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Hospital Acquired Infections: A grave concern and how entrepreneurship and new technologies can help solve the problem.

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Summary

Healthcare associated infections (HAIs) develop in a patient as a result of their exposure to healthcare facilities or procedures. They include methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant Enterococcus (VRE), *C. diff* (*Clostridium difficile*) and other infections caused by bacteria and viruses encountered in healthcare facilities. Rising infection rates are causing unnecessary suffering and death and are taxing the healthcare system as well as patients and families. In the U.S., approximately the same number of people die from hospital acquired infections (HAIs) as from breast cancer, AIDS and road accidents combined. The irony is patients acquire HAIs while receiving care at hospitals for another condition and these infections can even kill the patients. Current statistics show that in the United States, 1 in every 25 patients will contract an HAI and out of those, 1 in 9 will die and HAIs cost the healthcare industry upwards of $30 billion dollars annually. Hospitals in India also have a high burden of infections in their intensive care units (ICU) and general wards, many of which are resistant to antibiotic treatment.. This additional burden of costs attributable to these infections has serious implications to the Indian patient. Hence, to ensure cost efficiency and optimization of healthcare planning and delivery, we need to address the gravity of the issue of infection control. The purpose of the present article is to focus on issues that are

relevant to infection control in Indian hospitals and to discuss new strategies being used worldwide which can prove to be effective in controlling HAIs in India also if these advanced technologies are brought to India under the Make in India entrepreneurship programmes.

Keywords: Hospital Acquired Infection, Prevention, Standard Precautions, Monitoring, Surveillance, Antibiotic resistance, UV light, Infection control.

Introduction

Hospital-acquired infection (HAI) rates have ranged from 1% in parts of Europe and North America to more than 40% in certain parts of Asia, Latin America and sub-Saharan Africa. Research on hospital infections in India reveals several grave trends. In Indian ICUs, the rate of vancomycin-resistant enterococcus (VRE), a dangerous hospital infection, is five times the rate in the rest of the world(1,2) Patients acquire HAIs while receiving care at hospitals for another condition. These infections, such as MRSA (methicillin-resistant *Staphylococcus aureus*) and *C. diff* (*Clostridium difficile*), can prove to be lethal for patients coming to Hospitals for some other conditions (2, 3). Current CDC statistics show that even in developed countries like United States, HAIs are a big burden on healthcare economy.

What are healthcare associated infections, and how common are they?

Healthcare associated infections (also called nosocomial infections or hospital acquired infections) develop in a patient as a result of their exposure to healthcare facilities or procedures. Healthcare associated infections are caused by bacteria (e.g. Staphylococcus) and viruses (e.g. nor viruses). The most serious and deadly healthcare associated infections (HAIs) are bloodstream infections, pneumonia, gastrointestinal tract infections, infections involving more than one site, skin and soft-tissue infections, and surgical site infections. Other common types of HAIs are urinary tract infections and catheter-related local infections (4, 5). Canadians suffer more than 220,000 healthcare associated infections annually, and HAI rates are on the rise. One in nine hospital patients in Canada gets a healthcare associated infection that may force a longer stay, cause greater pain, or even death. Likewise, reports of the persistence and transmission of Norovirus in healthcare facilities—particularly affecting seniors in long term care facilities—have increased dramatically over the past ten years (4) In British Columbia, norovirus (NV) related gastroenteritis outbreaks in 2007 were more than double those reported in 2002.If more isn't done to eliminate these "superbugs" from our healthcare facilities, the rates of HAIs will continue to rise exponentially (5).

Antibiotic resistant infections are difficult, and sometimes impossible, to treat. They lead to longer hospital stays, increased treatment costs, and in some cases, death. The GARP research estimates that of the approximately 190,000 neonatal deaths in India each year due to sepsis – a bacterial infection that overwhelms the bloodstream – over 30 per cent are attributable to antibiotic resistance (6, 7).Antibiotic resistant hospital infections can be especially deadly because antibiotics are used intensely in hospitals compared with the community, and frequent use drives the development of highly resistant bacteria. (6, 8)

How do HAIs affect us?

HAIs are imposing avoidable suffering on patients and residents and their families as well as extra costs on the healthcare system and the wider economy. When patients get an infection, they experience increased morbidity (i.e. disease), increased risk of death, and longer hospital stays. Infections mean extra treatments, lab tests, medications, isolation supplies, cleaning, laundry, and nursing and physician care, all of which tie up scarce healthcare resources, increased suffering and death (9) There have been numerous studies worldwide on the increased mortality associated with HAIs (.For example, In Canada, researchers estimate that healthcare associated infections are linked to between 8,500 and 12,000 deaths per year. This makes healthcare associated infections the fourth leading cause of death for Canadians (behind cancer, heart disease and stroke), up from the top eleven causes two decades ago. The United States Centers for Disease Control and Prevention considers HAIs one of the top ten causes of death in the US. The UK Health Protection Agency found that patients with a healthcare associated infection were 7 times more likely to die than uninfected patients. The SARS (Severe Acute Respiratory Syndrome) epidemic, which resulted in 44 Canadian deaths, showed what devastating impact infection outbreaks can have on patients and the healthcare system.

The sufferings caused by HAIs and raising hospital accountability.

Much of the suffering and death caused by HAIs is needless. Sanitation, Cleaning, laundry, and other support services are a vital element of infection prevention and control strategies. Pathogens such as C. difficile, VRE, MRSA, norovirus, influenza, and severe acute respiratory syndrome (SARS) associated coronavirus can survive in the healthcare environment for extended periods of time, even months(10.11). In fact, these infections are inherently well adapted to survive in dust and on floors, bedrails, telephones, call buttons, curtains and other surfaces. Washing hands is important, but if bacteria and viruses are not eliminated from the environment, hands will quickly become contaminated again. “Breaking the chain of infection” requires well-resourced, well-trained, and stable in-house healthcare teams attacking all of the links of transmission; sufficient beds, equipment and trained staff ,modern high-quality infrastructure and standardized procedures, monitoring and public reporting. Hospitals in Canada and Europe have demonstrated that investment in more cleaning and infection control, training of staff and workforce

stability has brought infection rates down. Healthcare facilities should adopt strict microbiological standards to replace the current standard that rooms and equipment "appear clean." In a UK study, 3 researchers found that 90 per cent of the wards that had been declared clean in a visual assessment were shown by microbiological testing to have an unacceptable load of microorganisms. Mandatory public reporting of healthcare associated infection rates and deaths by healthcare facilities are also necessary to improve transparency and accountability (12, 13).

Situation in India

Organisms causing hospital infections in India are similar to those around the world with S. aureus and P. aeruginosa among the most common disease-causing pathogens. A prospective study of 71 burn patients at Post Graduate Institute of Medical Education and Research (PGIMER) in Chandigarh found that up to 59 patients (83 per cent) had hospital-acquired infections. Another six-month study conducted in 2001 of the intensive care units (ICUs) at All India Institute of Medical Sciences (AIIMS) in New Delhi, found that 140 of 1,253 patients (11 per cent) had hospital-acquired infections, where P. aeruginosa made up 21 per cent of isolates, 23 per cent were S. aureus, 16 per cent Klebsiella spp., 15 per cent Acinetobacter baumannii and 8 per cent Escherichia coli. A large proportion of these hospital infections are easily preventable with increased hospital infection control, including stepping up hygiene practices, such as frequent hand-washing and disinfection (8, 15).

However, In India, hospitals often do not follow infection control practices, and this leads to the spread of diseases. Surveillance of antibiotic resistance, combined with tracking physician prescribing patterns, can be the foundation of successful infection control programmes in hospitals. But surveillance is a challenge in many places, where microbiology laboratories and trained staff may be unavailable. In India, unless there is a paradigm shift from a narrow individual patient- based approach to a more inclusive approach targeting control of the microbial environment and processes of care, significant improvement in this vital area of healthcare would not be possible. Programs and Protocols are being developed and implemented energetically in individual ICUs across India, but change is urgently also required at the administrative levels in terms of integrating all factors that go into effective infection control practices. For example, the cost of infection control should be accepted as a part of administrative responsibility rather allowing it to be imposed on the patient. The call is for a fundamental shift in approach to infection control in critical care and institutes must not shy away from it.

Solution in the form of a new technology from Xenex

Xenex was founded by Dr. Julie Stachowiak and Dr. Mark Stibich, both holding PhDs in epidemiology from Johns Hopkins. The Xenex mission is to save lives and reduce suffering by destroying deadly microorganisms that can cause hospital acquired infections (HAIs). They have launched Xenex, a mobile robotic device which is said to combat germs in hospitals with blasts of UV light. It is claimed to disinfect hospital rooms in five to 10 minutes. Xenex uses xenon lamps to sterilize hospital surfaces with ultra-violet light. The technology is said to have a higher microbicidal effect than mercury lamps and is claimed to be safer, since xenon gas is inert and harmless whereas mercury gas is highly toxic. Xenex's technology is currently being used in more than 20 hospitals in the US. It is used on high-touch surfaces such as tray tables, telephones and bedrails (16, 17, and 18).

Basically, in Xenex, High intensity ultraviolet light is produced by xenon flash lamps across the entire disinfecting spectrum known as UV-C. This UV-C energy passes through the cell walls of bacteria, viruses and bacterial spores. The DNA, RNA and proteins inside the microorganism absorb this intense UV-C energy which makes the pathogens vulnerable to UV-C light damage at different wavelengths depending on the organism. The primary types of cellular damage caused by Pulsed Xenon UV are **photohydration** (pulling water molecules into the DNA that prevents transcription), **photosplitting** (breaking the backbone of the DNA), and **photodimerization** (improper fusing of DNA bases), all of which prevent cell replication. Additionally, **photo crosslinking** causes cell wall damage and can cause cell lysis, an irreversible form of cell death. Disinfecting across the entire spectrum helps prevent pathogens from repairing themselves. Right now, Xenex offers the only Pulsed Xenon UV disinfection system on the market. Xanax Germ-Zapping Robots™ are developed and designed to be highly effective, efficient and portable, allowing for the proven and systematic disinfection of any space within a healthcare facility in a very short time.
Rochester,USA based Mayo Clinic was able to reduce *Clostridium difficile* infection rates by 30 percent by adding pulsed xenon ultraviolet light disinfection robots to the patient room cleaning process . Now, Mayo Clinic uses the UV robots for every discharge in their high-risk units, and has potential plans to expand their use into operating rooms and equipment storage rooms. (17, 18)

Conclusions:

We need coordinated, multifaceted infection control strategies that include all healthcare staff. Beyond the focus on hand hygiene, these strategies must emphasize cleaning, laundry, sterilization and other support services that are vital to preventing and controlling infection outbreaks. The problem is not a lack of information on how to prevent and control infections; there is a wealth of evidence and recommended practices. The problem is that governments and health authorities have shown a lack of will and provided

inadequate funding for the fundamentals of cleaning and infection control. Hospital Infection Society of India (HISI) is an association of medical professionals with a special interest in prevention and control of hospital infections working to build awareness, provide training and disseminate best practices in this area. If one out of four hospital patients are victims of HAI in our country, this is a healthcare concern that simply cannot be ignored. Efforts are needed to strengthen Infection control programs, appropriate national strategies for prevention of HAIs, antibiotic stewardship and repeated prevalence studies in our institution in order to decrease the prevalence of HAIs.

Although the effectiveness of Xenex technology has resulted in many hospitals in USA lapping up the Xenex robots (16), the technology is still extremely expensive and only few high end hospitals in India can afford that at the moment. However, looking at the scales of HAIs in India and how they are burdening our healthcare system, we suggest that this technology can be made available for domestic markets by indigenous production.The Make in India campaign opens up a significant range of opportunities for entrepreneurs to leverage this opportunity as hospitals need this product on large scale right now. So technologies like Xenex can be brought home under make in India programmes, especially with the help of investors interest and government support and sponsorship so that problems due to HAIs, which effect everyone in the society, are not ignored any longer.

References

1.Hanson LC, Weber DJ, Rutala WA.Risk factors for nosocomial pneumonia in the elderly.Am J Med 1992;92:161-6.

2 McFarland LV, Elmer GW, Surawicz CM. Breaking the cycle: treatment strategies for 163 cases of recurrent Clostridium difficile disease. Am J Gastroenterol 2002;97:1769-75

3 Aslam S, Hamill RJ, Musher DM. Treatment of Clostridium difficile-associated disease: old therapies and new strategies. Lancet 2005;5:549-57

4.Craven DE, Kunches LM,Lichtenberg DA,Kollisch NR, Barry MA, Heeren TC *et al.* Nosocomial infection and fatality in medical and surgical intensive care unit patients.Arch Intern Med 1988;148:1161

5.Lorente L, Blot S, Rello J. Evidence on measures for the prevention of ventilator-associated pneumonia. Eur Respir J. 2007;30:1193–207

6 Raghunath D. Emerging antibiotic resistance in bacteria with special reference to India. J Biosci. 2008;33:593–603

7 Saxena P, Mani RK. Preventing hospital acquired infections: A challenge we must accept . Indian J Crit Care Med 2014;18:125-6

8 A prospective study of hospital-acquired infections in burn patients at a tertiary care referral centre in North IndiaNeelam Taneja, Rekha Emmanuel P.S. Chari Meera SharmaBurns **November 2004**Volume 30(7) 665–669

9 Guidelines for prevention of hospital acquired injectionsYatin Mehta, Abhinav Gupta,Subhash Todi, SN Myatra, D. P. Samaddar, Vijaya Patil, Pradip Kumar Bhattacharya,and Suresh Ramasubban .Indian J Crit Care Med. 2014 Mar; 18(3): 149–163.

10.Linden PK. Approach to the immunocompromised host with infection in the intensive care unit. Infect Dis Clin North Am. 2009;23:535–56

11.Edwards JR, Peterson KD, Mu Y, Banerjee S, Allen-Bridson K, Morrell G, et al. National Healthcare Safety Network (NHSN) report: Data summary for 2006 through 2008, issued December 2009. Am J Infect Control. 2009;37:783–805

12.Lautenbach E.Expanding the universe of methicillin-resistant *staphylococcus aureus* prevention. Ann Intern Med. 2008;148:474–6

13.Recommendations for preventing transmission of infections among chronic hemodialysis patients. MMWR Recomm Rep. 2001;50:1–43.

14.Dellit TH, Owens RC, McGowan JE, Jr, Gerding DN, Weinstein RA, Burke JP, et al. Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. Clin Infect Dis. 2007;44:159–77

15.Dasgupta S, Das S, Chawan NS, Hazra A. Nosocomial infections in the intensive care unit: Incidence, risk factors, outcome and associated pathogens in a public tertiary teaching hospital of Eastern India. Indian J Crit Care Med 2015;19:14-20

16.Sitzlar B, Vajravelu RK, Jury L, Donskey CJ, Jump RL. Environmental decontamination with ultraviolet radiation to prevent recurrent Clostridium difficile infection in 2 roommates in a long-term care Facility. Infect Control Hosp Epidemiol 2012;33:534-6.

17 Shannon Barnet Combination of chemicals, UV light stops infection transmission best, study finds Infection control and clinical quality | *Becker's Hospital Review***,**October 08, 2015

18 Heather Punke Mayo Clinic reduces C. diff infections 30% using UV light disinfection.Infection control and clinical quality ,*Becker's Hospital Review***,** (Twitter | Google+) | December 28, 2015