



Hospital Acquired Infection Revisited: Route of Transmission

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

Aims: to revisited hospital route of infection transmission in patients under medical care with its related problems and re-focus on some important MDR nosocomial infection agents route of transmission to vulnerable patients.

Discussion: Accidental infections acquired in hospitals or hospital acquired infection (HAI) is a global major health condition, and become a major obstacle in the present day era of hospitalization. Increased risk of morbidity with mortality, lengthened hospitalization, massive prescription of antibiotics, and socio-economically become a definite financial burden. Disinfection and sterilization in hospitals is of increasing concern. Besides that, the abuse of antibiotics has led to the prompt wide spread of multidrug-resistant drugs (MDR) microorganisms which is characterized by the ability to quickly adapt to an environment that previously does not support its growth commonly and able to initiate serious life-threatening HAI. The need to understand route of transmission and its associated obstacles will help combating MDR microorganisms.

Conclusion: The Global emergence of MDR microorganisms with its difficult route of infections has created a major obstacle to combat the bacterial pathogens, and need serious attention from all stakeholders, throughout the world.

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1. INTRODUCTION

Nosocomial infections are a significant global health concern and pose a major challenge in the field of healthcare. It also called health-care-associated or hospital-acquired infections (HAIs), as per definition are a simple subset of infectious diseases acquired in a health-care facility (hospital or clinic) during the process of receiving health care procedure. Despite the fact that; it is not as simple as the definition [1,2]. To be classified nosocomial, the occurrence of newly active infection cannot be present at the time of the patient's admitted to the hospital; but rather, it must develop during their hospitalization; especially patients undergo invasive diagnostic procedures [3,4]. These infections Hospital-acquired infections can lead to increased morbidity and mortality rates, prolonged hospital stays, excessive use of antibiotics, and substantial financial burdens [1-4].

Specifically, hospital acquired infections are clearly infectious diseases which a patient experience within 48 hours' of post-hospitalization, 3 days following hospital discharge, or 30 days after a surgery; HAI is associated with patient's length of stay during his/her health care procedure [3,4] and the patients has not had the infection before hospitalization nor has the patient been in the latent period of the disease [1-3]. Not every HAI is Preventable [5].

The aims of this mini review is to revisit hospital routes of infection transmissions in patients under medical care with its related problems with re-focus on route of transmission of several important microorganisms commonly known as HAI agent.

2. SCOPE OF THE PROBLEM

The magnitude of HAI among patients, both outpatient and inpatient, needs to be extensively studied in order to increase all stakeholder's awareness [6]. The global burden of HAI is several folds higher in low and middle-income countries compared to high-income ones [7]. The rate of universal HAIs was 0.14 % with annual increasing trend of 0.06 % [2]. Geographically, prevalence in central Africa is higher than in other parts of the world by 0.27 (95% CI, 0.22–0.34) [2]. Based on type of hospital wards, the

burn (Burn patients with Blood stream infection-BSI) [8], Transplant (which consist of vulnerable patient, sophisticated transplant procedures, immunosuppressive regimens, and prevention of transplant-associated complications) [9], and Neonatal wards (premature infants in the intensive care) [10] and ICU had the highest rates [11]. The prevalence of HAIs was higher in male patients than in female patients (mostly in BSI) [12].

According to the World Health Organization (WHO), out of every 100 admitted patients in acute-care hospitals, seven patients in high-income countries and 15 patients in low- and middle-income countries will obtain at least one health care-associated infection (HAI) during their hospital stay [13]. Approximately, HAI associated morbidity occurs in one in every 10 affected patients.

2.1 Economic Burden

From the economic burden, the global hospital acquired infection control market size is assessed reaching USD 4.26 billion in the year of 2024, and is predicted to reach USD 5.18 billion by 2029, growing at a Compounded annual growth rate (CAGR) of 3.97% during the forecast period (2024-2029) [14]. Unwanted infections that are acquired in hospitals or healthcare facilities contribute to remarkable post-discharge insurance claims which is connected to prescribe medications, primary care follow-up, laboratory tests, physiotherapy rehabilitation and even homecare; as in the case of healthcare-associated Methicillin-resistant Staphylococcus aureus infections [15]. In some cases, this is drawn out over the course of years, depending on the type of infection, severity of the disease and patient health status. Therefore, insurers have a real and compelling financial incentive to make investments and drive improvement in hospital safety, focused on the serious and grave problem of HAIs.

No conclusive evidence suggesting interventions lead to improvements in infection prevention. In reality, appropriately reported HAIs are recorded among the most frequent sources of hospital/health care discharges, accounting for estimated two million discharges per year [16].

In October 2008, United States's Medicare (the Centers for Medicare & Medicaid Services, CMS)

stopped reimbursing hospitals for certain hospital-acquired outcomes [17,18]. Officially, Medicare implemented the Hospital-Acquired Conditions (HACs) Initiative, a policy denying incremental payment for eight conditions related to complications of hospital care, also known as “never events” [18]. These shifts of policy abjure remittance for several debatable conditions happening during the hospital care and stay and, those conditions were not clearly stated on admission, including some healthcare-associated infections [17-19]. Hospitals were forced to shift their service into pay for performance system [20]. The aim is to reduce the financially careless and preventable act of medical intervention conducted by and in the hospitals [21] and as positive consequence of improvement in their standards and behaviors, they receive a substantial financial incentive [22].

Unfortunately, multiple studies and analysis revealed that no significant effect of CMS penalties on reduction of HAIs; Penalization was not associated with significant changes in rates of hospital acquired conditions [23-25].

Instead, convincing studies revealed shocking evidence that exposes penalties actually have had a noteworthy effect on hospital act on up-coding for reimbursement [26-29]. Up-coding is the intentional act of upgrading the seriousness of a medical ailment and treatment by entering the Diagnosis Related Group (DRG) code that will carry the highest reimbursement. This increasingly rampant but silent movement of billing fraud and abuse [29-31] has increased the direct cost of hospital coverage [27-29], with very little effect on actual infection rates [19,24,25,31]. Patients were considered as if they were already infected at the of admission to the hospital, and thus did not meet the criteria for HAI; this is to be expected as a director in the ‘false’ declining infection case reporting.

These findings from financial burden showed us, anticipating HAIs may be far more strenuous for hospitals to fulfil; an urging requirement for avant-garde, evidence-based and ardent acts to drive new prevention strategies.

2.2 Types of HAI's and Previous Clinical Symptom Involved

Common type of nosocomial acquired infections includes catheter-associated urinary tract infections, central line-associated bloodstream infections (CLABSI) [32,33], surgical site

infections (SSI) [32,34], ventilator-associated pneumonia (VAP) [32,35], hospital-acquired pneumonia (HAP) [32,36], and Clostridium difficile infections (CDI) [32,37] which classify overestimate as HAIs. Apart from all that, all stakeholders must equally understand that most HAIs can be prevented, if appropriate strategies are implemented [34].

Actually, there are numerous symptoms that can facilitate an infection to happen include frequent productive cough which usually have future exacerbation risk [38], shortness of breath as a hospital based risk acquired from wet breathing systems [39], abdominal pain which seldom present as surgically treated non traumatic acute abdomen [40], rebound pain or tenderness which usually acute and related to post-operative patient [41], acute changes in mental status, acute change in mental status or ACMS [42], suprapubic pain [43], polyuria [44], dysuria [45], and costovertebral angle tenderness [46].

2.3 Route of Transmission

COVID-19 pandemic actually taught all stakeholders to emphasize the urgent necessity of good practice of healthy behavior [47], hand hygiene [48] and the application of conventional infection control methods in the hospital perimeter [49,50], as the World Health Organization (WHO) report [51] and the Centers for Disease Control and Prevention (CDC) recommended [52] in reducing the number of hospital-acquired infections. The next section will discuss the possible route of transmission.

The adaptability of certain emerging pathogen [53], especially in specific areas of hospital [54], provides the pathogen's ability to penetrate the dynamics of hospital's prevention measures, for example in case of SARS-CoV-2 [55] regarding both the risk of exposure to accompanying caregivers that to look after the patients during their hospitalization [56] and the need to maintain quality of care, while at the same time, ensuring all the staff ready to serve and well prepared [57]. Hospital staff (not limited to doctors and nurses) contribute actively to the prevention and management of HAI [57,58] as they are involved in basic personal hygienic care of the patient [59], navigating and implementing quality improvement initiatives [60], conducted necessary automating surveillance [61] via correct microbiological sampling [62], and features of rigid antibiotic stewardship [63]. These long lists of action showed us that factors associated with HAI's are not simple.

2.4 Contamination: Unthinkable Hospital Surface Act as Reservoirs

Despite previous report regarding the inanimate hospital milieu (e.g., open surfaces and medical equipment) becomes contaminated with nosocomial pathogens [64,65], the data that suggest contamination by patient's excreta, e.g., fomites, that lead to nosocomial infections secondarily [66].

HAIs often develop through contaminated medical equipment at the surgical site or through antibiotic-resistant pathogens. These infections are not limited to the patient, but also affect hospital specialists and staff. According to recent reports, only 20% of nosocomial infections are preventable [67-70].

3. SOME IMPORTANT MDR HOSPITAL ACQUIRED INFECTION'S AGENTS: FOCUS ON INCREASED RESISTANCE

Several bacterial pathogens are difficult to overcome, while it has been related with HAI infections. With the most prevalent HAIs episodes being caused by *Acinetobacter baumannii* [71], a group of Gram-negative nonfermenting betaproteobacteria called *Burkholderia cepacia* complex (Bcc) [72], *Pseudomonas aeruginosa*, a gram-negative bacillus that is ubiquitous and abundant in the environment, especially in moist condition [73], *Clostridium difficile* that can cause severe

diarrhea [74], extended-spectrum beta-lactamase (ESBL)-producing *Escherichia coli* [75], Carbapenemase-producing carbapenem-resistant Enterobacterales (CP-CRE) [76], vancomycin-resistant *Enterococci* (VRE) that commonly reported causing the outbreak in surgical ICU ward [77], methicillin-resistant *S. aureus* (MRSA) [78], vancomycin-intermediate *S. aureus* (VISA) [79], and vancomycin-resistant *S. aureus* (VRSA) [79,80] with their increasing prevalence (both VISA and VRSA infections) is truly a cause of global concern. Finally *Mycobacterium tuberculosis*, [81] a causative agent responsible for numerous outbreaks of nosocomial tuberculosis due to its multidrug-resistant strains.

One of the considerable problems associated with these sophisticated infections is the increased resistance of bacteria, especially among gram-negative bacteria [82]. Clinically available antibiotics used to tackle infection in the hospital make a specific pattern drug of choice and its alternatives infection treatment whether primary, secondary, or tertiary option [83]. Unfortunately, it often led to surge incidence of HAIs caused by antibiotic resistant organisms responsible for an increase in morbidity and mortality [84]. Antimicrobial resistance (AMR) imposes a significant health and economic toll on the individual and population health [85], and its active surveillance considered as the best effort to minimize HAI's [86].

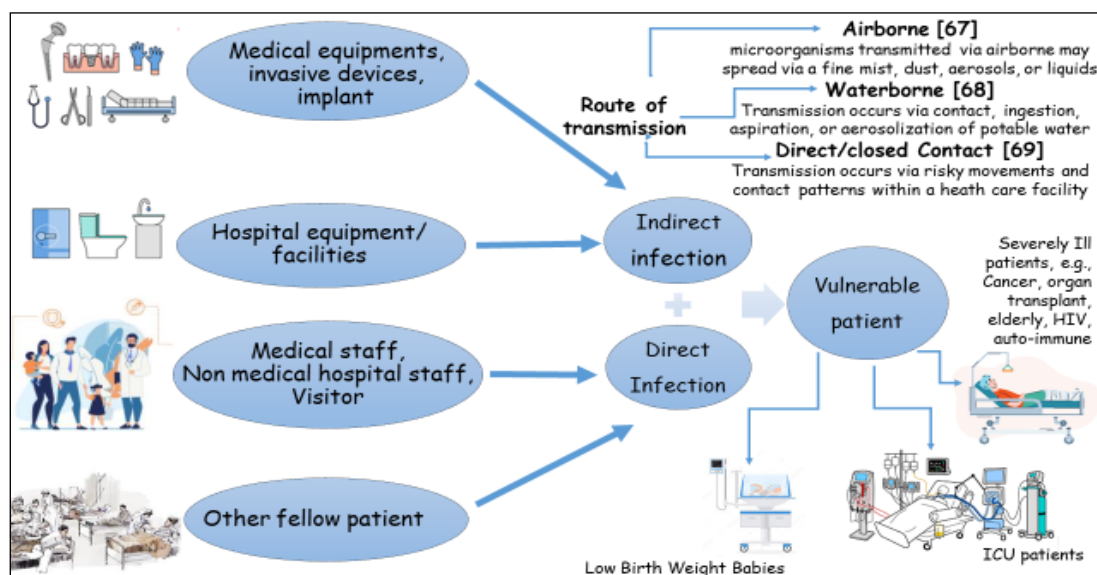


Fig. 1. Schematic illustration of transmission routes of hospital-acquired infections (HAI) or nosocomial infection [70, with modification]

The Center for Disease Control and Prevention (CDC) report on 2019, annually, there were 2.8+ million episodes of antibiotic-resistant infections in the United States alone, and greater than 35,000 related mortalities [87]. In 2019, from the above HAI common infections, the CDC included in their urgent threat list of several potentially fatal organisms, named the carbapenem-resistant *Acinetobacter*, carbapenem-resistant *Enterobacterales* (CRE), and *C. difficile* [87].

From surveillance data, Carbapenem-resistant *Acinetobacter* are often found in severely ill ICU patients and responsible for causing ventilator assisted pneumonia [88], as well as surgical wound [89], bloodstream [90], and urinary tract infections [91]. The effort to minimize the proliferation of such infections is very difficult due to frequent unthinkable contamination of healthcare facilities' surfaces and shared medical equipment [92], causing outbreaks in these health facilities [93-95]. CRE encompasses a family of gram-negative bacteria that cause infections with high mortality rates [96] are one of the major concerns for patients in healthcare facilities, principally among patients requiring invasive devices especially catheters [97] or receive long-term antibiotic therapy [98], because some bacteria of this family are resistant to nearly all antibiotics available in the market [99].

On the other hand, *C. difficile* infections can cause life-threatening diarrhea [87]. This type of diarrhea often acquired while receiving antibiotic treatment for other medical conditions [100]; the most serious episode of infection being evolved soon after the administration of fluoroquinolones [101]. These infections are more common and severe among the vulnerable elderly patients [102]. Momentarily, antibiotic down regulate helpful gut bacteria's flora on the intestine. The lingering toxin and less bacterial presence in the gut can create diarrhea. You can read about it and cite some more scientific papers.

The increased rate of morbidity and mortality due to HAIs with associated prolonged hospital stay and additional medication should be controlled. In order to manage HAIs, especially among the vulnerable groups of patients, the effort to make early correct diagnosis and followed by appropriate treatment based on severity of illness, and effective infection surveillance control are essential.

4. CONCLUSION

The Global emergence of MDR microorganisms with its difficult route of infections has created a major obstacle to combat the bacterial pathogens, a serious need requires attention from all stakeholders. As the basis of HAIs, bacterial resistance event to a single common antibiotic can be a beginning of serious problem to hospitalized patients, because the use of second- and third-line treatments. It has serious side effects for the patients and prolong care and recovery, sometimes even lead to fatal complication. Therefore, infection preventive measures and antibiotic stewardship are the priority in healthcare facilities to decrease the spread of antibiotic-resistant bacterial pathogens.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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