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SHORT PAPER

Healthcare-Associated-Infections: preliminary results from a real-time reporting system of an Italian neurologic research hospital

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Keywords: Healthcare-Associated-Infection; Clinical Information System; Electronic Health Record; Digital Health; Infection Prevention and Control Strategies.
Parole chiave: Infezioni correlate all'assistenza; sistemi informativi; cartella clinica elettronica; sanità digitale; strategie di controllo della prevenzione delle infezioni.

Abstract

Background. *Healthcare-Associated-Infections are a critical concern in healthcare settings, posing serious threats to patient safety and causing significant morbidity, mortality, and financial strain. This study aims to calculate healthcare-associated-infections trends in the hospital setting through an automatic reporting system.*
Study design. *The study is a descriptive analysis of automatically generated trends of an innovative digital tool based on existing hospital information flows.*
Methods. *An algorithm was developed within a Clinical Information System to create a suite of quality indicators for monitoring healthcare-associated-infections trends. The algorithm used criteria related to admission, laboratory tests and antimicrobial administrations. A descriptive analysis was conducted for patients aged 18 or older, admitted to a neurological or to a neuro-rehabilitation department of a neurologic hospital from 2019 to 2022.*
Results. *The results showed fluctuations in healthcare-associated-infections prevalence from 2.9% to 5.6% and hospital infections prevalence from 4.5% to 10.9%, with notable increases in 2020 and 2021. The majority (70.3%) of healthcare associated infections identified by the tool were confirmed to be potentially hospital-acquired, according to the European Centre of Disease Prevention and Control's definition.*
Discussion and Conclusions. *The study posits the algorithm as a vital tool for automatically monitoring hospital infections, providing valuable preliminary results for improving care quality and guiding the infections' prevention and control strategies, with plans to benchmark the algorithm against a gold standard in the future.*

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Background

Healthcare-associated-infections (HAIs) can be defined as infections occurring in a patient during the process of care in any healthcare facility, which were not present or incubating at the time of admission (1). They represent the most frequent adverse event associated with patient care, contributing to significant morbidity, mortality, and financial burden on patients and healthcare systems (2). During the period 2016-2017, the European Center for Disease Control and Prevention (ECDC) reported more than 3.8 million patients with at least one HAI and about 4.5 million HAIs episodes per year in acute care hospitals (3). These numbers resulted in an estimated total of 98,166 patients with at least one HAI on any given day with a point prevalence estimated at 6.5%. In Europe, according to ECDC estimates, HAIs caused annually 16 million additional days of hospital stay and 37,000 directly attributable deaths. In Italy, the mean national incidence rate of HAIs is between 5% and 10% (4). In Neurology wards the observed incidence rate was 6.6% with the most common HAIs being urinary tract infection (44.2%) (5).

The existing disease surveillance systems could help and support the estimates of HAIs at the hospital level, but they vary widely, from the more traditional to the more innovative ones, as those based on social media contents (6), which are platforms currently used for finding and exchanging health information (7). Effective decision making in the healthcare setting is highly dependent on access to reliable standardised and robust data (8, 9). However, these surveillance systems did not always provide useful information for public health specialists (3). The process of data collection and standardization is often unsustainable in healthcare settings having been based mostly on manual registries. In the era of digitalization new tools for data collection, standardistzion and aggregation are crucial to improve quality in healthcare setting, such as Clinical Information System (CIS). CISs are the set of resources, techniques, devices, and methodologies that are used in different healthcare settings to aggregate routine healthcare data. The IRCCS Fondazione Istituto Neurologico C. Mondino, (Mondino Foundation) of Pavia, a neurologic university and research hospital, is equipped with a CIS. This CIS is able to gather and standardize data from multiple sources, including clinical data from the Electronic Health Records (EHR) and administrative data from further information flows.

Materials and methods

The aim of this study is to share preliminary results from an algorithm able to automatically generate reports about HAIs trends. The algorithms has been created in a CIS, which is intended as a tool with the aim of elaborating a set of quality indicators (QIs), including the epidemiological measures about HAIs and hospital infections. The tool was customized within our hospital by a group of data scientists, and the QIs of the present study were designed by a group of public health specialists operating in the hospital health direction who would ultimately be using it. In order to elaborate the algorithm for the HAIs and hospital infections reporting, information flows from Hospital Discharge Data (HDD) and the EHR were included. The HDD included demographic and clinical variables, and also admission and discharge data related to the timing and source of admission. EHR included clinical data and variables related to laboratory tests, imaging examinations, medical procedures, and drugs prescriptions of each patient.

The following inclusion criteria were used to elaborate the HAI prevalence, defining a patient aged 18 years or older and admitted to the hospital setting in the reference year with a HAI, according to ECDC definition {Commission Implementing Decision (EU), 2018}, as follows: i) who performed laboratory culture test for a microorganism after 48 hours from the admission time; ii) who were administered antimicrobials for systemic use during the hospital stay; and iii) who performed one of the following tests after 48 hours from the admission time: blood culture or CerebroSpinal Fluid (CSF) culture or stool culture or urine culture or sputum culture.

To elaborate the prevalence of infections, the same criteria of the HAI were used, but including the laboratory tests performed within the first 48 hours after the admission time.

This descriptive analysis included data from all patients attended in our 135-beds hospital during four consecutive years, from January 1, 2019, through December 31, 2022. The following variables were considered in the current analysis: year of discharge, prevalence of infections, prevalence of HAIs. Using data retrieved from the CIS, this study computed rates of infections and HAIs for each calendar year. A descriptive comparison was performed between departments and temporal trends within the hospital. A random and representative sample of the medical records under review was read for the presence of HAIs.

Results

From 2019 through 2022 our hospital admitted 11,323 patients in 111 beds. Table 1 shows the QIs for this population. The prevalence of infections in admitted patients sharply fluctuated between 4.5 percent and 10.9 percent, showing an upward trend during the 2020 and 2021, while the prevalence of HAIs varied between 2.9 percent and 5.6 percent.

In our neurology department, the total discharges stabilized between 2,221 and 2,883 per year. The infections prevalence consistently varied between 2.8 percent and 8.1 percent and the HAIs prevalence was between 1.5 percent and 3.4 percent.

In the neuro-rehabilitation department, the annual total discharges remained constant at 310 to 324. The prevalence of infections exhibited consistent variation ranging from 17.7 percent to 30.6 percent, while the HAIs prevalence was between 14.5 percent and 20.9 percent.

According to the findings of a reading of a representative sample (60 out of 539) of our records, 70.3 percent of the cases that were identified as HAIs in our CIS platform were confirmed as potentially acquired at our hospital, as further defined by the ECDC {Commission Implementing Decision (EU), 2018}, and to all the cases was diagnosed an infection.

Discussion

Out of the 11,323 patients admitted to the Mondino Foundation, a sharp fluctuation in prevalence was observed among inpatients for HAIs between 2.9 and 5.6 percent, with an upward trend observed in 2020 and 2021. The prevalence of HAIs in the neurology department varied between 1.5 and 3.4 percent. Within the rehabilitation department, the prevalence of HAIs varied between 14.5 and 20.9 percent. The review of 60 out of 539 medical records with HAIs indicated that to all the patients an infection was diagnosed and to 70.3% (percent) of them an HAI was detected and was subsequently confirmed as potentially acquired at our institution, as the ECDC further defines the term (10). However, it should be specified that the definition of HAI proposed by ECDC is applicable in the context of epidemiologic studies and mainly with regard to bacterial infections, whereas for other types of infections, including those for medico-legal purposes, a specific causal link to the healthcare setting must be assessed (11). For this reason, it was decided to give priority to sensitivity in the construction of an algorithm for the detection of HAIs, also for wider application to other care settings. The remaining percentage of cases were acquired elsewhere but took antimicrobial therapy and underwent cultural test for infection assessment within the first 48 hours after admission time. The findings demonstrated that the prevalence of HAIs, with an overall period estimation of 4.3%, was consistent with the prevalence between 4 and 6% that was found in the existing literature (3-5), with a foreseeable rise in the number of cases occurring during the pandemic, specifically in the years 2020 and 2021, also due to antimicrobial off-label administration. The definition of these infections as hospital-related is still under discussion, because they might not be clearly attributable to the hospital (12, 13). The number of HAIs - both in the neurology and neuro-rehabilitation departments . decreased in 2022 in comparison to the previous period. Indeed, in 2022 the Mondino Foundation improved its Infections'

Table 1. Trends of Healthcare-Associated Infections and Hospital infections in patients admitted to the hospital, the neurology department, and the neuro-rehabilitation department, over the period 2019-2022.

HAIs in hospital (all departments)	**2019**	**2020**	**2021**	**2022**
Infections prevalence (%)	6.9%	10.9%	8.5%	4.5%
HAIs prevalence (%)	4.3%	5.6%	4.4%	2.9%
HAIs in neurology department				
Infections prevalence (%)	4.9%	8.1%	6.0%	2.8%
HAIs prevalence (%)	2.5%	3.4%	2.4%	1.5%
HAIs in neuro-rehabilitation department				
Infections prevalence (%)	26.2%	30.6%	27.5%	17.7%
HAIs prevalence (%)	20.8%	20.9%	19.4%	14.5%

Prevention and Control (IPC) activities in the hospital in a comprehensive way (14). Thus, our results suggested that healthcare providers became more sensitive to infection control and prevention.

When compared to the neurology department, the neuro-rehabilitation department appeared to have a significantly higher prevalence of HAIs. This could be explained by the fact that usually these patients come from other hospitals and care settings. Furthermore, the average length of stay in the neuro-rehabilitation department is usually longer than the average length of stay in the neurology department, which significantly increases the amount of time that patients are exposed to the possibility of getting an infection.

The importance of calculating these indicators at the hospital level was brought to light by the findings of this article. Indeed, these data can be utilized to benchmark the hospital performance, eventually enhance the quality of care, and simultaneously save money, aiming at population health management strategies (15, 16).

The current study presented some limitations. Firstly, the algorithm only partially succeeded in meeting the precise definition of HAI that is provided by the ECDC (10). On the one hand, the algorithm took into account the results of a culture test, but it did not stratify the results according to whether or not they were positive. On the other hand, the administration of an antimicrobial therapy was a sign that a probable infection was present, meaning that it partially addressed this limitation of the study. This tool had a great deal of potential for further development and demonstrated results that were comparable to those found in the literature (5).

Conclusions

The findings of our study represented a significant first step toward the automatic measurement of hospital infections to monitor and improve the quality of care in a hospital. This tool, which automatically generates quality indicators, enabled an analysis of the number of hospital infections and HAIs that were present in the Mondino Foundation. Additionally, it provided the Health Direction with insights that can be used to monitor the results of their IPC strategies. It will be necessary in the future to verify the existing algorithm against a gold standard.

Riassunto

Infezioni correlate all'assistenza: risultati preliminari da una generazione automatica di report mediante i dati raccolti dai sistemi informativi di un IRCCS neurologico italiano.

Introduzione. Le infezioni correlate all'assistenza sono un problema critico in ambito sanitario, in quanto rappresentano una seria minaccia per la sicurezza dei pazienti e causano morbilità, mortalità e oneri finanziari significativi. Questo studio si propone di calcolare gli andamenti delle infezioni correlate all'assistenza in ambito ospedaliero attraverso un sistema di segnalazione automatica.

Disegno dello studio. Lo studio è un'analisi descrittiva degli andamenti generati automaticamente da uno strumento digitale innovativo basato sui flussi informativi ospedalieri esistenti.

Metodi. È stato sviluppato un algoritmo all'interno di un sistema informativo per creare un set di indicatori di qualità per il monitoraggio degli andamenti delle infezioni nosocomiali. L'algoritmo ha utilizzato criteri relativi al ricovero, agli esami di laboratorio e alle somministrazioni di antimicrobici. È stata condotta un'analisi descrittiva per i pazienti di età pari o superiore a 18 anni, ricoverati in un reparto neurologico o di neuro-riabilitazione di un ospedale neurologico dal 2019 al 2022.

Risultati. I risultati hanno mostrato fluttuazioni nella prevalenza delle infezioni correlate all'assistenza dal 2,9% al 5,6% e nella prevalenza delle infezioni ospedaliere dal 4,5% al 10,9%, con notevoli aumenti nel 2020 e nel 2021. La maggior parte (70,3%) delle infezioni correlate all'assistenza identificate dallo strumento è stata confermata come potenzialmente acquisita in ospedale, secondo la definizione dello European Centre of Disease Prevention and Control.

Conclusioni. Lo studio propone un algoritmo come strumento essenziale per il monitoraggio automatico delle infezioni ospedaliere, fornendo risultati preliminari preziosi per migliorare la qualità delle cure e guidare le strategie preventive ospedaliere, con l'intenzione futura di confrontare l'algoritmo con un gold standard ai fini di una validazione.

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