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Nosocomial zoonoses: A neglected way of spread of epidemics

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Abstract

Nosocomial zoonoses are zoonotic diseases that spread through hospitals and health care centers. The nosocomial transmission of zoonotic infections is one of the least studied causes of its epidemic or even pandemic spread. Lack of knowledge of this way of spread, its propensity for epidemic development, and the unavailability of timely treatments and vaccinations to stop the transmission make this route a threat to world health. A One Health approach involving the cooperative efforts of public health experts, veterinarians, and administrative authorities is necessary to prevent the outbreak of these infections. Therefore, the current review aims at raising public knowledge of nosocomial zoonotic illnesses, their transmission, and the need for specific preventive measures.

Keywords: Hospital-acquired infections, nosocomial zoonosis, one health, zoonotic disease

Introduction

The term 'nosocomial zoonoses' is a combinatorial product of two separate terms- 'nosocomial infections' and 'zoonoses'. The word 'nosocomial' has derived from a Greek word 'nosokomiakos', meaning 'of the hospital'. Nosocomial infections are infections acquired by staying in a hospital. These are also known as hospital-acquired infections. The term zoonoses has also been derived from the Greek words 'zoon' meaning animal and 'nosos' meaning disease. These are the infections that people get from animals. Hence, nosocomial zoonoses are zoonotic diseases that spread through hospitals and health care centers. All nosocomial infections are not zoonotic in nature. Only those infections which are zoonotic and involve the participation of hospitals in their spread should be considered nosocomial zoonoses.

WHO defines zoonoses as diseases and infections that are naturally transmitted between vertebrate animals and humans. As per the reports of the CDC, at least 61% of all human pathogens are zoonotic. This constitutes 75% of all emerging pathogens. According to Gebreyes *et al.* (2014) [3], zoonotic illnesses are to blame for about 2.7 million of the approximately 2.5 billion episodes of human illness and mortality that occur each year. Zoonoses are a major global threat being faced these days with more than half of all infections that people acquire being zoonotic in nature. A zoonotic agent may be a virus, bacteria, fungus, parasite, or prion. The route of transmission of these zoonotic agents varies from disease to disease. Some get transmitted through airborne routes; others require vectors for their spread. Some zoonotic diseases are acquired through close proximity or contact with animals while others through consumption of infected animal products. Apart from these well-mentioned routes, there is another important yet hidden way of transmission of several zoonotic diseases i.e. through hospitals or health care centers.

Hospital-acquired infections

Infections acquired during the hospital stay are called Nosocomial (hospital-acquired) infections (HAI). This definition is further refined with only those infections being considered nosocomial which developed at least 48 hours after hospital admission without proven prior incubation. In addition, if infections occur up to 3 days after discharge or within 30 days of a surgical procedure, they are attributed to the admitting hospital (Revelas, 2012) [9]. Hospitals are considered an early portal for infection. It is estimated that HAIs account for around 1.7 million infections and about 99,000 associated deaths in just American hospitals each year. Of all healthcare-acquired infection infections, 32% are urinary tract infections, 22% are surgical site infections, 15% are due to pneumonia (lung infections), and 14% are bloodstream

infections (Klevens *et al.*, 2007) [7].

The source of infection in a hospital may be either endogenous or exogenous. Endogenous infection, also known as self-infection, or auto-infection may occur due to the patient's own overgrowth of bacterial flora. Non-judicious and overuse of broad-spectrum antimicrobials affects an otherwise normal balance in the patient's normal flora allowing more resistant bacteria to survive and proliferate and cause superinfection. Exogenous infection is the result of the use of contaminated equipment or devices, non-sterile techniques used in invasive procedures, handling of tubes or catheters, or may spread from other patients and health workers.

Nosocomial spread of zoonotic diseases

The introduction of zoonotic infections into a single hospitalized patient serves as a nidus for the potential dissemination of nosocomial outbreaks of zoonotic disease. To maintain a zoonotic epidemic in a hospital, animals must be present as a continuing source of infection. The infection must be maintainable and transferable in the environment or in health care workers or patients. The nosocomial spread of zoonotic diseases may be either direct or indirect. In direct transmission, the animal itself is present in the hospital premises as a source of infection to humans whereas in indirect transmission, the spread of a zoonotic disease may or may not involve the presence of an animal in the hospital.

Indirect spread

The indirect spread of nosocomial zoonoses is similar to that of any hospital-acquired infection. The only difference here is that the infection being spread is zoonotic in nature. There are two ways in which a zoonotic disease can spread indirectly in a hospital. It can either spread in a veterinary hospital involving the presence of an infected animal or in a human hospital without the presence of the animal in that hospital. The first case involves the spread of zoonotic disease from an infected animal taken to a veterinary hospital for treatment. Nosocomial zoonosis among veterinarians ranges from 16.7% and 64% (Jackson and Villarreal, 2012) [4] with fungal infections being the main cause of zoonoses (Sanchez *et al.*, 2017) [10]. The infected animal may act as a source of infection to veterinary doctors, technicians or other healthy animal owners present in the hospital. From them, the infection may spread further. Veterinarians have been found to potentially disseminate zoonotic pathogens to their relatives or the animals they are treating (Baker and Gray, 2009) [1].

The other indirect way of spread occurs when an individual after acquiring a zoonotic infection from an animal is admitted to a human hospital and transmits the infection to healthcare workers and others. Around 9% of Marburg and Ebola cases documented between 1967 and 2011, were found to be health-care workers (WHO, 2014). This is the most common form of spread seen in various emerging zoonotic outbreaks. Nosocomial transmission has been demonstrated for Viral Haemorrhagic Fevers (VHFs) due to Ebola, Marburg, Lassa, Crimean-Congo hemorrhagic fever, Argentine hemorrhagic fever, and Bolivian hemorrhagic fever viruses (Weinstein *et al.*, 2001) [13].

Hospital outbreaks of MERS-CoV: an excellent example of indirect nosocomial spread

Middle East Respiratory Syndrome (MERS) was first

reported in Saudi Arabia in 2012. The outbreaks remained restricted to the countries of the Middle East until May 2015 when it started emerging in South Korea. Between May and July 2015 about 186 patients were serologically confirmed as infected with MERS in Korea (Ki *et al.*, 2019) [6]. The reason for such a spread was later found to be nosocomial transmission by the index case, a 68-year-old Korean businessman who was diagnosed with MERS in a local hospital on 20 May 2015. The first super-spreading event of the Korean Outbreak occurred in that local hospital infecting about 28 individuals. Some of the infected patients went to another hospital (hospital A) infecting 90 individuals and bringing forth the second super-spreading event. Likewise, about 15 healthcare settings were involved, and spread through hospitals resulting in the infection of 185 individuals (Ki *et al.*, 2019) [6].

Direct spread

It involves the direct involvement of infected animals as a continuous source of infection. It may involve the presence of vectors (rats, mice, birds), Animal-assisted therapy (therapy dogs), or Organ transplantation.

Vectors in Nosocomial Spread of Zoonotic Diseases

Rodents like sewer rats (*Rattus norvegicus*) and house mice (*Mus musculus*) are the reservoirs and hosts for most of the zoonotic diseases and help in the transmission of salmonellosis, leptospirosis, rat-bite fever, lymphocytic choriomeningitis, and rickettsialpox, etc. Rodent-borne diseases may spread directly after being bitten or by inhaling the germ in the feces of rodents or indirectly as the result of consuming food and water contaminated by rodent feces or urine-transmitted diseases. Wild birds' droppings are a fertile source of *Histoplasma* and *Cryptococcus* (Marcus and Marcus, 1998) [8].

Animal-assisted Therapy in Nosocomial Spread of Zoonotic Diseases

Animal-assisted therapy (AAT) is a complementary therapy that involves animals as a form of treatment. A therapy dog is used to provide affection, comfort, and support to people in hospitals, retirement homes, and nursing homes. There are therapeutic visitation dogs, facility therapy dogs, etc. which are trained and provide assistance to patients in hospitals or other healthcare centers. Here they come in direct contact with individuals and can act as a potent source of zoonotic infection. Animals kept for pet therapy have reportedly resulted in the outbreak of *Staphylococcus aureus* in a group of debilitated patients in a rehabilitation and geriatric ward in a hospital in London (Scott *et al.*, 1988) [11].

Organ Transplantation in Nosocomial Spread of Zoonotic Diseases

Organ transplantation can be a reason for the spread of any zoonotic infection. Following organ transplants from an infected donor, recipients are found to have been infected with lymphocytic choriomeningitis virus (LCMV) (CDC, 2005) [2] and rabies (Srinivasan *et al.*, 2005) [12]. Xenotransplantation or heterologous transplant in humans, involving the use of non-human primate, porcine, and bovine cells/tissues/organs, is being studied. This may also result in the spread of some zoonotic diseases if not checked.

Prevention and Control of Nosocomial Zoonotic Diseases

Two basic principles that should always be followed in order to prevent the spread of nosocomial infections in healthcare facilities are separating the infection source from the rest of the hospital and cutting off any route of transmission. Standard preventive measures such as the use of gloves, gowns, masks, eye protection/face shields, shoes, and head coverings should be used at all times. Patient Care Equipment must be properly cleaned, disinfected, and sterilized. World Health Organizations' (WHO's) five moments for hand hygiene should always be followed. Medical facilities must always be kept free of rodents, wild birds, etc. Pathogen-free animals or gnotobiotics should only be considered for xenogeneic grafts. Animals used in pet therapy should be vaccinated and maintained in good health. Education of hospital staff at the 'grass-roots' level is mandatory. Direct communication between veterinarians and physician epidemiologists should be encouraged in the One Health program. Veterinarians have helped in the identification and timely reporting of several outbreaks. In the year 2012, the yellow fever outbreak in Eastern Bolivia was stopped from causing any causality in the human population due to the prompt and fruitful communication between public and animal health communities (Kelly *et.al*, 2020) ^[5]. Public-health officials in collaboration with veterinarians and administrative authorities can help stop large-scale outbreaks before they start. Therefore, the One Health mission should be propagated and implemented across the globe.

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