A Meta-Analysis on Evaluation of Nosocomial Infections Amongst Patients in a Tertiary Care Hospital

Baozhi Zhang, Xiao Ling Wu, and Ruiping Li

The Second Affiliated Hospital Of Guangdong Medical University, Zhanjiang, Guangdong, China

Correspondence should be addressed to Ruiping Li; apzljld@163.com

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Background. Hospital-acquired infections, also known as nosocomial infections, are one of the many severe outcomes amongst patients in tertiary care hospitals. Hospital-acquired influenza is amongst the most common infection which has affected huge population. Objectives. We have performed a meta-analysis in order to summarize the effects of epidemiology and clinical characteristics in HAI.

Methods. We performed literature review with help of PubMed, Cochrane Library, Embase, Scopus, Web of Science, China National Knowledge Infrastructure (CNKI), The Global Index Medicus (GIM), and other clinical databases till 2021. Many random models were used in order to obtain pooled proportions, mean difference, odds ratio, and CI. Results. A total of six studies were analyzed, where a total of 491 nosocomial and 4030 nonnosocomial infection cases were reported. The odds ratio of mortality was 0.02 with 95% CI and the risk ration for males was 1.08 with 95% CI.

Conclusion. The proportion of nosocomial infections in cases of influenza was higher in patients admitted in tertiary care hospitals. Thus, a surveillance system for vaccination for all the high-risk patients must be made mandatory.

1. Introduction

Nosocomial infections are one of the extensive problems faced by the hospitals at a global level. These nosocomial infections, often termed as hospital-acquired infections (HAIs) or even healthcare-associated infections (HCAI), are a major challenge as it affects large number of patients who are in need of intensive care [1, 2]. The majority of cases of distress and mortality are caused because of the nosocomial infections, where environmental contamination plays a crucial role in the transmission. Human influenza is among the transmissible critical respiratory illness which is spread by influenza A and B virus [3]. The nosocomial infection cases usually occur during the annual pinnacle of the collective influenza activity where the healthcare workforce and the patient visitors (family, relatives, and friends) were identified as the most frequent sources [4]. The most common hospital-acquired infections include the ventilator-associated pneumonia, blood-borne infections, surgical site infections, and urinary tract infections [5–7].

Around 8.7% of the patients in the hospitals fall under the risk of exposure to the nosocomial infections which multiply the complicated conditions such as cancer, surgery, or any cases of organ transplant, thereby surging the mortality rate [8]. In an epidemiological study conducted by WHO in 14 countries across the world, 8.7% cases of nosocomial infection cases were reported. This data ranged from 5.0% cases in North American region to 40% in the Asian subcontinent, Latin America, and Sahara regions of Africa [9].

There is a high range of pathogens which cause nosocomial infections such as Acinetobacter baumannii, methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant enterococci (VRE), Clostridium difficile, and Pseudomonas aeruginosa that dwell in the environment for a longer duration [10–12]. There are multiple environmental conditions which influence the presence of microorganisms, where number of people present plays the major role, followed by the level of moisture and material supporting microbial growth [13]. Therefore, for a
comprehensive understanding, we have performed meta-
-analysis on the origin and spread of nosocomial infections in
a tertiary care hospital.

2. Methodology

2.1. Search Strategy. The protocols’ preparation was done on
the basis of Preferred Reporting Items for Systematic Re-
views and Meta-analysis (PRISMA). The outcomes will be
outlined on how the articles were filtered and selected for
inclusion. The exploration of data was performed using
PubMed/MEDLINE (studies from 1997 to May 2021), Web
of Science (studies from 2001 to May 2021), The Global
Index Medicus (GIM) (studies from 2004 to May 2021),
Embase (studies from 1999 to April 2021), Cochrane and
China National Knowledge Infrastructure (CNKI), Scopus
(studies from 1995–2021), and MeSH library terms and
proper usage of keywords.

The combination of keywords used for search were
“nosocomial infections,” “hospital-acquired infections
(HAIs),” “healthcare-associated infections (HCAI),” “mul-
tidrug resistant organism (MDROs),” nosocomial patho-
gens, environmental contamination, healthcare-acquired
infections, and nosocomial bacterial infections. The
screening of title and abstract and the entire text review was
performed on the prospective studies that were found
eligible.

2.2. Inclusion Criteria. The inconsistency associated with the
inclusion of research works was concluded through dis-

cussion. The effort was put in to establish communication
with the authors of the papers which were included in the
study after filtering. The trials incorporated in the study were
based on the types of multiple units with which reported
patient data from the entire hospital, discrete clinical wards,
or subgroups without sorting a specific disease. The pop-
ulation-related inspection studies which recorded the reg-
ularity nosocomial infections and the retrospective or case-
control studies with clear and detailed data were also con-
sidered. The characteristics of included studies are
shown in Table 1.

2.3. Exclusion Criteria. Different studies with design
structure such as reviews, letters, conference abstracts, case
studies, and duplicate publications and the studies missing
the crucial data or original data were excluded. Some articles
were also removed as they were not accessible even after
contacting the authors. The studies which were not written
in English were also excluded along with the single reports
that consisted of incomplete datasets or guidelines.

2.4. Data Analysis and Statistical Assessment. Pooling of data
was done by reporting same outcomes and occurrence
measures (cumulative incidence and prevalence). Prevalence
was here defined as the number of incidences (infections)
reported every 100 patient who spent time in hospital for a
duration of time and ratio of patients suffering from
nosocomial (number of patients suffering from nosocomial
infection per 100 patients).

Cumulative incidence (CI) was defined in the analysis as
new cases per 100 patients over a duration of time. Data were
collected on the basis of prevalence of nosocomial infection,
devices linked with infections, ventilator days, incidences of
nosocomial infections in ICUs, and CI of SSI, surgical site
infection. Random meta-analysis was conducted on all the
data’s pooled. Forest plot and funnel plot were plotted
responding with 95% confidence intervals (CIs).

3. Results

We analyzed five studies on basis of characteristics of study
as mentioned in Table 1.

95% CI was 0.35 (0.29–0.42) which was found for
mortality and survival of hospital-acquired influenza, nos-
ocomial infections.

Odds ratio with 95% CI (0.01–0.08) have emphasized
that hospital-acquired cases were relatively higher as com-
pared to the CAI in influenza infections of patients in
tertiary care hospitals.

HAI cases were higher in comparison to the CAI cases.

Risk ratio was analyzed with 95% CI (0.93–1.26) for
identifying the prevalence of nosocomial and non-
osocomial infections in males.

The factor for gender was ruled out for nosocomial
infections and males were more prevalent to nonnosocomial
infections.

Risk of bias: there was no risk of bias in publication of the
studies.

4. Discussion and Conclusion

Six studies were involved in the study of evaluating the cases
of nosocomial infections in patients admitted in tertiary care
hospitals (Figure 1). Influenza cases were studied in this meta-
analysis where the hospital-acquired infections (nosocomial)
were compared with the community acquired infections
(nonnosocomial). An odds ratio (OR) of 0.02 with 95% CI
was noted for mortality in cases of nosocomial versus non-
osocomial infections. Risk ratio for cases in males was found
to be 1.08 with 95% CI. 95% CI was 0.35 (0.29–0.42) was
found for mortality and survival of hospital-acquired influ-
enza, nosocomial infections, as shown in Figure 2 (forest
plot), and the funnel plot for the same is shown in Figure 3.
Characteristics of study for the patients are shown in Table 2.

Total number of cases reported of nosocomial and nonnosocomial influenza infections of patients in tertiary care hospitals for each study are reported in Table 3. Odds ratio with 95% CI (0.01–0.08) have emphasized that hospital-acquired cases were relatively higher as compared to the CAI in influenza infections of patients in tertiary care hospitals; the forest plot is shown in Figure 4, and the funnel plot showed HAI cases were higher in comparison to the
CAI cases are shown in Figure 5.

Number of males reporting influenza cases in noso-
comial and nonnosocomial category in tertiary care
hospitals are shown in Table 4; the risk ratio was analyzed
Prospective related articles that were recognized and filtered using the following MeSH terms: "nosocomial infections", "HAIs" "HCAI", "MDROs" "nosocomial pathogens" "environmental contamination" "healthcare acquired infections" "nosocomial bacterial infections", "Tertiary care hospital", "hospital", "intensive care" utilizing (clinical databases and other databases) 

n = 223

Screening

Eligibility

Included

Identification

Table 1: Characteristics of included studies.

| Characteristics                  | [14] | [15] | [16] | [17] | [18] | [19] |
|----------------------------------|------|------|------|------|------|------|
| Study design                     | Case control | Case | Cross sectional | Cross sectional | Cross sectional | Cross sectional |
| Sample size (HAI)                | 382  | 1722 | 208  | 292  | 860  | 2421 |
| Mean age of patients (HAI)       | 62   | N/A  | 79.1 | 79   | 82   | 53.47|
| Mean age of patients (CAI)       | 60.4 | N/A  | 64.8 | 76   | 47   | 48.86|
| Gender                           | 46.5% female | 43.1% female | 50% female | 35.7% female | 54.38% female | 42.88% female |
| Duration of study                | 2017-2018 | 2010/2011–2015/2016 | 2016/12–2017/02 | 2017 | 2017 | 2020 |
| Country                          | United States | Spain | France | Australia | France | Spain |
| Study quality                    | 7    | 8    | 7    | 6    | 6    | 7    |

Possibly appropriate papers as per searches n = 226

Applicable to the objective of the paper = 174

Full text titles obtained for eligibility = 6

Studies included for acceptance which were Systematic Review and Meta-analysis based on inclusion criteria (n = 6)

Final Studies Included n = 6

Articles that were rejected on the basis of exclusion criteria: inappropriate conclusions or results, no clinical characteristics data, abstract failure to comply with retrieval criteria, non-English articles = 168

Removal of redundant records = 52

Other additional records recognized through other platforms (n = 3)

Figure 1: PRISMA study for the learning process.
with 95% CI (0.93–1.26) for identifying the prevalence of nosocomial and nonnosocomial infections in males, and its forest plot is shown in Figure 6, while the funnel plot on the risk ratio of the number of males affected by nosocomial infections in tertiary care hospital, and its prevalence in Figure 7.

As the ratio of hospital-acquired infections (nosocomial) is increasing in patients admitted in tertiary care hospitals, hence, a strict surveillance must be enforced for higher risk patients. In cases of diseases such as influenza which has high affinity in nosocomial infections, a system of vaccination must be implied for admissions.
**Table 4:** Gender-based analysis; number of males reporting influenza cases in nosocomial and non-nosocomial category in tertiary care hospitals.

| Characteristics | [14] | [15] | [16] | [17] | [18] | [19] |
|-----------------|------|------|------|------|------|------|
| HAI             | 23   | 53   | 17   | 18   | 31   | 142  |
| N (HAI)         | 37   | 96   | 49   | 28   | 57   | 224  |
| COI             | 35   | 926  | 87   | 122  | 392  | 626  |
| N (CAI)         | 74   | 1626 | 159  | 264  | 803  | 1103 |

HAI, hospital-acquired infection; CAI, community-acquired infection; N = number.

**Figure 5:** Funnel plot on the odds ratio of incidences of nosocomial versus non-nosocomial infections (for both HAI and CAI cases).

**Figure 6:** Forest plot on risk ratio of gender-based effect of nosocomial infections in tertiary care hospitals.
nosocomial infections in tertiary care hospital and its prevalence.

Abbreviations:

CI: Confidence interval
SSI: Surgical site infection
CLABSI: Central line-associated bloodstream infection
HAI: Hospital-acquired infection
CAI: Community-acquired infection
VAP: Ventilator-associated pneumonia
CVC: Central venous catheter
ICU: Intensive care unit
OR: Odds ratio
RR: Risk Ratio
HR: Hazard ratio.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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