PERSPECTIVES

Control of Health Care-associated Infections (HAI): Winning Both the Battles and the War

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At present, the United States (US) experiences its greatest life expectancy due mainly to improvements in mortality from cardiovascular diseases, which include coronary heart disease and stroke. These, in turn, are due largely to decreases in cigarette smoking as well as earlier and more aggressive diagnoses and treatments. These advances in health care delivery are, not surprisingly, accompanied by increasing numbers of complicating health care-associated infections (HAI). HAIs are a major and increasing cause of morbidity and mortality in the US as well as around the world. To win both the battles and the war against HAI requires a multidisciplinary approach to the vigorous implementation and maintenance of proper infection control procedures. This should include continuous surveillance and reinforcement of guidelines to enhance evidence-based practices to prevent and control HAI. It will also be necessary to implement a new paradigm of early and formal education of future health care providers into the biology of infection as well as the principles of infection control in the classroom and subsequently, with translation into their clinical training. Finally, there must also be the incorporation and expansion of continuing medical education for established health care providers about prevention and control of HAI.

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At present, the United States (US) experiences its greatest life expectancy, due mainly to improvements in cardiovascular mortality which include coronary heart disease and stroke.[1] These improvements have been due to many preventive and therapeutic factors, and include individual as well as public health efforts. With respect to coronary heart disease mortality, there have been marked decreases in cigarette smoking, but there have also been earlier and more aggressive diagnoses and treatments that are postulated to account for approximately half the decline.[2] These remarkable advances have occurred despite the emerging pandemics of obesity and diabetes.[2] Thus, the increased life expectancy in the US today is due, at least in part, to the fact that since World War II, there have been remarkable and unprecedented advances in health care delivery. These advances in health care delivery are, not surprisingly, accompanied by increasing numbers of complicating health care-associated infections (HAI). HAIs are a major and increasing cause of morbidity and mortality in the US as well as around the world. Five to ten percent of all admissions are complicated by HAI in both the US and Western Europe.[3] In the US alone, an estimated 1.7 million infections resulting in approximately 99,000 deaths occur annually, making HAIs among the top ten leading causes of death.[4] It is estimated that out of every 100 hospital admissions, 4.5 patients acquire an infection during their stay.[4] Beyond the human toll, there is an enormous financial burden to health care systems worldwide.

During the latter part of the 20th century and into the 21st century, there have been remarkable wins in the battles against HAI. For example, in the 1960s, new insights into the biology of infection complicating hip replacement surgery[5] abetted by improved infection control measures facilitated rapid and remarkable advances in the fields of joint replacement and organ transplantation. During the 1970s, rates of surgical site infections after colon surgery plummeted from about 40% to less than 10% when the biological principles of antibiotic prophylaxis in infection control became evident and were applied.[6] In the 1990s, implementation of effective infection control measures led to a 65% decrease in early onset neonatal infections due to group B streptococcal infections.[7] In the current decade, adoption of proper infection control techniques has led to a 50% decrease in catheter-associated blood stream infection rates, as demonstrated in 100 intensive care units (ICU)s.[8]

With respect to the war, however, as hospital infection control programs yield no revenue, their needs tend to have lower budgetary priorities except perhaps in preparation for facility licensing, inspections by the Joint Commission for Hospital Accreditation, or unexpected outbreaks of HAI. Further, The Centers for Medicare and Medicaid Services have undertaken payment reform and have ceased reimbursing hospitals for expenses related to certain HAIs. [9,10] While this provides a concrete incentive to hospitals to prevent HAIs, it further reduces revenues. In addition, intermittent slips in infection control techniques and injudicious selection and utilization of antibiotics all contribute to a complex web of causation in the emergence of resistant strains of bacteria and outbreaks that are increasingly difficult to control. Despite repeated introductions of new and, for a period of time, broadly

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effective antibiotics, medical techniques that either bypass or alter human defense systems or prolong survival of patients highly susceptible to infection inevitably increase their risks of serious infections. Over time, prolonged and widespread use of antibiotics has repeatedly led to the emergence of a few surviving bacteria possessing genes for faster reproduction or transmission, antibiotic resistance and greater virulence[11]. Bacterial species bear the increasingly familiar acronyms of CaMRSA (community-associated methicillin-resistant Staphylococcus aureus), C Diff (Clostridium difficile), MDRTB (multidrug-resistant tuberculosis), MRSA (methicillin-resistant Staphylococcus aureus), PRSP (penicillin-resistant Streptococcus pneumoniae), VISA (vancomycin-intermediate Staphlococcus aureus), VRE (vancomycin-resistant Enterocci) and VRSA (vancomycin-resistant Staphylococcus aureus) because of their widespread reporting in the media. At the same time, many professional groups bearing the less familiar acronyms of APIC (Association for Professionals in Infection Control and Epidemiology, Inc.), IDSA (Infectious Diseases Society of America), NNIS (National Nosocomial Infections Surveillance System), PIDS (Pediatric Infectious Disease Society), SHEA (Society for Healthcare Epidemiology of America), SIDP (Society of Infectious Diseases Pharmacists), and SIS (Surgical Infection Society) are battling increasingly hard to control them.

Some examples of new battles against hospital infection that should be anticipated include, but are certainly not limited to, the following four:

First, serious HAI will undoubtedly increase as microorganisms acquire new genetic material and some new attributes enhance virulence. A case in point is evident in the biological expressions accompanying the genetic and antigenic differences between the newly emerged CaMRSA and the older MRSA.[12] Unlike MRSA infections that may be in part prevented as a complication of elective surgery through screening for nasal carriage, CaMRSA infection can occur in the absence of nasal carriage. For example, in a recent study of 65 patients with overt CaMRSA skin and soft tissue infections systematically studied for colonization in nasal, axillary, inguinal, and rectal areas, only 25% had nasal colonizations.[13] In addition, CaMRSA has virulence genes that are already contributing to serious community outbreaks among healthy people. CaMRSA has been associated with poor hygiene, crowded living conditions, sharing of contaminated items, and trauma.[14] At-risk demographic groups include children, young adults, ethnic minorities and low socioeconomic level groups.[14] In the hospital setting, attempts to control the spread of MRSA include the utilization of contact precautions (including gloves and gowns during contact with patients either colonized or infected with bacterium). However, concern exists regarding the appropriate management of individuals from the community setting that may be colonized or infected and are potentials sources of infection. Alarmingly, from 2002 to 2005, in one public hospital, admissions of patients infected with CaMRSA increased 6.8 fold.[15] Such increases on a national basis would be particularly ominous. These considerations may explain, at least in part, the appearance of numerous state legislative actions for HAIs including MRSA.[16,17] However, much debate remains regarding the scientific evidence that has supported the implementation of legislative actions in regards to health care-associated infections, [9] and many guidelines remain dynamic.

Second, serious HAI will also increase as newer and broader spectrum antibiotics are increasingly utilized. A current unifying hypothesis for antibiotic-induced susceptibility to acquisition and spread of disparate antibiotic-resistant bacterial species such as C Diff and VRE in fecal flora is that the antibiotic effect of decreasing microbial diversity of normal colonizing microbial flora also diminishes the gut immune regulation of microbial flora, thereby permitting such bacteria to become established.[18] Such susceptibility to colonization lasts well beyond the durations of both use of the antibiotic as well as the recolonization of normal flora. Loss of normal colonizing flora compromises the mucosal immune system, which offers a plausible mechanism to explain why heavily colonized persons disseminate antibiotic-resistant organisms for prolonged periods.[19] Hence, certain antibiotics administered in the community to individuals subsequently hospitalized are important risks for introducing antibiotic-resistant bacteria into hospitals and infecting susceptible hospitalized patients. Currently there are no cogent data available to heath care providers to select antibiotics of comparable efficacy that are the least likely to enhance mucosal colonization with antibiotic resistant bacteria. An additional source of concern pertains to the inappropriate use of antibiotics both in outpatient and inpatient settings. Such use may lead to the development of further antimicrobial resistance. Antimicrobial stewardship programs are being utilized in hospitals throughout the country to address the above issue, though concern regarding inappropriate use in the outpatient setting remains a challenge.

Third, serious HAI will increase as unanticipated rises in hospital admissions create staffing problems, particularly in smaller hospitals with fewer staff. When ICUs becomes understaffed, breaches in technique increase. With respect to the crucial role of staffing of ICU nurses, initial efforts to respond may include 12-h or longer work shifts and increasing numbers of patients cared for by each nurse, along with using "pool" nurses transferred from other units within the hospital or employing new and inexperienced personnel. In addition, risks of acquisition of pneumonia or blood stream infections tend to increase as ICU nurse-patient ratios fall or as pool nurses substitute for regular staff.[20]

Fourth, HAI will increase if health care providers fail to apply well-accepted infection control measures. For example, the reuse of needles and syringes has, not surprisingly, led to recurrent outbreaks of hepatitis.[21] More recently, it was reported that patients who underwent heart stress tests at a medical center may have been exposed to HIV and other infectious diseases due to a nurse knowingly reusing medical supplies (e.g., saline bags and IV tubing) intended for one-time use. [22] With respect to the use of proper infection control procedures, it is worth noting the effectiveness of barrier precautions and related bundle approaches to the prevention of health care-associated infections. Barriers are clearly effective infection control measures, when properly used. It is important that personnel understand the underlying principles for efficacy of various measures and implement use properly as, for example, in the correct application of a bundle of measures to prevent catheter-associated blood stream infections.[8,23]

To win both the battles and the war against HAI requires a multidisciplinary approach, which includes elimination of lapses of health care providers to implement proper infection control procedures. This should include continuous surveillance and reinforcement of guidelines to enhance evidence-

based practices to prevent and control HAI. It will also be necessary to implement a new paradigm of early and formal education of future health care providers into the biology of infection as well as the principles of infection control in the classroom and subsequently with translation into their clinical training. Finally, there must also be the incorporation and expansion of continuing medical education for established health care providers about prevention and control of HAI.

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