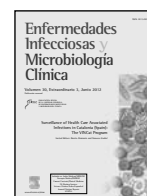




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Epidemiology of surgical site infections after total hip and knee joint replacement during 2007-2009: a report from the VINCat Program

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ABSTRACT

Keywords:

Surveillance
Surgical site infection
Prosthesis infection
Joint replacement

The VINCat Program is a system for epidemiological surveillance of healthcare-related infections in which the majority of Catalan hospitals participate. It has a specific module for surgical site infections (SSI) surveillance. Primary hip and knee arthroplasties are basic indicators of the program due to their high frequency and the important morbidity of SSI of these sites. Results are presented for surgical site infection (SSI) surveillance of primary hip and knee arthroplasties for the first three years of the VINCat Program.

The program requires SSI surveillance to be performed in a standardized, prospective and continuous manner by an infection control team from the centers. With primary arthroplasties, as with all procedures involving implants, the surveillance is maintained for 1 year after the intervention. The VINCat Program uses the SSI definitions of the Centers for Disease Control (CDC) and patients are stratified by surgical risk, following the classification of the National Healthcare Safety Network (NHSN).

During the period 2007-2009, 51 Catalan hospitals participated in the SSI surveillance of prosthetic orthopedic surgery. The overall SSI rate in the interventions for total primary hip prosthesis (7,804 procedures) was 3.0% (IC 95%: 2.6-3.4) and for total primary knee prosthesis (16,781 procedures) was 3.3% (IC95%: 3.0-3.6).

During the period 2007-2009, the overall SSI rates for total primary hip and knee arthroplasty were higher than those published by some surveillance systems in our environment. There were significant differences in the infection rates by procedure and in those adjusted by risk among the different hospitals.

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Vigilancia epidemiológica de la infección de localización quirúrgica tras artroplastia primaria de cadera y rodilla durante el período 2007-2009: informe del Programa VINCat

RESUMEN

Palabras clave:

Vigilancia epidemiológica
Infección de localización quirúrgica
Infección protésica
Recambio articular

El Programa VINCat es un sistema de vigilancia epidemiológica de las infecciones relacionadas con la atención sanitaria en el que participan la mayoría de los hospitales catalanes. El programa cuenta con un módulo específico para la vigilancia de las infecciones de localización quirúrgica (ILQ). Las artroplastias primarias de cadera y de rodilla son indicadores básicos del programa por su alta frecuencia y por la importante morbilidad que tienen las ILQ asociadas a estos procedimientos. En el presente artículo se presentan los resultados de la vigilancia epidemiológica de las infecciones de localización quirúrgica asociadas a las artroplastias primarias de cadera y de rodilla durante los primeros 3 años del Programa VINCat.

El programa exige a los centros que la vigilancia de la infección de localización quirúrgica se realice forma estandarizada, prospectiva y continuada por los equipos de control de las infecciones. Con las artroplastias primarias, al igual que sucede con el resto de los procedimientos que exigen la colocación de un implante, la vigilancia se prolonga durante un año desde la fecha de la intervención quirúrgica. El Programa VINCat

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utiliza las definiciones de ILQ del Center for Disease Control (CDC) y los pacientes se ajustan por riesgo siguiendo las directrices del National Healthcare Safety Network (NHSN).

Entre 2007 y 2009, 51 hospitales catalanes han participado en la vigilancia de las ILQ en la cirugía ortopédica protésica. La tasa global de ILQ en las intervenciones de prótesis total primaria de cadera (7.804 intervenciones) fue del 3% (IC del 95%: 2.6-3.4) y en las de prótesis total primaria de rodilla (16.781 intervenciones) fue del 3,3% (IC del 95%: 3-3,6).

En el periodo 2007-2009, la tasa global de ILQ en las artroplastias primarias de cadera y de rodilla fue algo más elevada que las publicadas por otros sistemas de vigilancia similares en nuestro entorno. Se han observado diferencias significativas en las tasas de infección por procedimiento y ajustadas por riesgo entre los distintos hospitales participantes.

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Introduction

Surgical site infections (SSI) are healthcare-related infections of particular importance due to their frequency, their morbidity and mortality, the high healthcare costs that they generate^{1,2} and because to a large extent they are preventable. SSI associated with knee and hip prosthetic orthopedic surgery are an important clinical problem because patients with prosthesis infections require prolonged antibiotic treatments, frequently require reintervention and it is occasionally necessary to remove and replace the prosthesis. This means that patients have very long hospital stays and periods of incapacity and/or of limitations of their quality of life³. For all of these reasons, SSI associated with prosthetic orthopedic surgery represents a considerable increase in our country's healthcare costs.

Epidemiological surveillance systems for hospital-acquired infections tend to include modules to monitor surgical site infections, making it possible to analyze the trends of the infections associated with each procedure, to compare the incidence of infections adjusted by surgical risk among hospitals with similar characteristics, and to prioritize and assess the effectiveness of the interventions designed to improve prevention of SSI. In relation to territorial surveillance systems, such as VINCat, the aggregate data helps healthcare planners to prioritize their interventions.

The VINCat Program⁴ was established in 2006 with the objective of epidemiological surveillance of hospital-acquired infections in the hospital network of Catalonia by means of various outcome and process indicators. In 2007 a standardized hospital-acquired infection surveillance system was introduced, to which 66 hospitals currently belong, the majority of them providing services to the national health system. The surveillance of SSI by the VINCat Program includes the surgical procedures with the greatest clinical importance, as defined by the frequency of the procedure or by the morbi-mortality of the infections associated with it.⁵ The surgical procedures in the SSI surveillance module of the VINCat Program are classified as basic procedures whose surveillance is highly recommended, and optional procedures in which the centers decide whether they want to participate. Total primary hip and knee arthroplasties are basic procedures and therefore almost all of the hospitals belonging to VINCat Program have participated in these two objectives. This article describes the epidemiology of surgical site infection associated with primary hip and knee arthroplasties in patients treated in the hospitals belonging to the VINCat Program in the period from 2007 to 2009.

Patients and Methods

Population and period of the study

Patients included in this study underwent primary elective surgery for total hip or knee arthroplasty in one of the hospitals belonging to the VINCat Program and those who were reported by their hospitals to the Coordinating Center following the guidelines in

the surveillance section. The criteria for inclusion were: scheduled elective surgery for first prosthetic replacement. The criteria for exclusion were: patients from centers in which less than 10 annual interventions were performed for this specific surgical procedure, and those from hospitals that could not guarantee prospective surveillance with effective monitoring of one year from the intervention. Patients undergoing these procedures and candidates for SSI surveillance are declared by the hospitals to the program after hospital discharge, using a web application. The period of study was from 1 January 2007 to 31 December 2009.

Participating centers

The VINCat Program requires the member hospitals to have an infection control team that can guarantee the active, prospective and standardized surveillance of the surgical procedures chosen. Fifty-one of the 68 centers that performed primary hip and knee arthroplasties in Catalonia during the period analyzed in this study participated in the SSI surveillance indicator.

The hospitals were stratified into 3 groups in accordance with their size: group 1: hospitals with more than 500 beds, group 2: from 200 to 500 beds and group 3: less than 200 beds.

Surveillance

The methodology used for SSI surveillance on the VINCat Program is described in the program manual⁵ and is the same as that used by the National Healthcare Safety Network (NHSN).⁶ The Centers for Disease Control (CDC) definitions of SSI⁷ were used and the procedures were stratified by surgical risk into the same categories (0 to 3) as in the NHSN.⁷ The SSI surveillance in primary knee and hip arthroplasties was carried out in a prospective and continuous manner. In the centers in which more than 100 interventions of each of the surgical procedures are performed, the hospital could choose between declaring 100 consecutive cases or performing continuous surveillance throughout the year. In the hospitals in which fewer than 100 interventions were performed per procedure, the program required all cases to be declared. For daily identification of the patients undergoing a certain surgical procedure, for their subsequent periodic monitoring, and to select the criteria that define a SSI, each infection control team used different systems adapted to the characteristics of the center and previously validated by the Program Coordinating Center (Table 1).

Results

Primary elective orthopedic prosthetic surgery

During the period 2007-2009, 51 Catalan hospitals participated in the surveillance of elective orthopedic surgery, monitoring 7804 total primary hip prosthesis and 16,781 total primary knee prosthesis patients.

Table 1
Surgical surveillance methodology of the VINCat Program

<i>In-hospital surveillance</i>
From the day of the intervention to hospital discharge: Active monitoring of the signs of SSI through a periodic visit (2-3 days), in the Hospitalization Unit where the patient is located and:
1. Review of the clinical progression from the doctors and nurses / oral information from doctors and nurses
2. Review of the patient's temperature curve
3. Review of antibiotic treatments
4. Review if surgical wound has been washed
5. Review of the microbiology cultures and complementary radiological examinations
6. Inspection of the wound when previous information is discordant or when it is insufficient to define or rule out surgical site infection
<i>Post-hospital discharge surveillance</i>
Covers a period of 12 months after a prosthetic implant was inserted. The post-discharge monitoring is mandatory and includes:
• Review of all readmissions (Mandatory)
• Review of all care in the Emergency Service (Mandatory)
• Review of outpatients' clinical progress from the surgical team (Mandatory)
• Review of the radiological examinations and microbiological cultures (Mandatory)
• Telephone control (Optional). Telephone control is considered for:
◦ Surgical procedures with very short average hospital stays (<5 days)
◦ Surgical procedures with implants that require surveillance of 12 months

Total hip prosthesis replacement

In terms of elective replacement of total hip prosthesis, the accumulated incidence of overall SSI was 3.0% (95% CI: 2.6-3.4). Most SSI were superficial. However, 72 (30.6%) were organ-space infections and the organ-space SSI rate was 0.9%. The general characteristics of the population and the annual infection rate trends over the period of study are shown in Table 2. Significant differences were not observed in the demographic variables, or in the surgical risk factors in the period analyzed. Approximately 73% of the infections were early, detected before day 30 after the surgical intervention. Table 3 shows the SSI rates on a percentile basis and adjusted according to the risk index of the National Nosocomial Infection Surveillance System (NISS). Table 4 shows the SSI rates by groups of hospitals. The SSI rates were lower in the hospitals from group 3 (<200 beds), although the variability of SSI rates in the 49 hospitals overall (Fig. 1) and within the hospital groups was also very broad (Fig. 2).

A microbiological diagnosis was obtained in 76% of the patients with the hip SSI criteria and more than one microorganism was reported in 23% of these. The most commonly identified microorganisms were: *Staphylococcus aureus* 34.2% (16.3% were MRSA), coagulase negative staphylococci 33.7%, and gram negative

Table 2
Total hip replacement. Characteristics of the included procedures and mean surgical site infections rate (VINCat Program 2007-2009)

	2007 41 hospitals	2008 43 hospitals	2009 49 hospitals	Total
No. of interventions	2,057	2,618	3,129	7,804
Age, years (SD)	68 (12)	68 (12)	68 (12)	68 (12)
Gender, M/F (%)	49/51	50/50	48/52	49/51
Adequate prophylaxis (%)	93	94	93	93
Mean duration, min. (SD)	106 (80)	103 (36)	101 (44)	103 (54)
ASA score >1 (%)	25	25	22	24
NNISS ≥1 (%)	44	43	40	42
SSI (%)	2.4	3.7	2.9	3.0
Early (<30 days) (%)	73	72	76	73.5

SD: standard deviation; M/F: male/female; ASA: American Society of Anesthetists; NNISS: National Nosocomial Infection Surveillance System; SSI: surgical site infections.

bacilli (GNB) 29.2% (*E. coli* and *Pseudomonas aeruginosa* were the most commonly GNB identified in this surgical site).

Total knee prosthesis replacement

In terms of elective replacement of total knee prosthesis, the overall SSI rate was 3.3% (95% CI: 3.0-3.6), slightly higher than the incidence of SSI observed in hip prosthesis. The percentage of organ-space infections was 34% and the organ-space SSI rate was 1.1%. The general characteristics of the population and the infection rate trends over the whole period of study are shown in Table 5. As in the case

Table 4
Total hip replacement. Mean and percentiles of surgical site infections by groups of hospitals (VINCat Program 2007-2009)

	Total VINCat	Group 1 >500 beds	Group 2 200-500 beds	Group 3 <200 beds
No. hospitals	49	9	14	26
No. interventions	7,804	1,872	2,999	2,933
Mean				
(by hospitals)	2.8%	3.3%	3.3%	2.3%
Percentiles				
(by hospitals)				
10%	0.6	0.6	1.1	0.0
25%	1.4	1.3	1.5	1.0
50% (median)	2.2	2.3	1.6	2.1
75%	3.9	5.9	2.9	3.6
90%	6.2	7.7	4.4	4.6

Table 3
Total hip replacement. Mean and distribution of surgical site infections rates for percentiles (VINCat Program 2007-2009)

Percentile									
NNISS surgical risk	No. hospitals	No. interventions	Total SSI	Mean SSI (%)	10%	25%	50% (Median)	75%	90%
0	47	4,460	103	2.3	0.0	0.0	2.0	3.3	5.9
1	49	2,803	94	3.4	0.0	0.0	2.9	4.6	7.8
2	45	480	34	7.1	0.0	0.0	0.0	8.3	20.0

NNISS: National Nosocomial Infection Surveillance System; SSI: surgical site infections.

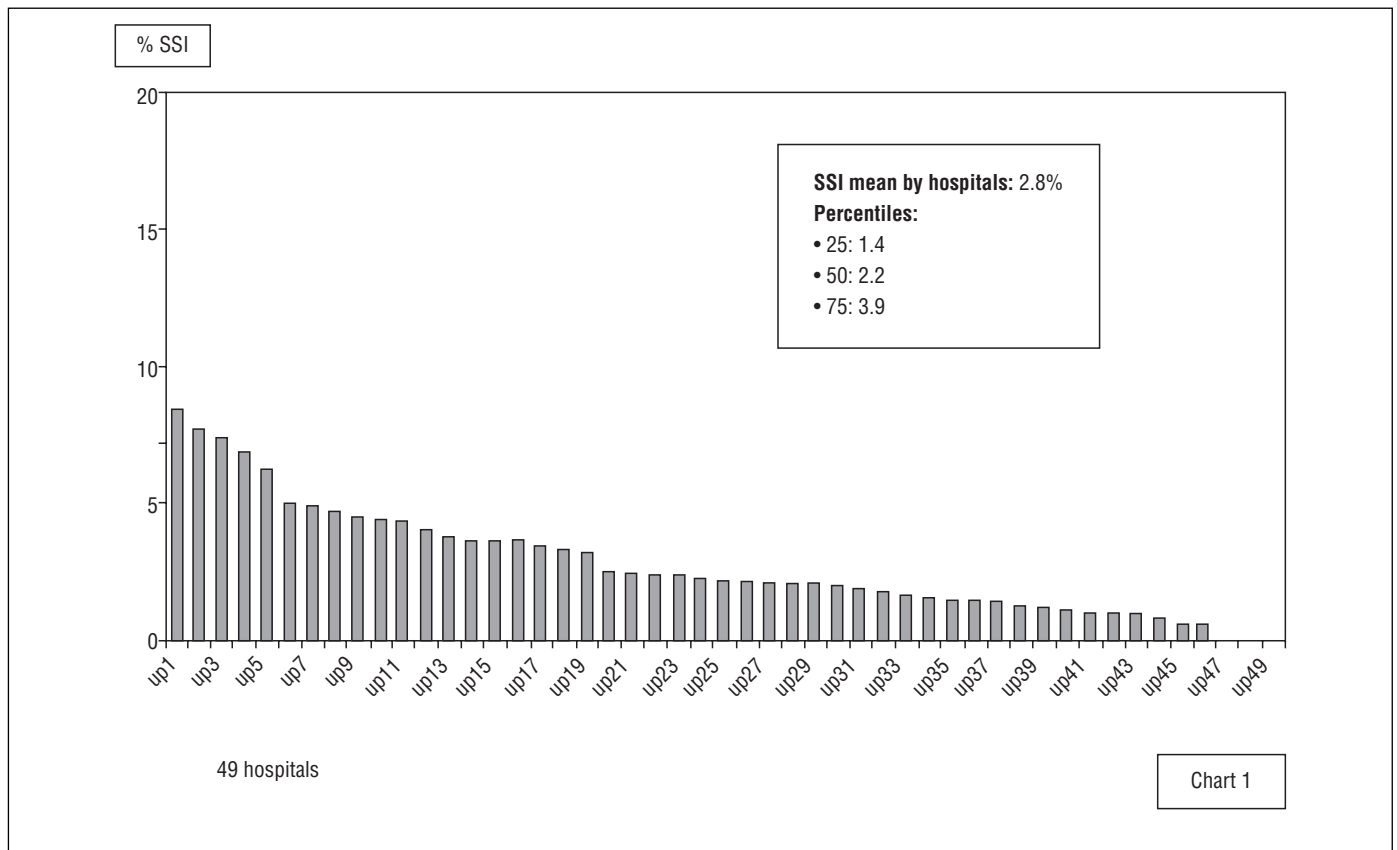


Figure 1. SSI rates in total hip replacement (2007-2009).

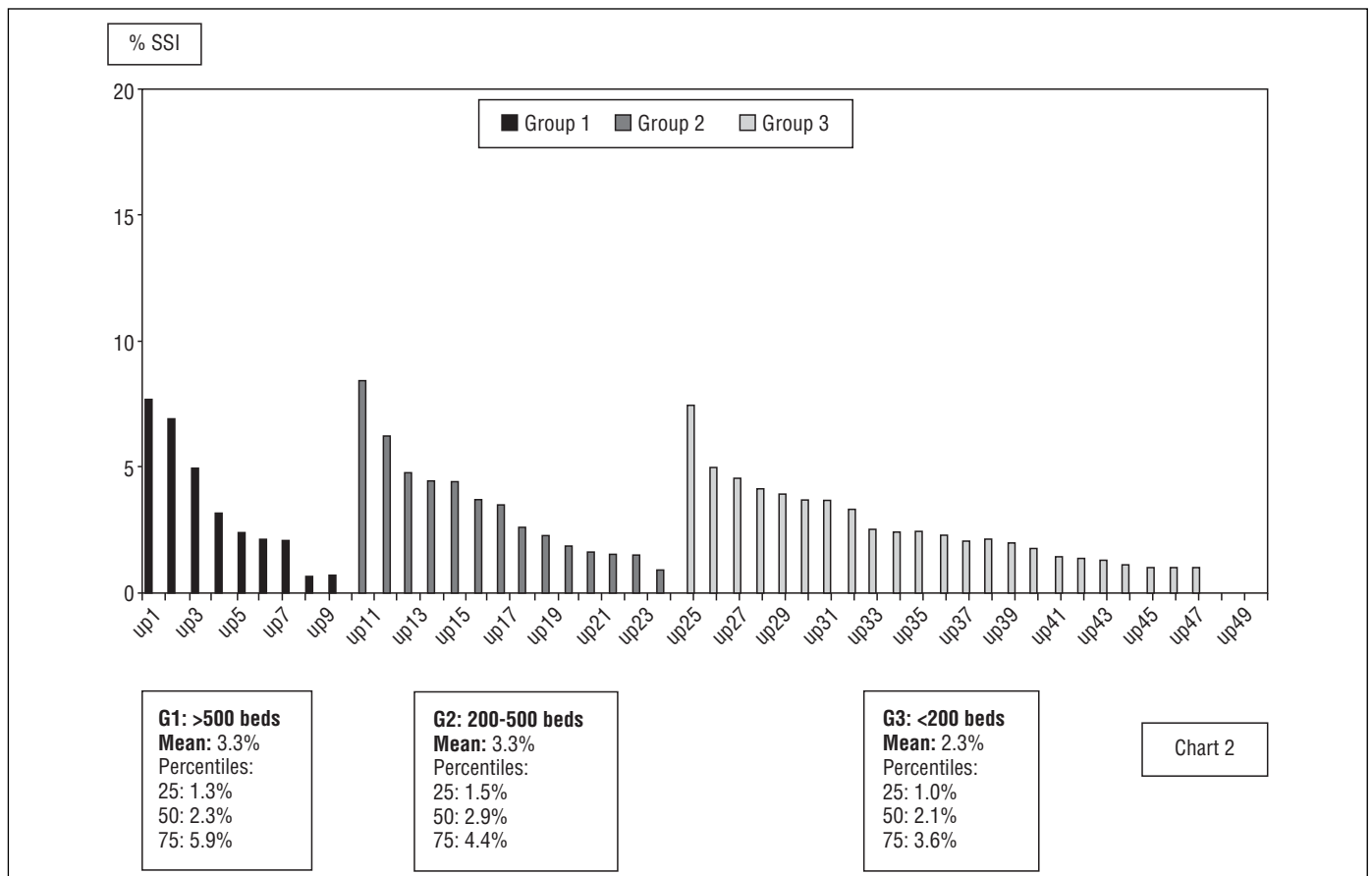


Figure 2. SSI rates in total hip replacement (2007-2009).

Table 5

Total knee replacement. Characteristics of the included procedures and mean surgical site infections rate (VINCat Program 2007-2009)

	2007 40 hospitals	2008 46 hospitals	2009 51 hospitals	Total
No. of interventions	4,541	5,732	6,508	16,781
Age, years (SD)	72 (7)	72 (8)	72(8)	72 (8)
Gender, M/F (%)	28/72	29/71	29/71	29/71
Adequate prophylaxis (%)	93	95	94	94
Mean duration, min. (SD)	103 (74)	101 (38)	99 (41)	100 (52)
ASA score >1 (%)	23	25	23	23
NNISS ≥ 1 (%)	40	41	36	39
SSI (%)	3.5	3.1	3.4	3.3
Early (<30 days) (%)	54	61	55	57

SD: standard deviation; M/F: male/female; ASA: American Society of Anesthetists; NNISS: National Nosocomial Infection Surveillance System; SSI: surgical site infections.

of primary hip arthroplasties, significant differences were not observed in demographic characteristics, or in surgical risk. Fifty-seven per cent of the infections were early, detected in the first 30 days after the intervention. Table 6 shows the SSI rates on a percentile basis and adjusted according to the surgical risk index of the NNIS. Table 7 shows the SSI rates by groups of hospitals. Unlike the data observed for hip prosthesis, the SSI rates were lower in the group 1 hospitals (>500 beds), although the variability of SSI rates in the 51 hospitals overall (Fig. 3) and within each of the hospital groups was also very broad (Fig. 4).

Etiology of the infection was documented in 67.7% of patients with a knee SSI, and more than one microorganism was isolated in 20.1% of cases. Coagulase negative staphylococci were the most frequently reported microorganisms in 39.8% of cases with microbiologic diagnosis, followed by *Staphylococcus aureus* in 38.7% (22.3% were MRSA). Gram negative bacilli were identified in 28.9% of cases and *Enterobacter*, *Pseudomonas aeruginosa* and *E. coli* were the predominant GNB.

Discussion

This article presents the results of the first 3 years of surveillance of surgical site infections of the VINCat Program for two surgical procedures of great healthcare importance: total primary hip and knee arthroplasties. Currently 75% of all Catalan hospitals in which prosthetic orthopedic surgery interventions are performed and practically all those that belong to the public healthcare network report their results to the VINCat Program.

The validity of the data is one of the greatest concerns in a system of epidemiological surveillance of hospital-acquired infections and most particularly in a system such as ours, in which many centers and many observers are involved. Since it began, the program has

Table 7

Total knee replacement. Mean and percentiles of surgical site infections by groups of hospitals (VINCat Program 2007-2009)

	Total VINCat	Group 1 >500 beds	Group 2 200-500 beds	Group 3 <200 beds
No. hospitals	51	9	15	27
No. interventions	16,781	3,245	6,225	7,311
Mean (by hospitals)	3.4%	3.0%	3.6%	3.4%
Percentiles (by hospitals)				
10%	1.2	1	1.1	1.1
25%	1.7	2	1.6	1.7
50% (median)	3.0	2.9	2.5	3.1
75%	4.1	3.8	5.9	4.1
90%	7.3	6	7.5	8.8

made a huge effort to train infection control professionals from all of the participating centers. Periodic training workshops have been held with the aim of homogenizing the surveillance system, the application of inclusion and exclusion criteria, uniform use of the SSI diagnostic criteria of the CDC and to guarantee precise post-discharge surveillance (see table 1). With the same aim, the Coordinating Center has drafted and updated the program manual (5) and has made it available to professionals on the program website.⁴

The rates for surgical site infection associated with hip and knee arthroplasties published in the literature vary greatly and range from 0.6% to 7% (1.8-13), although the majority of the surveillance systems from our environment with similar methodologies to ours have published rates below 3%.¹⁵

There are few studies that assess the sensitivity and specificity of the infection control professionals to detect SSI.¹⁶ To date specific studies have not been carried out on the VINCat Program to assess the validity of the SSI surveillance data for prosthetic orthopedic surgery, but the fact that the demographic characteristics of the patients, the SSI rates observed in each center, the overall aggregate rates and the rates by groups of hospitals were stable throughout these three years suggests that the data are consistent. The centers with results below the 25th percentile and above the 75th percentile have moreover been specifically notified to review their case search methodology, their application of diagnostic criteria and their post-discharge surveillance systematics.

There are some methodological differences between the SSI surveillance systems of the various countries that may explain, in part, the fact that the rates are somewhat higher than those published by other systems. VINCat is a surveillance program promoted by the Health Department of the Catalan government and there is a discrete economic penalty for public hospitals that do not join it. This is perhaps why almost all public hospitals participated. It is therefore

Table 6

Total knee replacement. Mean and distribution of surgical site infections rates for percentiles (VINCat Program 2007-2009)

NNISS surgical risk	No. hospitals	No. interventions	Total SSI	Mean SSI (%)	Percentile (by hospitals)				
					10%	25%	50% (Median)	75%	90%
0	51	10,081	279	2.8	0.60	1.4	2.2	3.8	7.5
1	51	5,758	235	4.1	0.0	2.0	3.2	5.4	8.1
2	51	822	42	5.1	0.0	0.0	0.0	6.7	14.4

NNISS: National Nosocomial Infection Surveillance System; SSI: surgical site infections.

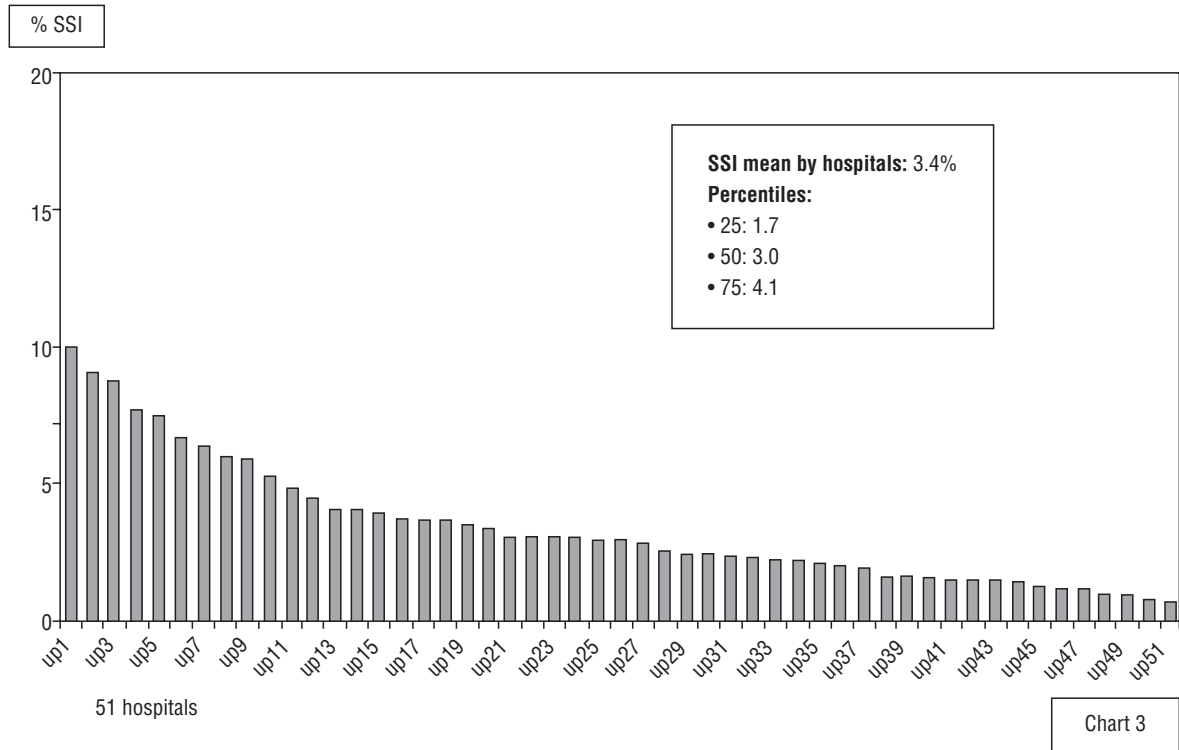


Figure 3. SSI rates in total knee replacement (2007-2009).

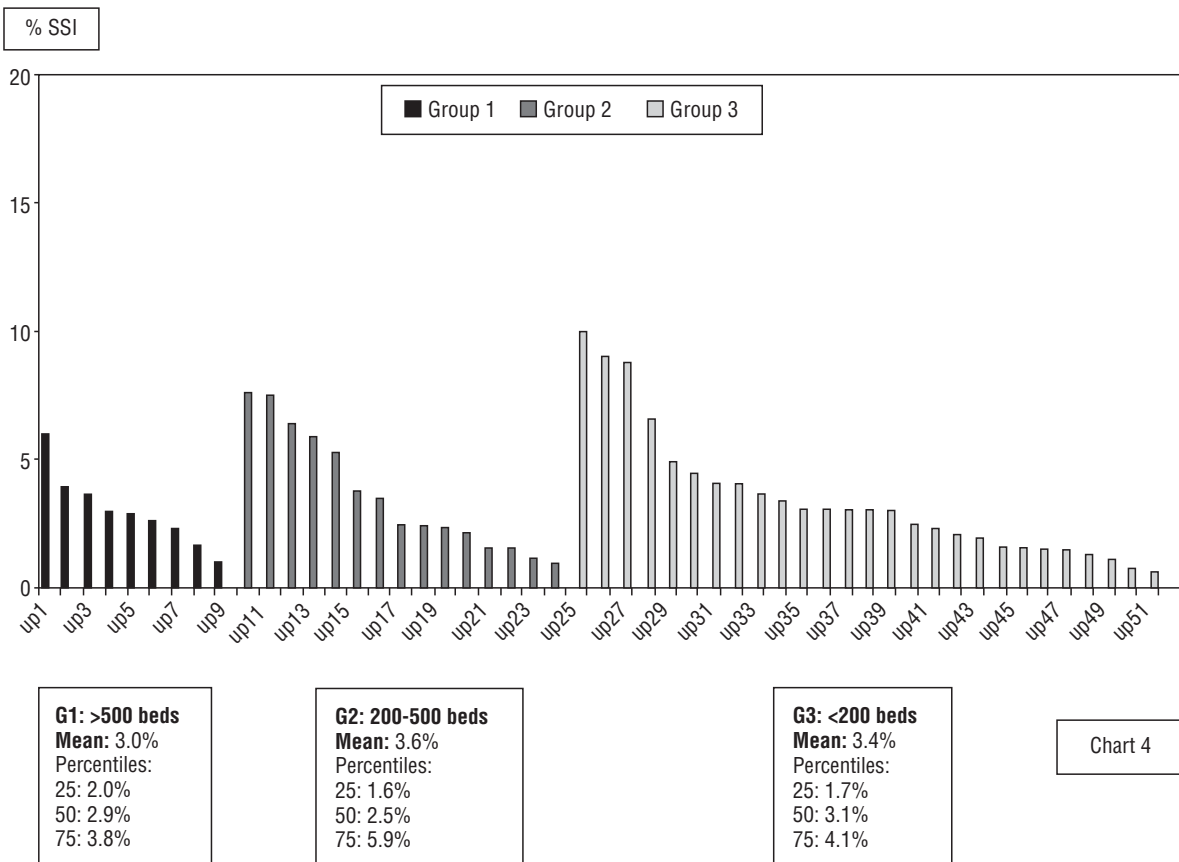


Figure 4. SSI rates in total knee replacement (2007-2009).

likely that the type of population included is more similar to that reported by mandatory surveillance systems such as the English Surgical Site Infection Surveillance System (SSISS),¹⁴ than to those in which participation is voluntary, such as the Dutch PREventie ZIEkenhuisinfecties door Surveillance (PREZIES)¹⁷ or the American National Healthcare Safety Network (NHSN). It is well known that the hospitals participating in the NHSN are not a representative sample of American hospitals and that their data could therefore suffer from selection bias. Moreover, in surveillance systems such as the SSISS they only have to report compulsorily the patients intervened during one quarter a year.¹⁴ This reduction in the number of patients assessed per hospital may have resulted in a more imprecise sample. With VINCAt, the majority of hospitals participating in the SSI surveillance for prosthetic orthopedic surgery chose to perform active surveillance of all of the cases throughout the year.

Some surveillance systems have published data that do not include all participating hospitals,¹⁰ and in others the SSI surveillance for prosthetic surgery was limited to 120 days¹ instead of one year. All of these differences hinder comparison of the rates among the surveillance systems of the different countries.

Until relatively recently, the majority of surveillance systems did not include post-discharge surveillance, so their rates showed a systematic underestimation of SSI. It is now well known that the percentage of SSI diagnosed after discharge is increasingly high (9-10,18-20); however there are systems such as the SSISS that do not require their centers to perform active SSI surveillance after discharges.¹⁴ The fact that there is no consensus on the most precise methodology used to perform post-discharge surveillance means that we observe methodological variability not just among the different surveillance systems, but also among the different centers within the same system. The VINCAt Program has undertaken a considerable training effort to ensure that post-discharge surveillance is active, structured and homogeneous in all centers (see table 1), which may help to explain these results.

As with other national systems,^{14,19} the variability of the rates among the different hospitals belonging to the VINCAt Program was very important (see tables 1 and 3). When the centers have typical rates above the 75th percentile they are informed and invited to analyze possible causes and to establish improvement measures. With the hospitals that usually have rates below the 25th percentile and particularly when they are lower than those of the literature, the Coordinating Center suggests that they review the procedure to search for cases, to apply the SSI diagnostic criteria and the effectiveness of the post-discharge surveillance.

Since the Study on the Efficacy of Nosocomial Infection Control (SENIC) study, it has been known that hospitals that perform systematic SSI surveillance and that circulate their results have better SSI rates.²⁰ Knowing one's own rates and comparing them with those of hospitals with a similar size and complexity should represent a stimulus for the introduction of new prevention measures. During the study period it was not possible to observe an improvement in the aggregate rates, but several hospitals have introduced individual improvement programs and have obtained highly satisfactory results. The high variability in the rates among hospitals makes it difficult to carry out multi-center intervention programs that can be useful for hospitals with such different situations. However, the fact that several institutions have implemented plans adapted to their needs and that these adaptations have been effective represents an additional stimulus for the generalization of these practices, which should be reflected in future improvements in the overall results of the program.

In summary, there are various possible reasons for the disparity of results obtained by the VINCAt Program in relation to the results of other surgical infection surveillance programs. Detailed knowledge of the infection rates will make it possible to introduce

prevention strategies and to reduce the incidence of this important complication.

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Conflicts of Interest

All authors declare that they have no conflicts of interest in this article.

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