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IMPACT OF IMPLEMENTING THE CHECKLIST PROCEDURE ON THE INCIDENCE OF SURGICAL SITE INFECTIONS IN CESAREAN SECTION WOMEN

G.BRAHIMI
Department of Epidemiology and Preventive Medicine, BeniMessous University Hospital Centre.

H. OULD BABA ALI
Department of Epidemiology and Preventive Medicine, BeniMessous University Hospital Centre.

S. AIT SEDDIK
Department of Epidemiology and Preventive Medicine, BeniMessous University Hospital Centre.

S. AMRIT
Department of Epidemiology and Preventive Medicine, BeniMessous University Hospital Centre.

Abstract

Introduction: Surgical site infections (SSI) constitute a significant source of morbidity and mortality for cesarean parturients, with considerable impact on the healthcare system. Although the occurrence of SSIs depends on several factors, including those related to the patient, pregnancy complications, surgical procedure, and healthcare environment, these infections are largely preventable. The occurrence of SSIs may raise questions about the quality and safety of surgical interventions. Prevention of SSIs depends on a set of best practices to be applied before, during, and after surgical intervention. The aim of our study is to assess the impact of implementing the Pre- and Per-operative Safety Checklist on the incidence of SSIs in cesarean women. **Materials and Methods**: This was a before-after evaluation study conducted in 2014 and 2015. Recruitment of parturients took place between February and April of each year, with the implementation of the checklist for SSI prevention after the first year of surveillance. Data collection was done in real-time (daily) with follow-up until Day 30. Data were entered and analyzed using Epi Info6 version 6.04 (CDC, Atlanta, USA), and multivariate analysis was performed using Epi Info 7 version 3.5.4. **Results**: A total of 611 cesarean sections were included, 311 in the pre-checklist study and 300 in the post-checklist study. The checklist was observed for 60% of procedures, i.e., 179 cesareans were performed with checklist application. A total of 66 cases of SSIs were recorded during the study period, of which 59 (89.4%) were superficial infections, 6 (9%) were deep SSIs, and 1 case was an organ or cavity infection (endometritis). The impact of prevention on reducing the incidence rate of SSIs was demonstrated in our study by applying a small number of effective measures to prevent infections, as listed on a Checklist for Patient Safety. A significant decrease in the incidence rate between the two study periods was achieved, dropping from 16.7% to 4.7% (an 86% reduction), and the risk of SSIs in cesarean parturients was reduced to 0.063 (OR = 0.063, 95% CI: [0.02-0.2], p <0.00001), meaning it is 15.9 times lower after implementing all prevention measures. The utility of such a tool reminding the application of best practices was thus demonstrated, with convincing results, which would also lead to healthcare cost savings. The Checklist should now be an integral part of daily work for teams, ensuring safer surgery.

Index Terms: Surgical Site Infections - Caesarean Section - Impact Study - Patient Safety - Check-List, Risk Factors.

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I. INTRODUCTION

As with any surgical procedure, the risk of surgical site infection (SSI) is present after a cesarean section. SSIs represent one of the main causes of morbidity and dissatisfaction among parturients, increasing the average length of hospital stay by 2 to 7 days[1,2,3]. They increase the burden of care and are costly[4]. The incidence rate of SSIs in the Obstetrics and Gynecology department at CHU Béni Messous was 5.4% in 2005, reached 10.9% in 2006, then decreased to 4.2% in 2007[5]. However, this reduction is relative to the follow-up rate at J30, which was 46.2% in 2005, improved to 61% in 2006, and then decreased to 58% in 2007. Epidemiological surveillance with feedback to surgeons is one of the elements of prevention and evaluation of actions taken; its interest has been studied in reducing SSIs[6,7,8,9], but it is not sufficient to compensate for the lack of resources and rigor in care organization. Scientific literature shows that the implementation of process indicators such as Checklists (CL)[10] or care bundles has been demonstrated to be less costly and more effective in preventing infections compared to outcome indicators. This has been tested in 8 countries of different economic levels, and its effectiveness has been proven, with mortality rates decreasing from 1.5% to 0.8% and complications decreasing by 36%[11,12]. Will its implementation in the operating theater of the obstetrics and gynecology department for cesarean sections have an impact on the incidence of SSIs? Therefore, we propose to conduct a comparative study before and after the implementation of the CL to estimate the SSI rate among women undergoing cesarean sections and evaluate its impact.

Objectives of the study : To assess the impact of implementing the Patient Safety Checklist in pre- and peri-operative care on the incidence of surgical site infections (SSIs) in women undergoing cesarean section.

II. MATERIALS AND METHODS

This is a before-and-after study aimed at evaluating the impact of the Patient Safety Checklist in the operating room on the incidence rate of SSIs in women undergoing cesarean section. The "initial" situation serves as a reference for evaluating the effectiveness of our intervention. The follow-up of women undergoing cesarean section is prospective and longitudinal.

Our study was conducted in the Obstetrics and Gynecology department of CHU Béni Messous. Recruitment of parturients was carried out during two periods: from February to June 2014 for the pre-implementation study and from February to June 2015 for the post-implementation study of the WHO Surgical Safety Checklist.

Parturients who underwent emergency or scheduled cesarean section, regardless of the indication, primiparous or multiparous (including those who had previously undergone cesarean section), were included, while those transferred to the Obstetrics and Gynecology department postpartum after a cesarean section performed in another facility were excluded.

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The primary outcome measure is the occurrence of a surgical site infection.

The diagnostic criteria for SSIs used are those from the CDC in Atlanta[13,14] and recommendations from the French High Council of Public Health.

Data collection was done in real-time (daily) on a pre-established form in pre-, peri-, and post-operative periods, including variables related to the patient (age, obesity, diabetes, premature rupture of membranes, ASA score, preoperative skin preparation), intervention (surgeon, type of anesthesia, contamination class, number of people present in the operating room, duration of intervention, data on antibiotic prophylaxis (number of antibiotics administered, name of the molecule, dosage pre- and post-operatively).

Characteristics of the SSI: date of infection, time of occurrence (during hospitalization or follow-up at J30), microorganisms, antibiotic treatment, prolongation of stay or rehospitalization,...

Patient follow-up was carried out in the postpartum unit by the epidemiology service physicians until J30. For follow-up until J30, all cesarean section patients were given a follow-up letter with telephone reminders.

Any suspicion of SSI was subject to sampling for bacteriological diagnosis. The identified microorganisms were systematically subjected to antibiotic susceptibility testing.

Treatment and Data Analysis : The data were entered, analyzed, and processed using Epi Info6 software version 6.04 CDC, Atlanta, USA, after checking (errors and inconsistencies were identified through data cleaning), and multivariate analysis was performed using Epi Info 7 software version 3.5.4- July 30, 2012.

Appropriate statistical tests according to the nature and sizes of the variables were calculated. These included the Pearson chi-squared test, Yates-corrected chi-squared test, Fisher's exact test with a significance level set at 5%, for comparing two means, a Student's t-test was used, and for more than two samples, ANOVA was used for normally distributed data with homogeneous variances and a 95% confidence interval. When variances differed significantly (Bartlett's test of homogeneity of variances), a non-parametric test rather than ANOVA was used (Mann-Whitney test or Wilcoxon test). To estimate the strength of association, both raw and adjusted Odds Ratios (OR) were calculated.

III. ACTION PLAN

Our action plan consisted of introducing the WHO Surgical Safety Checklist, which we adapted to our context by adding certain points deemed necessary in the management of surgical infectious risk, such as hand hygiene compliance and preoperative skin preparation.

Meetings were organized with the authorities (the director of the hospital, the head of the obstetrics and gynecology department), and after their agreement, the team was informed.

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An assessment was made before the introduction of the checklist by conducting two audits: one on surgical hand disinfection (SHD) and the other on preoperative skin preparation. Insufficiencies were observed in terms of resources and practices:

For SHD, these included non-compliance of the handwashing station in the emergency operating room, absence of protocols for different SHD techniques, non-compliance with pre-SHD recommendations (32.7% of cases for wearing jewelry and 32.7% for attire), non-compliance with hand disinfection (in 21.2% of cases), and failure to adhere to the overall SHD time (below the time defined by the protocol in 100% of cases).

For preoperative skin preparation (PSP), these included the absence of a protocol for field preparation in the operating room, absence of a written protocol for preoperative showering, unavailability of antiseptic soap, and non-compliance with the cleansing phase.

Following this assessment, resources were made available to healthcare professionals. A new handwashing station was installed in the emergency operating room, along with dispensers for mild soap, hydroalcoholic solution, and single-use hand towels.

The department was supplied with products for handwashing (mild soap, hydroalcoholic solution, single-use hand towels) and products for skin cleansing (antiseptic soap). Protocols for various SHD techniques, operating field preparation were established and displayed. Brochures for preoperative skin preparation were developed and made available to practitioners in the obstetrics and gynecology department at pre-anesthesia and prenatal consultations.Training was conducted in January 2015 over a one-month period, involving medical and paramedical staff (a total of forty-six individuals), organized by six physicians from the hospital hygiene unit. The training program included teaching on the fundamental aspects of hygiene, standard precautions, hand hygiene techniques, and recommendations for antibiotic prophylaxis prescription. For the checklist, a presentation illustrating its importance in hospital hygiene was developed with a demonstration of its implementation process. The courses were delivered through oral theoretical presentations and practical demonstrations followed by discussions. Staff in the operating room were accompanied over a one-month period to encourage and promote adherence to care protocols and to ensure the use and proper execution of the checklist. The checklist is completed by a coordinator, under the responsibility of the surgeon and anesthesiologist in charge of the intervention. In practice, when the patient enters the operating room, the checklist coordinator asks questions aloud to verify the list of 12 points divided into 3 timeframes and checks off the items on the support (paper), and each member of the operating room team carries out the verifications that concern them aloud

1st time before anesthesia induction: 6 items: Verification of patient identity, confirmation of intervention and site/awareness of setup/verification of preoperative skin preparation/verification of surgical and anesthetic equipment/identification of patient and/or intervention-related problems

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2nd time before surgical incision: New verification of patient identity, side, setup, anesthetic or intervention-specific risks to anticipate material and equipment accordingly in the room, SHD compliance, operating field, and antibiotic administration

3rd time after the intervention and before leaving the room: Check of materials and textiles to avoid oversights, verification of proper labeling of samples, and if necessary, reporting of equipment problems, traceability.

IV. RESULTS

A total of 611 cesarean sections were included, 311 in the study before and 300 in the study after the implementation of the checklist, which was observed for 60% of the procedures, totaling 179 cesareans performed with checklist application. Follow-up of the parturients was ensured up to day 30.

The mean age of the parturients was 31.9 years (± 5.8 years, range: 15 to 47 years). The majority, 71.5% (437/611), had an ASA score of 1. The mean duration of the cesarean section was 57.6 ± 13.57 minutes (range: 30 to 120 minutes), and 55.3% (338/611) of the procedures were performed urgently, that is to say during labor.

Comparing the characteristics of the two study populations, the parturients were not statistically different in terms of age, comorbidities (ASA score), urgency of the cesarean section, or duration of the procedure.

A total of 66 cases of SSI were recorded during the study period, of which 59 (89.4%) were superficial infections, 6 (9%) were deep SSIs, and 1 case of organ or cavity infection (endometritis). The diagnosis of SSI was clinical and/or radiological for 44 cases and bacteriological for 18 cases. Forty-two cases (63.6%) underwent pus cytobacteriological analysis, 24 SSIs (57%) were decapitated (negative wound culture) due to sampling after a mean antibiotic therapy initiation delay of 6.9 days ± 2.8 days; prescribed treatment was monotherapy in 76.9% of cases and combination therapy in 23.1%.

Twenty germs were isolated, 65% were Gram-positive cocci, and 35% were Gram-negative bacilli (GNB). Staphylococcus aureus was the most frequently isolated pathogen (n=9), representing 45% of isolated germs, followed by Streptococcus agalactiae in 20% of cases (n=4), Pseudomonas aeruginosa (n=2), and E. coli (n=2) in 10% of cases.

The mean time to onset of infections was 7 ± 3.9 days (median = 6 days, range: 1 to 19 days). Of the 66 cases of SSI, 18 (27.3%) were diagnosed during the patient's hospital stay, with 13 requiring extended hospitalization for a mean duration of 7 days ± 2.7, and 48 (72.7%) after hospital discharge. Among them, 16.9% (8/48) required re-hospitalization for a mean duration of 9.62 days ± 4.86.

As the checklist was not observed for all cesarean sections performed in the study after its implementation, we analyzed the impact of healthcare workers' training without verified checklist and that of healthcare workers' training with verified checklist to verify the presence or absence of a dose-response relationship (dose-effect):

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A significant decrease in the incidence of SSI was observed between the study before and after the implementation of the action plan. In the study before, 52 SSIs occurred, resulting in an incidence rate of 16.7%, and after the implementation of the action plan, 14 parturients had an SSI, resulting in an incidence rate of 4.7% (p<0.001). A greater decrease in incidence was observed when the checklist was adhered to, as 4 SSIs occurred among the 179 parturients cesareans with checklist control in the operating room, resulting in an incidence rate of 2.23%. The most significant decrease in incidence was observed for superficial infections, decreasing from 15.11% (47/311) to 4% (12/300), a reduction of 73.5% (p<0.001), while no significant difference was observed in the incidence rates of deep SSIs and organ or cavity infections between the two periods.

During the study, we identified risk factors associated with the occurrence of SSI:

Premature rupture of membranes more than 12 hours before hospitalization increased the risk of SSI by 6 times (crude OR [2.97-12.2], p <0.01), and when adjusted for other factors, it remained associated with SSI with an adjusted OR of 5.6 (p = 0.001, 95% CI: [2.4; 13.2]).

An ASA score greater than or equal to 3 was identified as a risk factor for SSI with a crude OR of 3.2 (95% CI [2.97-12.2], p<0.01), and it was 3.7 when adjusted with other factors (adjusted OR 3.7, 95% CI: [1.8; 7.6], p <0.001).

Altemeier class ≥ 3 was associated with SSI with a crude OR of 6.78 (95% CI [3.6-12.7], p <0.01) and an adjusted OR of 9.9 (95% CI: [4.6; 21.2], p <0.001).

The number of people present in the operating room, when high (≥ 5), was associated with SSI with a crude OR of 2.37 (95% CI [1.09-7.27], p <0.05) and an adjusted OR of 3.5 (ORa=3.5, 95% CI: [1.3-9.1], p <0.01).

Table I: Summarizes the univariate and multivariate analysis of risk factors and protective factors for SSI in cesarean section patients in a university hospital center

Variable	Infectés (66)	Non infectés (545)	Uni-variate analysis			Multivariate analysis		
			Crude OR	IC à 95%	p Value	OR adjusted	IC à 95%	p Value
Premature rupture of memebranes > 12H	18 (27.3%)	32 (5.9%)	5.9	[2.97- 12.2]	<0.01	5.6	[2.4- 13.2]	<0.001
Score ASA ≥ 3	16 (24.2%)	50 (9.2%)	3.3	[1.6 – 6.3]	< 0.01	3.7	[1.8- 7.6]	<0.001
Altemeier Class ≥ 3	25 (37.9%)	45 (8.3%)	6.8	[3.6- 12.7]	<0.01	9.9	[4.6- 21.2]	<0.001
Number of people in the operating theatre ≥ 5	60 (90.9%)	428 (78.5%)	2.7	[1.09- 7.27]	<0.05	3.5	[1.3- 9.1]	<0.01
Training of healthcare workers without verified checklist (CL)	10 (15.1%)	111(20.4%)	0.45	[0.22- 0.95]	<0.05	0.25	[0.1- 0.6]	<0.01
Training of healthcare workers with verified checklist (CL)	4 (6%)	175 (32.1%)	0.11	[0.04- 0.32]	<0.01	0.063	[0.02-0.2]	<0.001

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V. DISCUSSION

This study on the impact of implementing a "care-bundle" for the prevention of surgical site infections (SSI), specifically the CL safety checklist for pre- and peri-operative care coupled with healthcare personnel training, among women undergoing cesarean sections, is the first of its kind conducted in Algeria. This prevention strategy was made possible through close collaboration between the obstetrics and gynecology department, the hospital hygiene unit, and the support of hospital management. It led to a significant reduction in the incidence rate of SSIs among women undergoing cesarean sections and identified risk factors through multivariate analysis. Four factors remained associated with the occurrence of SSIs among these women:

Premature rupture of membranes, frequently reported in the literature due to the increased risk of chorioamnionitis (an infection of the placenta and amniotic fluid)[15]. The longer the duration, the higher the risk of SSI[15,17,18]. Definitions vary, with some studies considering rupture before admission and others considering the duration of rupture before labor. This factor is consistently found in multivariate analyses[19,20,21,22]. This risk was also reported in Demisew study[23]; however, prolonged rupture of the membrane (> 12 hours) was significantly associated ($p < 0.05$) with chorioamnionitis, which in turn was significantly associated with SSI ($p < 0.001$). Jido TA. and *al.*[24] found a significantly higher incidence rate of SSI after premature rupture of the membranes (11.3% versus 0.4%, $p < 0.01$). Barbut F. and *al.*[25] did not report this factor as a risk for SSI, although it was more frequent in patients who had an SSI (5.88% versus 2.36%, $p = 0.10$), probably due to the small sample size and the timeframe considered as a risk for SSI after premature rupture of the membranes (more than 6 hours instead of 12 hours). In our study, when the time of premature rupture of the membranes was more than 12 hours before hospitalization, this factor increased the risk of SSI by 6 times ([2.97-12.2] $p < 0.01$), and after adjusting for other factors, it remained associated with SSI with an ORa of 5.6 ($p < 0.001$, 95% CI: [2.4 ; 13.2]), despite 78% of the parturients being put on antibiotic prophylaxis after hospitalization.

The ASA score, which reflects the presence of comorbidities, has been cited in previous studies[1,26,27,28]. Filbert J.[29] demonstrated a significant association between the occurrence of a surgical site infection (SSI) and an ASA score greater than 2 in a prospective study of women undergoing cesarean sections. Alseny-Gouly C. and *al.*[30] found, during multivariate analysis, an almost twofold higher risk (adjusted odds ratio [ORa] = 1.8 [1.1–3.0]; $p < 0.05$) when the ASA score was greater than 1. Tang R and *al.*[31] reported a nearly twofold increased risk of SSI for ASA score 2. In Barbut F. and al.'s study[25], SSI rates stratified by ASA score were 2.17%, 4.13%, and 6.25% for patients with ASA scores of 1, 2, and 3, respectively. In our study, although the majority of our patients (89.2%) had a low ASA risk (young and healthy parturients), the SSI incidence rate was significantly higher for ASA score ≥ 3 (24.2% versus 9.2% for ASA <3, $p < 0.01$) with an adjusted OR of 3.7 (95% CI [1.8–7.6]).

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Regarding the contamination class, it is clear that the cleanliness of the operated site is linked to the risk of SSI. Contaminated and dirty surgeries are much more exposed to the risk of infection than clean surgeries, and this factor often proves significant for classes ≥ 3. A meta-analysis, based on WHO databases for the African region with 11 references, found that Altemeir Class ≥ 3 was cited 4 times as a risk factor for infection. Mitt P.[32] reported a high risk for classes 3 and 4 (OR 3.8; 95% CI, 1.2–11.8; p < 0.01). Tang R et *al.*[31] found an OR of 2.9 for contaminated wounds. Filbert J.[29] found a risk of SSI in women undergoing cesarean sections of 2.4 (95% CI, [1.1–5.0]; p < 0.05). In Morocco, this factor was also found to be associated with SSI[33]. This risk factor was highlighted in our study, with contaminated surgeries (categories ≥3 of the Altemeier classification) being more exposed to the risk of SSI with an adjusted OR of 9.9 (95% CI: [4.6–21.2], p < 0.001).

Regarding the number of people in the operating room, the shedding of skin from personnel represents a significant amount of microorganism-carrying cells dispersed in the air, serving as potential sources of wound contamination[34,35,36,37]. A systematic literature review, including 27 original articles, with 14 articles evaluating the number of people in the operating room (ranging from 3 to 20 people), found two studies describing a significant association between the number of people and SSI rates[38]. Another retrospective study involving 3259 surgical interventions reported a relationship between the number of people in the operating room and the infection rate, which increased significantly from 1.5% for <9 people to 6.9% for >16 people[39].

In our study, the presence of ≥5 people in the operating room was significantly associated with the occurrence of infection with an adjusted OR of 3.5 (95% CI [1.3–9.1], p < 0.001).

The evaluation also focused on protective factors, namely the impact of training healthcare personnel without completed CL and the impact of training healthcare personnel with adherence to the CL. Despite the simplicity of the CL, the completion rate did not exceed two-thirds (60.4%). Adherence to the CL was better during daytime hours (68.3% during the day versus 31.6% in the evening, p < 0.001), and on weekdays (63.14% on weekdays versus 40% on weekends, p < 0.01). This can be explained by the significant workload and reduced staffing levels during weekends and nights. However, regarding the urgency of the surgical procedure, no difference was observed (56.14% (96/171) of CLs were completed for emergency procedures and 65.35% (83/127) for scheduled interventions.

In terms of completion quality, the completeness rate was 83.2%, which can be attributed to the presence of full-time coordinators in both operating rooms (emergency and cold rooms) who received training on CL implementation, were motivated, and actively involved in operational risk management. The CL was well followed upon its implementation during the months of February and March, but a relaxation was observed in April and May (67% versus 48%, p < 0.001). In a study conducted by Fourcade and *al*[40]*.* In French centers, they had a CL completion rate of 95.5% and 95.8%, but completion rates were 64% and 68%, respectively. Paugam-Burtz and *al.*[41] found CL

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utilization rates of 88%, 89%, and 76% over three 15-day evaluation periods, with completion rates of 90% for pre-induction and pre-incision items and 75% for postoperative items. The study by BECRET and *al.*[42] conducted at the Bouffard Medico-Surgical Hospital (HMCB) in the Republic of Djibouti found a completion rate of 49% but very poor completion quality results (24%), despite its mandatory status.

In our study, the incidence rate of SSIs was 16.72% (52/311) during the first period (in 2014) and 4.7% (14/300) after the implementation of prevention measures, significantly reducing the incidence of SSIs in women undergoing cesarean sections.

Many studies have reported a link between healthcare personnel training and a decrease in rates of healthcare-associated infections (HAIs)[43]. The first study to truly demonstrate the impact of prevention programs in terms of reducing HAIs was the SENIC study conducted by the CDC in the 1970s in a representative sample of American hospitals. The program involved healthcare personnel training and the implementation of active surveillance with HAI reporting. The authors observed a significant reduction in HAIs (surgical site infections, urinary tract infections, and bacterial pneumonias) of 26% in hospitals that adopted this program, whereas hospitals without the program saw an 18% increase in these infections. Aouni and *al.*[44] reported a significant decrease in the incidence rate of healthcare-associated pneumonia from 18.4% to 11.1% ($p = 0.037$) in a study conducted in 3 intensive care units at the Central Army Hospital after the implementation of a prevention program (healthcare personnel training, provision of handwashing materials). Makhlouf[45] reported a reduction in the rate of surgical site infections in the obstetrics and gynecology department after a training and education program for healthcare personnel, decreasing from 5.1% to 4.7% (NS). The multidisciplinary team of Rauk PN[46] reported an 84% reduction in the rate of surgical site infections in cesarean deliveries, decreasing from 7.5% (33/441) in January-July 2006 to 1.2% (5/436) in January-July 2007 ($p < 0.001$) after an education and training program for personnel.

Riley MM and *al.*[47] reported a 63.5% reduction in surgical site infection rates in cesarean deliveries by ensuring adherence to prevention guidelines and improving skin antisepsis ($p < 0.01$). The rate of surgical site infections decreased from 6.27% before the implementation of measures to 2.29% after.

We found similar results, as when evaluating the impact of healthcare personnel training with awareness-raising and the implementation of incentive reminders in the workplace without adherence to the surgical checklist (CL) in the operating room, we significantly reduced the rate of surgical site infections in cesarean deliveries. The risk of a surgical site infection was reduced fourfold after adjustment for confounding factors (adjusted odds ratio of 0.25, 95% CI: [0.1-0.6], $p = 0.002$).

Regarding the impact of adherence to the surgical checklist (CL) in the operating room, four surgical site infections occurred among the 179 cesarean deliveries with CL control in the operating room, resulting in an incidence rate of 2.23%.

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The first study to demonstrate the impact of the CL on reducing surgical site infections was conducted by the WHO as part of the "The Safe Surgery Saves Lives" program led by Haynes and *al.*[48] between October 2007 and September 2008 in eight hospitals in eight cities with different economic levels. The results were very conclusive; postoperative complications were reduced by 36.4% after the introduction of the checklist (11.0% before versus 7.0% after, $p < 0.001$), and surgical site infections by 45.2% (6.2% before versus 3.4% after, $p < 0.001$).

Ng W. et al.[49] observed a significant reduction in the rate of surgical site infections (SSIs) in cesarean deliveries by 50% (from 8.2% initially to 4.1%) after implementing a surgical safety checklist with a care bundle for SSI prevention, including optimizing the timing of antibiotic prophylaxis and improving the surgical site preparation by avoiding inappropriate hair removal (through patient education during prenatal consultations).

Rogier M.P.H. and Crolla[50] reported a 36% decrease in the rate of SSIs after adjusting for confounding factors following the implementation of a care bundle. This was a prospective quasi-experimental cohort study conducted on patients undergoing colorectal surgery between 2008 and 2012 (4 years). The bundle of measures included preoperative antibiotic prophylaxis, appropriate hair removal before surgery, preoperative normothermia, and adherence to operating room discipline.

A systematic review and meta-analysis conducted by Judith and al.[51], based on the results of numerous randomized comparative trials focused on "the impact of a care bundle on the incidence of SSIs." The list of measures included basic interventions such as antibiotic administration, appropriate hair removal, glycemic control, and normothermia. Sixteen randomized trials and fifteen cohort studies were included in the analysis, with the SSI rate being 7% (328/4649) in the group with the implementation of measures and 15% (585/3866) in the control group, resulting in a risk reduction of 0.55 (95% CI [0.39–0.77], $p < 0.01$).

An Australian study[52] showed a 50% reduction in the SSI rate after implementing a care bundle transcribed onto a checklist, with the SSI rate being 15% (95% CI [10.4–20.2]) before versus 7% (95% CI [3.4–12.6]) after.

A Tunisian study[53] reported a significant reduction after implementing the WHO checklist, with the proportion of SSIs being 13.5% in the study before implementation, decreasing to 1.3% afterward.

In our study, adopting a before-and-after methodology, we observed a decrease in the incidence rate of SSIs by introducing the adherence aid tool for preventive measures, the "Patient Safety in the Operating Room" checklist with the care bundle for SSI prevention including healthcare personnel training, improvement in adherence and quality of surgical hand disinfection technique by friction, and improvement in surgical site preparation by avoiding inappropriate hair removal. The SSI rate decreased by 86%, and the risk of SSI occurrence in cesarean deliveries was 0.063 (95% CI: [0.02–0.2], $p < 0.00001$), meaning it was 15.9 times lower after implementing all measures.

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VI. CONCLUSION

Ultimately, it seems that the SSI surveillance program coupled with the implementation of the checklist had a protective impact, affirming that infectious risk management requires meticulous organization and effective coordination among all stakeholders (nurses, surgeons, anesthetists) involved in various technical activities in the operating room. The essence of SSI prevention revolves around preventable infections. Other risk factors specific to patients remain an intrinsic characteristic and do not provide healthcare providers with any

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