Official Journal of the Brazilian Association of Infection Control and Hospital Epidemiology

Journal of INFECTION CONTROL

ISSN 2316-5324 | Ano VIII . Volume 8 . Número 3 . Jul/Set . 2019

> ACESSE AQUI A REVISTA ONLINE

ARTIGO ORIGINAL

Combined impact of multiple interventions on trends of incidence of surgical site infections in a teaching hospital: a joinpoint regression analysis

Impacto combinado de múltiplas intervenções nas tendências de incidência de infecções do sítio cirúrgico em um hospital de ensino: uma análise de regressão de ponto de junção

Impacto combinado de múltiples intervenciones sobre las tendencias de incidencia de infecciones del sitio quirúrgico en un hospital universitario: un análisis de regresión de punto de unión

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Recebido em: *22/07/2019*
Aceito em: *02/08/2019*
Disponível online: *30/12/2019*

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ABSTRACT

Background*:** The burden of surgical site infections (SSI) in Brazilian hospitals is high. Both international and local guidelines from governmental agencies advise preventive interventions against SSI. ***Objective: To measure the combined impact of successive interventions applied in a teaching hospital on the time trends of SSI rates. ***Methods*:** Prospective surveillance (both in-hospital and post-discharge) of SSI was performed. A time series of monthly overall SSI rates was obtained for the period from January 2011 through December 2016. During that period, successive interventions, including rules for preoperative care (e.g. hair removal) and intra-operative procedures (e.g., antimicrobial prophylaxis) where implemented. Joinpoint regression analysis was performed on that time series, in order to identify both significant linear trends and trend changes (joinpoints). ***Results*:** Overall SSI rate for the study period was 8,5%. Monthly states were stable from January 2011 through April 2013 (trend analysis, beta=0.04; p=0.53). In May/2013 there was a joinpoint (p=0.03) and from that month on a significant trend towards reduction (beta= -0.08; p<0.001). Coherently, yearly rates reduced from 9.9% (in 2011) to 6.9% (in 2016; p<0.001). ***Discussion*:** Time series analysis with Joinpoint Regression models was a useful tool for identifying the combined impact of several preventive measures on the incidence of SSI.

Key-words: *Heatlhcare-associated infections; Epidemiology; Surgical Site Infections.*

RESUMO

Justificativa: A carga de infecções do sítio cirúrgico (ISC) nos hospitais brasileiros é alta. As diretrizes internacionais e locais das agências governamentais aconselham intervenções preventivas contra a ISC. **Objetivo:** Medir o impacto combinado de intervenções sucessivas aplicadas em um hospital de ensino nas tendências temporais das taxas de ISC. **Métodos:**

Foi realizada vigilância prospectiva (tanto hospitalar como pós-alta) de ISC. Uma série temporal de taxas mensais globais de ISC foi obtida para o período de janeiro de 2011 a dezembro de 2016. Durante esse período, intervenções sucessivas, incluindo regras para cuidados pré-operatórios (por exemplo, depilação) e procedimentos intra-operatórios (por exemplo, profilaxia antimicrobiana) foram implementadas . A análise de regressão do ponto de junção foi realizada nessa série temporal, a fim de identificar tendências lineares significativas e mudanças de tendência (pontos de junção). **Resultados:** A taxa geral de SSI para o período do estudo foi de 8,5%. Os estados mensais ficaram estáveis de janeiro de 2011 a abril de 2013 (análise de tendência, beta = 0,04; p = 0,53). Em maio / 2013 houve um ponto de junção (p = 0,03) e a partir desse mês houve uma tendência significativa de redução (beta = -0,08; p <0,001). De forma coerente, as taxas anuais reduziram de 9,9% (em 2011) para 6,9% (em 2016; p <0,001). **Discussão:** A análise de séries temporais com os modelos de regressão do Joinpoint foi uma ferramenta útil para identificar o impacto combinado de várias medidas preventivas na incidência de ISC.

Palavras-chave: *Infecções associadas ao tratamento térmico; Epidemiologia; Infecções do Local Cirúrgico.*

RESUMEN

Antecedentes: la carga de las infecciones del sitio quirúrgico (ISQ) en los hospitales brasileños es alta. Las pautas internacionales y locales de agencias gubernamentales aconsejan intervenciones preventivas contra SSI. Objetivo: medir el impacto combinado de las sucesivas intervenciones aplicadas en un hospital universitario sobre las tendencias temporales de las tasas de SSI. **Métodos:** se realizó una vigilancia prospectiva (tanto en el hospital como después del alta) de SSI. Se obtuvo una serie temporal de tasas mensuales generales de SSI para el período comprendido entre enero de 2011 y diciembre de 2016. Durante ese período, se implementaron intervenciones sucesivas, incluidas las reglas para la atención preoperatoria (por ejemplo, depilación) y los procedimientos intraoperatorios (por ejemplo, profilaxis antimicrobiana). El análisis de regresión de punto de unión se realizó en esa serie de tiempo, para identificar tendencias lineales significativas y cambios de tendencia (puntos de unión). **Resultados:** La tasa general de SSI para el período de estudio fue del 8,5%. Los estados mensuales se mantuvieron estables desde enero de 2011 hasta abril de 2013 (análisis de tendencias, beta = 0.04; p = 0.53). En mayo / 2013 hubo un punto de unión (p = 0.03) y desde ese mes una tendencia significativa hacia la reducción (beta = -0.08; p <0.001). Coherentemente, las tasas anuales se redujeron de 9.9% (en 2011) a 6.9% (en 2016; p <0.001). **Discusión:** El análisis de series de tiempo con modelos de regresión Joinpoint fue una herramienta útil para identificar el impacto combinado de varias medidas preventivas sobre la incidencia de ISQ.

Palabras clave: *infecciones asociadas al cuidado del calor; Epidemiología; Infecciones del sitio quirúrgico.*

INTRODUCTION

Surgical site infections (SSI) are a major threat for patients worldwide.[1] A systematic review conducted by the World Health Organization found that their incidence is even greater in low-to-middle income countries.[2] Coherently, studies conducted in Brazil identified a high burden of SSI[3,4], even in small hospitals.[5]

In São Paulo State, the Center for Health Surveillance (Centro de Vigilância Epidemiológica) issued in 2007 a Program for Prevention and Control of SSI (PROVITAE; http://www.saude.sp.gov.br/cve-centro-de-vigilancia--epidemiologica-prof.-alexandre-vranjac/areas-de-vigilancia/infeccao-hospitalar/projeto-provitae). That program included guidelines and quality standards for perioperative care. Those guidelines were highly similar to current international recommendations.[6,7]

Improvement in quality of care (including infection control) in healthcare settings is often a gradual process.[8] Therefore, time series analysis is an attractive option for measuring the impact of those interventions.[9] The present study aimed at analyzing the impact of multiple, successive preventive interventions on the time trends of SSI in a teaching hospital.

METHODS

Setting

The study as conducted in a teaching hospital in inner São Paulo State. The hospital has 450 beds and provides tertiary care for an area comprising about one million inhabitants. The Infection Control Committee performs prospective surveillance of SSI, both in-hospital and post-discharge, since 2010. Post-discharge surveillance is based on telephone calls on the 15^{th} and 30^{th} days after the surgical procedure.[10]

Interventions

During the period from 2010 through 2016, following PROVITAE and international guidelines, the following measures were reinforced: (1) minimize hair removal and perform it immediately before surgery; (2) timely administration of antimicrobial prophylaxis and repetition of doses whenever necessary; (3) control of staff moving through operating rooms; (4) educational meetings with surgeons, with feedback of SSI rates.

Database

Each and every surgical procedure is registered in a Database in the software EPI INFO 7 (Centers for Diseases Control and Prevention, Atlanta, GA, USA). That software also allows us to calculate monthly SSI rates. For this study, monthly overall numerators and denominators were obtained in that Database for a time series for the period from January 2011 through December 2016.

Statistical analysis

The time series was submitted to Joinpoint Regression Analysis (software Joinpoint 4.6, National Cancer Institute, Galveston, USA). As an alternative analysis, we also compared each yearly aggregate SSI rate with data for the first year (2011), using a Poisson Regression model in the software NCSS9 (LLC, Kaysville, UT, USA).

RESULTS

The overall SSI rate for the period was 8.5%. **Table 1** presents the yearly rates, with statistical comparison with the first year of the study (2011). We notice that, while there is marginal significance for 2014, there was significant reduction in yearly rates in 2015 and 2016. Most noticeably, the SSI rate in the last year was 6.8%, compared to 9.9% in 2011 (p<0.001).

Monthly rates (altogether with yearly average rates) are presented in figure 1. Figure 2 presents the Joinpoint Analysis of time trends. Briefly, rates were stable from January 2011 through April 2013 (beta=0.03; p=0.53). There was a trend change in May/2013 (p=0.03 in Joinpoint Regression). After that month, we found a continuous linear trend towards reduction of rates (beta= 00,08; p<0.001).

Table 1. Yearly aggregate rates of SSI in the study hospital.

Year	SSI rate	IRR (95%CI)	p
2011	9.9%	Reference	Reference
2012	8.9%	0.89 (78-1.02)	0.10
2013	10.3%	1.01 (0.90-1.15)	0.83
2014	8.8%	0.89 (0.78-1.00)	0.058
2015	7.5%	0.75 (0.66-0.86)	<0.001
2016	6.8%	0.69 (0.60-0.79)	<0.001

Note. Poisson Regression Analysis was performed, with 211 rates as reference. Statistically significant results (p<0.05) are presented in boldface. Notice that results for year 2014 were marginally significant.
SSI, Surgical site infections; IRR, Incidence Rate Ratio; CI, Confidence Interval.
ggregate rates of SSI in the study hospital.

DISCUSSION

Three aspects in our results are noteworthy. The first is refers to the SSI rates, which are considerably higher than those usually reported. In part, those rates were due to post-discharge surveillance.[11-13] In our hospital, approximately two thirds of infections are detected by telephone call during the month immediately after the surgical procedure.[10] Since this strategy was performed from the very beginning of the time series analyzed in this study, we can reliably say that our results were not due to any surveillance bias.

The second relevant aspect regards studies comparing rates "before-and-after" interventions (which are a subset of the "quasi-experimental" designs).[14] The usual procedure adopted by researchers is to compare baseline rates with those achieved after the interventions. This approach is at best suboptimal, and often truly misleading.[15] Let us give a brief example, in which

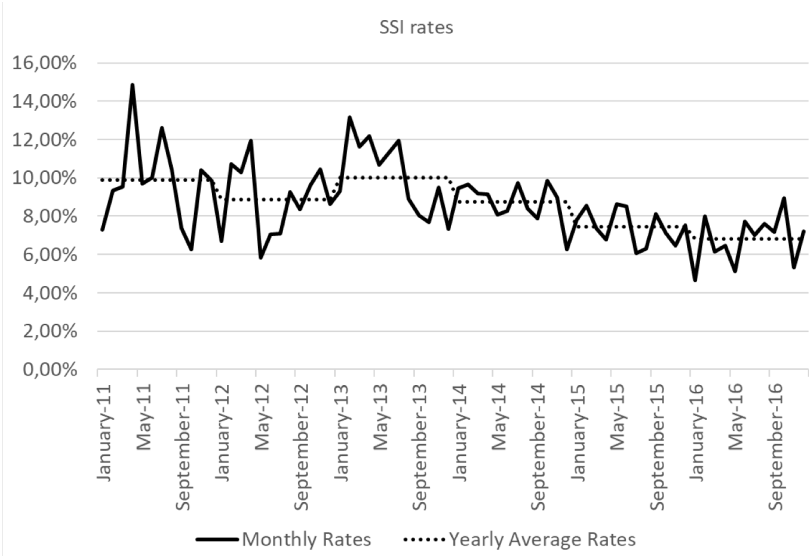

Figure 1. Monthly and yearly average rates of SSI in the Study Hospital.

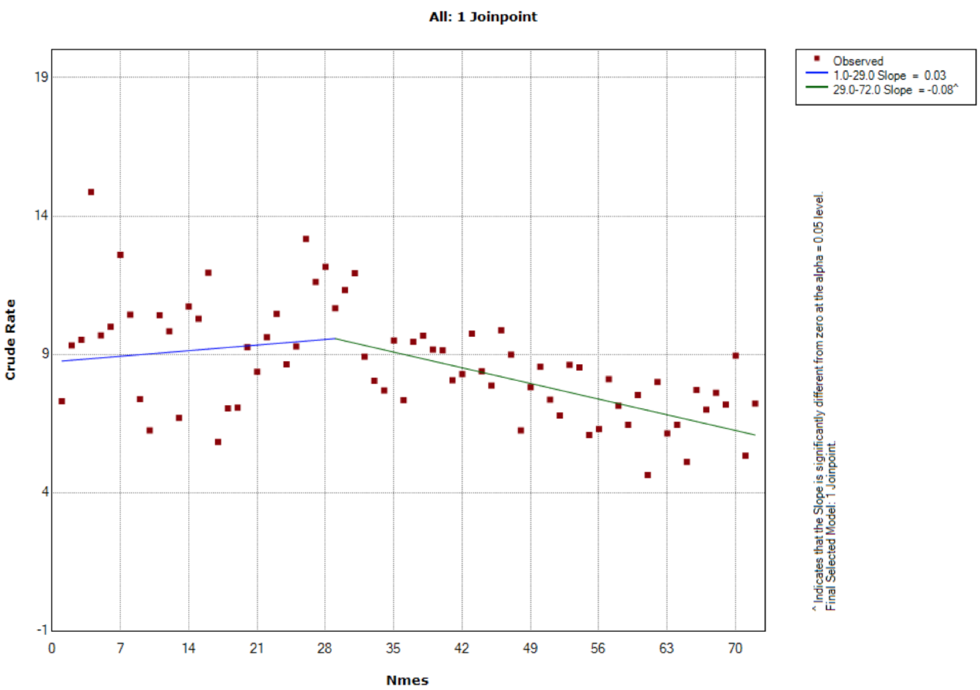

Figure 2. Joinpoint Regression analysis graphic for SSI rates in the Study Hospital.
Notice the joinpoint (trend change) at month 29 (May 2013), and significant reduction trend afterwards.

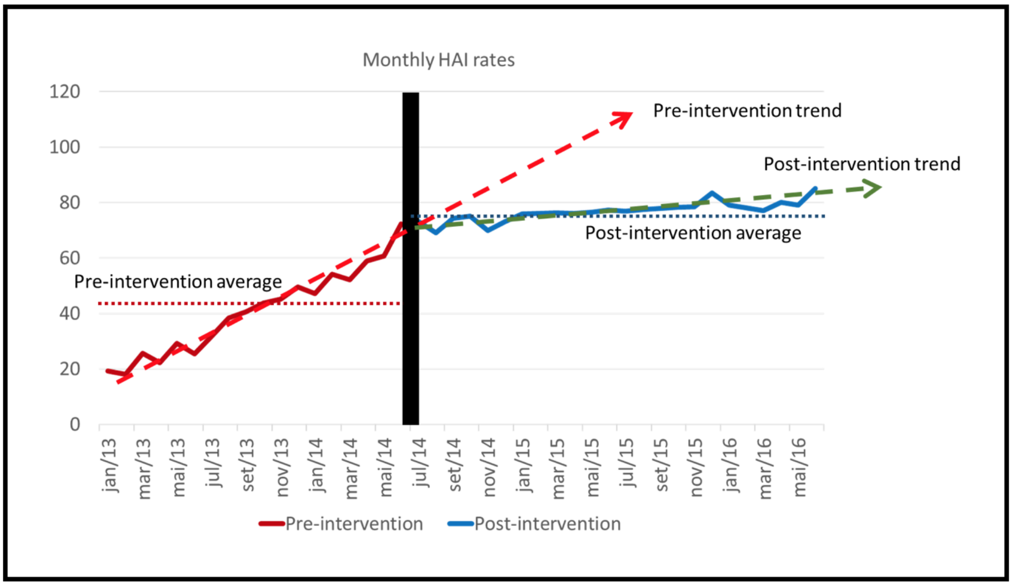

Figure 3. A hypothetical result of a hand-hygiene campaign over healthcare-associated infection rates, in a before-and-after (quasi-experimental study).

an intervention (e.g., a hand hygiene campaign) does lower nor stop the increasing incidence of healthcare-association infections. In this same example, let us imagine that the increase is slower after the intervention. Thus, post-intervention rates will be higher than baseline (pre-intervention), but we can still say that the impact was good. Figure 3 represents graphically this example. The optimal approach to "before-and-after" studies is the Interrupted Time Series Design (ITS), which detects changes in time trends after point interventions.[16] That design has been increasingly used in healthcare epidemiology.[17,18]

Intervention is represented by the black vertical bar. Notice that, even though post-intervention average rates are higher, there was an impact in slowing the increasing trend in incidence. Therefore, time series analysis is more adequate to identify the impact than comparison of "before-and-after" rates.

Unfortunately, since our interventions were multiple and implemented, we could not identify a "turning point" to work in ITS models. Our alternative was to use the Joinpoint Regression analysis, a multivariable strategy that detects both the statistical significance of time trends and abrupt changes in those trends.[19-21]

Overall, we found that increasing efforts – including education, normative interventions and prospective feedback to surgical teams – resulted ultimately in a change of SSI trends towards reduction. From our perspective, this is an argument for insisting in infection control policies, even when their results cannot be detected in short-term horizons. Also, our results emphasize the importance of including time series analysis in the everyday healthcare epidemiology.

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