

A Simple Infection Prevention 'Bundle' Including Preoperative Bath With Hair-Wash to Reduce Surgical Site Infection (SSI) Following Elective Caesarean and Gynaecological Surgery in India

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ABSTRACT

Background: Surgical site infections (SSIs) may be reduced by following SSI prevention measures. We assessed the SSI rate following caesarean section (CS) and gynaecologic surgery after implementing a simple SSI prevention bundle including preoperative bath and hair wash. **Methods:** The study was carried out in two hospitals in North India (Post Graduate Institute of Medical Education and Research [PGIMER] and Civil Hospital CH) from August 2018 to July 2019. The SSI rate during intervention period (9 months) was compared with baseline rate (3 months). Womens' knowledge about SSI was assessed preoperatively and after counselling, postoperatively. **Results:** The baseline SSI rate after CS (n = 165) was 11.1% at PGIMER and 8.5% at CH. After gynae surgery (n = 172), it was 13% at PGIMER and 11.5% at CH. During intervention, (CS = 585, gynae surgery = 503), SSI rate was reduced significantly at PGIMER (CS: 11.1% to 3.7%, $P = 0.048$; gynae surgery: 13% to 7.1%, $P = 0.027$), but not at CH (CS: 8.5% to 8.2%, $P = 0.903$; gynae surgery: 11.5% to 11.4%, $P = 0.984$). Three measures were followed more often at PGIMER than at CH: before CS, bath with hair-wash: 99.3% vs 78.5%, $P = 0.00$, hair-clipper vs razor: 100% vs 5.1%, $P = 0.00$ and antibiotic prophylaxis ≤ 120 min: 100% vs 92.4%, $P = 0.00$; and before gynae surgery, bath with hair-wash: 93.2% vs 71%, $P = 0.00$, hair-clipper vs razor: 93.6% vs 1.9%, $P = 0.00$ and antibiotic prophylaxis ≤ 120 min: 100% vs 80.8%, $P = 0.00$. Postoperatively, womens' knowledge about SSI prevention improved significantly at the two sites. **Conclusion:** The reduction in SSI at PGIMER was attributed to better compliance to SSI prevention measures listed above. Counselling women about simple SSI prevention method like preoperative bath with scalp hair wash increased their knowledge about these significantly.

Keywords: Caesarean section, gynaecological abdominal surgery, SSI

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Introduction

Surgical site infections (SSI) lead to increased burden on healthcare systems, besides causing distress to patients. The World Health Organization (WHO) reported SSI to be the most frequent hospital acquired infection in low- or middle-income

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countries (LMICs) with a pooled incidence of 11.8%.^[1] The SSI rates in India were reported as 30.7% and 5.4% among clean surgeries.^[2] While the global estimates of SSI vary from 0.5% to 15%, studies in India report higher rates ranging from 23% to 38%.^[2] The incidence of SSI following a caesarean section (CS) ranges from 3% to 15% worldwide.^[3] The SSI rate after hysterectomy was 1.7% in the USA.^[4,5] In India, Shahane *et al.*^[6] reported the SSI rate to be 6%, while Bangal *et al.*^[7] reported it to be 2.8% in gynaecological surgeries. Pathak *et al.*^[8] observed the SSI rate to be 7.84% among 1173 patients undergoing obstetric and gynaecologic surgeries in rural India, with a lower incidence among obstetric than gynaecologic surgeries (1.2% vs 10.3%).

SSI may be prevented by following a group of pre, intra, and postoperative prevention measures or 'bundles'.^[9,10] These include adequate glycaemic control, preoperative shower, preoperative cleansing of surgical site with antiseptics, preoperative antimicrobial prophylaxis, sterile surgical equipment, short duration of surgery, less blood loss, maintaining normothermia, proper oxygenation and care of incision after surgery.^[11-13] A less frequently addressed issue is the regimen for preoperative bath or shower. A Cochrane review evaluating chlorhexidine (CHG) wipes or showers concluded that though it may reduce the microbial burden, clinical evidence of benefit was not present.^[14] The CDC advises a shower or full body bath with soap (antimicrobial or non-antimicrobial) or an antiseptic agent at least the night before surgery.^[15] Two sequential showers with CHG (4%), with 1-min pause before rinsing resulted in its skin surface concentration to be higher than its minimum inhibitory concentration for SSI pathogens, but whether this will translate into lower SSI rates is not known.^[15] Compliance may be better with a single preoperative bath as a regimen of daily CHG bath for 5 days preoperatively was associated with a low full adherence rate of 39%.^[10]

The issue of washing scalp hair during a preoperative bath is not addressed specifically, though a preoperative shower is likely to include it. Among 1093 patients undergoing elective clean biliary tract, inguinal hernia and breast surgeries, a CHG shower (including scalp) a day before surgery reduced SSIs better than a partial wash restricted to surgical site.^[14,16] This issue assumes importance in India, as culturally, many Indian women have long hair and use a bucket for bathing, rather than a shower. A bucket-bath may not always include scalp hair wash. Furthermore, they may have travelled from villages or small towns to big hospitals in cities for surgery. Due to lack of awareness, as well as lack of proper facility away from home, they may be unable to take a proper preoperative bath with hair wash. Unwashed scalp hair for several days may harbour SSI causing bacteria which may reach the surgical site by touching by the patient's hands. Hence, ensuring compliance to a preoperative bath regimen may help to reduce SSI after CS and gynaecological abdominal surgery.

This study was planned to see the incidence of SSI after implementing simple SSI prevention measures which included a

preoperative bath with scalp hair wash among women undergoing elective CS and gynaecological surgery. As many women consult primary care physicians prior to admission to a hospital for CS or gynaecological surgery, knowledge about simple SSI prevention measures may help them to guide these women.

Methods

This study was approved and funded by the Indian Council of Medical Research, India. It was carried out from August 2018 to July 2019 after approval of the Ethics Committees of the Post Graduate Institute of Medical Education and Research, Chandigarh and Civil Hospital, Panchkula, Haryana. Women undergoing Elective CS and Elective Gynaecological abdominal surgery (hysterectomy and surgery on the ovaries or tubes for benign or malignant indications) were enrolled after an informed written consent and willingness to follow the SSI prevention measures. We excluded women with history of infection within 2 weeks prior to surgery (eg, febrile illness and urinary tract infection) or intraoperatively (pelvic or peritoneal abscess), and those needing intraoperative bowel or urinary tract surgery. Women undergoing emergency surgery (CS or laparotomy for ruptured ectopic pregnancy) were also excluded.

A SSI prevention bundle checklist was prepared incorporating SSI prevention measures as advised by the WHO.^[12,13] A SSI prevention measures pro forma was prepared to record clinical data, anti-microbial prophylaxis, surgical details and postoperative outcome. SSI is classified as a superficial, deep and organ space infection (CDC, 2018).^[17] A pro forma to note women's knowledge about the SSI prevention measures was designed by a psychologist.

For the first 3 months, baseline data of SSI were collected. During this period, as per hospital practice, patients were following routine SSI prevention measures advised by the doctor in-charge. During the next 9 months, the SSI prevention bundle was implemented. Women admitted for elective CS or gynaecological surgery were asked preoperatively about their knowledge and acceptability of SSI prevention measures. The 15-point knowledge assessment questionnaire assigned a score of 0 (lack of knowledge) or 1 (knowledge present) about each health related question. Women were allocated into a 'good' (score 11–15), 'average' (score 6–10) or 'poor' (score 0–5) category. After they had answered the questionnaire preoperatively, project staff educated them about SSI prevention measures. Thereafter, they were counselled to follow the SSI prevention bundle with emphasis on the preoperative bath regimen including scalp hair wash within 24 h preceding surgery. They were advised to use their routine soap and shampoo and to wear clean cotton clothes after bath. Bathing facilities (warm water or shower) were made available in the wards. If surgery was delayed to beyond 24 h but less than 48 h, the bath regimen (but not hair wash) was repeated. If surgery was postponed by more than 48 h, the entire bath regimen including hair wash was repeated. The SSI prevention measures followed pre-, intra- and postoperatively

were noted. Details of surgery, antimicrobial surgical prophylaxis and postoperative course including temperature record and investigations were also noted. Postoperatively, knowledge and acceptability of SSI prevention measures were reassessed.

The women were followed-up till discharge from hospital and for a total of 30 days, telephonically or during hospital visits. Telephone number of project staff was provided and they were asked to report in case of fever, discharge from the surgical site or any other problem. The incidence of SSI was noted, along with its treatment. In women, who developed SSI or endometritis, swabs were collected from infected area for bacterial culture and sensitivity for further management by treating consultant.

The primary outcome was the change in incidence of SSI as compared with the baseline following implementation of the SSI prevention bundle among women undergoing elective CS and gynaecological abdominal surgery. The secondary outcome was to observe the knowledge, acceptability and compliance of women toward preoperative bath including scalp hair wash as a part of the SSI prevention bundle.

Results

Figures 1 and 2 show the flowchart of recruitment of women at the two sites. Table 1 shows the demographic details of women undergoing elective CS. The mean age of women at PGI (30.3 ± 4.8 years and 29.7 ± 4.8 years) was higher than at CH (26.6 ± 3.7 years and 26.9 ± 4.4 years), and the mean BMI and haemoglobin level were similar. However, women at PGI had an overall higher education level: 53% and 43% were graduates or

above as compared with 34% and 27% at CH. Although majority of the women were housewives, more women at PGI were employed as compared with CH. The most common indication for elective CS was previous CS. Adherent placenta was more common at PGI which is a tertiary hospital than at CH which is a district hospital.

Table 2 shows the demographic details of women undergoing elective gynaecological abdominal surgery. The mean age of the women at PGI and CH at baseline was similar, but was higher at PGI at intervention (45.9 ± 13.6 years vs 41.3 ± 7.5 years). The mean BMI was similar, however, the mean haemoglobin of women at PGI was lower than at CH at baseline (10.9 ± 1.7 g/dl vs 12.2 ± 1.6 g/dl, P = 0.001). Women at PGI had a higher level of education: 26.7% and 33.2% were graduates or above as compared with only 3.8% and 5.1% at CH. Although majority of the women were housewives, more women at PGI were employed as compared with CH. The indications for surgery were significantly different at the two sites (P = 0.000), with malignancy being the most common indication at PGI and fibroid uterus at CH.

Table 3 shows the incidence of SSI at baseline and during intervention. At PGI, the incidence of SSI reduced significantly during intervention as compared with baseline (11.1% to 3.7% in CS, 13% to 7.1% in gynaecological surgery). However, this reduction was not observed at CH (8.5% and 8.2% in CS and 11.5% and 11.4% in gynaecological surgery). Majority of the women had superficial SSI. At baseline, one woman at CH had organ-space SSI after hysterectomy for fibroids and had laparotomy for pelvic abscess after 3 weeks. During intervention,

Table 1: Demographic details of women undergoing Elective Caesarean Section at the two sites

Patient Characteristics	Baseline period (CS)			Intervention period (CS)		
	PGIMER (n=36)	CH (n=129)	P	PGIMER (n=267)	CH (n=318)	P
Age (years)	30.3±4.8	26.6±3.7	0.000	29.7±4.8	26.9±4.4	0.02
Range	21-38	18-38		19-57	18-46	
BMI (kg/m ²) Mean±SD	25.2±4.0	25.7±5.7	0.539	26.3±5.1	25.9±4.3	0.411
Range	17-34	11.2-49.9		17-42.2	12.1-43.5	
Hb (g/dl) Mean±SD	11.6±1.6	11.2±1.5	0.211	11.12±1.4	11.5±1.6	0.1
Range	8.6-15	7.4-14.2		6-14	6.3-14.6	
Education			0.105			0.000
Illiterate	0	8 (6.2%)		9 (3.4)	33 (10.4)	
Up to class 8	2 (5.6%)	23 (17.8%)		40 (14.9)	70 (22)	
Class 9 to 12	15 (41.7%)	54 (41.9%)		103 (38.6)	129 (40.6)	
Graduate or more	19 (52.9%)	44 (34.1%)		115 (43)	86 (27)	
Occupation			0.506			0.001
Housewife	30 (83%)	113 (87.6%)		226 (84.6)	292 (91.8)	
Semi-skilled (labourer/tailor/domestic help)	0	0		2 (0.74)	5 (1.6)	
Skilled/professional	6 (17%)	16 (12.4%)		39 (14.5)	21 (6.6)	
Indications for CS			0.000			0.000
Previous CS	15 (41.7%)	82 (63.6%)		116 (43.4%)	216 (67.9%)	
Malpresentation	11 (30.6%)	10 (7.8%)		51 (19.1%)	56 (17.6%)	
Cephalo-pelvic disproportion	0	9 (7.0%)		3 (1.1%)	10 (3.1%)	
Fetal growth restriction	0	18 (14.0%)		15 (5.6%)	23 (7.2%)	
Bad Obstetric History	3 (8.4%)	9 (7%)		52 (19.5%)	12 (3.8%)	
Adherent placenta	7 (19.44%)	1 (0.8%)		30 (11.2%)	1 (0.3%)	

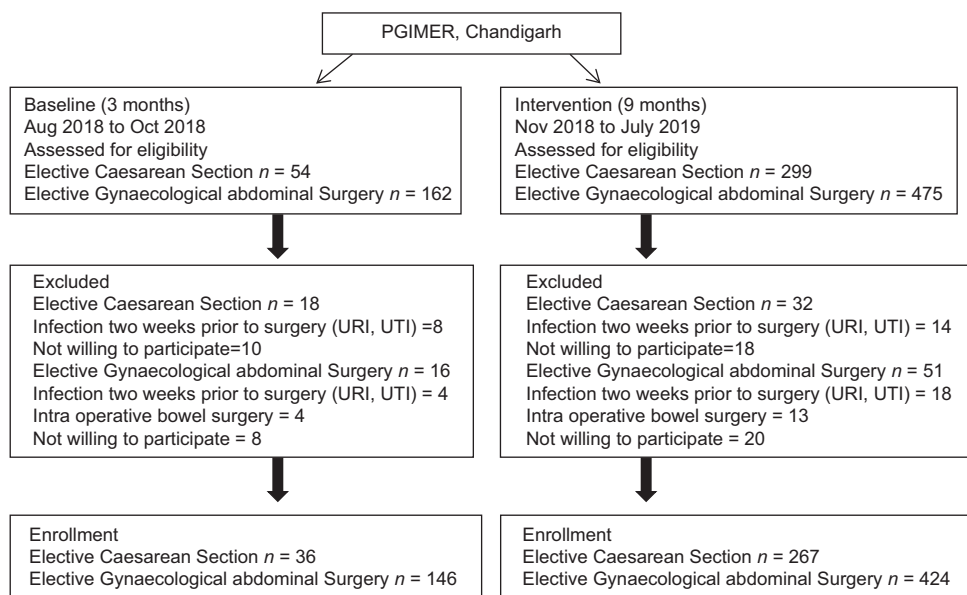


Figure 1: Flowchart of patient recruitment at baseline and during intervention in PGIMER, Chandigarh

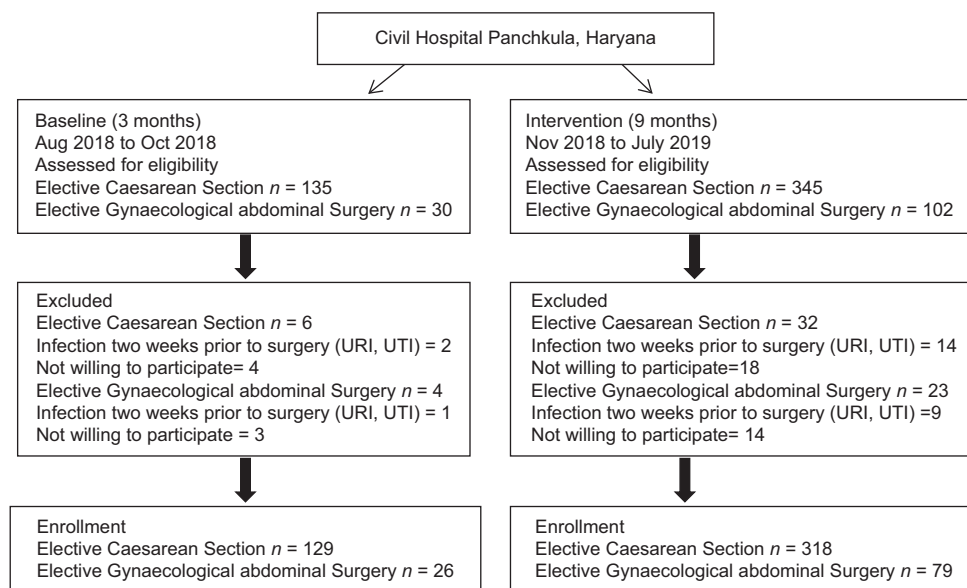


Figure 2: Flowchart of patient recruitment at baseline and during intervention in Civil Hospital, Panchkula, Haryana

one woman at CH had organ space SSI after CS and had laparotomy for pyoperitoneum after 17 days.

Tables 4 and 5 list the SSI prevention measures followed during CS and gynaecological surgery at the two sites. At PGI, there was a significant increase in the uptake of two measures during intervention as compared with baseline: preoperative bath with hair wash (CS: 50% to 93.2%, gynae surgery: 65% to 99.3%) and use of clipper instead of razor for incision-site hair removal (CS: 75% to 93.6%, gynae surgery: 74% to 100%). At CH, there was increased uptake of preoperative bath with hair wash during intervention (CS: 21% to 71%, gynae surgery: 27% to 78.5%). Also, institution of antibiotic prophylaxis ≤120 min increased (CS: 29% to 80.8%, gynae surgery: 84.6% to 92.4%). However, use of clipper for hair removal was not practiced.

During intervention, three preoperative measures were followed in significantly more women at PGI than at CH. Among women undergoing CS: bath with hair-wash: 93.2% vs 71%, $P = 0.000$, antibiotic ≤120 min: 100% vs 80.8%, $P = 0.000$ and use of clipper: 93.6% vs 1.9%, $P = 0.000$; and among women undergoing gynaecological surgery: bath with hair-wash: 99.3% vs 78.5%, $P = 0.000$, antibiotic ≤120 min: 100% vs 92.4%, $P = 0.000$ and using clipper: 100% vs 5.1%, $P = 0.000$. Tables 6 and 7 show the pre- and postoperative knowledge assessment of women during intervention. Preoperatively, knowledge regarding a few practices was less and fewer than 20% women at each site were aware of pre- and postoperative bath with hair wash and its timing, pre- and postoperative exercises related to legs and breathing, postoperative ambulation and using a hair clipper instead of a razor. This questionnaire was answered again in the postoperative

Table 2: Demographic details of women undergoing Elective Gynaecological abdominal Surgery at the two sites

Patient Characteristics	Baseline period (Gynae Surgery)			Intervention period (Gynae Surgery)		
	PGIMER (n=146)	CH (n=26)	P	PGIMER (n=424)	CH (n=79)	P
Age (years) Mean±SD	44.2±13.4	42.0±6.2	0.197	45.9±13.6	41.3±7.5	0.003
Range	10-76	30-52		16-85	22-58	
BMI (kg/m ²) Mean±SD	24.1±4.8	22.7±3.9	0.153	24.8±5.4	23.6±12.3	0.056
Range	14.2-39.2	15.5-30.3		13-43.4	14.2-38.8	
Hb (g/dl) Mean±SD	10.9±1.7	12.2±1.6	0.001	11.4±1.6	11.9±1.9	0.08
Range	6.7-16.7	7.9-14.8		6.7-16	9.3-14.8	
Education			0.000			0.000
Illiterate	23 (15.8%)	13 (50%)		75 (17.7)	23 (29.1)	
Up to class 8	32 (21.9%)	8 (30.8%)		87 (20.5)	33 (41.8)	
Class 9-12	52 (35.6%)	4 (15.4%)		121 (28.5)	19 (24.1)	
Graduate or more	39 (26.7%)	1 (3.8%)		141 (33.2)	4 (5.1)	
Occupation			0.208			0.005
Housewife	113 (77.4%)	24 (92.3%)		345 (81.4)	71 (89.9)	
Semi-skilled (labourer/tailor/domestic help)	4 (2.7%)	0		9 (2.1)	5 (6.3)	
Skilled/professional	29 (19.9%)	2 (7.7%)		70 (16.5)	3 (3.8)	
Indication for Surgery						0.000
Fibroids/menorrhagia	48 (32.9%)	23 (88.5%)		152 (35.8%)	64 (81%)	
Benign ovarian tumour/endometriosis	53 (36.3%)	3 (11.5%)		106 (25%)	10 (12.7%)	
Malignant ovarian tumour	30 (20.5%)	0		107 (25.2%)	0	
Carcinoma endometrium	8 (5.5%)	0		34 (8%)	0	
Carcinoma cervix/CIN	7 (4.8%)	0		17 (4%)	0	
Uterine sarcoma				8 (2%)	0	
Tubal recanalization				1 (0.23%)	5 (6.3%)	

Table 3: Comparison of incidence of SSI at baseline and post intervention at the two sites

Incidence of SSI	PGIMER	CH	P
Elective Caesarean Section			
Incidence of SSI during baseline period (3 months)	4/36 (11.1%)	11/129 (8.5%)	0.714
Superficial	4/4 (100%)	10/11 (91%)	
Deep	0	1/11 (9%)	
Organ/Space	0	0	
Incidence of SSI during intervention period (9 months)	10/267 (3.7%)	26/318 (8.2%)	0.026
Superficial	10 (100%)	25 (96.2%)	
Deep	0	0	
Organ/Space	0	1 (3.8%)	
P	0.048	0.903	
Gynaecological Abdominal Surgery			
Incidence of SSI during baseline period (3 months)	19/146 (13%)	3/26 (11.5%)	0.098
Superficial	17/19 (89.5%)	2/3 (66.7%)	
Deep	2/19 (10.5%)	0	
Organ/Space	0	1/3 (33.3%)	
Incidence of SSI during intervention period (9 months)	30/424 (7.1%)	9/79 (11.4%)	0.188
Superficial	27 (90%)	8 (88.9%)	
Deep	3 (10%)	1 (11.1%)	
Organ/Space	0	0	
P	0.027	0.984	

period and a significant improvement in the knowledge score was observed at the two sites, with about 80% having a ‘good’ score as compared with fewer than 8% in the preoperative period.

Discussion

In this study, we observed the incidence of SSI following an intervention in which research staff provided information about

simple SSI prevention measures to women undergoing elective CS and gynaecological abdominal surgery, and encouraged their uptake by women. We also noted the SSI prevention bundle measures being followed before, during and after surgery in two hospitals in North India. During the intervention period, the SSI rate was reduced significantly at Post Graduate Institute of Medical Education and Research (PGIMER) as compared with baseline (CS: 11.1% to 3.7%, *P* = 0.048; gynae surgery:

Table 4: SSI prevention bundle checklist measures followed at baseline and after intervention among women undergoing Elective Caesarean Section at the two sites

SSI prevention bundle checklist measures	PGIMER		CH	
	CS			
	Baseline (n=36)	Intervention (n=267)	Baseline (n=129)	Intervention (n=318)
Preoperative bath and hair wash	18 (50%)*	249 (93.2%)*	27 (21%)#	226 (71%)#
Preoperative antibiotic ≤120 min	36 (100%)	267 (100%)	38 (29%) ##	257 (80.8%)##
Mechanical bowel prep and oral antibiotics	NA	NA	NA	NA
Hair removal with clipper or cream	27 (75%)**	250 (93.6%)**	None	6 (1.9%)
Surgical site prep with antiseptic (betadine)	36 (100%)	267 (100%)	129 (100%)	318 (100%)
Surgical hand prep	36 (100%)	267 (100%)	129 (100%)	318 (100%)
Enhanced nutritional support	NA	NA	NA	NA
Perioperative oxygenation (60%) in women given GA	8/8 (100%) women given GA	51/51 (100%) women given GA	NA (spinal anaesthesia)	NA (spinal anaesthesia)
Maintaining normothermia	36 (100%)	267 (100%)	129 (100%)	318 (100%)
Perioperative blood glucose control in diabetics	1/1 (100%) with diabetes	11/11 (100%) with diabetes	1/1 (100%)	NA
Maintenance of adequate circulating volume	36 (100%)	267 (100%)	129 (100%)	318 (100%)
Drapes and gowns	36 (100%)	267 (100%)	129 (100%)	318 (100%)
Incisional wound irrigation	Not Followed	Not Followed	Not Followed	Not Followed
Postoperative				
No additional antibiotic or its prolongation	34/36 (94%)	252/267 (94%)	all women had prolongation of antibiotic	all women had prolongation of antibiotic
Standard dressings	36 (100%)	267 (100%)	129 (100%)	318 (100%)
Antimicrobial prophylaxis in presence of drain	NA	Drain- 2 Additional antibiotic=2	NA	NA

P (significant) ***,##P=0.000

Table 5: SSI prevention bundle checklist measures followed at baseline and after intervention among women undergoing Elective Gynaecological abdominal surgery at the two sites

SSI prevention bundle checklist measures	PGIMER		CH	
	Gynae surgery			
	Baseline (n=146)	Intervention (n=424)	Baseline (n=26)	Intervention (n=79)
Preoperative bath and hair wash	95 (65%) *	421 (99.3%)*	7 (27%)#	62 (78.5%)#
Preoperative antibiotic ≤120 min	146 (100%)	424 (100%) No - 0	22 (84.6%)	73 (92.4%)
Mechanical bowel prep and oral antibiotics	30/30 (100%) (ovarian tumour)	107/107 (100%) (ovarian tumour)	NA	NA
Hair removal with clipper or cream	108 (74%)**	424 (100%)**	None	4 (5.1%)
Surgical site prep with antiseptic (betadine)	146 (100%)	424 (100%)	26 (100%)	79 (100%)
Surgical hand prep	146 (100%)	424 (100%)	26 (100%)	79 (100%)
Enhanced nutritional support	8/8 (100%) (post NACT)	54/54 (100%) (post NACT)	NA	NA
Perioperative oxygenation (60%) in women given GA	95/95 (100%) women given GA	399/399 (100%) women given GA	NA (spinal anaesthesia)	NA (spinal anaesthesia)
Maintaining normothermia	146 (100%)	424 (100%)	26 (100%)	79 (100%)
Perioperative blood glucose control in diabetics	13/13 (100%) diabetic	47/47 (100%) diabetic	1/1 (100%) diabetic	NA
Maintenance of adequate circulating volume	146 (100%)	424 (100%)	26 (100%)	79 (100%)
Sterile drapes and gowns	146 (100%)	424 (100%)	26 (100%)	79 (100%)
Incisional wound irrigation	Not Followed	Not Followed	Not Followed	Not Followed
Postoperative				
No additional antibiotic or its prolongation	133/146 (91%)	383/424 (90%)	0	0
Standard dressings	146 (100%)	424 (100%)	26 (100%)	79 (100%)
Antimicrobial prophylaxis in presence of drain	Drain- 2 Additional antibiotic=2	Drain-10 Additional antibiotic=8	NA	NA

P (significant) *,**,#P=0.000

Table 6: Pre- and Postoperative knowledge assessment of women (at intervention) undergoing Elective Caesarean section at two sites

Knowledge Assessment Questions	PGIMER (n=267)			CH (n=318)		
	Preoperative	Postoperative	P	Preoperative	Postoperative	P
Does she know her haemoglobin level?	108 (40.4)	206 (77.2)	0.000	108 (33.9)	213 (66.9)	0.000
If her blood pressure was normal or high?	80 (29.9)	200 (74.9)	0.000	143 (44.9)	208 (65.4)	0.000
If her sugar level was normal or high?	72 (26.9)	195 (73)	0.000	147 (46.2)	207 (65.1)	0.000
Is her weight according to height is normal, less or high?	126 (47.2)	243 (91)	0.000	243 (76.4)	308 (96.9)	0.000
Should a preoperative bath be taken within 24 h of surgery?	51 (19.1)	253 (94.8)	0.000	19 (5.9)	299 (94)	0.000
Should a postoperative bath be taken 72 h (3 days) after surgery?	23 (8.6)	247 (92.5)	0.000	6 (1.9)	302 (94.9)	0.000
Does bath before surgery include hair wash?	38 (14.2)	251 (94)	0.000	22 (6.9)	301 (94.7)	0.000
Washing/cleaning her hands before and after meals/before touching surgical area and after using toilet?	149 (55.8)	249 (93.3)	0.000	136 (42.8)	307 (96.5)	0.000
Pre/post operation related exercises related to legs and breathing?	15 (5.6)	217 (81.3)	0.000	14 (4.4)	295 (92.8)	0.000
Can a patient be allowed to walk on the next day after hysterectomy or C.S.?	42 (15.7)	246 (92.1)	0.000	64 (20.1)	313 (98.4)	0.000
Is she able to record her own temperature using a thermometer?	196 (73.4)	217 (81.3)	0.000	133 (41.8)	147 (46.2)	0.001
Should hair be removed at site of incision before surgery?	103 (38.6)	231 (86.5)	0.000	273 (85.9)	289 (90.9)	0.000
A fresh disposable blade be used for each patient?	119 (44.6)	246 (92.1)	0.000	289 (90.9)	313 (98.4)	0.000
Is a clipper better than a razor?	39 (14.6)	204 (76.4)	0.000	11 (3.5)	224 (70.4)	0.000
If the wound dressing is wet or stained with discharge, should it be changed?	94 (35.2)	249 (93.3)	0.000	258 (81.1)	316 (99.4)	0.000
Knowledge score						
0-5	173 (64.8)	9 (3.4)	0.00	153 (48.1)	4 (1.3)	0.00
6-10	75 (28.1)	46 (17.2)		145 (45.6)	48 (15.1)	
11-15	19 (7.1)	212 (79.4)		20 (6.3)	266 (83.6)	

(%) in parentheses

Table 7: Pre- and Postoperative knowledge assessment of women (at intervention) undergoing Elective Gynaecological abdominal surgery at two sites

Knowledge Assessment Questions	PGIMER (n=424)			CH (n=79)		
	Preoperative	Postoperative	P	Preoperative	Postoperative	P
Does she know her haemoglobin level?	150 (35.4)	359 (84.7)	0.000	18 (22.8)	58 (73.4)	0.000
If her blood pressure was normal or high?	127 (29.9)	346 (81.6)	0.000	30 (37.9)	53 (67.1)	0.000
If her sugar level was normal or high?	102 (24.1)	341 (80.4)	0.000	28 (35.4)	53 (67.1)	0.000
Is her weight according to height is normal, less or high?	141 (33.3)	369 (87)	0.000	51 (64.6)	75 (94.9)	0.000
Should a preoperative bath be taken within 24 h of surgery?	75 (17.7)	406 (95.8)	0.000	8 (10.1)	78 (98.7)	0.000
Should a postoperative bath be taken 72 h (3 days) after surgery?	28 (6.6)	403 (95)	0.000	3 (3.8)	79 (100)	NA
Does bath before surgery include hair wash?	74 (17.5)	411 (96.9)	0.000	8 (10.1)	79 (100)	NA
Washing/cleaning her hands before and after meals/before touching surgical area and after using toilet?	272 (64.2)	412 (97.2)	0.000	34 (43)	77 (97.5)	0.000
Pre/post operation related exercises related to legs and breathing?	33 (7.8)	395 (93.2)	0.000	3 (3.8)	78 (98.7)	0.000
Can a patient be allowed to walk on the next day after hysterectomy or C.S.?	40 (9.4)	392 (92.5)	0.000	13 (16.5)	78 (98.7)	0.000
Is she able to record her own temperature using a thermometer?	231 (54.5)	292 (68.9)	0.000	19 (24.1)	23 (29.1)	0.125
Should hair be removed at site of incision before surgery?	116 (27.4)	380 (89.6)	0.000	63 (79.8)	70 (88.6)	0.016
A fresh disposable blade be used for each patient?	107 (25.2)	377 (88.9)	0.000	62 (78.5)	75 (94.9)	0.000
Is a clipper better than a razor?	50 (11.8)	352 (83)	0.000	3 (3.8)	60 (75.9)	0.000
If the wound dressing is wet or stained with discharge, should it be changed?	77 (18.2)	386 (91)	0.000	60 (75.9)	79 (100)	NA
Knowledge score						
0-5	302 (71.2)	13 (3.1)	0.00	52 (65.8)	0	0.00
6-10	89 (21)	53 (12.5)		22 (27.8)	16 (20.3)	
11-15	33 (7.8)	358 (84.4)		5 (6.3)	63 (79.7)	

(%) in parentheses

13% to 7.1%, $P = 0.027$). However, at CH, the SSI rate during the intervention period was not reduced as compared with baseline (CS: 8.5% to 8.2%, $P = 0.903$; gynae surgery: 11.5% to

11.4%, $P = 0.984$). Our key finding was that three SSI prevention measures were followed more often at PGIMER than at CH, before CS: bath with hair-wash: 99.3% vs 78.5%, $P = 0.00$, using

hair-clipper instead of razor for incision site hair removal: 100% vs 5.1%, $P = 0.00$ and antibiotic prophylaxis ≤ 120 min before incision: 100% vs 92.4%, $P = 0.00$, and before gynae surgery: bath with hair wash: 93.2% vs 71%, $P = 0.00$, hair-clipper vs razor: 93.6% vs 1.9%, $P = 0.00$ and antibiotic prophylaxis ≤ 120 min before incision: 100% vs 80.8%, $P = 0.00$.

The reduction in SSI at PGI was attributed to better compliance to the abovementioned prevention measures. This may be partly due to a better education level of women at PGI, and partly as PGI is a research institute where new interventions are adopted actively. Furthermore, in CH, preoperative antibiotic is administered in ward by nurses prior to shifting to operation theatre (OT), whereas, in PGI, it is administered by anaesthetists inside the OT, which is better timed. We also observed that counselling women about SSI prevention preoperatively increased their knowledge about these significantly as evident by a higher knowledge score in the postoperative period. These simple interventions are well documented SSI prevention measures.^[12,13] A preoperative bath including scalp hair wash is culturally relevant in India where most women wear long hair. Western literature advises a preoperative 'shower' which includes a hair wash, but this may not be so India, where most women have a bucket-bath which may not always include a hair wash.^[10,14,15]

Dhamecha *et al.*^[18] observed the SSI rate among women undergoing CS and gynaecological surgery ($n = 494$) in a tertiary hospital at Ahmedabad, India; their overall SSI rate of 4.25% was lower than the overall SSI rate at PGI (5.8%) and at CH (8.8%). Dhamecha *et al.*^[18] attributed a low SSI rate to surgery being performed by senior doctors as postgraduation had not yet started in their institute. In this study, surgeries were performed by medical officers in CH and by faculty and residents in PGI. A higher SSI rate (24.2%) among CS was reported by De *et al.*^[19] in New Delhi, India, with premature rupture of membranes, inappropriate antibiotic prophylaxis, and increased duration of hospital stay as significant risk factors. Naphade and Patole^[20] observed an SSI rate of 10.3% in gynaecological surgeries ($n = 985$) in a medical college in Maharashtra, which is similar to this study. The incidence of SSI may vary as these are multifactorial and depend on the patient load, type of hospital, and patient population.

The CDC advises a shower or bath (full body) with soap (antimicrobial or non-antimicrobial) or an antiseptic agent on at least the night before to reduce SSI.^[11] We advised women to use their regular soap and shampoo and the uptake of preoperative bath increased at the two sites, but it was higher at PGI than at CH. SSI prevention measures include preprocedure shower within 24 h of surgery, hair removal with clipper rather than shaving immediately before operation, antibiotic prophylaxis, proper skin preparation, good surgical technique, and covering incision site with a sterile dressing for 24 to 48 h.^[11,21,22] During the intervention, compliance to hair-clipper was low at CH (CS: 1.9% and gynae surgery: 5.1%), while it was 93.6% and 100% among CS and gynae surgery at PGI. A comparison of hair removal by

shaving versus clipping showed a higher risk of wound infection with shaving, as razor can lead to microlesions and colonization of skin at surgical site by microorganisms which increase the chance of postoperative infection.^[23,24] Depilating creams are comparable to clippers for postoperative wound infections, though may cause skin irritation in some.^[23,24]

Providing knowledge about SSI prevention should be included in hospital protocols and a study in France showed that 80% patients received no information about SSI during hospitalization.^[25] Our 15-point SSI prevention questionnaire showed that at each site, most women (>75%) were aware of hand hygiene, but few (<20%) were aware of a pre- or postoperative bath schedule or about legs and breathing exercises. During intervention, knowledge score improved significantly after counselling, showing good communication by research staff. Specifically, knowledge about preoperative bath and hair-wash was present in > 94% women at the two sites. However, compliance to this was present among 93.2% and 99.3% women at PGI (CS and gynae surgery, respectively) but significantly less among women at CH (71% and 78.5% in CS and gynae surgery, respectively). The possible reasons were less bathrooms (1 shower and 1 bathroom for 50 women) with erratic availability of warm water and fear of slipping in the bathroom. In PGI, one ward has three shower bathrooms for 42 women, and the other ward has 3 bathrooms for 57 women. Providing plastic stools or chairs improved compliance to bath at PGI. Hence, providing knowledge as well as proper facility may increase compliance to preoperative bath and hair wash. However, a bath on the 3rd postoperative day was more difficult to achieve as women, their relatives and even some health providers felt that bath should after suture removal (7th to 10th day) only. After reviewing available evidence, the PGI faculty agreed unanimously on a bath on the 3rd postoperative day (72 h after surgery).^[1,26-28] During bath, the stitch line is covered with a waterproof dressing or plastic cover, which is replaced by a fresh sterile dressing after bath. Motivating women for a postoperative bath in hospital makes them confident about taking it at home subsequently, or else, they avoid it till suture removal which leads to poor hygiene and may cause SSI. Although the knowledge of women about postoperative bath increased from <10% to >90% women during intervention, many women (~70%) did not take it in hospital because of their traditional beliefs. Even the response of healthcare providers toward postoperative bath in CH was not encouraging and one of them even stated 'water is the enemy of stitches' in vernacular language'.

A study from a teaching hospital in Nepal suggested that patients require information on SSI prevention to increase their involvement in its prevention.^[29] A significant decline in SSI rate from 8.6% to 2.9% was observed with a stepwise plan and bundle providing patient education and prevention measures in pre-, peri-, and postoperative period.^[30] Keeping this in mind, a video was prepared incorporating evidence-based health advice for Indian women undergoing a CS.^[1,26-28] The video is available on PGIMER website (www.pgimer.edu.in) and YouTube (https://youtu.be/W5gKB3_-AjQ). Finally, accumulation of accurate

data about SSIs along with implementation of SSI prevention bundles may lower its incidence in LMICs.^[31,32]

Conclusion

To conclude, providing knowledge about simple SSI prevention measures to patients and health staff including primary care physicians will increase the compliance of patients to follow simple measures like a preoperative bath with scalp hair wash. Further, providing facilities (eg, hair clippers, showers, and clean bathrooms with warm water in wards) will improve the uptake of these measures. Finally, assigning the preoperative antibiotic prophylaxis to the anaesthesia team inside the OT (rather than given by nursing staff in ward before shifting to OT) for its optimal timing may have a role in reducing the burden of SSI.

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The project staff prepared a script and were the actors in the video recorded with the help of Department of Photography, PGI, Chandigarh. This video explains health care advice to be followed before and after Caesarean section and gynaecological abdominal surgeries.

Ethics approval

1. PGIMER, Chandigarh: PGI/IEC/2018/000364 dated 26.03.2018
2. CH, Panchkula: CH/Pkl/2018 dated 02.04.2018

Authors contributions:Site 1: PGIMER

RB: design of study proposal, execution of study, compiling results & drafting the manuscript

VS: design of study proposal,

MR: execution of study and checking results

MB: design of study proposal, checking results

RN: design of knowledge assessment questionnaire, checking results

ND: execution of study, arranging facilities like showers and hair-clippers, checking results

Site 2: CH

SS: execution of study, checking results

AS: execution of study, checking results

LJ: execution of study, checking results

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patients have given their consent for their clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

References

1. WHO | Global guidelines on the prevention of surgical site infection. 2016. Available from: <http://www.who.int/gpsc/ssi-guidelines/en/>. [Last accessed on 2019 Jan 12].
2. Kamat US, Fereirra AMA, Kulkarni MS, Motghare DD. A prospective study of surgical site infections in a teaching hospital in Goa. *Indian J Surg* 2008;70:120-4.
3. Suarez-Easton S, Zafran N, Garmi G, Salim R. Postcesarean wound infection: Prevalence, impact, prevention, and management challenges. *Int J Womens Health* 2017;9:81-8.
4. Lake AG, McPencow AM, Dick-Biascoechea MA, Martin DK, Erekson EA. Surgical site infection after hysterectomy. *Am J Obstet Gynecol* 2013;209:490.e1-9.
5. Black JD, de Haydu C, Fan L, Sheth SS. Surgical site infections in gynecology. *Obstet Gynecol Surv* 2014;69:501-10.
6. Shahane V, Bhawal S, Lele MU. Surgical site infections: A one year prospective study in a tertiary care center. *Int J Health Sci* 2012;6:79-84.
7. Bangal VB, Borawake SK, Shinde KK, Gavhane SP. Study of surgical site infections following gynaecological surgery at tertiary care teaching hospital in Rural India. *Int J Biomed Res* 2014;5:113-6.
8. Pathak A, Lundborg CS, Mahadik K, Swami MB, Sharma M, Roy PK, *et al.* Incidence and risk factors for surgical site infections in obstetric and gynecological surgeries from a teaching hospital in rural India. *Antimicrob Resist Infect Control* 2017;6:66.
9. Tanner J, Padley W, Assadian O, Leaper D, Kiernan M, Edmiston C. Do surgical care bundles reduce the risk of surgical site infections in patients undergoing colorectal surgery? A systematic review and cohort meta-analysis of 8,515 patients. *Surgery* 2015;158:66-77.
10. Schweizer ML, Chiang H-Y, Septimus E, Moody J, Braun B, Hafner J, *et al.* Association of a bundled intervention with surgical site infections among patients undergoing cardiac, hip, or knee surgery. *JAMA* 2015;313:2162-71.
11. Berríos-Torres SI, Umscheid CA, Bratzler DW, Leas B, Stone EC, Kelz RR, *et al.* Centers for disease control and prevention guideline for the prevention of surgical site infection 2017. *JAMA Surg* 2017;152:784-91.
12. Allegranzi B, Bischoff P, de Jonge S, Kubilay NZ, Zayed B, Gomes SM, *et al.* New WHO recommendations on

- preoperative measures for surgical site infection prevention: An evidence-based global perspective. *Lancet Infect Dis* 2016;16:e276-87.
13. Allegranzi B, Zayed B, Bischoff P, Kubilay NZ, de Jonge S, de Vries F, *et al.* New WHO recommendations on intraoperative and postoperative measures for surgical site infection prevention: An evidence-based global perspective. *Lancet Infect Dis* 2016;16:e288-303.
 14. Webster J, Osborne S. Preoperative bathing or showering with skin antiseptics to prevent surgical site infection. *Cochrane Database Syst Rev* 2015;CD004985.doi: 10.1002/14651858.CD004985.pub5.
 15. Edmiston CE, Lee CJ, Krepel CJ, Spencer M, Leaper D, Brown KR, *et al.* Evidence for a standardized preadmission showering regimen to achieve maximal antiseptic skin surface concentrations of chlorhexidine gluconate, 4%, in surgical patients. *JAMA Surg* 2015;150:1027-33.
 16. Wihlborg O. The effect of washing with chlorhexidine soap on wound infection rate in general surgery. A controlled clinical study. *Ann Chir Gynaecol* 1987;76:263-5.
 17. CDC/NHSN Surveillance Definitions for Specific Types of Infections. 2020. Available from: https://www.cdc.gov/nhsn/pdfs/pscmanual/17pscnosinfdef_current.pdf. [Last accessed on 2020 Jan 4].
 18. Dhamecha M, Chauhan N, Kavathia G, Goswami Y, Gosai K. Incidence and predictors of surgical site infections: A study at a tertiary care hospital. *GCSMC J Med Sci* 2014;3:25-9.
 19. De D, Saxena S, Mehta G, Yadav R, Dutta R. Risk factor analysis and microbial etiology of surgical site infections following lower segment caesarean section. *Int J Antibiot* 2013. doi: 10.1155/2013/283025.
 20. Naphade SA, Patole K. Study of surgical site infections following gynaecological surgeries in a tertiary care hospital. *MVP J Med Sci* 2017;4:186-92.
 21. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Centers for disease control and prevention (CDC) hospital infection control practices advisory committee. *Am J Infect Control* 1999;27:97-132.
 22. Peleg D, Eberstark E, Warsof SL, Cohen N, Ben Shachar I. Early wound dressing removal after scheduled cesarean delivery: A randomized controlled trial. *Am J Obstet Gynecol* 2016;215:388.e1-5.
 23. Tanner J, Norrie P, Melen K. Preoperative hair removal to reduce surgical site infection. *Cochrane Database Syst Rev* 2011;CD004122.doi: 10.1002/14651858.CD004122.pub4.
 24. Niël-Weise BS, Wille JC, van den Broek PJ. Hair removal policies in clean surgery: Systematic review of randomized, controlled trials. *Infect Control Hosp Epidemiol* 2005;26:923-8.
 25. Merle V, Van Rossem V, Tavolacci M-P, Czernichow P. Knowledge and opinions of surgical patients regarding nosocomial infections. *J Hosp Infect* 2005;60:169-71.
 26. NHS. Can I get my stitches wet in the bath or shower?. [nhs.uk](https://www.nhs.uk/common-health-questions/accidents-first-aid-and-treatments/can-i-get-my-stitches-sutures-wet-in-the-bath-or-shower/). 2018. Available from: <https://www.nhs.uk/common-health-questions/accidents-first-aid-and-treatments/can-i-get-my-stitches-sutures-wet-in-the-bath-or-shower/>. [Last accessed on 2020 Jan 13].
 27. Hsu A, Mustoe TA. The principles of wound healing. In: Weinzwieg J, editor. *Plastic Surgery Secrets Plus*. 2nd ed. New York, NY: Elsevier; 2010;3. Available from: <https://www.sciencedirect.com/sdfe/pdf/download/eid/3-s2.0-B9780323034708000016/first-page-pdf>. DOI:10.1016/B978-0-323-03470-8.00001-6 Corpus ID: 16471862.
 28. US National Library of Medicine. NIH. Going home after a C-section. 2019. Available from: <https://medlineplus.gov/ency/article/007645.htm>. [Last accessed on 2020 Jan 02].
 29. Bajracharya SL, Maharjan S, Shrestha S. Knowledge of surgical site infection among post operative patients in Kathmandu University teaching hospital Dhulikel, Nepal. *Int J NursRes Pract* 2014;1:14-7.
 30. Pritchard A, Donohue K, Hyland T, Raab C, Omara E, Pettker C. Reducing cesarean delivery surgical site infection: Successful implementation of a bundle of care. *ObstetGynecol* 2016;127:7S.
 31. Mehtar S, Wanyoro A, Ogunsoola F, Ameh EA, Nthumba P, Kilpatrick C, *et al.* Implementation of surgical site infection surveillance in low-and middle-income countries: A position statement for the International Society for Infectious Diseases. *Int J Infect Dis* 2020;100:123-31.
 32. Jin J, Akau Ola S, Yip CH, Nthumba P, Ameh EA, de Jonge S, *et al.* The impact of quality improvement interventions in improving surgical infections and mortality in low and middle-income countries: A systematic review and meta-analysis. *World J Surg* 2021;45:2993-3006.