Effect of a Plan for Quality Improvement and Clinical Safety in the incidence of surgical site infections in appendectomy. A quasi-experimental study

Efecto de un Plan de Mejora de Calidad y Seguridad Clínica en la incidencia de infección de sitio quirúrgico en apendicectomía. Estudio cuasi-experimental

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Abstract

Objective: *Surgical site infections can be prevented. Control programs based on care bundle have proven to be effective in reducing its incidence. The objective of this study was to assess the effectiveness of a Plan for Quality Improvement and Clinical Safety in preventing the incidence of surgical site infection in patients undergoing appendectomy.* **Method:** *A quasi-experimental study was designed for analysis before and after the introduction of a Plan for Quality and Clinical Safety. Patients undergoing appendectomy were included. The incidence of surgical site infection was studied within 30 days from the time of surgery (maximum incubation period of surgical site infection). The effectiveness of the intervention was evaluated using the odds ratio (OR) adjusted with a logistic regression model.* **Results:** *A total of 606 patients were included, of which 267 were operated in the period 2009-2010 (before the plan) and 339 in 2012-2013 (after the plan). The incidence of surgical site infection decreased after the plan from 6 to 5.6% (OR: 0.72; 95% confidence interval: 0.33-1.56; p = 0.839). There was greater compliance of antibiotic prophylaxis, preoperative preparation and adherence to hand hygiene after the introduction of the measures.* **Conclusions:** *Although the reduction in the incidence of surgical site infection after the measures adopted did not show statistical significant differences, important progress has been made in the compliance of antibiotic prophylaxis, adherence to hand hygiene and in the preoperative preparation.*

KEY WORDS: *Appendectomy. Surgical wound infection. Patient care bundle. Antibiotic prophylaxis. Preoperative preparation. Hand hygiene.*

Resumen

Objetivo: *Las infecciones de sitio quirúrgico se pueden evitar y los programas de control basados en paquetes de medidas preventivas son eficaces para reducir su incidencia. El objetivo de este estudio fue evaluar el efecto de un Plan de Mejora de Calidad y Seguridad Clínica del paciente intervenido de apendicectomía en la incidencia de infección del sitio quirúrgico.* **Método:** *Se realizó un estudio cuasi-experimental con análisis antes y después de la introducción de un Plan de Calidad y Seguridad Clínica. Se incluyeron pacientes intervenidos de apendicectomía. Se estudió la incidencia de infección del sitio quirúrgico durante los 30 días posteriores a la cirugía (periodo máximo de incubación de infección quirúrgica). Se evaluó el efecto de la intervención con la odds ratio (OR) ajustada con un modelo de regresión logística.* **Resultados:** *Se incluyeron*

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606 pacientes, 267 en el periodo 2009-2010 (antes del plan) y 339 durante 2012-2013 (después del plan). La incidencia de infección del sitio quirúrgico descendió después del plan del 6 al 5.6% (OR: 0.72; intervalo de confianza del 95%: 0.33-1.56; p = 0.839). Hubo mayor cumplimiento de la profilaxis antibiótica, de la preparación prequirúrgica y de la adherencia a la higiene de manos tras la introducción de las medidas. **Conclusiones:** *Aunque la reducción de la incidencia de infección del sitio quirúrgico no presentó diferencias estadísticamente significativas tras las medidas adoptadas, se ha conseguido mejorar la administración de la profilaxis antibiótica, la adherencia a la higiene de manos y la preparación prequirúrgica.*

PALABRAS CLAVE: *Apendicectomía. Infección de sitio quirúrgico. Paquete de medidas. Profilaxis antibiótica. Preparación prequirúrgica. Higiene de manos.*

Introduction

Nosocomial infections are the most common complication during patient hospitalization. It has been estimated that 5% of patients admitted to a hospital acquire a nosocomial infection[1], and that one third or more of these infections could be prevented through different surveillance and control strategies[2]. Prevention of these infections is cheaper than their subsequent treatment[3].

Surgical site infection (SSI), according to the US Centers for Disease Control and Prevention criteria, is that infection related to a surgical procedure that occurs in the surgical incision or its vicinity within the 30 first days of the postoperative period (90 days in case of implant placement). SSI is the main cause of nosocomial infection in surgical patients[4].

Currently, in Spain, surgical infection is the leading cause of nosocomial infection in hospitalized patients, followed by urinary and respiratory infections, with 20%[5]. Appendicular surgery is, together colonic surgery, the surgical procedure with the highest risk of infection in the abdominal area[6].

The incidence of SSI in appendectomies ranges from 2 to 15%[7,8]. Patients with SSI are 60% more likely to be admitted to an intensive care unit, five times more likely to be readmitted to the hospital and twice more likely to die[9]. Therefore, the presence of SSI increases the risk and severity of the patient.

To reduce the incidence of surgical infection, we can act at three moments: at pre-surgical phase by means of antibiotic prophylaxis and preoperative hygiene, during surgery with the care of tissues and surgical technique optimization, and after the operation through epidemiological surveillance maintained during the maximum incubation period[10,11].

SSI incidence rates are an indicator of surgical practice quality, and control programs based on packages of preventive measures (care bundles) are efficacious and cost-effective[12]. Knowing the evidence of such measures, during the year 2011, a Plan for Quality Improvement and Clinical Safety of the patient undergoing appendectomy was implemented in our hospital. The purpose of this study was to assess the effect of said plan on the incidence of SSI.

Table 1. Surgical procedures included in the study (codes of the International Classification of Diseases, 9th revision, clinical modification)

Code	Surgical procedure
47.01	Laparoscopic appendectomy
47.09	Other appendectomy
47.2	Drainage of appendiceal abscess
47.91	Appendicostomy
47.92	Closure of appendiceal fistula
47.99	Other operations on appendix

Method

A quasi-experimental study with analysis before and after the introduction of a Plan for Quality Improvement and Clinical Safety was conducted at the Alcorcón Foundation University Hospital. The study included patients undergoing appendectomy at the department of general and digestive system surgery during the 2009-2010 (before the plan) and 2012-2013 (after the plan) periods. Patients were selected by consecutive inclusion. Table 1 describes the different appendicular surgical intervention procedures that were included in this study.

The sample size was calculated based on an 80% confidence level, 80% power, an infection incidence of 7% in the group without intervention and 3% in the intervention group, and 5% loss to follow-up. A sample of 534 patients was estimated to be necessary. The study was approved by the Ethics and Clinical Research Committee of the hospital.

Patient evolution was studied from the time of surgery until the end of the maximum incubation period of 30 days. The CDC criteria were used for the SSI

Table 2. Classification of surgical site infections according to the Centers for Disease Control and Prevention criteria

Infection type	Criteria
Superficial infection	Appearance within the first 30 days after surgery. It involves only the skin or subcutaneous cellular tissue of the area of incision and meets at least one of the following criteria: – Purulent drainage – Wound exudate positive culture – Medical diagnosis of superficial infection – The surgeon deliberately opens the incision and the culture thereof is positive or there is no culture, and additionally there is one of the following symptoms or clinical signs: pain, localized swelling, erythema or heat
Deep infection	Appearance within the first 30 days after surgery. It involves the deep soft tissues of the incision (fascial and muscle layers) and meets at least one of the following criteria: – Purulent drainage from the deep incision – Spontaneous dehiscence or opening of the wound by the surgeon and positive culture or no culture being found, and the patient has at least one of the following signs or symptoms: fever, localized pain or tenderness – Medical diagnosis of deep infection – Abscess diagnosed by direct examination of the incision, on re-intervention or detected on histopathologic exam or imaging test
Organ/space infection	Appearance within the first 30 days after surgery. It involves any body part other than the incision and meets one of the following criteria: – Purulent secretion from a drain placed into an organ or space – Positive culture in samples of fluids or tissues from organs or spaces – Abscess or other evidence of infection obtained by direct examination of the incision, on re-intervention or histopathologic exam or imaging test, involving the organ or space – Medical diagnosis of organ or space surgical infection

diagnosis (Table 2). The surgical infection risk was estimated with the National Nosocomial Infections Surveillance (NNIS) Index, which uses the American Society of Anesthesiologists (ASA) anesthetic risk value, the degree of surgical contamination and major surgery duration corresponding to the 75th percentile. Each patient's clinical evolution was studied by reviewing his/her clinical record at admission to observe surgical wound daily evolution, and microbiological cultures in case they had been obtained. In the case of hospitalized patients, SSI was assessed by a physician specialist in preventive medicine and a surgeon. After patient discharge, active follow-up was carried out by reviewing patients' periodic visits to the general and digestive system surgery outpatient clinic, to the emergency departments and primary care centers, through the Horus® application for access to medical records.

The variables included in the study were age, obesity (body mass index ≥ 30), diabetes mellitus, kidney failure, neoplasms, chronic obstructive pulmonary disease, neutropenia, liver cirrhosis, malnutrition, duration of surgery, blood transfusions, postoperative drainage, ASA risk (0-IV), degree of surgical pollution (clean, clean-contaminated, contaminated or dirty wound), laparoscopic intervention, pre-surgical preparation adequacy (antiseptic shower with 2% chlorhexidine soapy gel and 0.12% chlorhexidine gluconate antiseptic mouthwash), shaving of the surgical field, antibiotic prophylaxis adequacy (choice of antibiotic, dose, route, initiation time and duration) according to the antibiotic guideline in force established by the infection commission of our hospital (amoxicillin-clavulanic acid, 2 g intravenously prior to anesthetic induction), presence of surgical wound infection and causative microorganism.

To assess health personnel adherence to hand washing, professional category, washing technique, the antiseptic used and washing technique adequacy were analyzed at the five moments for hand hygiene recommended by the World Health Organization (WHO): before touching a patient, before clean/aseptic procedures, after body fluid exposure/risk, after touching a patient and after touching patient surroundings. Adherence to hand hygiene was assessed by trained anonymous observers who usually perform observation-based studies in health centers from the Community of Madrid.

A specific case report form and a relational and normalized database were designed with the Microsoft Access® program for data registration. A descriptive study of the sample was carried out. Quantitative variables were described with the mean and standard deviation (SD) or with the median and interquartile range if they did not follow a normal distribution. They were compared with Student's t-test, and if they did not follow a normal distribution, Mann-Whitney's U-test was used. Quantitative variables with more than two categories were compared with analysis of

Table 3. Measures of the Plan for Quality Improvement and Clinical Safety in appendectomy

1.Training campaign for all health personnel of the department of general and digestive system surgery explaining the plan.
2.Replacement of chlorhexidine with hydro-alcoholic solutions for hygienic and surgical hand washing.
3.Increase in the number of hydro-alcoholic solution dispensing points.
4.Substitution of the use of razor for electric clipper for surgical field shaving.
5.Surgical field antisepsis with 2% alcoholic chlorhexidine instead of iodine povidone.
6.Installation of hydro-alcoholic solution elbow-actioned dispensers and timer clocks in operating rooms.
7.Screen-saver projection with reminders of the measures adopted in the area of general and digestive system surgery.

variance (ANOVA), and if they did not meet the conditions for its application, non-parametric Kruskal-Wallis test was used. Qualitative variables were described with frequency distribution and were compared with Pearson's chi-square test of or Fisher's exact test in case of not meeting the application criteria.

A Plan for Quality Improvement and Clinical Safety for surgical patients was implemented in 2011 at the department of general and digestive system surgery, which is described in table 3. SSI cumulative incidence in appendectomies was estimated for two periods, before and after the plan. Year 2011 was excluded from the analysis because on that year the measures were progressively implemented. The effect of the intervention was assessed with the odds ratio (OR) and its confidence interval (CI), adjusting for the different covariates with a backward stepwise logistic regression model, taking into account the confounding and interaction of the various covariates. For internal model calibration (goodness of fit), the Hosmer-Lemeshow test was used. Statistical and epidemiological analyses were carried out with the SPSS v.22 and Epidat v.4.2 programs. Differences were considered statistically significant with a p-value < 0.05, and all estimations were described with their 95% CI.

Results

Six-hundred and six patients were studied, 267 during the 2009-2010 period (before the plan) and 339 in the 2012-2013 period (after the plan). Mean age was 31.7 years (SD: 20). The most common patient comorbidities were diabetes mellitus (2.6%) and obesity (1.8%). Patient characteristics and main study variables are shown in table 4.

There were 35 infections during the follow-up period, which entailed a SSI overall incidence of 5.78% (95% CI: 4.16-7.95), with 77% of them being superficially located infections. The most commonly involved microorganisms were *Escherichia coli* (37.5%) and *Pseudomonas aeruginosa* (25%). The incidence of SSI decreased after implementation of the plan from 6% (n = 16) to 5.6% (n = 19) (OR: 0.72; 95% CI: 0.33-1.56; p = 0.839). Mean hospital length of stay remained without significant changes, passing from 4.7 (SD: 7) to 4.6 days (SD: 5) after preventive measures implementation (p = 0.890). The types of infection according to their depth and most common causative microorganisms are described in table 5.

Antibiotic prophylaxis adequacy improved from 69.2 to 96.2% after the plan (p < 0.001). The most common cause of inadequacy was initiation time, which went from 27.9% to 2.8% after the measures were implemented (p < 0.001). With regard to patient pre-surgical preparation, it increased from 3 to 17.5% (p < 0.001). The main cause of preparation non-compliance prior to the plan was failure to administer the antiseptic shower to the patient (93.4%), and after its implementation, failure to use the antiseptic mouthwash (75.6%).

Adherence at the Department of General and Digestive System Surgery increased from 31% to 40% (p = 0.016) after implementation of the plan, with an adherence increase in WHO's 5th moment of hand hygiene of (after touching patient surroundings), which went from 1% to 36%. In figure 1, the evolution of adherence can be observed according to the moments, before and after the Improvement Plan.

SSI-associated risk factors were diabetes mellitus, inadequate presurgical preparation, clean-contaminated surgery, dirty surgery, duration of surgery above percentile 75, NNIS surgical risk index 2 and 3, ASA classification> II and use of postsurgical drainage. Table 6 describes the univariate analysis for the various risk factors for surgical infection.

In the multivariate analysis, the SSI-independent risk factors that were statistically significant after the

Table 4. Patient characteristics and main study variables

	Before the plan N (%)	After the plan N (%)	p
Gender			
Males	141 (52.8)	191 (56.3)	0.432
Females	126 (47.2)	148 (43.7)	0.432
Total	267 (100	339 (100)	
Mean age, years (SD)	31.8 (20)	31.7 (19)	0.700
Comorbidity			
Diabetes mellitus	7 (2.6)	9 (2.7)	0.594
Kidney failure	4 (1.5)	0 (0)	0.037
Neoplasm	3 (1.1)	1 (0.3)	0.791
COPD	2 (0.7)	1 (0.3)	0.412
Liver cirrhosis	1 (0.4)	0 (0)	0.441
Obesity	7 (2.6)	4 (1.2)	0.156
ASA			
I	180 (67.4)	206 (60.8)	0.091
II	72 (27)	112 (33)	0.106
III	14 (5.2)	21 (6.2)	0.618
IV	1 (0.4)	0 (0)	0.441
NNIS			
0	75 (28.1)	84 (24.8)	0.350
1	126 (47.2)	203 (59.9)	0.002
2	60 (22.5)	44 (13)	0.002
3	6 (2.2)	8 (2.4)	0.920
Type of surgery			
Open	210 (78.7)	265 (78.2)	0.886
Laparoscopy	46 (17.2)	51 (15)	0.466
Surgery duration			
Mean, minutes (SD)	66.1 (34)	57.8 (40)	0.045

ASA: American Society of Anesthesiologists; SD, standard deviation; COPD: chronic obstructive pulmonary disease; NNIS: National Nosocomial Infections Surveillance.

Table 5. Types of surgical site infection and most common microorganisms in appendectomy

	Before the plan N (%)	After the plan N (%)	p
Type of infection			
Superficial	11 (4.1)	16 (4.7)	0.248
Deep	3 (1.1)	2 (0.6)	0.630
Organ-space	2 (0.7)	1 (0.3)	0.238
Microorganisms			
Escherichia coli	4 (40)	5 (37.5)	0.936
Pseudomonas	3 (30)	3 (21.4)	0.707
aeruginosa	1 (10)	3 (21.4)	0.363
Enterobacter cloacae			

univariate analysis and those with $p \leq 0.2$ that were considered of interest due to their clinical and prognostic importance (kidney failure, neoplasm, shaving and emergency surgery) were studied. After the multivariate analysis, an ASA classification > II (OR: 5.66; 95% CI: 2.25-14.26), postsurgical drainage use (OR: 6.37; 95% CI: 2.66-15.25) and clean-contaminated surgery (OR: 0.20; CI 95%: 0.58-0.70) showed statistical significance.

Discussion

The presence of low SSI rates is proportional to a proper surgical practice and represents a good indicator of improvement in the quality and safety of the health care provided at each center[13,14]. Actions aimed at the prevention of infections are always a cost-effective measure. Hence, in the current context of limited resources, it also represents an added value to healthcare systems sustainability[15,16].

Assessment of the incidence of infection requires surveillance of surgical procedures that are frequently practiced, that are associated with a relatively high risk of SSI and that have serious consequences for the patient if infection occurs. In any type of surgery involves risk of infection, and in the case of appendectomy, which is one of the most frequently performed surgical procedures, measures of care should be maximized[17].

SSI overall incidence during the study period was 5.8%, and after the implementation of the preventive measures, it decreased from 6% to 5.6%; such a low figure as in our setting was not found in the reviewed literature, where most series show and incidence of at least 8%[18-20]. As in other studies, most commonly isolated microorganisms in patients with surgical infection after appendectomy were gram-negative bacilli, specifically *E. coli* and *P. aeruginosa*[21,22].

Some papers evaluate the incidence at patient discharge without monitoring the entire period of risk[23], which makes it difficult to compare infection incidence figures if patients are followed only during hospitalization and not within the first 30 days after surgery. Up to half appendectomy infections occur after hospital discharge[18]. In our case, follow-up has been performed over the first 30 days after surgery in order for SSI incidence not to be underestimated.

Regarding the implemented Plan for Quality Improvement and Clinical Safety, continued application of preventive measures such as those used in our hospital can prevent 33 to 60% of these infections, according to the reviewed literature[10,12,24,25].

SSI is one of the main causes of nosocomial infection, and preventive measures are therefore essential to reduce its incidence, cost and mortality. Patients with infection after an appendectomy have a mean cost to the health system three times higher than those not infected[26].

Although implementation of the plan reduced the incidence of SSI in our center, mean hospital length of stay showed no appreciable changes. Pérez Blanco

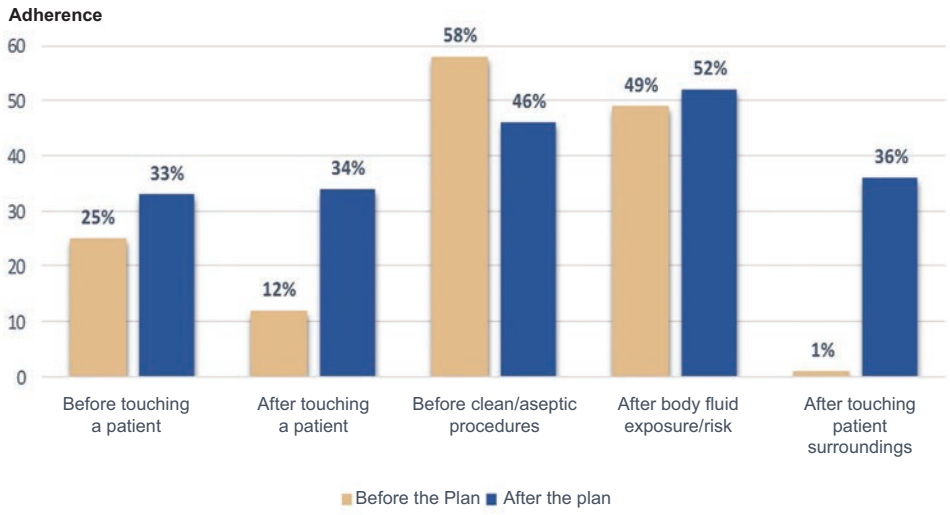

Figure 1. *Evolution of adherence to hand hygiene, according to the moments recommended by the World Health Organization, before and after the Plan for Quality Improvement and Clinical Safety.*

et al.[27], in a study carried out in our setting, obtained a reduction in mean hospital length of stay and surgical infection from 27.5% to 16.9% ($p > 0.05$) after assessing a protocol of preventive measures in colorectal surgery patients. In this sense, Izquierdo Blasco et al.[28], in a quasi-experimental study in cardiac surgery pediatric patients from a Spanish hospital, observed a decrease in SSI from 10.9% to 1.9% ($p < 0.05$). Other international reviews achieved favorable results, similar to those described[13,29-32].

One of the greatest achievements after the implementation of our plan was the improvement in antibiotic prophylaxis protocol compliance, which went from 69.2% to 96.2% ($p < 0.001$), with an overall adequacy of 81.9%, and with appropriate administration being considered if all criteria were met (choice of antibiotic, dose, initiation time, administration route and duration). These figures are higher than those in other national and international works that were reviewed[7,22,33-35]. The most common cause of inadequacy was failure to administer prophylaxis at the moment prior to surgery defined by the protocol. Several series in the literature coincide with this finding[7,22,34,35].

The explanation for not administering prophylaxis at the moment prior to surgery is because appendicitis cases are diagnosed at emergency areas and this makes for some delay to likely exist between patient assessment, prophylaxis administration and surgery. Prophylaxis was administered by operating room nursing staff, according to the hospital protocol, and was supervised by anesthesiologists. None of them knew they would be evaluated, and thus the Hawthorne effect was controlled for[36].

Surgical preparation constitutes an essential element in the prevention of wound infection. Patient skin is a reservoir of transient resident saprophyte microorganisms that are easily removed with washing with soap and water. There is also resident flora that needs antisepsis for its elimination[37-39]. In the study, failure to apply antiseptic mouthwash or body washing was regarded as incorrect preparation.

In our series, there was 11.1% of pre-surgical preparation overall compliance, which improved from 3% to 17.5% ($p < 0.001$) after the plan. The main cause of inadequacy before the plan was failure to prepare the patient, and after the plan, it was failure to administer the antiseptic mouth rinse. Compared with other studies, correct surgical preparation of our patients is lower[25,40,41], which is explained, as it occurred with antibiotic prophylaxis, by the fact that appendectomy is an emergency surgical procedure and the patient is transferred from the emergency ward directly to the operating room and there is no time for the application of preventive measures.

The Plan for Quality Improvement and Clinical Safety also included measures for hand hygiene promotion in the health personnel. The importance of hand washing in the transmission of nosocomial infections is widely documented. Hand hygiene is recognized as the most important measure for the prevention of health care-associated infections[42,43]. With proper hand hygiene, more than 50% of infections can be prevented in the healthcare field. This practice is not sufficiently recognized by professionals, and thus there is low adherence to the five moments for hand hygiene recommended by the WHO[42,44]

Table 6. Univariate analysis of surgical site infection risk factors in appendectomy

Risk factors	SSI	No SSI	Total	OR	CI 95%	p
	N (%)	N (%)	N(%)			
Before the plan	16 (6)	251 (94)	267 (44.1)	1.07	0.54-2.13	0.839
After the plan	19 (5.6)	320 (94.4)	339 (55.9)	0.93	0.47-1.85	0.839
Male gender	21 (60)	311 (54.5)	332 (54.8)	1.24	0.62-2.46	0.538
Female gender	14 (40)	260 (45.5)	274 (45.2)	0.81	0.41-1.60	0.538
Diabetes mellitus	3 (8.6)	13 (2.3)	16 (2.6)	4.02	1.09-14.84	0.049
Kidney failure	1 (2.9)	3 (0.5)	4 (0.7)	5.57	0.56-54.96	0.212
Neoplasm	1 (2.9)	3 (0.5)	4 (0.7)	5.57	0.56-54.96	0.212
COPD	0 (0)	3 (0.5)	3 (0.5)	-	-	-
Liver cirrosis	0 (0)	1 (0.2)	1 (0.2)	-	-	-
Neutropenia	0 (0)	0 (0)	0 (0)	-	-	-
Obesity	1 (2.9)	10 (1.8)	11 (1.8)	2.33	0.41-13.31	0.483
Malnutrition	0 (0)	0 (0)	0 (0)	-	-	-
Shaving	10 (28.6)	118 (20.7)	128 (21.1)	1.58	0.75-3.32	0.229
Inadequate surgical prophylaxis	1 (2.9)	12 (2.1)	13 (2.1)	1.79	0.22-14.49	0.457
Inadequate surgical preparation	27 (77.1)	511 (89.5)	538 (88.8)	0.39	0.17-0.90	0.030
Emergency surgery	19 (54.3)	265 (46.4)	284 (46.9)	1.37	0.69-2.72	0.232
Laparoscopy	4 (11.4)	93 (16.3)	97 (16)	0.66	0.23-1.92	0.635
Clean-contaminated surgery	3 (8.6)	205 (35.9)	208 (34.3)	0.23	0.08-0.65	0.001
Contaminated surgery	10 (28.6)	176 (30.8)	186 (30.7)	0.90	0.42-1.91	0.831
Dirty surgery	21 (60)	188 (32.9)	209 (34.5)	3.06	1.52-6.14	0.001
Surgery duration > percentile 75	15 (42.9)	133 (23.3)	148 (24.4)	2.47	1.23-4.96	0.011
ASA > 2	9 (25.7)	27 (4.7)	36 (5.9)	6.97	2.98-16.33	0.000
NNIS 2	12 (34.3)	92 (16.1)	104 (17.2)	2.72	1.31-5.65	0.009
NNIS 3	5 (14.3)	9 (1.6)	14 (2.3)	10.41	3.28-32.98	0.001
Postsurgical drainage	10 (28.6)	28 (4.9)	38 (6.3)	7.76	3.40-17.72	0.000
Blood transfusion	0 (0)	2 (0.4)	2 (0.3)	-	-	-

ASA: American Society of Anesthesiologists; COPD: chronic obstructive pulmonary disease; 95% CI: 95% confidence interval; SSI: surgical site infection; NNIS: National Nosocomial Infections Surveillance; OR: odds ratio.

Hydro-alcoholic solutions allow hand disinfection in a simple, inexpensive and effective form, and are part of the preventive measures of our plan. After 2011, higher adherence to hand washing was observed in our center, which went from 37% to 42% ($p < 0.05$); specifically, in the department of general and digestive system surgery, it increased from 31% to 40% ($p < 0.05$), with these figures being similar to those reported in the Sánchez-Payá et al. study[45] in another Spanish university hospital.

Although the design of this study is based on highly scientific evidence, one possible limitation would be not having been able to detect some postoperative period surgical infections occurred outside the hospital that would have not been captured in patient records. However, these are rather infrequent and we believe that our results have not been affected by this fact.

To avoid bias due to loss to follow-up, when the sample size was calculated, a percentage of possible

losses during the assessed period was estimated. Our center has an electronic medical record system and patients are followed at primary care with the Horus® computer-based application after hospital discharge, and selection and information biases could therefore also be controlled.

As a consequence of the study, different measures were taken in our hospital, including communicating the results to responsible doctors in order to increase compliance with these recommendations, since there is evidence that an evaluation of procedures based on knowledge of the results by surgeons (feedback) can significantly decrease the rates of infection[27].

Conclusions

A care bundle is a set of evidence-based measures and practices that, when applied together, improve health care. Surgical infections represent a major problem for patient safety in health systems, limit the benefits of surgery and involve an additional risk in terms of morbidity and mortality, as well as cost increase.

In our hospital, the incidence of SSI in appendectomy procedures was low, but there is always room for improvement Although the reduction in the incidence of infection had no statistical significance after the adopted measures, in a short time, we have achieved significant progress in fields such as antibiotic prophylaxis adequacy, adherence to hand hygiene and patient pre-surgical preparation, which we believe can serve as a reference to other health centers of similar characteristics. We consider perseverance and compliance with the initiated preventive measures essential, as well as their prolongation and evaluation on an ongoing basis, for the future improvement of this Plan for Quality Improvement and Clinical Safety and its implementation in all surgeries subsidiary thereof.

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Conflicts of interests

The authors declare that they have no conflicts of interest.

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