 39(4): 253-290.

**243-** Boyce JM, Opal SM, Chow JW, *et al*. Outbreak of multidrug-resistant Enterococcus faecium with transferable vanB class vancomycin resistance. J Clin Microbiol 1994; 32(5): 1148-1153.

**244-** Talon D, Vichard P, Muller A, Bertin M, Jeunet L, Bertrand X. Modelling the usefulness of a dedicated cohort facility to prevent the dissemination of MRSA. J Hosp Infect 2003; 54(1): 57-62.

**245-** Venier AG, Zaro-Goni D, Pefau M, *et al*. Performance of hand hygiene in 214 healthcare facilities in South-Western France. J Hosp Infect 2009; 71: 280-282.

**246-** Girou E, Chai SH, Oppein F, *et al*. Misuse of gloves: the foundation for poor compliance with hand hygiene and potential for microbial transmission? J Hosp Infect 2004; 57(2): 162-169.

**247-** Austin DJ, Bonten MJ, Weinstein RA, Slaughter S, Anderson RM. Vancomycin-resistant enterococci in intensive-care hospital settings: transmission dynamics, persistence, and the impact of infection control programs. Proc Natl Acad Sci U S A 1999; 96(12): 6908-6913.

**248-** Harbarth S, Pittet D. Control of nosocomial methicillin-resistant *Staphylococcus aureus*: where shall we send our hospital director next time? Infect Control Hosp Epidemiol 2003; 24(5): 314-316.

**249-** Pittet D, Mourouga P, Perneger TV . Compliance with handwashing in a teaching hospital. Ann Intern Med 1999; 130(2): 126-130.

**250-** Lucet JC, Rigaud MP, Mentre F, *et al*. Hand contamination before and after different hand hygiene techniques: a randomized clinical trial. J Hosp Infect 2002; 50(4): 276-280.

**251-** Thompson BL, Dwyer DM, Uss ery XT, Denman S, Vacek P, Schwartz B. Handwashing and glove use in a long-term-care facility. Infect Control Hosp Epidemiol 1997; 18(2): 97-103.

**252-** Lucet JC, Jonquet O. Prévention de la transmission croisée en réanimation. Réanimation 2002; 11: 248-249.

**253-** Société de réanimation de langue française. Recommandations des experts de la Société de réanimation de langue française, janvier 2002 : prévention de la transmission croisée en réanimation. Réanimation 2002; 11: 250-256.

**254-** Société de Réanimation de Langue Française. Prévention des infections à bactéries multirésistantes en réanimation (en dehors des modalités d'optimisation de l'antibiothérapie). XVI e Conférence de consensus en réanimation et médecine d'urgence. Réan Urg 1997; 6: 167-173.

**255-** Kirkland KB. Taking off the gloves: toward a less dogmatic approach to the use of contact isolation. Clin Infect Dis 2009; 48(6): 766-771.

**256-** Hota B. Contamination, disinfection, and cross-colonization: are hospital surfaces reservoirs for nosocomial infection? Clin Infect Dis 2004; 39(8): 1182-1189.

**257-** Denton M, Wilcox MH, Parnell P, *et al*. Role of environmental cleaning in controlling an outbreak of *Acinetobacter baumannii* on a neurosurgical intensive care unit. J Hosp Infect 2004; 56(2): 106-110.

**258-** Huang SS, Datta R, Platt R. Risk of acquiring antibiotic-resistant bacteria from prior room

occupants. Arch Intern Med 2006; 166(18): 1945-1951.

**259-** Opal SM, Mayer KH, Stenberg MJ, *et al*. Frequent acquisition of multiple strains of methicillin-resistant *Staphylococcus aureus* by healthcare workers in an endemic hospital environment. Infect Control Hosp Epidemiol 1990; 11(9): 479-485.

**260-** Eveillard M, Martin Y, Hidri N, Bouss ougant Y, Joly-Guillou ML. Carriage of methicillin-resistant *Staphylococcus aureus* among hospital employees: prevalence, duration, and transmission to households. Infect Control Hosp Epidemiol 2004; 25(2): 114-120.

## ANNEX - STRATEGY USED FOR BIBLIOGRAPHICAL SEARCH AND ANALYSIS

The bibliographical search strategy was defined by the organizing committee, in liaison with the group of experts. Training of the bibliographical group preceded the search itself. The latter was structured according to sub-groups divided into fields. They included:

- interrogation of national and international databases ((Nosobase, Medline, Current Contents, Cochrane, etc.) and the Internet sites of the main scientific companies and international institutions involved in this field;
- the list of chosen key words: *"Cross Infection/prevention and control"* [MeSH], *"Communicable Disease Control"* [MeSH], *"Contact precautions"* OR *"Contact"* AND *"Precaution"* OR *"Precautions"* [MeSH], *"Staphylococcus aureus"* [MeSH], *"Methicillin resistance"* [MeSH], *"Acinetobacter baumannii"* [MeSH], *"Pseudomonas aeruginosa"* [MeSH], *"Rotavirus"* [MeSH], *"Screening"* [Text Word], *"Cross infection"* [MeSH], *"Epidemiology"* [MeSH], *"Surveillance"* [Text Word], *"Culture"* [MeSH], *"Multidrug"* [All Fields] AND *"Resistant"* [All Fields] AND *"Microbiology"* [Subheading] OR *"Bacteria"* [MeSH], *"Enterobacteriaceae"* [Text Word], *"Extended spectrum beta-lactamases (EBLSE)"* [Text Word], *"Multidrug-resistant gram negatives"* [Text Word], *"Culture survey"* [Text Word], *"Routine surveillance"* [Text Word], *"Surveillance strategies"* [Text Word], *"Active surveillance culture"* [Text Word], *"Detecting asymptomatic colonisation"* [Text Word], *"Cross transmission"* [Text Word], *"Resistant bacteria"* [Text Word], *"Long-term-care facilities"* [Text Word], *"Barrier precautions"* [Text Word], *"Control"* [Text Word], *"Intensive microbial surveillance"* [Text Word];
- the interrogation method (MeSH terms, full text, cross terms used … );
- an evaluation of the different publications (recommendation guides, good practice guides, scientific reviews … ) according to the method presented in the 2002 HAS guide, with:
  - rating of recommendations (A,B, C or IA, IB, IC, II, no recommendation, where applicable),
  - level of evidence (1 to 4);
- a synoptic table indicating the number of publications or reviews conserved for analysis and/or rejected (if applicable);
- the full set of analysis files grouped and classed according to the type of document
  - recommendations,
  - good practice guides,
  - systematic reviews,
  - scientific publications.

A global synthesis of this literary analysis made use of tools taken from the methodological guide proposed by the ANAES [1] in 2000, and the work of L.-R. Salmi [2].

Whenever possible (according to the number of identified references), dual reviewing was implemented. An example of the proposed and implemented tool is presented on the following page:

---

1 ANAES. Guide d'analyse de la littérature et gradation des recommandations. ANAES ed, Paris, 2000, 60 pages.

2 Salmi LR. Lecture critique et communication médicale scientifique : comment lire, présenter, rédiger et publier une étude clinique ou épidémiologique. Paris : Elsevier, 2002, 354 p.

Sub-group:

Type of document analyzed: recent recommendations / systematic reviews / scientific publications

File n°:

Title:

| |
|---|
| Authors (Institute):<br><br>Available / consulted on:<br><br>(date of consultation)<br><br>Review:<br><br>Year: |

| |
|---|
| Summary: (if available) |

Free comments from the reviewer including:

- summary of recommendations: (if applicable)
- rating of recommendations: (if applicable)
- limitations of the study: (if applicable)

| |
|---|
| Level of evidence:  from 1 to 4  (described in plain text) |