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Short report

Use of health databases to deal with underreporting of surgical site infections due to suboptimal post-discharge follow-up

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SUMMARY

This study describes a combined surveillance of surgical site infection implemented in an Italian region, which relies on integration of the specific surveillance (SIChER) with other sources and the targeted review of a small proportion of cases. Additional information on post-surgical follow-up was obtained from hospital discharge, microbiology laboratory and emergency department databases. Based on these data, 76 patients were reclassified as possible cases and revised by the health trust representatives. Eventually 45 new cases were confirmed, leading to an increase in the infection ratio from 1.13% to 1.45%. The proposed method appears to be accurate and sustainable over time.

Introduction

Surgical site infections (SSIs) are among the most common healthcare-associated infections (HCAIs) but, unlike most HCAIs that occur mainly during hospitalization, they often have onset after discharge [1]. This feature makes SSI surveillance particularly difficult and expensive, since it involves an extended post-surgery follow-up [2]. On the other hand, surveillance of SSI is an essential activity to quantify but also to minimize the clinical risk associated with surgery [2,3]. In fact, it has been observed that surveillance *per se* can reduce the rate of infection by increasing the awareness and the attention of health workers [2,3]. For this reason, SSI surveillance is widely considered a good practice [4–6]. Several European countries have joined the SSI surveillance system coordinated by the European Centre for Disease Prevention and Control (ECDC) whose protocol, while requiring the period of hospitalization as a minimum standard of duration of surveillance, recommends a follow-up of 30 and 90 days for non-prosthetic and prosthetic surgical procedures, respectively [4]. Therefore, a critical problem that hospitals must solve when implementing SSI surveillance is active post-discharge

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monitoring of patients undergoing surgery. Unfortunately, in hospitals where SSI surveillance is performed, due to the costs associated with post-discharge monitoring, the duration of follow-up may be shorter than optimal, preventing the achievement of accurate quantification of the frequency of infection and the possibility of appropriate healthcare benchmarking [7]. A systematic review of several primary studies shows that the likely onset of SSI can be inferred based on diagnoses and procedures performed during hospitalization, using the hospital discharge database [8]. More recently, a validation study of a semi-automatic SSI surveillance system, carried out in Korea, has shown that the use of electronic screening algorithms followed by a review of selected cases can provide accurate results and reduce the workload related to surveillance [9].

This article proposes a combined approach of SSI surveillance, based on the integration of data from the Emilia-Romagna region SSI surveillance system (SIChER) and from other health databases (hospital discharge, microbiology laboratory and emergency department) followed by the targeted revision of a minority of cases. The proposed approach, implemented in an Italian northern region, aims to reduce the underreporting related to the post-discharge follow-up period in a context where the duration of follow-up is not optimal and there is availability of accurate health databases.

Methods

The present study includes data on surgical procedures carried out from January to December 2017 in four health trusts of Emilia-Romagna, a northern Italian region of 4.5 million inhabitants. The participating health trusts consist of 16 public hospitals, one of which is a university polyclinic. SIChER has been in place in Emilia-Romagna for several years and covers all public health trusts [10]. SIChER allows for a direct record linkage to other regional health databases which are included in the residents' administrative data system, through an anonymous patient identifier [10]. The surveillance is based on the SSI HAI-Net protocol issued and periodically updated by the ECDC and includes surgical procedures selected and grouped according to the US National Healthcare Safety Network (NHSN) classification [4,5]. The study included surgical operations belonging to nine NHSN categories (appendix surgery; breast surgery; gall bladder surgery; colon surgery; Caesarean section; kidney surgery; ovarian surgery; prostate surgery; small bowel surgery). The selected NHSN categories refer to high-volume operative procedures not requiring prosthesis.

Information on post-discharge follow-up, provided in SIChER, was integrated by combining data from three health data sources (hospital discharge, microbiology laboratory, and emergency department databases), according to a standardized approach. For each SIChER record, additional data on hospital readmissions, microbiology tests, and access to the emergency room were searched and analysed. A specific list of ICD-9/ICD-10 codes, defined in previous publications, was used to identify surgical procedures and diagnoses of interest in the hospital discharge database [8]. The microbiology data were obtained from the surveillance system of the antimicrobial resistance of Emilia-Romagna (LAB), a well-established laboratory network, active for 15 years, which covers all public hospitals in the region and provides data for annual report and scientific publications [11–14]. The LAB system is accessible via the web through the Emilia-Romagna region portal (http://salute.regione.emilia-romagna.it/siseps/sanita/lab/analisi-statistica).

Patients for whom no SSI had been reported in SIChER were reclassified as possible cases when, considering the post-discharge period up to 30 days after surgery, at least one of the following criteria was met: (i) hospital readmission for SSI-related surgical procedure and/or diagnosis; (ii) access to emergency department for SSI-related diagnosis; (iii) positive bacterial culture of clinical sample from the surgical site plus any hospital readmission; (iv) positive bacterial culture of clinical samples both from the surgical site and from blood. Based on additional data, infections were also classified as superficial, deep, and organ/space. The four health trusts included in the study performed a systematic revision of the additional possible SSIs. The review was carried out by the representatives of the health trusts for the surveillance of SIChER who consulted all the available documents including the medical records in electronic or paper version, the data of the post-intervention controls in the hospital ambulatory and the laboratory tests, in close collaboration with the surgeons responsible for the cases. The reviewed cases were reclassified as 'confirmed' if the evidence obtained through the clinical records was sufficient to define the SSI or 'excluded' if the information enabled ascertaining the absence of an SSI, whereas the category 'possible infection' remained unchanged if the available data were insufficient to confirm or exclude the infection. The data analysis was performed using Stata v.14.2 (Stata Corp., College Station, TX, USA).

Results

The study sample included 14,200 surgical operations performed in four health trusts. The mean duration of hospital stay after surgery was 4.8 days (median: 3; interquartile range (IQR): 3) and the mean duration of SSI follow-up was 9.2 days (median: 3; IQR: 9). The number of SSIs reported to SIChER during 2017 by the health trusts participating in this study was 161 with an infection ratio of 1.13%; 66 of these infections (41%) were diagnosed during hospitalization, 95 (59%) after discharge. Out of 161 reported SSIs, 105 were superficial (65%) and 56 deep or organ/space infections (35%). The infection ratios of the four participating health trusts ranged between 0.46% and 1.58% (Figure 1). A further 76 possible cases of SSI were retrieved using health databases; the main contribution was provided by the discharge database, alone or in combination with other databases (61 additional cases; 80%) (Table I). After the revision of the 76 possible infections: an SSI was confirmed in 45 cases (59%) and excluded in 24 cases (32%), whereas seven cases (9%) remained in the category of possible infections (Table I). The criteria 'hospital readmission for SSI-related surgical procedure and/or diagnosis', 'positive bacterial culture of clinical samples both from the surgical site and from blood' and a combination of two criteria achieved the highest percentages of confirmed cases: 80%, 75% and 88%, respectively (Table I). Considering the new confirmed SSI, 12 out of 45 were related to colon surgery (27%), eight to Caesarean section (18%), seven to breast surgery (16%), seven to gallbladder surgery (16%) and 11 (24%) to the other five NHSN categories included in the analysis; this distribution was not

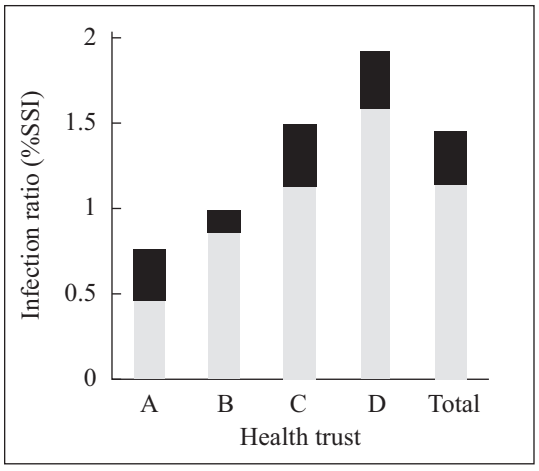

Figure 1. Surgical site infection (SSI) ratio in four health trusts of Emilia-Romagna region (2017). The infection ratios were calculated considering infections reported in the SSI surveillance system of the Emilia-Romagna region (SIChER; grey bars) and confirmed infections identified through other regional health databases (black bars). The four participating health trusts consist of 16 public hospitals, one of which is a university teaching hospital.

significantly different from that of the 161 SSIs reported in SIChER. Fifteen additional infections (33%) were superficial; the remaining 30 (67%) were deep or organ/space. By adding the confirmed infections to those reported in SIChER, the total number of SSIs rose from 161 to 206 cases with an infection ratio of 1.45% ranging between 0.75% and 1.91% at health trust level (Figure 1) and a proportion of post-discharge diagnosis of 68% (140/206). On average, the additional confirmed cases identified through health databases increased by 28% the number of SSIs while, at health trust level, the rise ranged between 14% and 65%. Considering possible infections the total number of SSIs rose to 213 (32% increase compared to SSIs reported in SIChER) reaching a ratio of 1.5%

Discussion

The results of the study show a significant increase in the number of SSIs when considering other information sources in addition to SIChER. This combined approach refers to the specific ISS surveillance for pre-discharge and partly post-discharge follow-up while other health databases are used to improve the completeness of post-discharge follow-up by identifying a limited number of potential infections to be thoroughly reviewed. The implemented algorithm worked satisfactorily with 45 out of 76 possible additional SSIs (59%) confirmed. This proportion rises to 65% (45/69) if the seven cases remaining in the category 'possible' infection are excluded. The study algorithm made it possible to identify a significant number of undetected SSIs, mainly deep or organ/space infections, resulting in an average increase in the infection ratio of 28%. The observed increase is visible in all participating health trusts, although to a different extent. This heterogeneity is justified by possible differences between health trusts in the accuracy and completeness of surveillance as well as by actual differences in infection rates. The difficulties due to the length of follow-up, greatly exceeding the duration of hospitalization, are already known. For this reason, other researchers, who had evaluated alternative approaches to SSI surveillance, relied on the use of non-specific sources such as hospital discharge databases [7–9]. Surveillance using non-specific IT sources (defined as indirect surveillance) is certainly less expensive and sustainable over time [7]. According to experts' opinion, indirect surveillance would also be accurate (except for superficial infections occurring post-discharge) in the presence of good-quality health databases [7]. There is also an algorithm-based surveillance that identifies potential infections through semi-automatic consultation of health databases, and subsequent targeted review of a minority of medical records has been accurate and sustainable [9].

The current study has several strengths. First, the definition of additional probable SSIs, which only applies to the post-discharge period, is based on criteria already defined in other studies and it uses representative data from well-established health databases [8]. Similarly, data from the laboratory and the emergency department databases appears to be specific and reliable [7]. Moreover, including only high-volume operating procedures, which are commonly performed in all health trusts, improves sample homogeneity and allows for comparison between health trusts. A weak point of the study is the retrospective method of the case review which did not enable confirmation or exclusion of SSI in seven out of 76 possible

Table I
Percentage distribution of possible cases of surgical site infections (SSIs) retrieved in four health trusts through health databases with specification of definition criteria and reclassification of diagnosis after revision (Emilia-Romagna region, 2017)

Definition criteria	Total (no.)	Reclassification of SSI diagnosis					
		Confirmed		Possible		Excluded	
		No.	%	No.	%	No.	%
Hospital readmission for SSI-related surgical procedure and/or diagnosis	25	20	80.0	1	4.0	4	16.0
Access to emergency department for SSI-related diagnosis	11	5	45.4	3	27.3	3	27.3
Positive bacterial culture of clinical sample from the surgical site plus any hospital readmission	28	10	35.7	1	3.6	17	60.7
Positive bacterial culture of clinical samples both from the surgical site and from blood	4	3	75.0	1	25.0	0	0.0
Combination of two or more previous criteria[a]	8	7	87.5	1	12.5	0	0.0
Total	76	45	59.2	7	9.2	24	31.6

[a] All cases included in this category had at least one hospital readmission after surgery.

infections (9%), retrieved through consultation of health databases. On the other hand, a prospective validation of the cases would be very expensive in terms of resources requiring a parallel evaluation for the entire duration of the follow-up. Another potential weakness concerns the data sources: if the proposed approach appears particularly useful considering the short hospital stay after surgery, it may not be sufficiently sensitive in the presence of superficial infections that do not require rehospitalization or when a microbiological test is not performed. This underestimation seems to be confirmed by the lower frequency of superficial infections (33%) among the new SSIs identified through the algorithm in the study compared to the proportion of superficial SSIs reported in SIChER (65%). On the other hand, it is important to note that most superficial SSIs tend to occur soon after surgery whereas the study algorithm only identifies later infections; in addition, superficial SSIs have a lower health burden due to the limited clinical impact compared to deep or organ/space SSIs. Moreover, while there is available evidence that supports the accuracy of indirect surveillance such as the one proposed in this study, there are no simple alternatives to put into practice [7—9]. Indeed, active surveillance for all patients undergoing surgery is not easy to implement and surveillance based on reports made directly by the patients has low accuracy; therefore, possible methods to increase its performance (e.g. specific tools that facilitate timely communication of any adverse effects to the surgical team) should still be validated.

In conclusion, the proposed approach appears to be sufficiently accurate and sustainable as it combines the strengths of SSI surveillance with adequate and low-cost post-discharge follow-up requiring the review of a limited number of potential SSI cases. Based on the study findings, the regional coordinators of the SIChER system, in agreement with the local representatives, decided to systematically carry out the interrogation of the health databases to identify infections not detected by SIChER and periodically to provide the health trusts with a list of possible infections to be reviewed locally. The following recommendations were also made to the health trusts:

- improve post-discharge follow-up in terms of duration and quality;
- make a timely review of the list of possible cases provided by the regional referents of the SIChER system in order to refute or confirm the presence of infection;
- identify the specific problems that, at the local level, have led to the underreporting;
- update the SIChER database with the new confirmed infections.

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Conflict of interest statement
None declared.

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