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Contact precaution procedures in healthcare facilities

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Abstract

Background. *Multidrug resistance is an established and growing worldwide public health problem, since few therapeutic options remain available. MRSA is the leading Gram-positive organism which has spread both in the community and healthcare environment. Gram-negative bacteria, either fermenter (enterobacteriaceae) or nonfermenter, pose a major challenge to the healthcare providers because they can express a wide multidrug resistance.*
Methods. *Specific keywords combinations were analitically searched in PubMed and Scopus databases. Publications concerning contact precaution procedures were reviewed.*
Results. *The review on infection control and isolation precautions was carried out focusing on bundles that could help healthcare personnel to improve their action.*
Conclusions. *This paper clearly refers to measures in order to control the spread of infectious disease. We provided some synthetic tables that could improve healthcare workers knowledge and help them to apply all fundamental concepts in infection control.*

Introduction

The use of antibiotics represented an important step in medicine history, but in recent decades many microorganisms developed antimicrobial resistance (1) and consequently MDRO are a growing worldwide public health problem.

Although many antimicrobial classes are in use, remarkably few agents are currently available for the treatment of MDRO, specially when considering severe nosocomial infections (2, 3).

Therefore, also a non-antibiotic strategy, including surveillance and infection control procedures is needed, because concerted interventions including isolation can substantially reduce healthcare associated MDRO infections. The overall scientific evidence supports the use of multiple interventions, whereas it is still unclear which bundles of interventions are most effective to reduce the MDRO rates (4, 5).

Transmission control is not only effective in reducing the incidence of infections caused by the targeted pathogens, but actually offers collateral benefit avoiding other MDRO spread. This phenomenon is largely mediated by the fact that patients colonized with one

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resistant pathogen are frequently colonized with other MDRO.

This study aims to create a list of simple rules for healthcare personnel for a patient in isolation whose primary objective is to encourage and increase adherence to these procedures.

Methods

A narrative review of literature (6) was conducted, searching using the main biomedical databases (PubMed, Scopus), authoritative websites regarding infections and recent guidelines. There are no restrictions regarding the temporal or language of publication.

The objective of this review was to identify the main recommendations aimed at reducing the transmission of infectious diseases.

The most important information found in this review was used to build a Bundle for implementation of a culture of safety and protection for healthcare personnel in the healthcare facilities (Hf).

In 2001, the Institute for Healthcare Improvement (IHI) developed the Bundle concept (7) to improve care quality and security. The bundle concept helps healthcare workers to provide inpatient care for critically ill patients (patient in an ICU, patients needing mechanical ventilation or patient with central lines) (Institute for Healtcare Improvement).

Today, contemporary scientific literature encourages the use of Bundles in health services to stimulate and improve the culture of risk and safety of care in all health professionals and beyond (7, 8).

Isolation

Transmission control is not only effective in reducing the incidence of infections caused by the targeted pathogens, but actually offers collateral benefit avoiding other MDRO spread. This phenomenon is largely mediated by the fact that patients colonized with one resistant pathogen are frequently colonized with other MDRO. Relatively high rates of co-colonization by methicillin-resistant *S. aureus* (MRSA), vancomycin-resistant enterococci (VRE) and other MDRO has been reported (5, 9, 10). This transmission control acts on multiple antimicrobial-resistant pathogens.

Several terms for isolation precautions have been used over the years adding confusion among healthcare personnel (11). However, the latest CDC/HICPAC guidelines clearly refer to standard precautions and Transmission-Based Precautions (12). These measures can be used singly or in combination.

In the first tier are those measures designed for the care of all patient in healthcare settings with a documented or suspected infection status (12): they include the performance of hand hygiene according to pre-specified guidelines, use of personal protective equipment, respiratory hygiene/cough etiquette, safe injection practices, use of masks for catheter insertion and lumbar puncture procedures, safe handling of contaminated equipment, textiles and laundry and routine cleaning and disinfection of environmental surfaces. Avoiding the exposure to potentially infectious sources such as blood, wounds, mucous membranes and excretions is the primary goal of standard precautions (SP) (5, 13).

In addition to standard precaution, healthcare workers use the *transmission-based precautions* for patient with an infection or colonization with highly transmissible pathogens. (12) These measures are specific Personal Protective Equipment (PPE) for the type of pathogens.

Negative effects of isolation precautions are also well documented. The principal effects are the adverse effect on care and increased costs. Patients on isolation

precautions may be examined less often, receive less care, become depressed or anxious and most importantly, have more preventable adverse events than do patients who are not isolated (13). So, the healthcare personnel must make efforts to counteract possible adverse effects on patients.

Isolation by contact, droplet nuclei and air

The main kind of *transmission-based precautions* are *contact precautions, airbone precautions, droplet precautions*.

Contact precautions: CP apply only to some patients, are more restrictive and often require physical patient isolation (5). CP are aimed at preventing transmission of epidemiologically important pathogens from a colonized or infected patient through direct (the patient) or indirect (surfaces or objects in the patient's environment) contact (12, 13). Those are used to prevent transmission of infectious pathogens which are spread by direct or indirect contact with the patient or the patient's environment (14).

Contact isolation is mostly indicated for patients colonized or infected with MDRO that have a high risk of exogenous cross-transmission, such as MRSA or VRE. Patient is placed in a single room or geographically separated from the other patients. When individual rooms are insufficient, "*cohorting*" gathering in the same room of infected/colonized patients with the same MDRO is possible.

The application of such precautions requires that gowns and gloves should be worn when entering the patient's room and removed before leaving it. Dedicated equipment such as stethoscopes or blood pressure cuffs should remain in the isolation room and not be used for other patients (15). All materials should be discarded before exiting the patient room (16). If supported by the hospital and laboratory information systems, electronic alerts that notify admitting personnel of patients who were colonized/ infected with a resistant pathogen on a previous admission can help expedite isolation of patients (17).

When necessary (*respiratory transmission*) also droplet and air isolation must be included. Patient charts and records need to be placed outside the room. Non-disposable items, that cannot be easily cleaned should be used only for the colonized/infected patient. All linen must be considered as contaminated and placed in a double bag outside the room. Patients transfer should be avoided and the receiving ward or institution informed.

Droplet precautions: are used to prevent transmission of infectious pathogens which are spread through close respiratory or mucous membrane contact with respiratory secretions (12). Patient is placed in a single room or geographically separated from the other patients. If single room is not available, it must be safeguard a spatial separation of ≥3 feet between patient beds. Patients transfer is possible if patient wear a mask.

Airbone precautions: are used to prevent transmission of infectious pathogens which are spread in the air and that remain infectious over long time (12). Patient is placed in a room with at least 6 or 12 air changes per hour (18-23). The room door must be closed and the patient must be in the room. Patients transfer is possible if patient wear a surgical mask. The healthcare staff must wear a N95 or higher-level respirator for respiratory protection.

The specific patient placement and PPE for healthcare staff which require each type of isolation and pathogens are outlined in the Table 1.

Hand hygiene

Proper hand hygiene is the single most important, simplest and least expensive means of preventing healthcare-associated infections (24-26). A landmark study by Pittet et al. (24) demonstrated that implementing a multidisciplinary program to promote increased compliance of healthcare

Table 1 - Type of isolation and pathogens.

Type of isolation	Example of pathogens	Patient placement and PPE for healthcare staff
Contact	*Clostridium difficile* *MDR* pathogens Infectious diarrhoea due to pathogens such as *Salmonella, Norovirus, Rotavirus*, etc	Single room or "cohorting"of patients with the same pathogen; Gloves and gowns, also masks and glasses
Droplet	*Influenz*a or other *respiratory* virus	Single room or "cohorting"of patients with the same pathogen; Gloves and gowns, also masks and glasses
Airbone	*Mycobacterium tuberculosis* Measles, chickenpox and disseminated herpes zoster	Rooms with at least 6 or 12 air changes per hour; N95 or higher-level respirator for respiratory protection

workers with recommended hand hygiene practices, reduces prevalence of healthcare associated infections. In addition, several studies carried out in various countries have clearly shown that it is equally important to stop transmission of MDRO (25). Hand hygiene can be accomplished by cleaning hands with an alcohol based formulation or by using soap and water (27). The former may increase hand washing compliance and is not harmful to hands, however if visibly soiled with organic material or debris (i.e. faeces, blood) hands should be first cleaned with soap and running water (26). Convenient access to hand hygiene products will improve adherence, therefore small containers of waterless alcohol based formulation may be carried by staff for use when hand washing facilities are not easily accessible. Recent recommendations identify five moments for hand hygiene which healthcare workers should always accomplish: a) before patient contact (i.e. shaking hands, abdominal palpation); b) before aseptic task (i.e. wound dressing, invasive device management); c) after body fluid exposure (i.e. exscretions, urine); d) after patient contact; e) after contact with patient surroundings (i.e. bed rails, bedside table) (27).

Patient communication

The Joint Commission recommends that patient education is an essential component of transmission control and prevention. Several studies explored patient's willingness to learn about transmission control and their preferred ways to learn. In particular Gudnadottir et al. (28) showed that patients expressed interest in more than 1 form of educational material: 70% chose written material, 57% verbal information, 53% an informational video, and 50% Internet-based material. Patients with a higher level of education were more likely to prefer written material. Patients emphasized simple language and incorporation of actual patient stories.

Overall, to improve the efficacy of source-isolation and contact precautions in general, patient care providers should consider colonised or infected patients as active partners in reducing transmission and involve patients and relatives in regular, ongoing conversations about transmission prevention. Indications specifically aimed at visitors, are present in the guidelines developed by Siegel and colleagues (5).

Protection – Gloves, gowns, eyes

Healthcare personnel should also be wearing gloves, masks, gowns and glasses

when "at risk" care is given (splashing generating procedures, open tracheostomy...) or contact with uncontrolled secretions (draining wounds, stool incontinence) (29).

Many studies showed the efficacy of gloves in reducing contamination, in particular Pittet et al. (24) demonstrated that Bacterial contamination increased linearly with time on ungloved hands during patient care (average, 16 colony-forming units [CFUs] per minute; 95% confidence interval, 11-21 CFUs per minute), whereas only by 3 cfu with gloves.

A recent systematic review indicated that gloving reduces acquisition of microorganisms on the hands but does not completely prevent contamination of the hands.

Adherence to glove utilization among healthcare workers (HCW) was suboptimal, as gloves were overused and often misused. The major break in compliance with glove use was failure to change gloves between procedures on the same patient. There is still not enough evidence to prove the influence of glove use on adherence to hand hygiene (30). Therefore proper training, specially among nurses, is an essential target (31-35).

Along ago (36) contact precautions including gowns and gloves have been shown to delay colonization by 5 days and reduce the rate of healthcare associated infections by 2.2 times. More recently, Morgan et al. and Snyder et al. have demonstrated the added value of personal protective equipment to decrease the likelihood of MDRO contamination of healthcare workers (HCW) (37, 38).

Environmental decontamination

We concentrated on environmental contamination associated to contact precautions, excluding some specific aspects as *Legionella* spp water treatment (39-41).

MRSA resists desiccation and can survive in hospital dust for up to a year (42). If staff enter a room containing an MRSA patient, two-thirds of them will acquire the patient's strain on gloved hands or apron. Even if they do not touch the patient directly, four in ten will still exit the room carrying (43). It is thought that contamination of near-patient hand-touch sites provides the biggest risk of MRSA acquisition for patients. In addition, there is a small but significant increase in the risk of acquiring MRSA if a patient is admitted into a room previously occupied by carrier patients (44, 45).

There is some evidence that cleaning removes MRSA from the ward environment with benefit for patients. An outbreak of MRSA lingered for several months on a urological ward, resisting all the usual infection control interventions such as promotion of hand hygiene and isolation of patients. Only when a specific cleaning program was implements the outbreak stopped (45).

Similarly, another outbreak of glycopeptide-intermediate *S. aureus* (GISA) in an intensive therapy unit proved difficult to control until a wave of further control measures, including enhanced cleaning was introduced (46).

VRE are not credited with the same degree of pathogenicity as MRSA, but they may still cause infections in vulnerable patients, including outbreaks that are difficult to control.

A paper described clearly the impact of improved environmental cleaning on the spread of VRE in a medical intensive care unit (ICU) (47). *Acinetobacter* spp, *P. aeruginosa* and other Gram-negatives can also be recovered from the hospital environment with ease, including inanimate hand-touch sites near the patient (48, 49). The importance of cleaning in controlling outbreaks of *Acinetobacter* spp. has been emphasised in previous studies (44).

C. difficile represents a major challenge for healthcare personnel and environmental cleaning. Environmental contamination with

spores is now well accepted as a risk factor for the acquisition of *C. difficile*. Furthermore, as the level of environmental contamination increases, so does the amount of *C. difficile* on the hands of HCW, and once again near patient hand-touch sites are regarded as a particular risk (50).

Therefore, to prevent and reduce infection transmission, many studies show that surface cleaning and disinfection in hospital is indispensable (4).

The environment of the infected patient must be cleaned and disinfected twice a day (respecting dilutions and contact times of detergent/disinfectant products), with particular attention to the surfaces most frequently in contact with the patient (use disinfectant preferably with chlorine 1000 ppm) and at points where dust can accumulate (beds, bedside tables, technical beams).

Hospital transfer and discharge

In order to control multidrug resistant organisms circulation, guidelines recommend to implement systems to designate patients known to be colonized or infected with a targeted MDRO and to notify receiving healthcare facilities and personnel prior to transfer of such patients within or between facilities (5).

Discussion

The measures against infectious agents transmission are fundamental to fight MDR. Specially with a reduction of effective available agents and pharmaceutical policy problem (1, 51, 52).

A multidisciplinary approach is essential to prevent the spread of infectious diseases in inpatients. So, an accurate knowledge of isolation precaution for healthcare staff is essential to improve a safety practice (53-61).

In daily practice, healthcare workers allow clinical protocols to offer appropriate treatment and care service to patients.

However, there are an exstensive body of knowledge materials that is focused on transmission isolation to MDR pathogens. So, it is necessary to offer to all HCW a comprehensive body of resources and clinical instructions. Some clinical instructions are listed in Table 2, 3, 4, 5.

Table 2 shows an overview of the clinical instruction to prevent transmission control, like a Bundle. Those are aimed at supporting HCW role in transmission control.

Next, table 3 presents the main results related to operational issues in MDR screening. The screening should be carried out when there is clinical concern, for example, if there are a new infections or clusters or if a new patient is admitted to healthcare setting.

Table 4 focused on hand hygiene, that is the single most important, simplest and least expensive means of preventing healthcare-associated infections (24, 25).

Table 5 shows an overview of the clinical instruction to environmental decontamination.

Conclusion

Even if antibiotics in healthcare setting may be taken to prevent a bacterial infection developing, the use of these has also exacerbated the spread of resistance. The consequences of antibiotic resistance are very serious. So, transmission precautions play a key role in reducing antibiotic resistance in healthcare settings.

Several terms for isolation precautions have been used over the years adding confusion among healthcare personnel (11). However, this paper clearly refers to measures to control the spread of infectious disease. Tables could improve the knowledge of HCW. The present study certainly represents a springboard for further studies on the subject.

Table 2 - Summary sheet about *Staphylococcus aureus* meticillin resistant (MRSA), *Enterococcus* vancomincina resistant (VRE), *Enterobacteriacae* resistant to carbapenems (CRE), *Pneudomonas aeruginosa*, *Acinetobacter baumannii*, *Clostridium difficile*.

Information	• Medical and Nursing Staff • Relatives / caregivers • Personal Cleaning Company
Patient positioning	• Single room with toilets • Cohorting isolation with colonized or infected patient with the same microorganism • Spatial isolation (1.5 meters) with a patient at low risk of infection or on discharge
Outside the hospital room	• Outside the patient room, prepare a trolley that is equipped with: gowns, non-sterile disposable gloves, masks, glasses, hydro-alcoholic gel to rub hands
In the hospital room	• Infectious risk Container for Hazardous Health Waste • Dedicated equipment: phonendoscope, sphygmomanometer • Non-dedicated equipment (eg thermometer or oxygen saturation sensor): disinfect before using on another patient • hydro-alcoholic gel solution dispenser for hand hygiene
Care precaution	*Before assisting the patient* • perform hand hygiene • wear non-sterile disposable gloves and non-sterile single-use gowns *After contact with the patient* • remove the gloves and the gown before leaving the room: eliminate them in the container for hazardous medical waste • perform hand hygiene
Bedding material management	• Replace daily dirty laundry and dispose it in special waterproof bag • Avoid contamination of the environment and personnel
Patient transfers	• Travel and transfer must be limited; inform personnel of the transport service and of the facility where the patient should be taken about precautions needed

Table 3 - Surveillance and screening: Routine screening is not usually recommended but should be considered when: 1) in case of transmission to new patients; 2) in the presence of clusters; 3) in case of entrance of new patients in the ward. On patient or caregivers with MRSA is necessary to carry out surveillance cultures and at the end of therapy.

Pathogen	Surveillance and screening
MRSA	The medical staff who is colonized / infected must immediately start therapy and perform control cultures on the 10th, 15th and 20th day of treatment to document the eventual remediation. Swabs can be performed on: anterior nostrils, pharynx, rectum or perineal area, sputum, urine, sites of insertion of invasive devices, skin lesions and wounds.
VRE	Swabs can be performed on: 1) faeces; 2) rectum. It is possible to use molecular screening for rapid detection of VRE, however it is not effective as the culture test for false positive results.
P. aeruginosa *A. baumannii*	Patients selection to be submitted to such screening, as well as its frequency, may vary according to the surveillance program adopted or according to different epidemiological and organizational contexts. In case of epidemy, a molecular investigation of the strains may be useful. At the end of the therapy, three subsequent negative tests are required to stop contact precautions.
CRE	Colonized patients' screening can be performed on: rectal swab only or, in combination, oropharyngeal, endotracheal, inguinal, wound or urine samples. The selection of patients to be submitted to such screening and its frequency, may vary according to the surveillance program adopted or according to different epidemiological and organizational contexts. CRE analysis must be indicate on the sample. In case of epidemy, a molecular investigation of the strains may be useful. At the end of the therapy, three subsequent negative tests are required to stop contact precautions.
Clostridium difficile	Routine screening for *C.difficile* should commonly be performed for all suspected infected patients. To reduce the risk of *C. difficile* transmission is necessary to promptly submit to the test (with a sample of diarrheal or non-solid stools), patients with diarrhea on admission or with arising within the first 48 hours or after at least 2 days of hospitalization, symptomatic patients discharged for no more than 4 weeks, from another hospital or from Health Facilities. Laboratory diagnosis is recommended on the detection in the faeces of *C. difficile* and/or its antigens, toxins or nucleic acids. After treatment do not perform healing confirmation tests.

Table 4 - Hand hygiene

Pathogen	Treatment
MRSA, VRE	Alcohol based solution, water and soap or antiseptic soap. The antiseptics of election are: 1) Triclosan 0.5 - 1.0% in hydro-alcoholic solution; 2) Chlorhexidine 4% in hydro-alcoholic solution.
Pseudomonas aeruginosa	Alcohol based solution with soap and water or antiseptic soap. The antiseptics of election are: 1) Triclosan 0.5 - 1.0% in hydro-alcoholic solution; 2) Chlorhexidine 4% in hydro-alcoholic solution. 3% hydrogen peroxide (10 volumes)
Acinetobacter baumannii, CRE	Alcohol based solution, water and soap or antiseptic soap. The antiseptics of election are: Chlorhexidine 4% in hydro-alcoholic solution.
Clostridium difficile	In cases of suspected / ascertained infectious diarrhea with C.difficile, hand hygiene with hydroalcoholic preparations is not sufficient and is necessary hand wash to insist with soap and water and the use of gloves. In case of CD spore contamination, a particularly useful and effective reference product for hand antisepsis is the aqueous solution of NaDCC (sodium-dichloro-isocyanurate) at a concentration of 500-1000 ppm AvCl (AvailableChlorine free chlorine available).

Table 5 - Cleaning procedure: MDRO can contaminate all material in the room; during isolation patient is advisable that only material strictly necessary for assistance is kept in the room. The environment of the infected patient must be cleaned and disinfected twice a day (respecting dilutions and contact times of the detergent / disinfectant products), paying particular attention to the surfaces most frequently in contact with the patient and to the points where they can accumulate most easily the dust. Make sure that the daily cleaning of the surfaces that are most in contact with the hands is correctly carried out. Use check-lists to check the daily cleaning of the surfaces most frequently in contact with the hands.

Hospital unit	Treatment for pathogen
Equipment and devices for assistance (bedpan and urinals, sphygmomanometer, phonendoscope, electromedical equipment)	MRSA, *A. baumannii*, CRE, VRE, *P. aeruginosa*: isopropyl alcohol 70%, hydroalcoholic solution of chlorhexidine. *C. difficile*: glutaraldehyde 2%, glutaraldehyde phenolate 1/8, peracetic acid, sodium hypopclorite 1000-5000 ppm (01% -0.5% active chlorine) with exposure of at least 30 minutes.
Environmental hygiene, room cleaning	MRSA, VRE, CRE, *A. baumannii*, *P. aeruginosa*. The disinfection treatment with solutions based on chlorine derivatives (preferably with active chlorine at a concentration of 1,000 ppm) requires careful preliminary cleaning of the surfaces to be treated. If it is impossible to guarantee a correct preliminary cleaning, diluted solutions of detergent polyphenols can be used, which have a less extensive spectrum of activity than active chlorine but guarantee effectiveness even in the presence of dirt thanks to the "onestep" treatment: cleaning and contemporary disinfection. *C. difficile* contaminates the environment through vegetative forms and spores: the problem is particularly critical if the patient has abundant liquid stool discharges or is incontinent. The contamination can interest objects near the patient, surrounding environment, medical devices/materials in use and, in particular, toilets. The vegetative forms of *C. difficile* are sensitive to common environmental disinfectants and are easily eliminated. It is much more difficult to guarantee the inactivity of spores that can survive for very long time (months). The use of diluted sodium hypochlorite of 5000-6000 ppm is recommended. The biphasic treatment is very effective: cleaning with water and detergents or with polyphenol-detergent solutions at 0.5% for 10 minutes followed by the final disinfection treatment (both of the environment and of the instruments) with 1000 ppm of AvCl obtained from sodium hypochlorite or NaDCC for 10 minutes. The cleaning staff must be immediately notified of an environmental contamination of faecal origin. The bathrooms and the tools such as commode chairs or bedpans that are usually contaminated with faeces represent a reservoir of C.Difficile spores and therefore must be scrupulously sanitized. After patient discharge with *C. difficile*, rooms must be thoroughly cleaned and sanitized

Riassunto

Procedure di precauzione da contatto nelle strutture sanitarie

Introduzione. La multi antibiotico resistenza rappresenta un crescente problema di sanità pubblica, poiché le opzioni terapeutiche rimangono limitate. Tra i Gram-positivi, MRSA è il principale microrganismo diffuso sia in comunità che in ambiente ospedaliero. I Gram-negativi, sia fermentanti (enterobacteriaceae) che non fermentanti, pongono una grande sfida a tutti gli operatori sanitari poiché possono esprimere un'ampia antibiotico-resistenza.

Metodi. Specifiche combinazioni di parole chiave sono state analiticamente ricercate sui database di PubMed e Scopus. Le publications che riguardavano le procedure di precauzione da contatto sono state revisionate.

Risultati. È stata condotta la revisione della letteratura scientifica sul controllo delle infezioni e le procedure di isolamento, focalizzando l'attenzione sui bundles che possono aiutare il personale sanitario nel miglioramento della propria azione.

Conclusioni. Questo studio si riferisce chiaramente alle misure di controllo nei confronti della diffusione delle malattie infettive. Sono state proposte delle tabelle riassuntive per migliorare la conoscenza del personale sanitario.

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