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Modern Techniques in Hospital Infection Control

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Abstract

A rapid increase has been observed in nosocomial (hospital-acquired) infections due to a growing population of immunocompromised hosts and those taking invasive measures to prolong life. Many advances have been made in the control of nosocomial infections, but the sheer magnitude of the problem dictates the continued search for better methods. The papers in this series are based on a conference sponsored by the Section on Hospital Epidemiology of the Society for Pediatrician, 15-17 November 1981, and are intended to provide guidelines for infection control practices in different hospital areas. Given the wide variety of hospitals and the differences in patient populations, it is understood that the practical application of these guidelines will vary considerably. The continued effort to assess the efficacy and utility of the methods suggested in the following papers is necessary to gauge their merit and to search for even better methods.

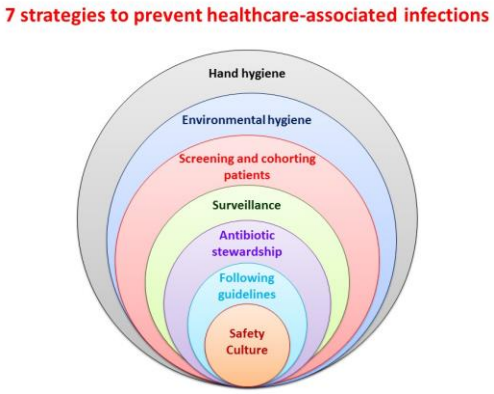
Keywords*: nosocomial, immunocompromised, infection control.*

1. Introduction

With the presence of infectious agents increasingly showing patterns of resistance and the rapid transfer of diseases across the global sphere, the challenge of infection control is monumental. New diseases are emerging all the time and many old ones are reappearing, mutating, and presenting clinical features in a different way. This ever-changing field of infective pathology adds to the complexity of infection control. An example of this can be seen in the epidemiological shift of Hepatitis C. Once a disease only recognized among intravenous drug users, it is now increasingly being seen in the general population. As the fight to control and prevent infection becomes more difficult, the need to understand infectious agents, modes of disease transmission, and the most effective forms of

prevention becomes ever more important. (Weldon and Hoffman2023)

In the introduction, we discuss how infection control is a central topic in the field of hospital care. Though a concept that has only recently been added to new topics in healthcare, it has long been a subject of debate and argument. The absence of infection in hospitals should be a major objective of all healthcare workers and providers. An understanding of the history, principles, and theories underpinning infection control should assist healthcare workers to achieve this objective. According to A. J. Naidoo, author of "The Essentials of Nursing and Healthcare," "All healthcare workers, whether working in a hospital or a community setting, must consider the implications of their practice on the health of their clients and take all possible steps to protect them from hospital and other acquired infections."



1.1 Importance of Hospital Infection Control

A hospital must be a place of healing. However, individuals with various diseases are treated there. Many of these diseases are communicated to others, while there is a risk of acquiring new infections while hospitalized. Treatment with antimicrobial agents and the creation of sophisticated life-supporting techniques have added to the problem. Other patients receiving care in today's hospitals are also more susceptible to infection. Invasion of the body's natural defense and repair systems by disease and treatment is now more common than before. Surgery and the use of invasive medical devices are a necessary part of therapy for many conditions. But they increase the risk that a patient may acquire an infection, which would add to their morbidity and discomfort. Certain underlying or concurrent diseases are known to increase a patient's risk of acquiring infections. Major advances in medical therapeutics have made many more patients recipients of immunosuppressive and antineoplastic therapy, or they may have major alterations in immune response due to treatment with corticosteroids. Lastly, the increase in and changing mix of the patient population has resulted in more individuals at an increased risk of infection. Elderly persons, for example, have higher rates of underlying disease, and they constitute an ever-larger portion of the hospital patient population. The ultimate reason for an emphasis on infection control is simple. Infections are to be prevented in order to avoid patients getting any sicker. Control efforts can be viewed as an integral part of the treatment process. Modern infection control dates from acceptance in the mid-1900s that many hospital-acquired infections were preventable with relatively simple, cost-conscious measures. Today's infection control professionals (ICPs) continue to apply a methodical, practical, and highly effective approach to prevention and controlling infections in healthcare. And the old adage that the best therapy for disease treatment is prevention of the disease still holds true today in every type of hospital. (McNett, 2020)

1.2 Scope of Modern Techniques

The term modern technology can encompass many forms of application within infection control. For the purpose of this essay, modern technology will be taken to mean any advanced method or application in microbiological science with the aim of providing a solution to an existing problem or providing a more effective method of accomplishing a task. The problem in focus here is infection control, with the task being the reduction of transmission of infective agents into susceptible patients and subsequent prevention of infection. This could be seen as setting out to perform terminal cleaning of a patient's ward more effectively to prevent the next patient acquiring an infection, or it could be taking measures in food preparation for immunocompromised patients to ensure they will not contract a foodborne infection. This concept of defining a problem and task and going on to find a solution is the essence of evidence-based medicine and can be directly transferred to the field of microbiology and

infection control through the application of modern science. (Cook & Wright, 2022)

The concept of using modern techniques in hospital infection control is based upon the premise that the rapid advances made in scientific technology and in our understanding of the epidemiology of infectious diseases should be utilized in improving the level of control of hospital-acquired infections. Whether the technology has been borrowed from high-risk industries such as nuclear power or the aviation industry, or whether it utilizes the remediation of high-touch areas within the hospital, the goal is the same: prevent patients from becoming infected with avoidable healthcare-associated infections. Although many of the published studies on modern technology are in the form of randomized trials or systematic reviews concerning efficacy, this essay will attempt to give an all-encompassing overview of various types of technology available and their potential application in the prevention of healthcare-associated infections.

2. Basic Principles

Personal protective equipment (PPE) is a method of care used to minimize the risk of exposure to microorganisms. PPE includes items such as gloves, aprons, and masks, which create a physical barrier between the healthcare worker and potential infectious material. The use of PPE is a fundamental principle in the prevention of the spread of infection to patients and healthcare workers. Gloves should be worn for and changed between the care of different patients and should be considered a single-use item. Hands should be decontaminated before and after glove use to ensure that the gloves are being used as a method of protecting both the patient and the healthcare worker from the spread of microorganisms. Wearing an apron protects the uniform or clothing from contamination, and masks protect the respiratory tract from airborne organisms. The nurse or healthcare worker should consider the type of care being provided and the degree of exposure to microorganisms when selecting the appropriate PPE to use. An understanding of when and how to use PPE is essential for all healthcare workers and should be closely monitored to ensure that it is being used correctly. (Jones et al.2020)

Hand hygiene is now regarded as one of the most important infection prevention measures. Hand decontamination can be achieved using an alcohol-based hand rub or by hand washing with soap and water. Alcohol hand rub is more effective and a more practical method of decontaminating the hands, as it is quicker to use, accessible, and kinder to the skin. Alcohol hand rub should be used when the hands are not visibly soiled. Hand washing with soap and water is a necessary practice when the hands are visibly soiled or when caring for patients with Clostridium difficile and other spore-forming organisms. Hands should be washed for at least 10-15 seconds, and a more systematic approach to hand hygiene has been described by the 'My 5 Moments for Hand Hygiene' approach. This concept defines the key moments when healthcare workers should perform hand hygiene during the care of patients. Remembering these moments, particularly those related to aseptic non-touch technique, is vital in preventing the spread of infection to high-risk patients. Hand hygiene is an extremely effective yet simple infection control measure and should be considered a basic principle for all healthcare workers.

Effective infection prevention starts with recognizing that every healthcare worker has a responsibility to break the chain of infection within the healthcare setting. A clear understanding of the basic principles of infection prevention and control is key to preventing the spread of infection. These principles are general and can be applied to all areas of healthcare. It is essential that all healthcare workers are aware of the risks of infection associated with the care they provide and are able to identify those patients who are most susceptible to infection.

2.1 Hand Hygiene

Hand hygiene is the most important measure to avoid the transmission of harmful germs and prevent healthcare-associated infections (1). In an effort to stop the spread of antibiotic-resistant bacteria, including Methicillin Resistant Staphylococcus Aureus (MRSA), Vancomycin Resistant Enterococcus (VRE), and Clostridium Difficile, the Centers for Disease Control and Prevention (CDC) have

produced guidelines that outline the most effective approaches in healthcare. This evidence-based guidance is intended to assist healthcare providers in reducing the transmission of MDROs in healthcare settings. The 2002 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings is designed to provide healthcare facilities with strategies to reduce the transmission of infections. This guideline includes hand hygiene as an AIC (Category IA) recommendation, which indicates that there is scientific evidence and an MRSA/Care guideline that includes a patient safety guide highlighting the importance of hand hygiene. Hand hygiene: A handbook for medical professionals, an evidence-based hand hygiene education module, and slide set are published materials developed by the CDC. Several studies have shown a correlation between the decreased rate of infection with the increased practice of hand hygiene. Hand hygiene reduces the number of microorganisms on the hands and is effective in the prevention of cross-transmission of microorganisms from healthcare worker to patient. Three recent studies from pediatric ICUs suggest that higher rates of hand hygiene are associated with decreased nosocomial infection. The association is dose-dependent, with an increase in hand hygiene frequency leading to a decrease in infection rate. (Hadaway, 2020)

2.2 Personal Protective Equipment

There are many different types of PPE ranging from hats and aprons to goggles, masks, and respirators. The choice of which item to use is determined by the type of patient care activity it is intended for and the degree of fluid and microorganism resistance required. It is important, therefore, that all HCWs are aware of the correct PPE to be used for each individual activity they carry out. This needs to be made explicitly clear in their training and/or workplace guidelines. For example, a HCW emptying a bedpan may only require an apron and gloves, whereas someone assisting in a surgical procedure may need to wear a full body suit, hat, mask, and goggles. A useful means of control in ensuring correct PPE usage is to introduce a system of checklists for task indications and appropriate PPE. This is particularly applicable for isolation patients.

Success in the prevention of transmission of infection during patient care is largely related to a reduction of the risk of direct or indirect contact transmission. This is accomplished through the use of personal protective equipment and by adopting a strategy that builds care activities around patient needs and where a clear understanding of task indications and isolation precautions is apparent. Personal protective equipment has an important role in providing a barrier between microorganisms and the HCW. Providing that an appropriate combination of PPE is used for all patient care activities where there is likelihood of coming into contact with body fluids, there will be a reduced risk of disease transmission. It is important to note, however, that the use of PPE alone is not effective in preventing the transmission of microorganisms and in some cases may increase the risk.

2.3 Environmental Cleaning

Environmental cleaning has been given a lot of importance in reducing hospital-acquired infections. According to the Health Act 2006, NHS Trusts are now required to identify a board director who is responsible for infection control. Also, after the Jan 2008 report "The Cleaner Hospitals," the National Patient Safety Agency (NPSA) stated that it will take a zero tolerance approach to infections in hospitals with a focus on cleanliness to reduce the incidence of HCAIs. Environmental cleaning includes patient equipment, commodes, etc., cleaning of the general environment, and finally domestic cleaning. The current evidence base favors the use of disposable equipment as it is very effective in preventing cross-infection. In cases where this is not possible and equipment needs to be shared, e.g., a stethoscope between various staff members and/or patients, it should be cleaned after use of each patient. This is recommended in AN EPIC 3 as part of infection control in the aim to reduce HAIs in clients. All hospital environments should have a clean infrastructure. In cases where new multi-drug resistant strains of bacteria are emerging, it is now encouraged to run surveillance for these bacteria in the environment. An example would be the recent surveillance programs put in place to identify Clostridium difficile in the NHS. Step one of eradicating such bacteria would be to clean the environment with

detergent and water, step two to then disinfect the area with a biocidal agent. A recent publication by the DH on Clostridium difficile found that using hypochlorite-based products was the most effective at removing or killing strains of C. difficile. This was after testing various different types of disinfectant, including different alcohol-based products. However, some literature has suggested that there is no complete evidence that hypochlorite is the most effective due to finding limited difference between different germicides but with a significant difference between cleaning methods, e.g., low level vs. terminal cleaning. Because of this, it is important that the most effective method is chosen, with this being the one that gets closest to achieving the goals of step one and two of the cleaning process. This leads us on to the final area of domestic cleaning. Involvement of domestic staff and the way in which they work have direct links to infection rates in a hospital. It has been recognized that providing domestic staff with better wages and training will increase their interaction and willingness to be involved in infection control measures. It was the reorganization of domestic services that cleaned the hospital environment and helped in eradicating MRSA. With the exception of new civilizations and ATP drives, this cleaner environment is now being maintained. (Kunasekaran et al.2022)

3. Advanced Technologies

Automated Sterilization Systems are evolving rapidly, and the future systems are likely to have sensors to detect whether items are correctly sterilized. Otherwise, they will re-sterilize them. They are likely to be faster and use less energy than current sterilizers. It is important that future systems are still compatible with the wide range of materials used in medical devices and do not damage items. RFID tagging of sterilized instruments is a future method of ensuring that items have been correctly sterilized and have been stored in a hygienic environment. This is important for preventing surgical site infections. Step is an example of a system that is currently using this technology. (Boehler et al., 2021)

(UV-C) Disinfection emits UV-C light to quickly and effectively destroy harmful microorganisms on surfaces and in the air. It is a highly effective method of disinfection and is already used in a variety of healthcare settings, as well as food processing and manufacturing plants. It is simple to use and has a rapid disinfection cycle, which makes it a practical solution. Research indicates that it is effective against MRSA and C.difficile spores, which are the major cause of HAIs. UV-C Disinfection is likely to become a standard room disinfection technology in hospitals in the future.

3.1 UV-C Disinfection

UV-C disinfection: This light-based technology has been used to kill germs on surfaces and in the air for over a century. There are a broad range of UV disinfection devices available, ranging from small suitcase-sized portable machines to large fixed installations. Typically, UV-C devices are used to disinfect unoccupied spaces (e.g. hospital rooms, operating rooms) and are intended as an adjunct to, not a replacement for, manual cleaning and disinfection. UV-C devices can be deployed to disinfect specific rooms or areas known to be contaminated with infectious microorganisms, or as a terminal disinfection step to help control outbreaks. Specific uses for UV-C devices include disinfection of rooms of patients known to be infected or colonized with multidrug-resistant organisms, disinfection of rooms when patients with certain infections are known to be admitted, and nightly disinfection of all general patient care rooms on units where infected patients are being treated. The value of UV devices in preventing transmission of healthcare-associated pathogens and infections to patients is not yet clear, and device efficacy varies depending on the specific device and the context in which it is used. Devices need to be used according to manufacturers' instructions and following thorough cleaning of targeted surfaces, including removal of dust and other materials that might shield germs from the UV light. Standard precautions for protecting cleaning staff from potential UV-C exposure are also recommended. (Matthew et al.2022)

3.2 Automated Sterilization Systems

Autoclaves have long been the standard for sterilization in hospitals; however, newer

technologies are challenging this. Going into a detailed description of how each technology works is beyond the scope of this essay. A cost-benefit analysis of newer technologies over autoclaves has not been conducted. It is likely that the high temperatures of steam sterilization are cost-effective in preventing infection when compared to surface techniques. Newer technologies are very attractive due to ease of use and lack of maintenance. Time will tell if any new technology can match the excellent sterilization and low cost of autoclaves. Plasma sterilizers are able to rapidly sterilize heat-sensitive materials. Hydrogen peroxide is in a vapor or gas form and is effective for sterilizing large enclosures or room environments. The duration and concentration required for different technologies have a significant effect, and studies in these areas are required to determine effective sterilization parameters. (Ferràs-Tarragó et al.2022)

3.3 Antimicrobial Surfaces

Other metals with antimicrobial activity include silver, which has been applied to coatings for a variety of medical devices. Silver has also been incorporated into wound dressings and hydrogel sheets to prevent infection in cuts, abrasions, and burns. A newer and revolutionary technology is the use of ionic silver impregnated in plastics; with plastics being an ever-growing material in healthcare and the ion leaching characteristics of ionic silver, this technology is likely to be seen widespread in the future. The mechanism of ion leaching is an important characteristic to ensure the antimicrobial efficacy of silver-impregnated plastics, and studies have found that certain commercial brands have inadequate ion leaching to effectively kill bacteria. An alternative metal to compare to other copper and silver antimicrobials is titanium dioxide, which has photocatalytic activity under UV light and has been formulated into a variety of applications from a coating on existing materials to incorporation in porcelain tiles. Finally, there are a number of antimicrobial coatings using various chemicals and compounds that have been applied to a wide range of substrates from fabrics and plastics to electronics. (Song et al.2021)

The antimicrobial surfaces are a growing field in infection prevention. Unlike other interventions, it is a passive one, acting constantly to kill microbes that contaminate the environment. With the high rate of recontamination of high touch surfaces, antimicrobial surfaces serve as a key intervention in breaking the chain of pathogen transmission. There are a number of different antimicrobial surface technologies in the market including coatings, metals, and plastics. One of the most popular is copper alloys, which have substantial antimicrobial activity. Stainless steel surfaces are often coated with different copper alloys or entirely replaced by copper alloys for frequently touched items. The antimicrobial activity of copper alloy surfaces helps to kill microbes acquired from previous patients, reducing the risk of HCAI infection in subsequent patients.

4. Surveillance and Monitoring

Surveillance and monitoring is a fundamental operation of infection control practice. Monitoring in a systematic manner of the frequency and patterns of HAI occurrence will allow the infection control team to detect any departure from the norm. This will enable prompt investigation of increased infection rates, or change in the nature of infection e.g. following the introduction of a new clinical practice. The overall aim is to identify and control the source of infection to prevent further spread. The traditional method of infection surveillance has been the manual collection of data as and when required. This method is slow, consuming and not in depth. However, recent information technology developments have revolutionised the way in which infection surveillance can be. Computerised infection tracking systems are

becoming increasingly sophisticated and their use is widespread. Data on infection type, location, the infecting organisms and patient groups at risk can be entered and the system will then produce specific information when required, or generate regular reports and dynamic graphics. This will enable trends to be easily identified and monitored, comparing current data with past infection rates. It will also provide a useful method of presenting data to others, for example a hospital manager or clinical colleagues. In the current climate of increasing clinical accountability and cost effectiveness, this can be a useful tool in demonstrating the value of infection control and where resources could be best utilised. Another form of sophistication to surveillance is the use of real-time data analysis. This is a complex method of data mining and statistical process designed to scan and analyse computerised data of infection occurrence as it is entered. An occurrence of specific pre-defined criteria will trigger an immediate alert to the infection control team, enabling a quick response to any increase in infection rates. This concept has been taken a stage further and applied in the community setting with the use of primary care data. The recent development of electronic health records in general practice has provided a rich source of data on patient demographics, co-morbidity, clinical events, diagnoses and prescribing. Use of this information can be valuable in detecting specific groups of patients at risk of infection. This data is vast and complex, and new methods are currently being researched on how to best extract and make use of this information. (Lintz, 2023)

4.1 Infection Tracking Systems

An infectious disease surveillance and monitoring system integrates the gathering, analysis, interpretation, and dissemination of information followed by public health intervention. It is a systematic, ongoing collection, analysis, and interpretation of health knowledge crucial for the planning, implementation, and analysis of public health observe. An effective surveillance and monitoring system facilitates timely collection, administration, and use of data from a variety of different sources in response to potential changes in health trends. It is a crucial link between data collection and public health action. The establishment of an infection surveillance system takes a proactive approach to facilitate early detection of any changes in infection rates and the potential for outbreaks. Once an outbreak is recognized, surveillance data supplies informative feedback on the effectiveness of the applied control measures.

The aim is to control and eradicate the transmission of newly-chinfections of this type in a well-timed manner and also the hospital-wide transmission of widespread infections. It is provided that there are sufficient resources available to analyze the data efficiently and that the information is handed to those at risk of infection throughout their stay within the hospital. This method may be conducive to a rise in the resources used for the infection prevention and control but provided it is for a timely analysis, it is going to save cash in the future by reducing infection and the linked costs of therapy through effective prevention measures.

The infection tracking system is a chronological sequence of procedures assumed to recognize the beginning and stop of an outbreak by systematically gathering and examining data. Two types of data are concerned in outbreak detection. The first is historical data on the frequency of infections and the underlying possible opportunities for cross transmission. This type of data is frequently obtainable and increases the capability to compare actual to expected results over time. The second type of data is the monitoring of precise infections. If the infection rate is high, a lot of resources are used on the tracking of latest infections. Computerized infection tracking software is now available to automate this procedure. For a particular infection, the centers start by defining a case, then analyzing the etiology and pathogenesis to decide the mode of transmission, building control measures, and stopping when the data no longer supports ongoing transmission. (Hemdan et al.2023)(Richards et al.2020)

4.2 Real-time Data Analysis

However, this analysis takes time and is not suitable for outbreak detection. Expert Rule Based Methods use a set of decision rules from experts in infection control and hospital

epidemiology to help automated detection of outbreaks. A series of highly sensitive algorithms are being used to detect point source outbreaks seen in hospital-acquired infection. ECART (Epidemic Control And Reporting) uses an approximation to an exact statistical method for prospective detection of known outbreaks of a particular infection. Time series analysis has also been used for detection of outbreaks in surveillance data; however, this is a complex method and has yet to be adopted into real-time automated analysis. The above sophisticated methods of analysis are restricted to more advanced users of data analysis. The vast majority of infection control practitioners in the UK do not have the statistical knowledge nor the time to effectively use these methods on routine surveillance data. This motivated the development of the WWS (Who Where and When Who is At Risk and Why What and When Did it Happen) method, which simply identifies who is getting what infections, when and where they are getting it, and why the infection is occurring. This information is essential for research into the causes and prevention of infection.

Immediately following data input into infection control databases, the analysis process begins. There is increasing belief in the importance of automated analysis of infection control surveillance data. During the past 2 decades, there has been significant progress in this area. Simplistic analyses that solely generate frequencies of infections have been replaced by more sophisticated statistical algorithms that can detect temporal and/or significant changes in infection rates. Time-critical sequential statistical tests such as the CUSUM and Shewhart methods have been used to detect shifts in infection rates. These methods have been used with success in single unit analyses, for example, the visual surveillance of rates of central line infections in ICUs.

4.3 Outbreak Investigation

While surveillance and monitoring can aid in early detection and possibly early control of an outbreak, the fundamental steps for carrying out an outbreak investigation is when a link has been established that an outbreak may be occurring. Guidelines for outbreak investigations have been published by the Centers for Disease Control (CDC) and tend to follow the same basic principles regardless of the infective agent involved. The key to a successful investigation is defining the problem, establishing a case definition, conducting surveillance, developing hypotheses, more systematic testing of hypotheses and finally implementation and evaluation of control measures. The author will not touch on statistical analysis in outbreak investigations as this is quite complex and often will involve input from an epidemiologist. Overall statistical analysis tends to involve comparison of disease rates and or risks between exposed and non-exposed individuals to identify potential risk factors. Specific statistical tests should be discussed with an epidemiologist but are usually a test of significance to determine if a suspected exposure is indeed a risk factor and followed by regression analysis to help understand relationships between variables. Case and/or cohort control studies are often used to generate results of statistical testing. At ECRI, an independent, nonprofit organization improving the safety, quality, and cost-effectiveness of patient care, probabilistic record linkage software was used to detect nosocomial transmission of MRSA. The infection control team was alerted to matches generated by the software and initiated an investigation which typically involved further chart review, interviews with patients and more comprehensive microbiological testing to determine which isolates were related. This investigation methodology detected many more cases of transmission than routine surveillance over the same time period and helped to identify characteristics of patients and types of contacts most likely to cause transmission, thus providing valuable information to help reduce transmission in the future. An earlier investigation using the same method also identified that patients who had never shown clinical signs of disease but were found to be asymptomatic carriers were a common source of transmission to other patients. Identification of this previously unknown mode of MRSA transmission helped to change infection control practices at the hospital. Both investigations demonstrated the utility of more thorough outbreak investigations in generating valuable information to improve infection control. (Tun et al., 2021)

5. Education and Training

Guideline adherence and impact can be monitored through infection control surveillance. This can involve specific surveys or case studies of given patient populations, rates of procedures, or certain nosocomial infections. Surveillance methodology may need to be altered, and its value and added costs compared to what it displaces.

The effectiveness of guidelines will depend on your knowledge of them. The rationale behind a recommendation or its evidence base may not be immediately obvious. Staff in a hospital are from a wide range of professions and backgrounds, and some may find it difficult to understand written guidelines. An instruction, e.g. to use a specific cleaning practice, may need further dissection into the how, when, where, and why of that practice. Guidelines regarding basic hygiene and the prevention of cross-infection may be quite different in countries or areas with different healthcare resources, so health professionals need to weigh the scientific evidence behind a guideline against those of local practicalities. A national survey of infection control nurses in the US revealed a broad lack of knowledge of guideline recommendations and brought attention to some guideline topics that were controversial or not state of the art. Targeting guideline knowledge to specific professional groups, for example, the unwell/not too frail patient versus terminally ill patient care of life support, would also be beneficial. Successful development and implementation of guidelines will require education and possibly behavior change among various health professionals who are already set in established practices.

Infection control guidelines may be subdivided into two sections: 1. Recommendations to prevent the transmission of infections from recognized and unrecognized sources; 2. Surveillance, identifying local problems and checking whether recommended practices are being followed. The first is concerned with direct patient care, e.g. barrier nursing, and the second with the safety of all staff and others who have contact with the patient, e.g. practices for handling soiled linen and use of specific equipment. An effective national guideline that is properly implemented should minimize the risk of, for example, transmission of MRSA, epidemic methicillin-resistant Staphylococcus aureus, which has caused significant problems in the UK in recent years.

5.1 Infection Control Guidelines

Infection control guidelines help prevent the transmission of infection from one patient to another, from patients to healthcare workers, and from healthcare workers to patients. These guidelines are intended to be prescriptive in nature. The SHEA guidelines are evidence-based and, if followed, will prevent infection in most situations. They are derived from the relevant infection control guideline topic with the quality of evidence and the strength of the recommendation. The HICPAC guidelines include a Category IA designation which comprises a strong and consistent evidence and a Category IC designation which comprises an expert opinion for a practice that may lead to the prevention of infection. An effective educational program incorporates knowledge of infection control in its curriculum, provides education and training in infection control practices and strategies to all relevant healthcare personnel, with training levels commensurate with each person's degree of direct patient contact or exposure to potentially infectious materials. It is a lifelong learning process in an ever-changing healthcare environment. The goals are to increase the basic knowledge of all healthcare workers regarding infection control, increase compliance with infection control practices, and ultimately improve patient care by preventing healthcare-associated infections. To be optimally effective, education and training in infection control should be integrated into all educational programs for healthcare professionals and paraprofessionals. This includes, but is not limited to, pre- and post-licensure education, medical and nursing school curricula, training programs for allied health professionals, and continuing education. An effective dissemination strategy is required for translation of knowledge in infection control to clinical practice.

5.2 Staff Training Programs

Training is a vitally important component of any plan to improve hospital infection control.

Behavioral and attitudinal change is a slow process, and it has been well documented that changes in the knowledge, attitudes, and especially the behavior of healthcare workers are essential for the success of infection control and prevention. There are still many healthcare workers who do not believe that their day to day activities are a source of nosocomial infection. Education about the risks their activities pose and the practices that serve to mitigate those risks can serve to persuade them to make necessary changes in behavior. In many cases, the unsubstantiated beliefs of healthcare workers may be contrary to recommended infection control practices. In such cases, when presented with evidence-based information, healthcare workers are likely to alter their current practices. This has been the motivation behind legislative measures in the United States requiring infection control education for specific groups of healthcare workers. Enforcement of infection control practices is not a desired means of promoting change in healthcare worker behavior. Workers who are compelled to practice certain infection control measures are not likely to continue those practices when supervision is removed. A more effective approach is to empower healthcare workers with the knowledge and skills necessary to protect their own health, the health of their patients, and their family members. Infection control education serves just this purpose. (Tartari et al.2021)

5.3 Continuous Professional Development

In the past, medical practitioners seeking to develop new skills have generally had to engage in forms of professional activity that were time-consuming and sometimes not directly relevant to their educational needs. The traditional academic routes for postgraduate education are degree courses or research. Whether taught or research based, they share one feature: the need for the student to take significant periods of time out of the workplace. It is through a vision of an educational strategy based on learning from experience, with an emphasis on professional development, that the collaboration seeks to address the learning needs of practitioners in infection control. Professional development has been defined as the development of medical practitioners throughout their careers by continuing medical education, self-directed learning, learning on the job, and outcome assessment in clinical practice. An NHS facing increasing demands to improve patient safety and standards in care may depend on a small enriched minority for academic leadership and educational roles. However, for changes in infection control practice to be sustained, there must be a comprehensive strategy for the professional development of all healthcare workers in the UK. This is particularly true for senior doctors, dental surgeons, and vets, who are taking on leadership roles in infection control.

6. Collaboration and Communication

Effective communication strategies are essential for patient safety to be achieved in the healthcare setting. Communication within a team of healthcare professionals is often not effective. Each profession has its own terminology and way of communicating. Ineffective communication has been the root cause of many adverse events and it is in the interest of the patient and the healthcare industry as a whole to change this. This is a complex issue, and there are no easy solutions. Communication can be improved by team building within the different professions to gain a better understanding and respect for each team member's role. Openness and respect will make it easier for a team member to voice their concerns if they believe that the safety of the patient is being compromised. This is an important skill that is often lost in the hierarchical environment of the healthcare setting. Other strategies include the use of briefs and checklists and the education of healthcare professionals in the use of assertive communication techniques.

Interdisciplinary teams play a key role in promoting the goal of patient safety within an institution. Each professional brings their own unique perspective and knowledge of their field to the team. The physical therapist may look at patient care and safety from one perspective, while the nurse looks at the same from another. Through collaboration, the combined knowledge of the different professions can be used to best identify a problem and find the most effective solution. The understanding and ideas generated

through interdisciplinary teamwork will help to identify specific, measurable objectives aimed at improving patient safety. Each team member can identify and carry out tasks that are within the scope of their own practice but that all contribute to the same overarching goal. (Burgener, 2020)

6.1 Interdisciplinary Teams

This team can also perform surveillance activities and parallel studies to assess the effectiveness of certain strategies by comparing previous infection rates and recent infection rates. If there is no improvement in the recent rates, that means that particular strategy is not effective. In the same case, if there is an increase in infection rates, that means some preventive measures are causing the increased rates. This way, one can identify problems and quickly change the strategy to prevent further infection. So, surveillance and continuous monitoring are also important activities that can be done by interdisciplinary teams.

For example, whenever any new infection outbreaks occur, microbiologists can provide details of the causative agent and its mode of transmission to infection control professionals. Infectious disease clinicians can study the clinical impact of that infection and suggest preventive measures or treatments. By combining all this information, guidelines can be made for the prevention and treatment of that specific infection. Such collaboration is not possible with a single infection control person working on this whole process.

nurses (Jankowski et al.2023)

6.2 Effective Communication Strategies

With the increasing frequency of multi-team systems being used in healthcare, it is important to recognize that individual team members may belong to multiple teams. This requires the need for a structural system of team-to-team handovers and recognition of a higher organizational membership. The movement of information between teams may often occur at change of shift and is vital to continuity of care. This should be improved with the use of ISBAR (introduction, situation, background, assessment, recommendation) tool to provide structured and essential information transfer between team members.

Open communication and a positive team culture are vital to error mitigation. Behaviors such as aggression, poor attitude, or disrespect have been shown to hinder team performance, which may affect patient safety. These should be avoided and strategies utilized to promote good team morale, such as celebrating the success of a team member or team.

Open communication is vital between team members in assessing a situation and making decisions about the best course of action. This may be improved with the use of structured communication tools. One such tool is STEP, which stands for status, team, environment, progress. This was designed to provide a common mental model of an event, fostering shared situational awareness and aiding team-to-team handovers. The implementation of components into practice, e.g. a shared team brief, has been shown to improve acute care team performance.

Team communication in healthcare is often more complex than other industries due to the hierarchical nature of the medical profession. This often results in barriers in information transfer. Subordinate members may be hesitant to voice concerns about a course of action for fear of disapproval from superiors. The impact of this was displayed in a study on pediatric house officers where it was found they would only communicate a median of 6.6 clinical events to senior physicians and brought 2.5 events to their attention.

Once the team has been formed, effective communication is crucial to the team's success. Communication has been identified as an essential factor throughout multiple professions and is increasingly recognized to be central to the understanding and prevention of adverse events. Communication failures have been identified as the root cause for events in the healthcare setting. The Joint Commission reported over 60% of events leading to death involved a breakdown in communication. Most of these events were related to misinterpretation of handwritten orders, confusion about drug dosages, and lack of follow-up.

6.3 Information Sharing Platforms

Information sharing is important for building common understanding about strategies for infection control among healthcare workers.

Electronic mail is widely used for sharing information. Listservs are also frequently used for sharing information among workers with similar interests. The world-wide-web provides an important mechanism for accessing and sharing guidelines. Many professional organizations have their own websites on which they post guidelines and other relevant resources. AHRQ is developing a web-based clearinghouse for evidence-based practice guidelines with the aim of furthering the dissemination and implementation of these guidelines. CD-ROMs and other electronic databases are valuable for sharing information, particularly in areas where access to the world-wide-web is not possible. These information sharing mechanisms are important for ensuring that healthcare workers throughout the world have access to the best and most current information for preventing healthcare-associated infections.

7. Conclusion

Two-tiered strategies that first focus on the reduction of the level of microbial contamination of the hands and the immediate environment and second, address the need for ongoing measures to prevent the acquisition and transmission of MDROs have now been tested and proven effective. Measures employing general improvement of hygiene and cleaning practices coupled with the use of enhanced barrier precautions for high-risk patients have been widely adopted to control epidemic MRSA, VRE, and C. difficile. It has been the development of innovative strategies and new data to control the transmission of MDROs that has brought effective and achievable solutions to the problems of the second tier.

While the isolation of the infectious patient and the use of barrier precautions are effective, they have limitations. Microorganisms can be spread by indirect means on the hands of health care workers and by touching contaminated patient care items. It has been shown in several studies that invisible blood on the hands of health care workers is often transferred to the environment and to other patients. An approach using barrier protection must also include measures to prevent contamination of the hands. And gloves are not fail-safe. They may have small defects of which the wearer is unaware, or they may tear. Failure to remove gloves aseptically is common, and special precautions are often not taken to prevent hand contamination when gloves are changed between patient contacts. Glove use may also engender a false sense of security, resulting in lax attention to washing hands.

The development of strategies to prevent the transmission of infectious agents has significantly impacted the way health care is administered. The infection control community has met the challenges of emerging pathogens and the problems related to antibiotic resistance with innovative and well-founded scientific strategies. In many instances, the strategies have been based on the results of well-designed studies that have defined the nature of the risk and the mode of transmission of specific nosocomial pathogens.

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