Revisiting the principles of infection control

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Abstract
In the era of antimicrobial resistance, where the choice of antibiotics that we have to treat infections is becoming limited, infection control and hospital epidemiology are moving from being the orphan child of antimicrobial stewardship to becoming the necessity we can’t live without. The responsibility lies with every healthcare worker to know the what, when and how of infection control as we have to pursue different avenues to not only safeguard the antibiotics we have left but also to maintain a healthy environment for our patients. This article explores issues around infection control and hospital epidemiology.

Introduction
According to the World Health Organization (WHO) (2016): “infection control is a list of measures put in place to protect people who are vulnerable to acquiring an infection in the general community or while receiving care in a range of different health facilities”, with the basis of infection control being proper hand hygiene.1

Infection control has evolved into a discipline that applies epidemiologic and scientific principles and moreover applies statistical analysis to measure the prevention or reduction in rates of nosocomial infections. This has led to the phrase “infection prevention and hospital epidemiology”, as the words “prevention” and “epidemiology” more accurately define the discipline. Implementing an effective infection control programme reduces rates of nosocomial infections and is cost-effective to healthcare systems.2

Infection control policies and guidelines are mainly centred around reducing or preventing the spread of nosocomial pathogens to patients and healthcare workers3 with the main aim of infection control being to use resources in a safe and effective manner so that patients and staff are protected against pathogens.4

In South Africa, major healthcare facilities often lack infection control policies and, when present, they are usually poor.4 The lack of infection control policies in major healthcare facilities across the country leads to poor containment of the spread of infection.4

Guidelines in South Africa for infection control are formulated taking into consideration the five most important challenges faced by healthcare professionals namely antimicrobial resistance, bloodstream infections caused by catheterisation, nosocomial pneumonia, nosocomial urinary tract infections and nosocomial intra-abdominal infections.4

Infection prevention and control guidelines
Infection control plays an important role in both the control and prevention of communicable diseases in all sections of a healthcare system.5 Communicable disease is any disease the causative agents of which may pass or be carried from one person to another, directly or indirectly. Modes of transmission include (1) direct contact with body secretions from either an ulcer, open wounds, or through the respiratory tract; (2) indirect contact with inanimate objects such as drinking glasses, toys, or bedding; and (3) vectors such as flies, mosquitoes, or other insects capable of spreading the disease.5 With an increase in airline traffic infectious diseases are now spreading geographically much faster than at any time in history6. Any disease is only a few hours away from becoming a threat somewhere else.6

Also, in the last ten years alone, the WHO has verified that more than 1100 epidemics worldwide have occurred. Cholera, yellow fever, and epidemic meningococcal diseases made a comeback towards the end of the last century. Severe acute respiratory syndrome (SARS) and avian influenza have triggered major international concerns, and emerging viral diseases such as Ebola, Marburg haemorrhagic fever, and the Zika and Nipah viruses pose new threats to global public health security. The rise of antimicrobial resistance also places antimicrobials under threat.6

A basic knowledge and understanding of the epidemiology of various infectious diseases is required. Likewise the factors that predispose patients to infections, as well as the procedures and treatment that may actually lead to these infections in patients.6
This knowledge should be steered by an infection control team, that may include an infectious disease specialist, nursing practitioner, pharmacist, microbiologists and all the professional staff who support them in the clinical setting. Healthcare workers themselves are occupationally exposed to the risk of acquiring infections through direct contact with infected patients, bodily fluids and even sharps, like needles.

It is thus important for healthcare workers to receive ongoing education on the importance of infection control. They should also be issued with personal proactive equipment (masks, gloves, etc.) and be taught how to use them. There should be running water and basins that are conveniently placed to make hand washing an easy task. Healthcare professionals should also be educated on the correct way to wash their hands and the use of foams/alcohol rubs as disinfectants.

Nosocomial infections can be defined as “hospital acquired infections (HAI) occurring within 48 hours of hospital admission, three days of discharge or 30 days of an operation.” HAIs happen in all areas of the healthcare system; some of these areas include the medical wards, surgical centres, outpatient departments, and clinics, and long-care wards like rehabilitation centres and nursing homes. Outbreaks of nosocomial infections can be managed by implementing proper infection control measures. These should be taken to ensure that nosocomial infections do not occur in designated healthcare settings that accommodate suspected cases of emerging infectious diseases. The following measures could be implemented: negative-pressure quarantine intensive care units (ICUs) and wards should be built in accordance with the demand in the area and should be planned from the outset. The infection control team should have the following in place: regulations, standards, procedures, and operational instructions on protection against infections from emerging respiratory, gastrointestinal, body fluid, and insect-borne infectious diseases as standard operating procedures (SOPs). These can then be reinforced with regular training sessions on prevention and control of emerging or unknown infectious diseases. These teams could furthermore host emergency exercises regarding nosocomial infection events among members of the healthcare team to strengthen the infection control system.

See Figure 1 for ways that HAIs are spread and contracted.

Infection control is often termed the “orphan child” of antimicrobial stewardship and to this effect requires all healthcare workers to pull together as a team. Here the pharmacist plays a very active role in the provision of effective knowledge on the importance of infection control. Before anything else, effective hand washing techniques should be practiced ensuring soaps are used when washing hands. This is to protect the patient, healthcare workers and the community.

Guidelines should include environmental infection control and part of the recommendations should be that proper ventilation and water systems are in place, that an infection control team is present and regularly conducts infection-risk assessments, that dust-control procedures and barriers are used if any construction, renovations or demolitions are taking place, tests should be done by airborne particle sampling to ensure the air filtration system is effective, procedures should be put into place in operating theatres to prevent airborne contamination when patients suffering from tuberculosis are undergoing surgery, guidelines should be created for recovering water supply after any disruptions, environmental surfaces should be correctly disinfected, there should be policies in place for the sterilisation of healthcare laundry and guidelines should be in place when animals are being used within healthcare facilities.

Sterilisation is described as a process undertaken to destroy or eliminate all forms of microbial life and is carried out in a specialised facility either by physical or chemical methods. Disinfection is a process which eliminates all organisms, except spores, on inanimate objects where contact between patient and surgical and medical devices occurs daily and for this reason sterilisation and disinfection of these devices are important.

Safety and infection control does not only include hand washing. Effective cleaning of medical devices and safe injection practices are necessary. Outbreaks of the hepatitis B and hepatitis C viruses among patients in healthcare facilities in the United States of America have been linked to poor injection practices.

The following were cited as the major breach areas leading to the spread of infection:

- Insertion of used syringes into multiple dose vials
- Use of same syringe to administer medication to different patients

The following principles can be put into place to reduce the spread of infection:

- Use of sterile disposable syringes (single-use only)
- Use of disposable needles

Also whenever possible use of single dose vials instead of multiple dose vials particularly when administering medication to different patients.

With all information provided it is important for the infection control committee to follow up on the practices to monitor adherence to the principles.

**Figure 1:** Possible ways of contracting and spreading hospital acquired infections

- **Direct contact**
  - skin to skin contact
  - skin on surface contact
  - when a patient touches another or contact between a patient and healthcare worker

- **Via droplets**
  - pathogens are spread via respiratory droplets produced when an infected person coughs, sneezes or talks
  - respiratory droplets are less than 5 microns in size
  - they are able to stay suspended in the air for long periods of time
  - they are able to infect people a distance away from them

- **Airborne**
  - respiratory droplets spread via respiratory droplets produced when an infected person coughs, sneezes or talks
Antimicrobial stewardship and infection control

Antibiotic resistance is a global crisis and it is estimated that by 2050 10 million lives a year and a cumulative 100 trillion US dollars of economic output are at risk. This is all due to the rise of drug resistant infections and this increases the responsibility on healthcare professionals worldwide to slow down the rise of drug resistance. Currently, 700 000 people die of resistant infections every year. In the event that antibiotics lose their effectiveness, key medical procedures (such as gut surgery, caesarean sections, joint replacements, and treatments that depress the immune system, such as chemotherapy for cancer and even lifesaving cardiac surgeries) could become too dangerous to perform due to the risk of sepsis. Most of the direct and much of the indirect impact of antimicrobial resistance will fall on low- and middle-income countries such as South Africa.

The Centers for Disease Control and Prevention (CDC) estimates that antimicrobial stewardship programmes optimise treatment of infections and reduce the risk and toxicity associated with antimicrobial treatment whilst improving patient care.

Antimicrobial stewardship and infection control teams have important roles in the control of infection in an effort to limit transmission of resistant pathogens and also to decrease antimicrobial pressure that promotes antimicrobial resistance. Infection control is not only important in healthcare settings but also in the daily lives of individuals. According to Gandhi and colleagues, successful infection control is achieved through attention to hand hygiene, surveillance by institutions in the monitoring of infection control practices and contact precautions for multi-drug resistant pathogens. For example, a decrease in the episodes of methicillin resistant Staphylococcus aureus (MRSA) central catheter-related bloodstream infection in the intensive care unit, may be achieved by using preventative measures of adequate infection control practices.

Approach to infection control

The five fundamental infection-control measures are surveillance, isolation, hand washing, disinfection, and sterilisation.

Infection control may be improved by using surveillance systems that detect and report any outbreaks or infectious trends in specific healthcare institutions. Education of all healthcare workers on a regular basis will not only create awareness about infection control policies and guidelines but also assist in improving adherence to these infection control policies.

Multi-drug resistant organisms are spread from health workers’ hands to patients, from patients to patients or through contact with an infected surface. All healthcare workers and patients are urged to wash their hands regularly and use hand rubs as a disinfectant as it has reduced the number of cases of MRSA and Clostridium difficile.

| Principle |
| Hospital environmental hygiene | • Hospital environment should be visibly clean. No dust or dirt should be seen.  
• If an outbreak of infection occurs, cleaning should be adapted in order to contain the outbreak.  
• Equipment shared between patients (e.g. thermometer) should be decontaminated according to manufacturer’s specifications after each use. |
| Hand hygiene | • Hands should be decontaminated before patient care, directly after patient care, if workers come into contact with bodily fluid and after contact with equipment in the immediate vicinity of the patient.  
• When disinfecting hands with an alcohol rub/foam ensure that the entire surface of the hand comes into contact with the product.  
• Alcohol based rubs should be made available at all points of care.  
• Patients and their family members should be provided with an alcohol rub and information on how to clean their hands. |
| Personal protective equipment | • Gloves, masks and disposable plastic aprons must be worn by healthcare workers.  
• Hands must be disinfected before and after glove use. |
| Sharps | • Handling of sharps should be kept to a minimum.  
• Needles should not be recap after use.  
• Sharps should be disposed of in designated sharps bins. |
| Aseptic techniques | • All healthcare workers should receive aseptic technique training. |

Hand hygiene

As part of a major global effort to improve hand hygiene in health care, the WHO launched the SAVE LIVES: Clean Your Hands annual global campaign in 2009. This is a natural extension of the WHO First Global Patient Safety Challenge: Clean Care is Safer Care.

Hand hygiene is the term used to refer to both hand washing with either plain or antiseptic-containing soap and water, and the use of alcohol based products like foams and gels that do not require water.

Hand hygiene is considered to be the cornerstone of infection control amongst healthcare workers. Improved hand hygiene practices amongst healthcare professionals have shown a decrease in the incidence of infections.

If hands are visibly soiled or dirty it is important to wash them using soap and water. Hands should be scrubbed together for at least 20 seconds. When hands are not visibly soiled, an oil-based hand rub/foam may be used to decontaminate them.

Hand hygiene practices often fail as a result of reduction in adherence amongst healthcare professionals to hand hygiene practices because of the following factors: wash basins are inconveniently located or there are not enough available, the availability of soap and paper towels is limited, hand washing...
agents cause irritation or leave the skin feeling dry and there is not enough time due to understaffing or overcrowding of facilities. In order to ensure proper hand hygiene amongst healthcare workers, they should be provided with soap and disinfectants, access to wash basins should be convenient, natural finger nail tips should be kept up to a quarter inch long, and artificial nails should be discouraged amongst healthcare professionals who come into direct contact with patients.

**Infection specific recommendations**

**Multidrug-resistant organisms (MDRO)**

Controlling MRSA requires an evidence-based approach. Experts agree that contact isolation and hand hygiene are two of the most important measures in preventing the spread of MRSA. The use of masks and disposable gowns is not compulsory. A study conducted in Europe shows a decline in the spread of MRSA when alcohol rubs are used by healthcare workers to disinfect their hands between patients.

Carbapenem-resistant enterobacteriaceae (CRE), or carba-pene-mase-producing enterobacteriaceae (CPE) are gram-negative bacteria that are resistant to the carbapenem class of antibiotics, which are considered the drugs of last resort for such infections. This group of bacteria is resistant because they produce an enzyme called carbapenemase that disables the drug molecule. Enterobacteriaceae are common commensals and infectious agents. Patients in hospitals, nursing homes and other healthcare facilities are most susceptible to a CRE infection. Patients who are on ventilator support and use medical devices like catheters have a greater risk of acquiring a CRE infection. It is thus important to control and contain CRE infections as they are costly, difficult to treat and increase the risk of mortality of the infected patient.

Guidelines suggest that hand hygiene and contact isolation are important measures that should be taken to contain the spread of CRE infection. It is also of vital importance to educate healthcare staff about preventing the spread of these infections. Antimicrobial stewardship should be carried out if there is an outbreak or a patient suffers from one of these infections as it is important to use the correct antibiotic at the correct dose and duration. Daily cleaning of facilities should also take place as the environment can harbour infections. Chlorhexidine bathing with 2% liquid chlorhexidine or 2% chlorhexidine impregnated wipes has been used to bathe patients daily, in a high-risk setting when there is an outbreak of a CRE infection.

**Clostridium difficile infection**

*Clostridium difficile* or *C. difficile* is a gram-positive, toxin-producing anaerobic bacterium that is a leading cause of infectious diarrhoea in hospitalised patients worldwide. This is a type of infection that is mainly acquired during medical care (hospital-associated infection). *C. difficile* is transmitted via the faecal-oral route and only a seemingly small infectious dose of the bacterium is capable of producing spores which can remain viable for years in the environment. The highest risk factor for the development of symptomatic infection is incompletely understood but is most commonly associated with the disruption of normal gut microbiota by antimicrobials.

Those that are at risk of this infection are the elderly who are on antimicrobial therapy and possibly getting medical care. At some stage admitted patients get antimicrobial therapy which studies have shown to be irrational and this predisposes the patients to *C. difficile* infection. This can be avoided by rational antimicrobial use and infection control practices. The spread of *C. difficile* is not restricted to one facility; the spread of the infection can escalate to a regional or state problem because most of these long-term treatment facilities transfer patients between facilities thus facilitating the spread of infection.

The Society for Healthcare Epidemiology of America (SHED) and the Infectious Diseases Society of America (IDSA) came up with an update to the clinical practice guideline for *C. difficile* in 2010 which is aimed at preventing the spread of infection in every possible way. Healthcare worker-, patient- and visitor-centred infection control and prevention should be implemented with emphasis on the practice of proper hand washing hygiene, ensuring soaps, water and proper towels are available at all times with clear and visible instructions on how to wash hands. Patient centred interventions involve the identification of diarrhoea as one of the symptoms of *C. difficile* infection and patients should be informed of the importance of hand washing after using the toilet. The WHO launches a yearly SAVE LIVES: Clean Your Hands campaign with the goal of maintaining a global profile on the importance of hand hygiene in health care. This can be used to promote hand hygiene in the specific healthcare setting during outbreaks. Routine screening of healthcare workers should be part of the policy and can be used to identify asymptomatic carriers of potentially pathogenic bacteria.

Another area of interest is the environment, and specifically cleaning and disinfecting the hospital environment. This entails the use of very potent cleaning agents (chlorine-containing agents) and routine microbial screening of the environment. As part of antimicrobial stewardship, the use of antimicrobial agents should be protected, and used only for specific indications, with the aim of reducing the duration of therapy. Having these measures in place, reduces the risk of acquiring *C. difficile* infections.

**Surgical site infections**

Skin serves as a natural defence mechanism that protects us from infections. Surgical procedures cause a break in the skin exposing the body to infections. These infections are called surgical site infection (SSI). The rate of occurrence of these infections is documented to be low at about 1% to 3% of cases.

SSI usually presents within 30 days after the surgical procedure and can occur in different ways:

- Superficial incisional SSI: the infection is present only in the area where the incision was made
• Deep incisional SSI: infection is present in deeper layers than the incision area around muscles and surrounding tissues
• Organ or space SSI: infection occurs further into the body organs and area between the organs

There are various causes and risk factors for SSIs. Some of these causes include poor wound cleaning, contamination of wound during surgical procedure, or infection present already at time of surgery. Some of these risk factors include:
• Advanced age
• Overweight
• Smoking
• Immunoscompromise or immunosuppression
• Abdominal surgery

Evidence-based preventative measures can help prevent SSIs. Surgical hand preparation is aimed at ensuring that hand washing is a regular practice before and after any surgical procedure. This practice is not restricted to healthcare workers only but also applies to the patient and caregiver when changing wound dressings. The rational use of antimicrobial prophylaxis, should include aspects such as the specific surgical procedure, the organ or area of the body where the procedure will be done, and the properties and spectrum of the antimicrobial agent.

Other preventative avenues have been explored for the prevention of SSIs some of which are preoperative bathing, preoperative skin preparation in theatre aimed at sterilising the skin with agents like chlorexidine alcohol, preoperative hair removal, use of sterile gloves at all times during surgery and dressing of wounds, use of laminar airflow in the operating room and effective post-surgical care.

Catheter-associated bloodstream infections

Healthcare Infection Control Practices Advisory Committee (HICPAC) developed and updated guidelines aimed at healthcare workers responsible for the insertion of intravascular catheters, and individuals who are in charge of monitoring and control of infection in the healthcare facility. Researchers have referred to these infections as catheter-related bloodstream infections (CRBSI) which lead to an increase in hospital stay and cost of care. For this infection spread to be controlled, implementation of guidelines requires the involvement of a multidisciplinary healthcare team whose ultimate goal is to eradicate CRBSI from spreading with the focus on the proper care and maintenance of catheters once inserted.

Guidelines should be aimed at preventing this infection with emphasis on the following:
• Education and training of healthcare workers involved in the insertion of catheters
• Ensuring use of sterile barriers (gloves) during the inserting process
• Ensuring skin area of insertion is sterilised with antiseptics like alcohol and chlorhexidine

Catheter-associated urinary tract infection

Of note is that urine is normally sterile but can in certain instances be a good growth medium for bacteria that enter the bladder and the urinary tract. Probably one of the most important considerations is the difficulty of obtaining uncontaminated voided midstream urine specimens. The healthcare worker should always ask where the sample came from as contamination in collecting the sample should be the first consideration. To this end quantitative thresholds have been established to distinguish bladder bacteriuria from urethral contamination.

The antimicrobial stewardship team should assist in the identification of asymptomatic bacteriuria, which is defined as isolation of a specified quantitative count of bacteria in an appropriately collected urine specimen from an individual without symptoms or signs of urinary tract infection. The quantitative thresholds are different for voided clean catch specimens and catheterised specimens. The presence of pyuria is not sufficient for diagnosis of bacteriuria. This was illustrated in a study of urine samples from asymptomatic elderly women; 60 percent of the samples with pyuria had no bacteriuria.

Urinary tract infections (UTIs) are some of the most common hospital-acquired infections. The majority of these infections are as a result of devices placed in the urinary tract (e.g. catheters). These infections are called catheter-associated UTIs, which are defined as urinary tract infections as a result of catheters placed within the urinary tract for longer than two days in which the day of insertion will be the first day.

Recommendations towards policy reform and guidelines are aimed at preventing these infections:
• Education on how the urine sample is obtained
• Inclusions of relevant definitions e.g. asymptomatic bacteriuria
• Education of all health workers involved in the insertion of catheters
• Classification of who should receive these catheters
• Education on how catheters are inserted
• Proper hygiene practices before, during and after catheter insertion
• Monitoring procedures to ensure proper catheter insertion
Conclusion

Infection control involves infection prevention and hospital epidemiology. Implementing an effective infection control programme reduces the rates of nosocomial infections and is cost-effective to healthcare systems. Infection control involves a functioning healthcare team that steers and monitors aspects such as hand washing campaigns, ensuring a hygienic hospital environment, correct personal protective equipment for staff members, discarding of sharps in a safe manner and that safe aseptic techniques are followed where necessary. Infection specific protocols should also be available, and these involve management of infections specific recommendations such as management of multi-drug resistant organisms, C. difficile prevention and management, surgical site infections, catheter-associated bloodstream infections and catheter-associated urinary tract infections. There are many more infections-specific recommendations that can be made, but if the team is familiar with the basics involved in infection control, similar principles can be implemented.

References