Original Article

Impact of modified quality control checklist on protocol adherence and outcomes in a post-surgical Intensive Care Unit

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ABSTRACT

Background and Aims: Quality improvement (QI) is the sum of all activities that create desired changes in the quality. An effective QI system results in a stepwise increase in quality of care. The efficiency of any health-care unit is judged by its quality indicators. We aimed to evaluate the impact of QI initiatives on outcomes in a surgical Intensive Care Unit (ICU). **Methods:** This was an observational study carried out using a compliance checklist, developed from the combination of the World Health Organization surgery checklist and Society for Healthcare Epidemiology of America guidelines for the prevention of infections. A total of 170 patients were prospectively evaluated for adherence to the checklist and occurrence of infections. This was compared with a random retrospective analysis of 170 patients who had undergone similar surgeries in the previous 3 months. **Results:** Introduction and supervised documentation of comprehensive checklist brought out significant improvement in the documentation of quality indicators (98% vs. 32%) in the prospective samples. There was no difference in mortality, health-care-related infection rates or length of ICU stay. **Conclusion:** The introduction of comprehensive surgical checklist improved documentation of parameters for quality control but did not decrease the rates of infection in comparison to the control sample.

Key words: Line care-bundles, quality control, surgery, surgical site infection

INTRODUCTION

Quality improvement (QI) consists of systematic and continuous actions that lead to measurable improvement in health-care services and the health status of targeted patient groups. The efficiency of any health-care unit is judged by its quality indicators.[1] The Institute of Medicine defines quality in health care as a direct correlation between the level of improved health services and the desired health outcomes of individuals and populations.[2] The impact of improvement in quality control manifests in composite outcomes of surgical patients and hence attention to basic care will provide the desired positive impact on patients.

The assessment of outcomes in surgery represents a quality assurance of patient care.[3] Catheter-related blood steam infections occurring in the Intensive Care Unit (ICU) are a source of the economic drain and poor patient outcomes.[4] Strict adherence to infection control protocols and to line care bundles are recommended to reduce infections in post-surgical settings. Monitoring of quality indicators provides an institution an opportunity to improve its quality of care through standardisation of processes, procedures and treatment protocols.

We hypothesised that the adherence to standards of care could reduce infectious complications after major

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surgery. We enhanced the surveillance to adherence in bundle care and line insertion and emphasised on team discussions before surgery as part of surgical checklist protocols. The outcomes on infections were closely followed in the ICU until shift to the wards. Besides infectious outcomes, we looked at composite outcomes that included mortality, the length of ICU stay (LOICU), ventilator-associated pneumonia (VAP) readmission to the ICU within 24 h, re-intubation within 24 h, needle stick injuries, bedsores and iatrogenic pneumothorax.

The primary aim of this study was to evaluate the impact of quality improvement initiatives using a comprehensive surgical checklist derived from standard surgical and line care bundles on outcomes in patients undergoing abdominal surgery. The secondary outcomes were the LOICU stay and hospital-related infection rates.

METHODS

This was an observational study carried out using a compliance checklist, developed from the combination of the World Health Organization (WHO) surgery checklist[5] and Society for Healthcare Epidemiology of America guidelines[6] for the prevention of infections.

The sample size was derived using Slovin's formula[7] applied to the number of cases performed each year. One hundred and seventy prospective samples of surgical patients were included for the adherence to infection control protocols and outcomes. This was compared to infection rates and outcomes in 170 retrospective patients selected by random number sampling excluding emergency surgeries or surgeries <4 h duration. The calculation was derived from Slovin's formula, $n = N/(1 + N e^2)$ where N represented the number of surgeries performed the previous year and **e** the confidence interval (CI). Using a value of N = 1300 and 95% CI, (e = 0.05) the sample size was calculated as 340 patients. The study was undertaken between April and July 2015, and the tool was an assessment of adherence to standards and bundles in care of surgical patients.

A training programme was initiated which was divided into induction training and in-service training. The induction training was provided for newcomers, both doctors and nurses who were educated on key performance indicators (KPI), QI programmes and standard operation plans including surgical safety checklists. The in-service programme was training provided for preceptors in the theatres and ICUs. They were taught to regularly monitor KPI and evaluate compliance and to undertake corrective or preventive actions appropriately. The teaching programme was carried out between the 3rd week and the end of March 2015 before the implementation of the new protocol that began from April 2015.

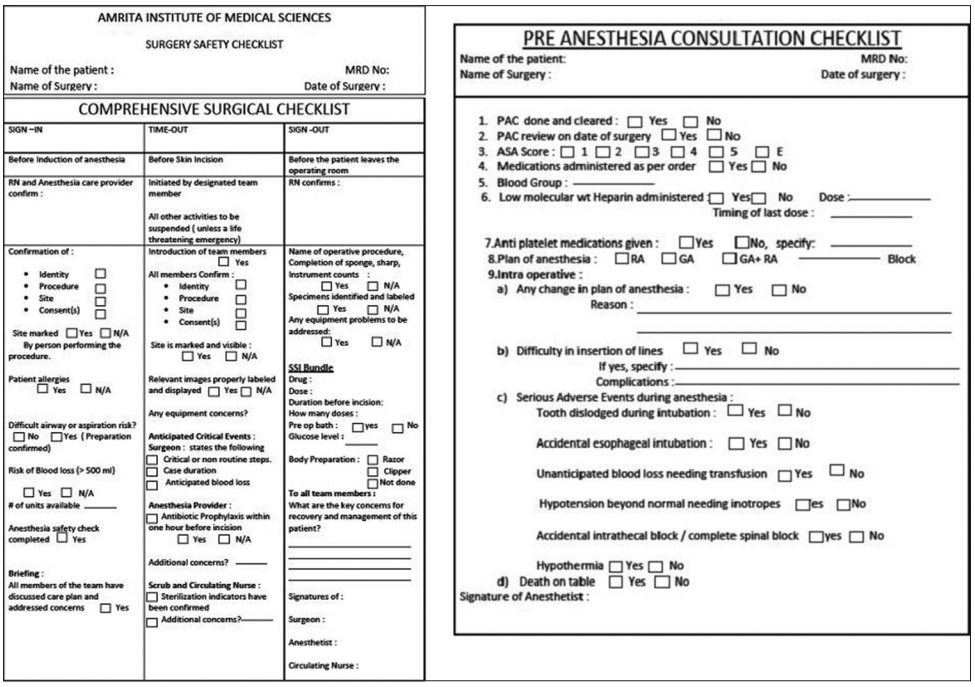
The study was carried out in the gastrointestinal surgical and urology units of a tertiary care referral hospital after obtaining local ethics committee approval and informed consent. All patients undergoing major abdominal surgery defined as surgery lasting more than 4 h were included in this study. Minor surgeries and emergency surgeries were not included. To obtain the association between the groups and different categorical variables Chi-square test was applied. To compare the mean differences of numerical variables between groups independent two-sample *t*-test was applied.

The comprehensive checklist [Figures 1-3] was provided to the anaesthesia team at the beginning of surgery and compliance to protocols entered by respective team members that included surgical and nursing teams and was endorsed by all three team members. In addition to noting the compliance, we also looked at the composite outcomes in the ICU as end points of infection control. All patients were followed until their discharge from the hospital.

RESULTS

The filled checklists and the data collected from the hospital information system medical records were analysed using simple percentage method.

We noted that, after the introduction of comprehensive checklist, there was a significant improvement in the documentation of QI parameters [Table 1] which included changes in the plan of anesthesia, difficulty in line insertion, and maintenance of sterility in the insertion of lines, plan for post-operative ventilation and serious adverse events as defined by the National Accreditation Board for Hospitals. There was a statistically significant increase in the documentation of each component of the WHO surgery checklist that defined the preparedness of the team for the proposed surgery in the prospective group compared to the retrospective group [$P < 0.001$, Table 1]. Adherence to bundles of care and their documentation had significantly improved in the prospective samples but



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SURGERY SAFETY CHECKLIST

Name of the patient : MRD No:

Name of Surgery : Date of Surgery :

COMPREHENSIVE SURGICAL CHECKLIST

SIGN –IN	TIME-OUT	SIGN -OUT
Before Induction of anesthesia	Before Skin Incision	Before the patient leaves the operating room
RN and Anesthesia care provider confirm :	Initiated by designated team member All other activities to be suspended (unless a life threatening emergency)	RN confirms :
Confirmation of : • Identity ☐ • Procedure ☐ • Site ☐ • Consent(s) ☐ Site marked ☐Yes ☐N/A By person performing the procedure. Patient allergies ☐ Yes ☐ N/A Difficult airway or aspiration risk? ☐ No ☐Yes (Preparation confirmed) Risk of Blood loss (> 500 ml) ☐ Yes ☐ N/A # of units available ____ Anesthesia safety check completed ☐ Yes Briefing : All members of the team have discussed care plan and addressed concerns ☐ Yes	Introduction of team members ☐ Yes All members Confirm : • Identity ☐ • Procedure ☐ • Site ☐ • Consent(s) ☐ Site is marked and visible : ☐ Yes ☐ N/A Relevant images properly labeled and displayed ☐ Yes ☐ N/A Any equipment concerns? Anticipated Critical Events : Surgeon : states the following ☐ Critical or non routine steps. ☐ Case duration ☐ Anticipated blood loss Anesthesia Provider : ☐ Antibiotic Prophylaxis within one hour before incision ☐ Yes ☐ N/A Additional concerns? ____ Scrub and Circulating Nurse : ☐ Sterilization indicators have been confirmed ☐ Additional concerns?____	Name of operative procedure, Completion of sponge, sharp, Instrument counts : ☐ Yes ☐ N/A Specimens identified and labeled ☐ Yes ☐ N/A Any equipment problems to be addressed: ☐ Yes ☐ N/A SSI Bundle Drug : Dose : Duration before incision: How many doses : Pre op bath : ☐yes ☐ No Glucose level : ____ Body Preparation : ☐ Razor ☐ Clipper ☐ Not done To all team members : What are the key concerns for recovery and management of this patient? Signatures of : Surgeon : Anesthetist : Circulating Nurse :

PRE ANESTHESIA CONSULTATION CHECKLIST

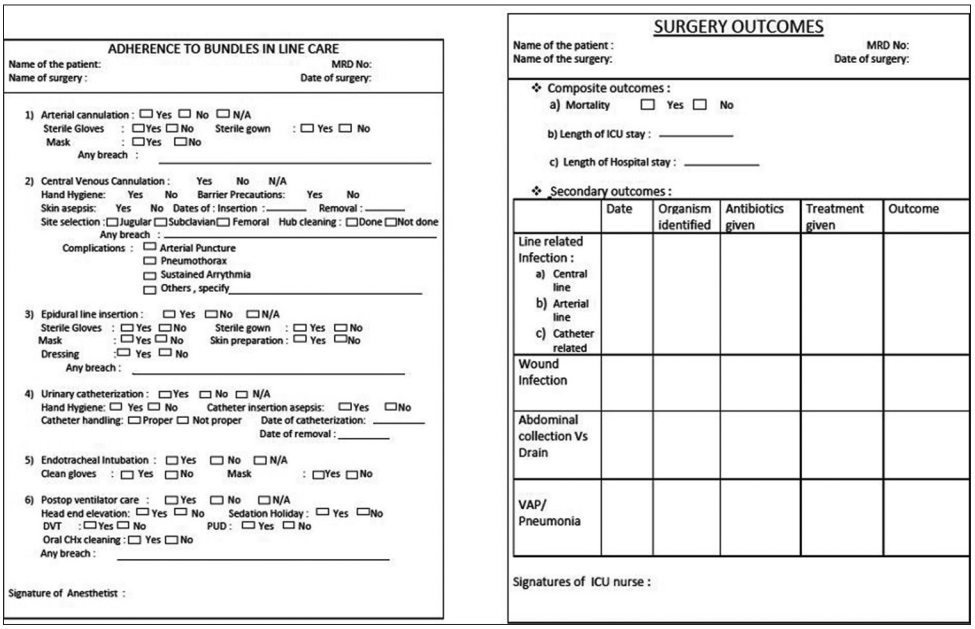
Name of the patient: MRD No:

Name of Surgery : Date of surgery :

1. PAC done and cleared : ☐ Yes ☐ No
2. PAC review on date of surgery ☐ Yes ☐ No
3. ASA Score : ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ E
4. Medications administered as per order ☐ Yes ☐ No
5. Blood Group : ____
6. Low molecular wt Heparin administered ☐ Yes☐ No Dose :____ Timing of last dose : ____
7. Anti platelet medications given : ☐Yes ☐No, specify: ____
8. Plan of anesthesia : ☐RA ☐GA ☐GA+ RA ____ Block
9. Intra operative :
   a) Any change in plan of anesthesia : ☐ Yes ☐ No
      Reason : ____
   b) Difficulty in insertion of lines ☐ Yes ☐ No
      If yes, specify : ____
      Complications : ____
   c) Serious Adverse Events during anesthesia :
      Tooth dislodged during intubation : ☐ Yes ☐ No
      Accidental esophageal intubation : ☐ Yes ☐ No
      Unanticipated blood loss needing transfusion ☐ Yes ☐ No
      Hypotension beyond normal needing inotropes ☐es ☐No
      Accidental intrathecal block / complete spinal block ☐yes ☐ No
      Hypothermia ☐ Yes ☐ No
   d) Death on table ☐ Yes ☐ No

Signature of Anesthetist :

Figure 1: Modified quality control checklist pages 1–2



ADHERENCE TO BUNDLES IN LINE CARE

Name of the patient: MRD No:

Name of surgery : Date of surgery:

1) Arterial cannulation : ☐ Yes ☐ No ☐ N/A
   Sterile Gloves : ☐Yes ☐ No Sterile gown : ☐ Yes ☐ No
   Mask : ☐Yes ☐No
   Any breach : ____
2) Central Venous Cannulation : Yes No N/A
   Hand Hygiene: Yes No Barrier Precautions: Yes No
   Skin asepsis: Yes No Dates of : Insertion :____ Removal : ____
   Site selection : ☐Jugular ☐Subclavian ☐ Femoral Hub cleaning : ☐Done ☐Not done
   Any breach : ____
   Complications : ☐ Arterial Puncture ☐ Pneumothorax ☐ Sustained Arrythmia ☐ Others , specify____
3) Epidural line insertion : ☐ Yes ☐No ☐ N/A
   Sterile Gloves : ☐ Yes ☐No Sterile gown : ☐ Yes ☐ No
   Mask : ☐Yes ☐ No Skin preparation : ☐ Yes ☐No
   Dressing :☐ Yes ☐ No
   Any breach : ____
4) Urinary catheterization : ☐Yes ☐ No ☐ N/A
   Hand Hygiene: ☐ Yes ☐ No Catheter insertion asepsis: ☐Yes ☐No
   Catheter handling: ☐ Proper ☐ Not proper Date of catheterization: ____ Date of removal : ____
5) Endotracheal Intubation : ☐ Yes ☐ No ☐ N/A
   Clean gloves : ☐ Yes ☐No Mask : ☐Yes ☐No
6) Postop ventilator care : ☐ Yes ☐ No ☐ N/A
   Head end elevation: ☐ Yes ☐ No Sedation Holiday : ☐ Yes ☐No
   DVT : ☐Yes ☐ No PUD : ☐ Yes ☐ No
   Oral CHx cleaning : ☐ Yes ☐No
   Any breach : ____

Signature of Anesthetist :

SURGERY OUTCOMES

Name of the patient : MRD No:

Name of the surgery: Date of surgery:

❖ Composite outcomes :
   a) Mortality ☐ Yes ☐ No
   b) Length of ICU stay : ____
   c) Length of Hospital stay : ____

❖ Secondary outcomes :

	Date	Organism identified	Antibiotics given	Treatment given	Outcome
Line related Infection : a) Central line b) Arterial line c) Catheter related					
Wound Infection					
Abdominal collection Vs Drain					
VAP/ Pneumonia					

Signatures of ICU nurse :

Figure 2: Modified quality control checklist pages 3–4

this did not result in any change in the post-operative infection rates or mortality [Table 2]. LOICU stay (as a reflection of infection rates) was similar between the two groups.

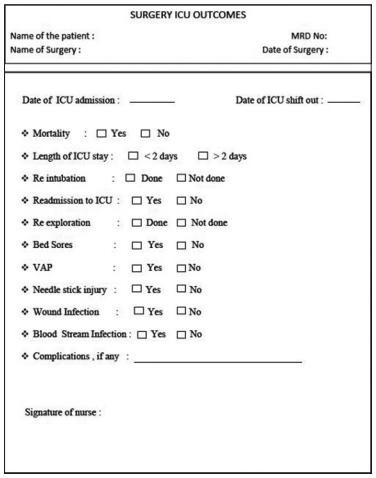
DISCUSSION

Centers for disease control (CDC) have introduced evidence based guidelines for improvement of patient care. A major contribution for spread of infection is related to hand hygiene and historically compliance is as low as 39%.[8] The CDC and WHO have emphasised the need for improved hand hygiene practices and introduced recommendations to improve compliance at all levels of health care providers.[9] Won and colleagues[10] in their study on hand hygiene demonstrated the positive impact of compliance programs on nosocomial infections. Nursing care is a crucial component in line-related infections, and there is growing evidence that

Table 1: Documentation of WHO checklist

WHO checklist elements	Documentation	Groups				*P*
		Retrospective		Prospective		
		n=170	Percentage	*n*=170	Percentage	
Patient confirmation	No	93	54.7	1	0.6	<0.001
	Yes	77	45.3	169	99.4	
Aspiration risk	No	32	18.8	0	0.0	<0.001
	Yes	138	81.2	170	100.0	
Risk of blood loss	No	28	16.5	1	0.6	<0.001
	Yes	142	83.5	169	99.4	
Anaesthesia safety check	No	57	33.5	2	1.2	<0.001
	Yes	113	66.5	168	98.8	
Introduction of team	No	3	1.8	1	0.6	0.31139
	Yes	167	98.2	169	99.4	
Site marking	No	5	2.9	11	6.5	0.09958
	Yes	165	97.1	159	93.5	
Images displayed	No	163	95.9	29	17.1	<0.001
	Yes	7	4.1	141	82.9	
Critical events	No	145	85.3	13	7.6	<0.001
	Yes	25	14.7	157	92.4	
Antibiotic prophylaxis before 1 h of surgery	No	20	11.8	1	0.6	<0.001
	Yes	150	88.2	169	99.4	
Sterilisation indicators	No	141	82.9	16	9.4	<0.001
	Yes	29	17.1	154	90.6	
Instrument counts	No	107	62.9	27	15.9	<0.001
	Yes	63	37.1	143	84.1	
Specimens identified	No	123	72.4	38	22.4	<0.001
	Yes	47	27.6	132	77.6	
Equipment problems	No	126	74.1	37	21.8	<0.001
	Yes	44	25.9	133	78.2	
Name of the antibiotic	No	39	22.9	14	8.2	<0.001
	Yes	131	77.1	156	91.8	
Pre-operative bath	No	44	25.9	15	8.8	<0.001
	Yes	126	74.1	155	91.2	
Glucose level	No	119	70.0	53	31.2	<0.001
	Yes	51	30.0	117	68.8	
Body preparation	No	80	47.1	24	14.1	<0.001
	Yes	90	52.9	146	85.9	

WHO – World Health Organization


SURGERY ICU OUTCOMES

Name of the patient : MRD No:
Name of Surgery : Date of Surgery :

Date of ICU admission : _____ Date of ICU shift out : _____

- Mortality : ☐ Yes ☐ No
- Length of ICU stay : ☐ < 2 days ☐ > 2 days
- Re intubation : ☐ Done ☐ Not done
- Readmission to ICU : ☐ Yes ☐ No
- Re exploration : ☐ Done ☐ Not done
- Bed Sores : ☐ Yes ☐ No
- VAP : ☐ Yes ☐ No
- Needle stick injury : ☐ Yes ☐ No
- Wound Infection : ☐ Yes ☐ No
- Blood Stream Infection : ☐ Yes ☐ No
- Complications , if any : _____

Signature of nurse :

Figure 3: Modified quality control checklist page 5

shortages amongst the nursing staff jeopardize the quality of patient care.[11]

Outcomes after surgery depend on the recovery, infections from indwelling lines and the surgical site. Surgical site infection (SSI) is one of the most dreaded post-operative complication and causes significant post-operative morbidity, mortality, prolongation of hospital stay and can also increase hospital costs.[12,13] Approximately, 160,000–300,000 SSIs occur each year in the US,[14,15] and up to 60% of have been estimated to be preventable by implementing evidence-based guidelines.[16,17] Catheter-related bloodstream infections (CRBSIs) and other post-operative complications are also found to be

Table 2: Comparison of Surgical Outcomes

Surgery outcomes	Occurrence	Groups				*P*
		Retrospective		Prospective		
		Count	Percentage	Count	Percentage	
Mortality	No	158	92.9	159	93.5	0.506
	Yes	12	7.1	11	6.5	
UTI/1000 catheter days	No	157	86.4	160	90.5	0.517
	Yes	13	13.6	10	9.5	
Wound infections	No	156	91.8	156	91.7	0.572
	Yes	14	8.2	14	8.3	
Drain related infections	No	164	96.5	158	92.9	0.110
	Yes	6	3.5	12	7.1	
VAP/1000 ventilator days	No	170	0	170	0	0
	Yes	0	0	0	0	
CRBSI/1000 central line days	No	169	98.94	167	97.04	0.614
	Yes	1	1.06	3	2.96	
Blood stream infection	No	165	97.1	159	93.5	0.098
	Yes	5	2.9	11	6.5	
ICU stay (days)						
<10	Yes	152	89.4	149	87.6	0.610
>10	Yes	18	10.6	21	12.4	
Total ICU stay in days (mean±SD)	4.79±3.94				4.64±3.42	0.703
Death within 24 h	2		1.2%	5	2.9%	>0.05
Reintubation within 48 h	0			5	2.9	
Readmissions within 48 h	0			1	0.6	
Medication errors	90		52.9%	82	48.2%	
Needle stick injuries	0			0		
Iatrogenic pneumothorax	0			2	1.2	

CRBSI – Catheter related blood stream infections; UTI – Urinary tract infection; VAP – Ventilator associated pneumonia; ICU – Intensive Care Unit; SD – Standard deviation

high in the healthcare settings. A wound infection is the commonest and the most troublesome disorder of wound healing. Post-operative wound infections have been a problem since surgery was started as a treatment modality.[18]

Specific interventions to reduce adverse post-operative events as per National Surgical Quality Improvement Programme included enforcement of protocols and adherence to the Institute for Healthcare Improvement ventilator bundles, including head of bed elevation, sedation holidays, encouraging early extubation and early institution of nutrition.[19] A 'bundle' of ventilator care processes (peptic ulcer disease prophylaxis, deep vein thrombosis prophylaxis, elevation of the head of the bed and a sedation vacation) which may also reduce VAP rates can serve as a focus for improvement strategies in ICUs.[20] However, scrupulous adherence in protocols and documentation are constantly needed to maintain standards of care.

A potentially preventable adverse outcome impacts the patient's experience and increases the overall cost of treating the patient. We hoped that endorsing these guidelines could improve outcomes in our patients. Surprisingly, we did not find any significant differences in the infection rates. However, our study results revealed that supervised documentation of comprehensive checklist brought out significant improvement in the documentation of quality indicators in the prospective samples. We had defined positive blood culture with signs and symptoms of infection in the patient as blood stream infection. CRBSI was defined as growth of the same organism as the blood culture at least 2 h earlier and with greater numbers of colony forming units. VAP was defined by a positive culture in the bronchoalveolar lavage and radiological evidence of lung infiltrates. The CRBSI rate was 2.96/1000 catheter days in the prospective and 1.06/1000 catheter days in the retrospective samples while bloodstream infections at 6.5% in the prospective and 2.5% in the retrospective group were not significantly different. The CRBSI rate was within the lower limits of reported incidence in literature.[21] Even though the time frame for both arms spanned across 6 months only, we felt that the patients in the prospective group could have been a sicker group than the retrospective patients. However, the differences in infection rates were not different statistically.

Measures to improve the quality of post-operative care and to reduce post-operative infections, the length of stay and other complications are to incorporate integrated inputs from nursing, anaesthesia and surgical teams during care, better communication among the surgical team, hospital-mandated use of a pre-operative surgical safety checklist and bundle adherence checklists.

An ideal situation demands the presence of a quality control team consisting of anaesthetists/intensivist, an infection control practitioner, nurse practitioner, surgeons, quality coordinators, pharmacist and nursing leaders. Monthly meetings including data reviews, critical incident reports on antibiotic usage and adherence to protocols on infection control are required.

Some of our patients discharged from the ICU had urine and bronchoalveolar lavage samples that were positive for organisms. In patient follow-up, we had excluded infection as a cause in patients who were asymptomatic and these patients were assigned to a group that could have contaminants or improper collection techniques.

The infection control practices in the ICUs play a vital role in the reduction of infections. Creation of awareness on the need for adherence to bundles of care must be addressed periodically. Periodical auditing of the documentation of various WHO surgery checklists and other checklists in the patient's medical records should be carried out to continue the improvement in documentation. Timely updates of improvements in practices along with an internal assessment of individuals will ensure safety in the standard of nursing in the post-operative ICU. We documented a significant increase in awareness and compliance in the components of the mandated checklist with inputs from the anaesthesia, nursing and surgical teams. We had aimed to keep the rates of infection following line introduction to be minimal and implemented this after formal training of staff members on the recommended practices of the line care. We concluded that although documentation and awareness had improved with our intervention, we had probably established safe standards in line placements and did not have too much scope to improve.

The major limitation of this study was our failure to categorise patients according to their health profiles while comparing prospective and retrospective samples. This could have resulted in reducing the impact of supervised enforcement in perioperative care on outcomes in our patients.

CONCLUSION

The introduction of comprehensive surgical safety checklist improved documentation of quality care bundles but did not change the rates of infection or the ICU stay in patients undergoing abdominal surgery.

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Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Ray B, Samaddar DP, Todi SK, Ramakrishnan N, John G, Ramasubban S. Quality indicators for ICU: ISCCM guidelines for ICUs in India. Indian J Crit Care Med 2009;13:173-206.
2. Quality Improvement. US Department of Health and Human Services, Health Resources and Services Administration; April, 2011. Available from: http://www.hrsa.gov/quality/toolbox/methodology/qualityimprovement/. [Last accessed on 2016 Feb 28].
3. Beuran M, Negoi I, Paun S, Stocia B, Vartic M. Quality management in general surgery. A review of the literature. J Acute Dis 2014;3:253-7.
4. Pronovost P, Needham D, Berenholtz S, Sinopoli D, Chu H, Cosgrove S, *et al.* An intervention to decrease catheter-related bloodstream infections in the ICU. N Engl J Med 2006;355:2725-32.
5. Implementation Manual: WHO Surgical Safety Check List. 1st ed. Available from: http://www.who.int/patientsafety/safesurgery/./SSSL_Manual_finalJun08.pdf. [Last accessed on 2016 Feb 28].
6. Anderson DJ, Podgorny K, Berríos-Torres SI, Bratzler DW, Dellinger EP, Greene L, *et al.* Strategies to prevent surgical site infections in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol 2014;35:605-27.
7. Slovin's Formula: What is it and When do I use it? Available from: http://www.statisticshowto.com/how-to-use-*slovins-formula*. [Last accessed on 2016 Jun 28].
8. World Health Organization. WHO Guidelines on Hand Hygiene in Health Care: First Global Patient Safety Challenge. 2009. (http://apps.who.int/iris/bitstream/10665/44102/1/9789241597906_eng.pdf) [Last accessed on 2016 Oct 30].
9. Pfoh E, Engineer C. Interventions to improve hand hygiene Compliance. Brief update review. Making Health Care safer II. An Updated Critical Analysis of the evidence for Patient Safety practices.
10. Won SP, Chou HC, Hsieh WS, Chen CY, Huang SM, Tsou KI, *et al.* Handwashing program for the prevention of nosocomial infections in a neonatal intensive care unit. Infect Control Hosp Epidemiol 2004;25:742-6.
11. Hugonnet S, Chevrolet JC, Pittet D. The effect of workload on infection risk in critically ill patients. Crit Care Med 2007; 35:76-81.
12. Anusha S, Vijaya LD, Pallavi K, Manna PK. An epidemiological study of surgical wound infections in a surgical unit of tertiary care teaching hospital. Indian J Pharm Pract 2010;3:8-13.
13. Smyth ET, Emmerson AM. Surgical site infection surveillance. J Hosp Infect 2000;45:173-84.

14. Agency for Healthcare Research and Quality. Healthcare Cost and Utilization Project- Statistics on Hospital Stays; 2013. Available from: http://www.hcupnet.ahrg.gov/. [Last accessed on 2016 Feb 28].
15. Scott RD. The Direct Medical Costs of Healthcare-Associated Infections in US and Benefits of Prevention. Available from: http://www.cdc.gov/hai/pdfs/hai/scott_costpaper.pdf. [Last accessed on 2016 Feb 28].
16. Meeks DW, Lally KP, Carrick MM, Lew DF, Thomas EJ, Doyle PD, *et al*. Compliance with guidelines to prevent surgical site infections: As simple as 1-2-3? Am J Surg 2011;201:76-83.
17. Umschield CA, Mitchell MD, Doshi JA, Agarwal R, Williams K. Estimating the proportion of healthcare associated infections that are reasonably preventable and the related mortality costs. Infect Control Hosp Epidemiol 2011;32:101-14.
18. Anand S, Singh MP, Swagata B. Surgical site infection among post-operative patients of tertiary care centre in Central India – A prospective study. Asian J Biomed Pharm Sci 2013;3:41-4.
19. McNelis J, Castaldi M. "The National Surgery Quality Improvement Project" (NSQIP): A new tool to increase patient safety and cost efficiency in a surgical intensive care unit. Patient Saf Surg 2014;8:19.
20. Resar R, Pronovost P, Haraden C, Simmonds T, Rainey T, Nolan T. Using a bundle approach to improve ventilator care processes and reduce ventilator-associated pneumonia. Jt Comm J Qual Patient Saf 2005;31:243-8.
21. Fletcher S. Catheter related blood stream infections. Contin Educ Anaesth Crit Care Pain 2005;5:49-51.