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Hospital Acquired Infection Revisited: Route of Transmission

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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 an need serious attention from all stakeholder, throughout the world.

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Keywords: long term wide spectrum Antibiotics, Multidrug-resistant drugs, Healthcare, medical staff, Gram negative bacteria, Antibiotic stewardship

1. INTRODUCTION

Nosocomial infections, also called health-care-associated or hospital-acquired infections (HAIs), per definition are a simple subset of infectious diseases acquired in a health-care facility 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]. Hospital- acquired infections are clearly infectious diseases which a patient experience within ≥ 48 hours' 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].

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33 The aims of this mini review is to revisited hospital route of infection transmission in patients
34 under medical care with its related problems with re-focus on route of transmission of
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36 2. SCOPE OF THE PROBLEM

37 The magnitude of HAI among patients, both outpatient and inpatient, need to be extensively
38 studied in order to increase all stakeholder's awareness [6]. The global burden of HAI is
39 several fold higher in low- and middle-income countries compared to high-income ones [7].
40 The rate of universal HAIs was 0.14 % with annual increasing trend by 0.06 % [2].
41 Geographically, prevalence in central Africa is higher than in other parts of the world by 0.27
42 (95% CI, 0.22–0.34) [2]. Based on type of hospital wards, the burn (Burn patients with Blood
43 stream infection-BSI) [8], Transplant (which consist of vulnerable patient, sophisticated
44 transplant procedures, immunosuppressive regimens, and prevention of transplant-
45 associated complications) [9], and Neonatal wards (premature infants in the intensive care)
46 [10] and ICU had the highest rates [11]. The prevalence of HAIs was higher in male patients
47 than in female patient (mostly in BSI) [12].

48 According to the World Health Organization (WHO), out of every 100 admitted patients in
49 acute-care hospitals, seven patients in high-income countries and 15 patients in low- and
50 middle-income countries will obtain at least one health care-associated infection (HAI) during
51 their hospital stay [13]. Approximately, HAI associated morbidity occur in one in every 10
52 affected patients.
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54 2.1 Economic Burden

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

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

71 In October 2008, United States's Medicare (the Centers for Medicare & Medicaid Services,
72 CMS) stopped reimbursing hospitals for certain hospital-acquired outcomes [17,18].
73 Officially, Medicare implemented the Hospital-Acquired Conditions (HACs) Initiative, a policy
74 denying incremental payment for eight condition related to complications of hospital care,
75 also known as "never events" [18]. These shift of policy abjure remittance for several
76 debatable conditions happening during the hospital care and stay and, those conditions were
77 not clearly stated on admission, including some healthcare-associated infections [17-19].
78 Hospitals were forced to shift its service into pay for performance system [20]. The aim is to
79 reduce the financially careless and preventable act of medical intervention conducted by and
80 in the hospitals [21] and as positive consequence of improvement in their standards and
81 behaviors, they receive a substantial financial incentive [22].

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

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

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

97 **2.2 types of HAI's and previous clinical symptom involved**

98 Common type of nosocomial acquired infections includes catheter-associated urinary tract
99 infections, central line-associated bloodstream infections (CLABSI) [32,33], surgical site
100 infections (SSI) [32,34], ventilator-associated pneumonia (VAP) [32,35], hospital-acquired
101 pneumonia (HAP) [32,36], and Clostridium difficile infections (CDI) [32,37] which
102 classification overestimates HAIs. But apart from all that, all stakeholders must equally
103 understand that most HAIs can be prevented if appropriate strategies are implemented [34].

104 Actually, there are numerous symptoms that can facilitate an infection to happen include
105 frequent productive cough which usually have future exacerbation risk [38], shortness of
106 breath as a hospital based risk acquired from wet breathing systems [39], abdominal pain
107 which seldom present as surgically treated non traumatic acute abdomen [40], rebound pain
108 or tenderness which usually acute and related to post-operative patient [41], acute changes
109 in mental status, acute change in mental status or ACMS [42], suprapubic pain [43], polyuria
110 [44], dysuria [45], and costovertebral angle tenderness [46].

111 **2.3 Route of transmission**

112 COVID-19 pandemic actually taught all stakeholder to emphasized the urgent necessity of
113 good practice of healthy behavior [47], hand hygiene [48] and the application of conventional
114 infection control methods in the hospital perimeter [49,50], as the World Health Organization
115 (WHO) report [51] and the Centers for Disease Control and Prevention (CDC) recommended
116 [52], in reducing the number of hospital-acquired infections. The next section will discuss the
117 possible route of transmission.

118 The adaptively of certain emerging pathogen [53], especially in specific areas of hospital
119 [54], provides the pathogen's ability to penetrate the dynamics of hospital's prevention
120 measures, for example in case of SARS-CoV-2 [55] regarding both the risk of exposure to
121 accompanying caregivers that to look after the patients during their hospitalization [56] and
122 the need to maintain quality of care while at the same time ensuring all the staff ready to
123 serve and well prepared [57]. Hospital staff (not limited to doctors and nurses) contribute
124 actively in the prevention and management of HAI [57,58] as they are involved in basic
125 personal hygienic care of the patient [59], navigating and implementing quality improvement
126 initiatives [60], conducted necessary automating surveillance [61] via correct microbiological

127 sampling [62], and features of rigid antibiotic stewardship [63]. These long lists of action
128 showed us that factors associated with HAI's are not simple.

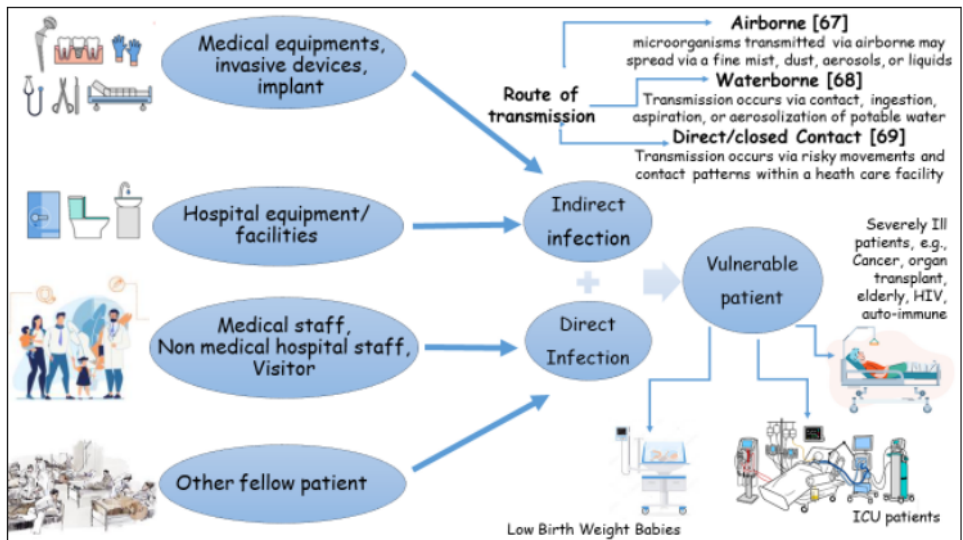
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130 **2.4 Contamination: unthinkable hospital surface act as reservoirs**

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

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

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

145 **3. SOME IMPORTANT MDR HOSPITAL ACQUIRED INFECTION'S AGENTS: 146 FOCUS ON INCREASED RESISTANCE**

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148 Several bacterial pathogens are difficult to overcome and since then have been related with
149 HAI infections, with the most prevalent HAIs episodes being caused by *Acinetobacter*
150 *baumannii* [71], a group of Gram-negative nonfermenting betaproteobacteria called
151 *Burkholderia cepacia* complex (Bcc) [72], *Pseudomonas aeruginosa*, a gram-negative
152 bacillus that is ubiquitous and abundant in the environment, especially in moist condition
153 [73], *Clostridium difficile* that can cause severe diarrhea [74], extended-spectrum beta-
154 lactamase (ESBL)-producing *Escherichia coli* [75], Carbapenemase-producing carbapenem-
155 resistant Enterobacterales (CP-CRE) [76], vancomycin-resistant *Enterococci* (VRE) that
156 commonly reported causing outbreak in surgical ICU ward [77], methicillin-resistant *S.*
157 *aureus* (MRSA) [78], vancomycin-intermediate *S. aureus* (VISA) [79], and vancomycin-
158 resistant *S. aureus* (VRSA) [79,80] which their increasing prevalence (both VISA and VRSA
159 infections) is truly a cause of global concern, and last but not least *Mycobacterium*

160 *tuberculosis*, [81] a causative agent responsible for numerous outbreaks of nosocomial
161 tuberculosis due to its multidrug-resistant strains.

162 One of the considerable problems associated with these sophisticated infections is the
163 increased resistance of bacteria, especially among gram-negative bacteria [82]. Clinically
164 available antibiotics use to tackle infection in the hospital make a specific pattern drug of
165 choice and its alternatives infection treatment whether primary, secondary or tertiary option
166 [83]. Unfortunately, it is often led to surge incidence of HAIs caused by antibiotic resistant
167 organisms responsible for an increase in morbidity and mortality [84]. Antimicrobial
168 resistance (AMR) imposes significant health and economic toll on the individual and
169 population health [85] and its active surveillance considered as the best effort to minimize
170 HAI's [86].

171 The Center for Disease Control and Prevention (CDC) report on 2019, annually, there were
172 2.8+ million episodes of antibiotic-resistant infections in the United States alone, and
173 >35,000 related mortalities [87]. In 2019, from the above HAI common infections, the CDC
174 included in their urgent threat list of several potentially fatal organisms, named the
175 carbapenem-resistant *Acinetobacter*, carbapenem-resistant *Enterobacterales* (CRE), and *C.*
176 *difficile* [87].

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

187 On the other hand, *C. difficile* infections can cause life-threatening diarrhea [87]. This type of
188 diarrhea often acquired while receiving antibiotic treatment for other medical conditions
189 [100]; the most serious episode of infection being evolved soon after the administration of
190 fluoroquinolones [101]. These infections are more common and severe among the
191 vulnerable elderly patients [102].

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

197 4. CONCLUSION

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

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213 **COMPETING INTERESTS**

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"Authors have declared that no competing interests exist."

217 **AUTHORS' CONTRIBUTIONS**

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"Author LSS' designed the study, performed the literature searching, wrote the protocol, and wrote the first draft of the manuscript until the final manuscript."

222 **CONSENT (WHERE EVER APPLICABLE)**

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Not needed

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Not needed

230 **REFERENCES**

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