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The impact of quality improvement interventions on compliance with standardised surgical count protocol and count discrepancies: A quality improvement study

Cover Page Footnote

This article is the result of a master's thesis in operating room nursing, with the ethical code IR.MUI.NUREMA.REC.1401.042. The researcher expresses their utmost gratitude to the respected officials of Isfahan University of Medical Sciences, the respected officials of Shahid Beheshti and Alzahra Hospitals of Isfahan and all the nurses and surgical technologists who participated.

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Abstract

Background: Unintentionally retained surgical items (RSI) are a global problem contributing to adverse events for surgical patients. The Association of periOperative Registered Nurses (AORN) has developed a standardised protocol for the surgical count; however, many hospitals do not follow the protocol for the surgical count. This study was conducted to investigate the effect of implementing quality improvement interventions, for counting surgical sponges, on compliance with the AORN surgical count protocol and occurrence of count discrepancies.

Method: This study was performed as an interventional quality improvement project from 1 February to 20 September 2022 with an intervention and a control group in the gynaecology operating rooms of two selected hospitals. Thirty perioperative nurses and surgical technologists working in the gynaecology operating room participated in this study and the count process was observed during 130 open gynaecological surgeries performed through abdominal incision – 65 surgeries in one hospital were assigned to the control group and 65 surgeries in the other hospital were assigned to the intervention group. Data were collected through direct observation and interview with perioperative nurses using a tool designed by the researcher. The quality improvement interventions implemented in the intervention group were training in and use of sponge counter bags and surgical sponge count sheets and training about the AORN surgical count protocol. No quality improvement interventions were implemented in the control group, and the surgical count was performed as it had been before the study.

Results: Compliance with the AORN surgical count protocol was significantly (26.87%) higher in the intervention group than the control group. Count discrepancies were also significantly higher in the control group than the intervention group (21 vs 9, P = 0.04). The mean time required to correct count discrepancies was less in the intervention group, but the difference was not statistically significant. All count discrepancies in both the control and intervention groups were corrected and radiography to correct the discrepancies was not required in any of the surgeries included in the study.

Conclusion: The implementation of quality improvement interventions, including training in count protocol and using counter bags and count sheets, is recommended to improve the counting performance of perioperative nurses and reduce the incidence of count discrepancies and incorrect counts.

Keywords: retained surgical sponges, count discrepancies, incorrect counts, surgical count, protocol

Introduction

Unintentionally retained surgical item (RSI) events were the most common surgery-specific never events reported by the Joint Commission from 2018 to 2021, with a frequency of 459.[1] Due to legal and medical problems the prevalence of RSIs can never be precisely determined but, in most studies, the frequency varies between one in 5500 to 18 760 hospitalisations and one in every 1000 to 1500 intra-abdominal operations.[2–4] In Iran, there are no documented statistics of the number of RSI events in operating rooms due to legal issues.[5] RSI is a catastrophic medical error and may lead to pain, infection, intestinal obstruction, abscess, peritonitis, adhesion, gastrointestinal and urinary damage, increased hospital stay, reoperation and even death for the patient, and legal costs and financial consequences for the hospital.[6–8] The hospital cost of each undetected RSI is estimated to be approximately US$166 135.[7]

Surgical cotton sponge products account for approximately 70 per cent of RSIs,[9] possibly because they are easily retained inside the patient's body due to their relatively small size, ubiquitous use and the difficulty in distinguishing a blood-soaked sponge from the surrounding tissues.[10] Gynaecology is among the surgical specialties with the highest prevalence of retained surgical sponges.[11–13] The occurrence of RSI in open surgeries such as caesarean section and abdominal hysterectomy is significantly high.[14]

The most widely used measure to prevent retained surgical sponges is accurate counting of all surgical sponges by perioperative personnel before and after use during the procedure and in accordance with established policies.[15,16]

The updated Association of periOperative Registered Nurses (AORN) guidelines for preventing RSI provide guidance for manual counting.[17–19] Technologies that are available to help with manual counting include radiography, barcoding and radiofrequency technology.[7,15,20,21] However access to surgical counting technology does not significantly improve RSI rates and the main cause of sponge retention is related to human factors, lack of adherence to policies and poor communication.[22] In a survey conducted by *AORN Journal* in 2022, respondents ranked personnel 'not following policy' as the most important factor preventing elimination of RSI events.[23] As technology-based interventions may not be financially feasible in low and middle-income countries, interventions that promote best practice may be more appropriate in these countries.[24] Applying a historical perspective to RSI events shows that our advances are not as significant as was proposed over 100 years ago. Unless a standardised counting process and counting technology is used, unacceptable rates of RSIs will continue.[25] Therefore, to safely take care of the patient during a surgical procedure perioperative nurses must follow the best practices for RSI prevention.[17]

There are many factors that increase the risk of an RSI, including surgical complexity, large number of surgical team members, presence of more than one surgical team, long surgical procedure, emergency surgery, high blood loss (more than 500 ml), high body mass index (BMI), lack of standardised counting processes, inability to communicate and count discrepancies.[3,15,26–30] A count discrepancy may be an incorrect surgical count or a counting error. An incorrect surgical count is a count discrepancy that remains unsolved after a visual search and preliminary wound exploration[30]; a counting error is incorrect reporting and recording of the count. When a counting error results in the count incorrectly given as correct, personnel may not attempt to correct the discrepancy and don't do a visual search. Counting error is the most common risk factor for RSI.[3,15,28,30–32] Previous reports indicate that 62 to 88 per cent of RSIs occurred when a correct count was reported suggesting that counting error is common.[2,3,33] Counting error can increase the risk of RSI because there is no longer an accurate picture of the current status of sponges and other accountable items.[33]

An RSI is 100 times more likely to occur in cases where there is a discrepancy in counting.[31] In addition, attempting to locate sponges and reconcile count discrepancies increases the duration and cost of surgery.[34] These detected discrepancies in counts should never be dismissed as human error[33]; implementing quality improvement measures, including a standardised manual counting process, aims to eliminate count discrepancies, both incorrect surgical counts and counting errors, and thus reduce the risk of RSI events.[35]

Before the beginning of this study, there was no standardised protocol for counting surgical sponges in either of the hospitals where the study was carried out, and there was a gap between the routine sponge counting method and the protocol recommended by AORN. In order to reduce this gap, the researcher implemented the quality improvement interventions developed for this study.

Aim

The aim of this project was to achieve the following measurable objectives:

1. increase the quality of surgical sponge manual counting
2. reduce the frequency of sponge count discrepancy
3. investigate the cause of discrepancies (based on misplaced sponges, miscounted sponges, documentation error).

Literature review

Various studies have investigated count discrepancies and the implementation of quality improvement interventions to reduce these count discrepancies as a measure to prevent RSI events. In their prospective observational field study Greenberg et al.[33] observed count discrepancies in 12.8 per cent of surgeries and recommended that any count discrepancy should be interpreted as a potential RSI event and never be ignored. Norton et al.[7] reported that a standardised count process and a team approach to the surgical count led to a reduction in count discrepancies by about 50 per cent. Similarly, after conducting an evidence-based quality improvement study to evaluate count discrepancies and the quality of the surgical count, Nelson[36] reported a 71.43 per cent reduction in incorrect surgical counts and concluded that implementation of the AORN surgical count guidelines by the perioperative nursing team improved the surgical count process. Also, a retrospective clinical trial study by Susmallian et al.[37] reported that after the implementation of an RSI prevention program the number of cases of serious consequences resulting from an RSI reduced despite an increase in the number of count discrepancies.

Method

Study design

This study was performed as a quality improvement project from 1 February to 20 September 2022 with an intervention and a control group in the gynaecology operating rooms of two hospitals in Iran.

Participants and setting

The participants were 30 circulating nurses, instrument nurses and surgical technologists who worked in gynaecology operating rooms. The reason for choosing gynaecology operating rooms was because, as mentioned previously, gynaecology has a higher prevalence of retained surgical sponges than most other surgical specialties.[12]

The setting was two hospitals affiliated with Isfahan University of Medical Sciences, Iran. All gynaecological open surgery procedures that were performed through an abdominal or pelvic incision were investigated. The procedures were allocated to the control and intervention groups by hospital – those performed in hospital A were allocated to the control group, those performed in hospital B to the intervention group. To randomise the procedures in both hospitals, patients whose medical record numbers were even numbers were included in the study.

Inclusion and exclusion criteria

Inclusion criteria for personnel were working in gynaecology operating rooms and willingness to participate in the study. Circulating nurses, instrument nurses and surgical technologists of all ages, levels of experience and levels of education were included, and their informed consent obtained. Personnel at hospital B who did not participate in the intervention training sessions were excluded, as were those who did not want to continue participating. Of the 15 nurses and surgical technologists working in gynaecology operating rooms at hospital A, none were excluded. Of the 23 perioperative nurses and surgical technologists working in the gynaecology operating rooms at hospital B, 19 were willing to participate in the study and four of those were excluded from the study due to not participating in the training session.

Inclusion criteria for procedures were abdominal or pelvic gynaecologic elective surgeries performed through an open incision and all surgeries performed by four particular surgeons in both hospitals. Exclusion criteria for procedures were the patient's condition becoming so critical that it was not possible to follow some stages of the surgical count and if the surgical sponge count sheet was not completed. Of the 130 eligible surgeries (65 in hospital A and 65 in hospital B), no surgery was excluded from our study; therefore, 65 surgical sponge counting processes by 15 perioperative nurses and surgical technologists were observed at both hospitals.

Sampling

The sample size was obtained based on previous similar studies[5] using the following formula.

$$n = \frac{(z_1 + z_2)^2 (2s^2)}{d^2}$$

The sample size of each group (with a 1:1 ratio of group size) is denoted by 'n'. The value of 'Z_1' for a confidence level of 95 per cent is 1.96, the value of 'Z_2' for a test power of 90 per cent is 1.28, 's' is an estimate of the average standard deviation of the

number of count discrepancies in two groups and 'd' is the minimum difference in the number of count discrepancies between the two groups that shows the difference to be significant, and is considered to be 0.6s. Allowing for a ten per cent sample attrition the final number of 65 procedures in each group was calculated. All perioperative nurses and surgical technologists who met the inclusion criteria were included in the study by census.

Interventions

The AORN protocol for counting surgical sponges includes 75 items: 27 items performed only by circulating personnel, 24 items performed by both circulating and instrument personnel, 15 items performed only by instrument personnel and nine items that relate to when counts should be performed (see figures 1–4 for lists of the items). Three quality improvement interventions based on the AORN protocol were implemented at hospital B.

1. Sponge counter bags

Commercially made blue sponge counter bags were used to facilitate ease of visibility when counting. The bags were in a coated steel rack attached to the IV pole. The rack had a basket for the box of unused sponge counter bags and prongs on both sides on which to hang the bags being used. Each bag contained ten pockets, in five rows of two, for 4x4 Raytec® sponges. There was a thin centre divider that could be broken to convert the bag to have five pockets for laparotomy sponges.

2. Standardised surgical sponge count sheet

The researcher prepared the surgical sponge count sheet after reviewing the AORN guidelines[13,38] and using the count sheet developed by the Australian College of Perioperative Nurses (ACORN)[39] as a model. Subsequently, based on the opinions of faculty members and specialists in the field, the count sheet was edited and a final version was examined for validity. The count sheet included the types of items being counted (e.g. 4x4 Raytec® sponges, laparotomy sponges), the number of counts, the names of personnel performing the counts, confirmation of counting when personnel changed during surgery, results of surgical sponges counts (i.e. correct, incorrect), the surgeon's awareness of count results, any adjunct technology that was used and associated records, an explanation for any waived counts, the number and location of radiopaque sponges intentionally retained as therapeutic packing, actions taken in the event of count discrepancies and a rationale if counts were not done or completed according to policy with the result of actions taken.

3. Training sessions

A two-hour training session was held in the operating room to educate personnel working at hospital B about the AORN protocol for counting surgical sponges and how to use the sponge counter bags and teach circulating personnel how to fill in the surgical sponge count sheet. The session consisted of power-point presentations by one of the researchers and a question time when all questions from participants were answered and ambiguities resolved. An educational pamphlet was provided for each participant, and the educational file was sent to the group of perioperative nurses and surgical technologists on one of the social networks. Since all personnel could not participate in this session simultaneously, the training session was held on two different days, coordinated by the operating room manager. For equity and ethical reasons, the personnel in the control group at hospital A were offered the same training after the study was completed.

None of these interventions were implemented at hospital A for the control group. In this group, surgical sponges were counted inside the surgical sponge bowl and the circulating nurses or surgical technologists recorded the number and type of sponges in a visible location (whiteboard) for the surgical team.

Data collection

The researchers observed and evaluated 65 surgical counting processes for the initial assessment in hospital A and 65 surgical counting process after the interventions were implemented in hospital B. For the first week of the study the researcher was present in the operation rooms of both hospitals but did not collect any data. This normalised the researcher's presence in the operation rooms in order to eliminate the Hawthorne effect.

Data collection for each case began from pre-operative setup and continued until all counting activities were completed and the patient was discharged from the operating room. All data were collected by the same

researcher in both hospitals through observation of counting activities and interviews with personnel. Data were recorded using an observational tool for each surgery on the day of surgery.

Data collection tool

A paper-based, structured observational tool was used for assessing surgical sponge count processes. The researcher developed the tool based on the AORN competency verification tools,[40,41] audit tool[42] and guidelines.[18,19,38,43] Subsequently, the tool was edited, based on the opinions of five faculty members and specialists in the field, and examined for validity. To verify the reliability, the tool was completed simultaneously by the researcher and a research colleague for five surgeries, and the similarity of the results was approved.

The tool was structured in four parts:

1. demographic characteristics of the participating perioperative nurses and surgical technologists (age, sex, years of experience, level of education)
2. characteristics of the surgical procedure (patient's BMI, duration of surgery, number of 4x4 Raytec® and laparotomy sponges used, personnel changes during the surgery, intra-operative blood transfusion, distraction during surgical count, number of sterile surgical team members, type of surgery)
3. details of counts and discrepancies (the number of counts performed, the number of count discrepancies, the reason for discrepancies (e.g. miscount, misplaced sponges and documentation error), the location of misplaced sponges, whether count discrepancies were corrected or not, the time required to reconcile the count, the sponge type with discrepancy and whether an x-ray was required to resolve the discrepancy)
4. count protocol recommended by AORN, consisting of 75 items, formatted with 'Yes', 'No' and 'N/A' (not applicable) tick boxes for recording observed count activity. If the item was performed, the option 'Yes' was marked and otherwise, the option 'No' was marked. The 'N/A' tick box was used for any item that was not required during the surgical sponge count process (e.g. the item 'using the sponge count sheet' was marked 'N/A' when observing surgeries at hospital A as count sheets were not provided to the control group). These 75 items were scored from 0 to 75 (1 = Yes and 0 = No). The data 'N/A' (not applicable) tick boxes were not considered in the analysis. For this reason, the protocol compliance score was calculated as a percentage from the following formula:

$$\text{compliance score} = \frac{Y \times 100}{75 - N/A}$$

where Y is the number of 'Yes' boxes ticked and N/A is the number of 'not applicable' boxes ticked.

Statistical analysis

SPSS version 22 software was used for data analysis. Descriptive statistics were used to determine the mean, standard deviation, number and percentage. The normality of the data was checked by the Kolmogorov-Smirnov test. T-test and Mann-Whitney test were used, respectively, based on the normality and non-normality of the data. Chi-square test was used for qualitative variables and t-test was used for quantitative variables. The significance level of the data was considered to be 0.05 ($P<0.05$).

The data for the 75 items in the AORN protocol were analysed in four clusters – Cluster 1 is items performed only by circulating personnel (27 items), Cluster 2 is items performed by both circulating and instrument personnel (24 items), Cluster 3 is items performed only by instrument personnel (15 items) and Cluster 4 is items that relate to when counts should be performed (nine items).

Ethical considerations

This study was approved by the Research Ethics Committee of Isfahan University of Medical Sciences, Isfahan, Iran (code: IR.MUI.NUREMA.REC.1401.042). A written informed consent was obtained from each participant before their participation in the study and the purpose of the study was explained to them. Participants were assured that their participation in this study was completely voluntary and that they could withdraw from the study at any time.

Table 1: Demographic characteristics of participants in the control and intervention groups

Characteristic		Control group (hospital A) N=15	Intervention group (hospital B) N=15	P (< 0.05)
Age (in years)		31.13 (SD=4.24)	29.26 (SD=5.89)	0.32
Work experience (in years)		8.6 (SD=5.16)	5.33 (SD=5.44)	0.10
Education level	bachelor (surgical technology)	15	12	0.18
	bachelor (nursing)	0	2	
	associate (surgical technology)	0	1	

SD=Standard deviation

Table 2: Characteristics of surgical cases in the control and intervention groups

Characteristic		Control group (hospital A) N=15	Intervention group (hospital B) N=15	P (< 0.05)
Patient's BMI (kg/m^2)		27.47 (SD=5.5)	27.27 (SD= 3.46)	0.80
Operative time (min)		201.15 (SD=82.81)	202.85 (SD=86.87)	0.91
Raytec® 4x4 sponges used		32.53 (SD=10.75)	30.46 (SD=12.55)	0.42
Laparotomy sponges used		3.6 (SD=1.72)	3.72 (SD=1.54)	0.42
Personnel change		21 (32.3%)	24 (36.9%)	0.58
Blood transfusion		17 (26.2%)	26 (40%)	0.09
Presence of distraction during counting		32 (49.3%)	33 (50.8%)	0.86
Sterile surgical team members	3 members	12	7	0.58
	4 members	42	44	0.09
	5 members	11	14	0.86
Type of surgery	TAH	21	18	0.97
	Caesarean	15	16	
	Caesarean hysterectomy	6	7	
	TAH + BSO	7	7	
	TAH, BSO, OMT, LND	3	5	
	TAH, BSO, HC	1	1	
	TAH, Cystoscopy	0	1	
	Myomectomy	7	5	
	Ovarian cystectomy	2	3	
	Oophorectomy	3	2	

SD = standard deviation, BMI = body mass index, TAH = total abdominal hysterectomy, BSO = bilateral salpingo-oophorectomy, OMT = omentectomy, LND = lymphadenectomy, HC = hemicolectomy

Results

The samples of this research consisted of 30 perioperative nurses and surgical technologists, and 130 open gynaecological surgeries in two selected hospitals. All personnel in the two hospitals were women. The control group and intervention group had no statistically significant differences in terms of demographic characteristics or surgical case characteristics (see tables 1 and 2).

Compliance with Cluster 1 items was 28.15 per cent higher in the intervention group than the control group. Compliance with Cluster 2 items was 32.22 per cent higher, compliance with Cluster 3 items was 20.32 per cent higher, and compliance with Cluster 4 items was 24.75 per cent higher. Overall compliance with all recommended items was 26.87 per cent higher in the intervention group than the control group. (See Table 3.)

Out of 130 surgeries, 30 count discrepancies for surgical sponges were observed. In the intervention group, there were nine discrepancies in nine surgeries. In the control group, there were 21 discrepancies in 18 surgeries (three surgeries had two discrepancies, i.e. more than one discrepancy per surgery). The reasons for the discrepancies included misplaced (missing) sponges, miscounted sponges and errors in recording the count. (See Table 4).

Table 3: Mean scores for compliance with AORN count protocol in the control and intervention groups

AORN recommended items	**Control group** (hospital A) M+/-SD	**Intervention group** (hospital B) M+/-SD	**P** (< 0.001)
Cluster 1: Items performed only by circulating presonnel (n=27)	62.61 +/- 10.93	90.76 +/- 5.98	<0.001
Cluster 2: Items performed by both circulating and instrument personnel (n=24)	66.54 +/- 7.37	86.86 +/- 6.50	<0.001
Cluster 3: Items performed only by instrument personnel (n=15)	52.06 +/- 11.43	84.28 +/- 9.17	<0.001
Cluster 4: Items relating to when counts should be performed (n=9)	66.96 +/- 17.31	91.71 +/- 10.95	<0.001
All items overall (N=75)	61.52 +/- 6.59	88.39 +/- 5.21	<0.001

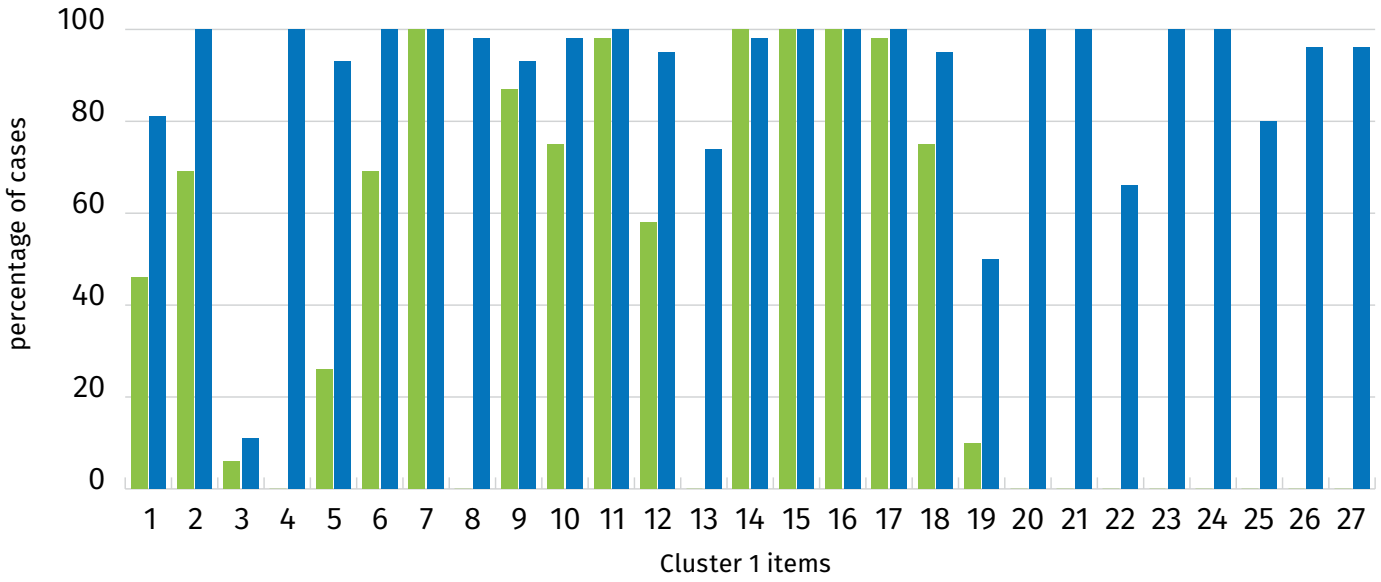
M = mean, SD = standard deviation

Table 4: Frequency and characteristics of count discrepancies in the control and intervention groups

Count discrepancy characteristics	**Control group** (hospital A) n (%)	**Intervention group** (hospital B) n (%)	**P** (< 0.05)
Total sponge discrepancy	21 (100)	9 (100)	0.04
Misplaced or retained sponges	10 (47.6)	3 (33.3)	0.04
Miscounted sponges	6 (28.6)	2 (22.2)	0.14
Error in recording the count	5 (23.8)	4 (44.4)	0.73
Misplaced sponges inside the patient's body	3 (30)	1 (33.3)	0.09
Misplaced sponges outside the patient's body	7 (70)	2 (66.7)	0.09
Reconciled discrepancies	21 (100)	9 (100)	
Mean time to resolve discrepancy (M+/-SD)	4.00+/-2.20 min	2.33+/-1.56 min	0.058
X-ray required to resolve discrepancy	0	0	
Mean total count activities (M+/-SD)	4.27+/-1.91	6.07+/-1.93	<0.001

M = mean, SD = standard deviation

Figures 1–4 show the percentage of cases in which each of the 75 items from the AORN protocol for counting surgical sponges were followed in the control and intervention groups.



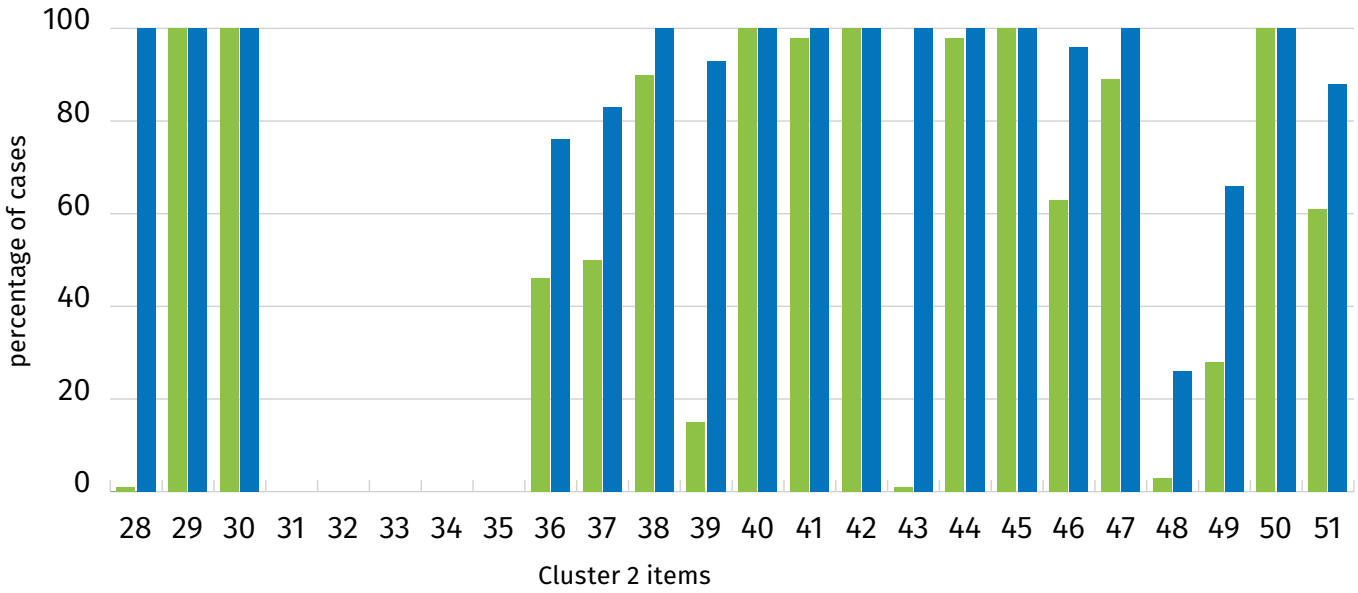
Control	0.46	0.69	0.06	0	0.26	0.69	1		0.87	0.75	0.98	0.58	0	1	1	1	0.98	0.75	0.1								
Intervention	0.81	1	0.11	1	0.93	1	1	0.98	0.93	0.98	1	0.95	0.74	0.98	1	1	1	0.95	0.5	1	1	0.66	1	1	0.8	0.96	0.96

Figure 1: Compliance with the AORN protocol in the control and intervention groups for items performed only by circulating personnel (Cluster 1, items 1–27)

Note: The sponge counter bag and count sheet were not available in the control group so 'N/A' was recorded for items 8 and 20 to 27 in the control group.

Key to items:

1. Searching the room to make sure there is no sponge from the previous procedure before the initial count.
2. Confirming the absence of previous procedure information on the whiteboard.
3. An auxiliary circulating nurse being present if the initial count is not performed before the patient enters.
4. Isolating the sponge used for skin antisepsis.
5. Viewing sponges being counted by the instrument nurse.
6. Counting sponges audibly.
7. Separating the sponges while counting.
8. Using the sponge count sheet.
9. Recording the number and type of sponges immediately after being added to the sterile field.
10. Recording sponges in a standard pattern.
11. Recording sponges in a visible location for the surgical team.
12. Recording sponges in agreement with the instrument nurse.
13. Recording all sponges placed in the surgical wound on placement and at removal.
14. Keeping counted sponges in the room until the count is completed.
15. Keeping waste containers in the room until the count is completed.
16. Disposing of counted sponges only after the patient leaves the room.
17. Not opening the dressing sponges until the closing count.
18. If a sponge is dropped from the sterile field, retrieving it and showing it to the instrument nurse, and including it in the final count.
19. Consulting with the surgical team about whether any supplies will be needed before the closing count.
20. Organising sponges with sponge counter bag.
21. Monitoring the placement of sponges in a suitable location (e.g. kick bucket) until transferred to bag.
22. Opening and separating the sponges completely before placing them in the bag.
23. Not putting the sponges on the edge of the kick bucket.
24. Placing only one sponge in each pocket of the bag.
25. Placing the sponge inside the bag so that its radiopaque marker is visible.
26. Filling the bag from bottom to top.
27. Placing unused sponges in the counter bag when final count is performed.



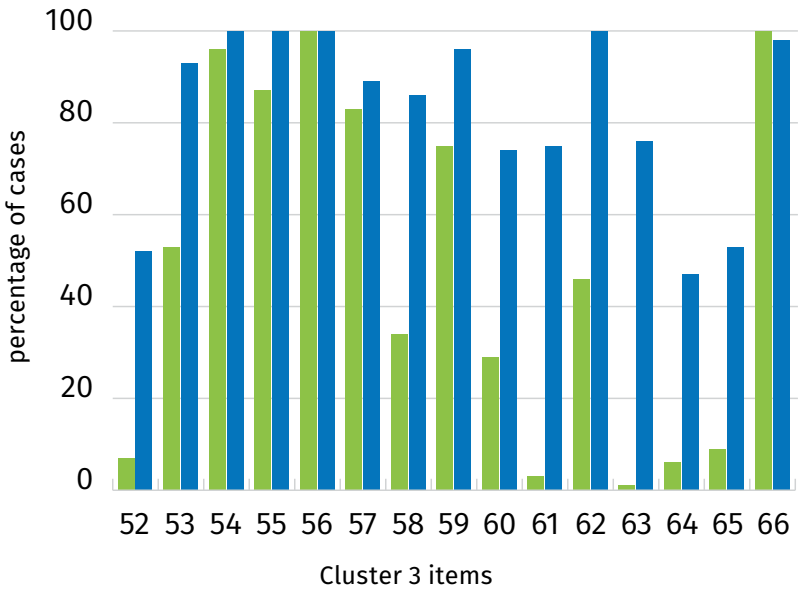
Control	0.01	1	1						0.46	0.5	0.9	0.15	1	0.98	1	0.01	0.98	1	0.63	0.89	0.03	0.28	1	0.61
Intervention	0.18	1	1						0.76	0.83	1	0.93	1	1	1	1	1	1	0.96	1	0.26	0.66	1	0.88

Figure 2: Compliance with the AORN protocol in the control and intervention groups for items performed by both circulating and instrument personnel (Cluster 2, items 28–51)

Note: In none of the surgeries were packages containing an incorrect number of sponges or sponges with a manufacturing defect encountered so items 31 to 35 were not observed in either the control group or the intervention group.

Key to items:

28. Performing initial count before patient enters the room, if possible.
29. Counting in a special place.
30. Counting packaged sponges according to the number of sponges in the packet.
31. When encountering packages containing an incorrect number of sponges, or sponges with a manufacturing defect, excluding the sponges from the count.
32. Removing incorrect packets and defective sponges from the field.
33. Isolating incorrect packets and defective sponges from the rest of the countable sponges.
34. Labelling incorrect packets and defective sponges.
35. Removing incorrect packets and defective sponges from the room before the patient's entry.
36. Reducing distractions and noise during counting.
37. Creating an uninterrupted environment and preventing rush in counting.
38. Maintaining the count running total in one location.
39. Performing final count when skin closure begins or at the end of surgery when counted sponges are no longer used.
40. Not providing counted sponges to the anaesthesia team.
41. Not performing counts during critical phases of the surgery, including time-out periods, critical dissections, confirming and opening of implants, induction of and emergence from anesthesia, and during care for and handling of specimens.
42. Using only radiopaque sponges in surgical wound.
43. Using non-radiopaque sponges for skin antisepsis.
44. Using non-radiopaque sponges for dressing.
45. Recounting, when counting is interrupted for any reason.
46. Performing counts in a specific order (e.g. large to small item size, proximal to distal from the wound).
47. Confirming the final count verbally as part of the surgical safety checklist.
48. Training the surgical team regarding the counting process.
49. Performing a structured hand-over communication of surgical count at times of relief of the registered circulating or instrument nurse.
50. Not subtracting or removing an item from the count.
51. Announcing a count discrepancy out loud.

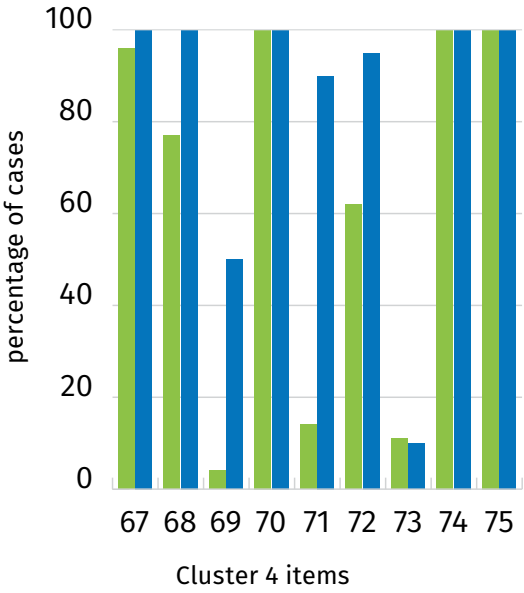


Control	0.07	0.53	0.96	0.87	1	0.83	0.34	0.75	0.29	0.03	0.46	0.01	0.06	0.09	1
Intervention	0.52	0.93	1	1	1	0.89	0.86	0.96	0.74	0.75	1	0.76	0.47	0.53	0.98

Figure 3: Compliance with the AORN protocol in the control and intervention groups for items performed only by instrument personnel (Cluster 3, 15 items)

Key to items:

52. Viewing sponges being counted by the circulating nurse.
53. Counting sponges audibly.
54. Separating the sponges and pointing at them while counting.
55. Using a standardised setup of the surgical field similarly to other personnel.
56. Not changing the original configuration of sponges.
57. Checking the integrity of the sponges when they are returned from the surgical site.
58. Knowing the location of sponges inside the wound and the sterile field during surgery.
59. Immediately removing used sponges from the sterile field.
60. Monitoring, if feasible, that a portion of any sponge placed in the surgical wound is left outside the wound so that the item remains visible.
61. Verifying methodical exploration of the surgical wound by the surgeon prior to wound closure.
62. Notifying the circulating nurse who is performing other patient care activities to record a sponge that was opened to assist the surgical team.
63. Notifying the circulating nurse when inserting and removing the sponge inside the surgical wound for documentation.
64. Notifying the circulating nurse about any sponge dropped from the surgical field.
65. Consulting with the surgeon about whether any supplies will be needed before performing the closing count.
66. Keeping the dressing sponges in their packaging until wound closure.



Control	0.96	0.77	0.04	1	0.14	0.62	0.11	1	1
Intervention	1	1	0.5	1	0.9	0.95	0.1	1	1

Figure 4: Compliance with the AORN protocol in the control and intervention groups for items relating to when counts should be performed (Cluster 4, 9 items)

Key to items:

67. Before skin incision (initial count)
68. When adding radiopaque sponges to the field.
69. Before closure of uterus or cavity within a cavity.
70. When closing the wound (closing count).
71. When closing the skin.
72. When changing a nurse permanently (e.g. end of shift).
73. When changing a nurse temporarily (e.g. rest, meal break).
74. When doubting the count is correct.
75. When any surgical team member requests a count.

Discussion

Our observations showed that the intervention group had higher mean scores for compliance with the AORN protocol for counting surgical sponges not only overall but also for each of the four clusters of items (items performed only by circulating personnel, items performed by both circulating and instrument personnel, items performed only by instrument personnel and items relating to when counts should be performed). We also found that there were fewer count discrepancies and discrepancies took less time to resolve in the intervention group than in the control group. Implementing the three quality improvement interventions in this study increased compliance with the AORN protocol for counting surgical sponges and significantly improved the quality of the surgical sponge count. This result is consistent with many studies into prevention of RSI events that emphasise the need to standardise the surgical count to improve the counting process and reduce incorrect counting.[15,17,44,45]

Structured observations of perioperative personnel during surgical counts in the current study provided a picture of the challenges that they face during the counting process. Warwick et al.[46] conducted an observational study to investigate compliance with the ACORN standard for counting surgical items and found that the rate of compliance was less than expected (60 per cent). Warwick et al.[46] identified challenges that perioperative nurses face during the counting process and argued that health service organisations need to develop policies and guidelines to support nurses to follow a standardised counting process.

Based on a finding of 1062 count discrepancies among 153 263 surgeries and one RSI event per 70 count discrepancies, Egorova et al.[31] concluded that count discrepancies increased the risk of RSI more than 100 times. As previously mentioned, gynaecology has a high prevalence of retained surgical sponges[11–13] and identifying count discrepancies is an important measure to prevent RSI events. The results of our study showed that implementing the three quality improvement interventions resulted in a significant reduction (up to 57 per cent) in count discrepancies.

In a study by Greenberg et al. nurses counted surgical items according to the AORN protocol and observed 13 sponge count discrepancies among 148 general surgeries (8.78%). Greenberg et al.[33] asserted that any count discrepancy should be interpreted as a potential RSI event and showed the need for measures to increase the accuracy of surgical sponge count. In our study we observed nine count discrepancies among 65 gynaecological surgeries (13.85%) in the intervention group. This is a higher frequency than found by Greenberg et al. and may be caused by gynaecological surgery being the specialty in our study, longer mean duration of surgery (203 minutes our study vs. 120 minutes Greenberg et al.) and, as is typical in gynaecological surgery, more sponges used per case (34 our study vs. 29 Greenberg et al.).

Our findings are consistent with a number of other studies. Nelson's quality improvement study[36] collected data from 455 surgical cases and 118 nurses over an eight-week period in 2018 using the Plan, Do, Study, Action (PDSA) method after implementing AORN practice guidelines for preventing RSIs. Prior to the study there was no standardised and consistent counting process used by nurses and, in 2015–2016, 408 count discrepancies and 13 RSI incidents had been reported. The results of the study showed that using AORN guidelines improved the surgical count process and led to a 71.43 per cent reduction in incorrect counts with no incidents of RSI.[36] Similarly, Norton et al.[7] reported that implementing a quality improvement program helped to reduce incorrect counts and count discrepancies by about 50 per cent. Further, Cima et al.[9] reported a 486 per cent improvement in efficiency after quality improvement interventions and the prevalence of RSIs events dropped from one in 70 426 cases before the interventions to one in 5500 cases after the interventions.

Susmallian et al.[37] reported an increase in count discrepancies after implementation of an RSI prevention program. This is perhaps because a major part of the program was introducing an error reporting system. Susmallian et al. divided count discrepancies into three categories: discrepancies that were corrected without any complications; discrepancies with minor complications, such as increased surgery time, which were finally corrected; and discrepancies with severe complications (RSI). Despite the increase in count discrepancies, the number of RSIs decreased.[37] In our study there were no RSI events. Although a sponge was misplaced in the patient's body in four cases (three in the control group and one in the intervention group), all count discrepancies were resolved in both the control and intervention groups.

In Greenberg's study,[33] in which the counting process was carried out according to the AORN protocol, the reasons for count discrepancies included misplaced sponges (59%), errors in recording the count (38%) and miscounted sponges (27%). In our study misplaced (missing) sponges was the most

common reason, overall, for count discrepancies, followed by miscounted sponges and errors in recording the count. Count discrepancies due to misplaced sponges were significantly lower in the intervention group compared to the control group (47.6% and 33.3% respectively, P = 0.04). Count discrepancies due to miscounted sponges were also reduced in the intervention group compared to the control group although the difference was not statistically significant (22.2% and 28.6% respectively, P = 0.14). Using sponge counter bags to separate sponges and make them visible to the surgical team increased counting accuracy and reduced count discrepancies due to misplaced and miscounted sponges.

In our study, the number of count discrepancies due to errors in recording the count was higher in the intervention group than the control group (44.4% and 23.8%, respectively). This is because circulating personnel forgot to document the number of sponges added to the sterile field during surgery. Butler et al.[47] found that, of 140 count errors, 64 per cent were documentation errors and 36 per cent were misplaced items and recommended measures to reduce documentation errors in the surgical count. Gibbs[48] recommends the use of a transparent and visible system, including a count board and a sponge counter bag, to increase counting accuracy. In this system, during the final count (after skin closure) the circulating nurse together with other members of the surgical team confirm that the number of sponges visible inside the count bag is equal to the number of sponges recorded on the count board.

All count discrepancies in our study were corrected in the intervention and control groups and there was no need for x-ray to resolve discrepancies in any of the surgeries. Studies show that most count discrepancies are eventually corrected. Geeroms et al.[49] conducted a survey among 100 plastic surgeons and residents using an online questionnaire and found that in 34.3 per cent of cases the number of sponges in the first count was incorrect but subsequently corrected, and that x-ray was required in, on average, 8.7 per cent of surgeries to rule out a retained surgical sponge in the patient. Greenberg et al. reported that out of 29 count discrepancies, 28 (96.%) were finally corrected.[33]

Resolving count discrepancies takes time and adds to the cost of surgery. Steelman et al.[34] found that perioperative nurses needed up to 90 minutes to resolve a count discrepancy which added, on average, US$1003 to the cost of the surgery. In our study, the mean time for reconciling count discrepancies was lower in the intervention group than the control group. Although the difference was not statistically significant, even a small reduction in duration of surgery can reduce costs, and reducing the frequency of count discrepancies, in turn, reduces the need to resolve them.

Limitations

This study was unable to examine the direct impact of our quality improvement interventions on RSIs because a very large sample size would be required to obtain conclusive results. Also, due to limited time and financial resources, only the field of gynaecological surgery was studied.

Conclusion

This study found that implementing quality improvement interventions increased compliance with the AORN protocol for counting surgical sponges, improved the quality of the counting process and significantly reduced surgical sponge count discrepancies. Therefore, the implementation of quality improvement interventions, including training in and use of sponge counter bags and surgical sponge count sheets and training in standardised surgical count protocol, are recommended to improve the counting performance of perioperative nurses and reduce count discrepancies, incorrect counts, the duration of surgery and frequency of RSI events.

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