Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/mjafi

Original Article

Control of hospital acquired infections in the ICU: A service perspective

Col Shivinder Singh ^{a,*}, Col Rakhee Goyal ^b, Brig G.S. Ramesh, vsm (Retd) ^c,
Maj Gen V. Ravishankar, vsm ^d, Gp Capt R.M. Sharma ^e,
Maj D.V. Bhargava ^f, Lt Col S.K. Singh ^g, Maj M.K. John ^h,
Surg Lt Cdr Anoop Sharma ^h

^a Senior Adviser (Anaesthesiology & Critical Care), Command Hospital (Western Command), C/O 56 APO, India

^b Senior Adviser (Anaesthesiology), Command Hospital (Southern Command), Pune 411040, India

^c Ex-Professor & Head, Dept. of Anaesthesiology & Critical Care, Armed Forces Medical College, Pune 411040, India

^d Commandant, Command Hospital (Southern Command), Pune 411040, India

^e Associate Professor, Dept. of Anaesthesiology & Critical Care, Armed Forces Medical College, Pune 411040, India

^f Clinical Tutor, Dept. of Anaesthesiology & Critical Care, Armed Forces Medical College, Pune 411040, India

^g Assistant Professor, Dept. of Anaesthesiology & Critical Care, Armed Forces Medical College, Pune 411040, India

^h Resident, Dept. of Anaesthesiology & Critical Care, Armed Forces Medical College, Pune 411040, India

ARTICLE INFO

Article history:

Received 2 January 2014

Accepted 8 August 2014

Available online 16 October 2014

Keywords:

Hospital acquired infections
Catheter related blood stream
infection
Ventilator-associated pneumonia
Catheter associated urinary tract
infection

ABSTRACT

Background: The service setting has some unique strengths and weaknesses that must be kept in mind when organizing Hospital acquired infections (HAI) prevention interventions. **Methods:** Following an initial study to gather data regarding HAI in the Surgical intensive care unit (ICU) we put into place various infection control interventions. The present study was carried out to analyse the effect of these interventions on the incidence of HAI in the ICU.

Results: The total admissions to the ICU were 253 patients. Eighty eight patients (34.78%) were admitted for more than 48 hr, 165 patients stayed for less than 48 h. The frequency of HAI was 7.95% (95% CI 3.54, 15). Hospital acquired pneumonia was observed in 2 of the 88 patients (2.27%) (95% CI 0.38, 7.30) which amounted to 9.70 infections per 1000 ventilator days. Bloodstream infection was detected in 3 out of 88 patients (3.4%) (95% CI 0.87, 8.99) amounting to 6.54 fresh infections per 1000 Central Venous Catheter days. Urinary tract infection was observed in 2 (2.27%) (95% CI 0.38, 7.30) at 2.86 fresh infections per 1000 catheter days. As compared to the previous study we found that there was a decline of HAI ranging from 60 to 70%.

Conclusion: Our study demonstrated that by meticulously following infection control protocols especially tailored to the service setting the incidence of HAI's can be reduced. However, the challenge is in maintaining the gains achieved since there is a rapid turnover of manpower in the ICU and a lack of a structured ICU design model.

© 2014, Armed Forces Medical Services (AFMS). All rights reserved.

* Corresponding author.

E-mail address: sshivinder@hotmail.com (S. Singh).
<http://dx.doi.org/10.1016/j.mjafi.2014.08.008>

0377-1237/© 2014, Armed Forces Medical Services (AFMS). All rights reserved.

Introduction

Hospital acquired infections (HAI) have assumed worrisome proportions in healthcare scenarios all over the world, be it the developed or developing world, the civil or service setting.

The service health care setting, however, has its own aspects which must be kept in mind while organizing infection control interventions. With the advent of systematic central procurement of equipment, decentralization of drug procurement with local purchase funds available at the hospital level, the non availability of state of the art equipment and quality drugs is now passé. The area of concern, however, is the paucity of trained manpower to achieve the basic nurse to patient ratio for nursing care.

With the above background, after a preliminary study to confirm the incidence of HAI in the surgical ICU, we instituted interventions towards control of HAI.¹ Thereafter, we observed the incidence again to see the effects of the interventions.

Interventions: Regular interactive discussion with nursing staff highlighting the important aspects of infection control, designating one nursing officer as infection control nurse in rotation, demonstration of hand washing, installation of flexi-boards demonstrating the technique of hand washing, installation of bedside white boards for each patient and noting “FASTHUG”.² (A mnemonic to enumerate all the daily actions required in the management of critical patients. Developed by Jean Louis Vincent in Belgium it is a short mnemonic that highlights seven evidenced based best practises for critical care. It is a tool used to ensure that the seven essential evidence based aspects of patient care are not forgotten by the ICU team. These stand for F = early enteral Feeding A = assessment of Analgesia S = assessment of Sedation T = Thromboembolic prophylaxis H = Head of bed elevation U = stress Ulcer prophylaxis G = Glycaemic control).

In addition the dates of insertion of catheters and lines, institution of ventilator-associated pneumonia bundle (VAP), catheter related blood stream infection (CRBSI) bundle, catheter associated urinary tract infection (CAUTI) bundle, use of subglottic suction, use of closed suction, attention to isolation of infected cases within the ICU. Introduction of shoe covers for all entrants to the ICU as mopping of the floor every 2 h wasn't possible.

Material and methods

The aim of the study was to analyse the effects of structured interventions, tailored to the service setting on the incidence of HAI in our hospital ICU. The results would be compared with the results of a prior study.¹

The objectives of the study were to answer the following questions.

1. To assess the feasibility of implementing the interventions in the service setting.
2. To analyse the effect of the various interventions on the incidence of HAI as compared to the earlier data?

3. To sensitise the staff to the problem of HAI and to keep the issue of HAI in the forefront.

Patients and methods: This hospital-based observational study was conducted from June to December 2012 at a 10 – bedded surgical intensive care unit (ICU) of a tertiary service hospital. Patients who were shifted out of the ICU within 48 h of admission were excluded from the study. All patients who were above 16 years of age, admitted in the surgical ICU with different complaints and presentations and developed clinical evidence of infection that did not originate from patient's original admitting diagnosis, were included in the study. A proforma was designed and used for data collection. All data items were collected for all patients in the ICU, irrespective of their length of stay. Data for all patients who developed an infection was collected, irrespective of when the infection occurred. Infections studied were CRBSI, CAUTI, and VAP. This did not influence any aspect of clinical diagnosis and clinical decision-making.

HAI definitions: In this survey an HAI was an infection which arose 48 h or more after admission to hospital and which was not present or incubating on admission. A prevalent HAI was considered present when the patient had signs and symptoms which met one of the centers for disease control (CDC) definitions as had been used in the previous study.³ The assessment, diagnosis and management of the patients was done as in the previous study.¹

Results

Statistical analysis to calculate 95% confidence intervals for incidence of infections was done using Epi-Table and chi square test for linear trend applied to length of stay and incidence of infection along with calculation of odds ratio was done using EPI Info software.

The total admissions to the ICU were 253 patients. While 88 patients (34.78%) were admitted for more than 48 h, 165 patients stayed in the ICU for less than 48 h. There were a total of 28 deaths. There were 161 (63.64%) males and 92 (36.36%) females. Only seven 7.95% (95% CI 3.54, 15) out of the eighty eight (88) patients were identified to acquire infection during their stay in the ICU. 128 patients of the 253 had central lines placed for a total of 459 days thus the average duration of indwelling CVCs was 459/128 that is 3.59 days per patient. Similarly for urinary catheters it was 699/218 that is 3.21 days per patient.

Details of patients who acquired nosocomial infection are summarized in Table 1. Hospital acquired pneumonia was observed in 2 of the 88 patients (2.27%) (95% CI 0.38, 7.30) all of these had undergone or were on mechanical ventilatory support. The total number of days that all patients were ventilated amounted to 206 days. Thus it amounted to 9.70 infections per 1000 ventilator days. They developed signs of consolidation after 3–5 days and we categorized them as ventilator-associated pneumonia (VAP). The identified pathogens on broncho-alveolar lavage (BAL) in such patients were *Acinetobacter* sensitive only to imipenem and polymixin in both the patients.

Table 1 – Details of patients with nosocomial infections.

Type of infection	Total no. & %	95% Confidence interval	Infections per 1000 intervention days
Patients admitted	253		
Patients who stayed more than 48 h	88 (100%)		
Patients with nosocomial infections	07 (7.95%)	3.54, 15	7/1364* 1000 = 5.13
Pneumonia	02 (2.27%)	3.54, 15	02/206* 1000 = 9.70
Blood stream infection	03 (3.41%)	0.87, 8.99	3/459* 1000 = 6.54
Urinary catheter infection	02 (2.27%)	0.38, 7.3	2/699* 1000 = 2.86

Blood stream infection was detected in 3 out of 88 (3.4%) 95% CI 0.87, 8.99 patients. The source of such blood stream infections was central venous lines. The total number of days that all patients had indwelling Central Venous Catheters amounted to 459 days. Thus it amounted to 6.54 fresh infections per 1000 Central Venous Catheter days.

Urinary tract infection was observed in 2 (2.27%) 95% CI 0.38, 7.30 of the patients. The total number of days that all patients had indwelling Foley's catheters was 699 days. Thus it amounted to 2.86 fresh infections per 1000 catheter days. Only one was detected to be culture positive with *Escherichia coli* grown.

The total number of patients who stayed for less than 5 days in the ICU was 209 out of which 1 developed HAI (Fig. 1). Three of the 35 patients who stayed from 5 to 10 days developed HAI and of the 9 patients who stayed more than 10 days 3 developed HAI (Table 2). This data was subjected to statistical analysis using chi square test for association between length of stay and the risk of developing HAI. Chi square value for linear trend was found to be 28.64, p value < 0.000, odds ratio 1 for stay less than 5 days, 18.0 for stay between 5 and 10 days and 69.67 for stay beyond 10 days (Fig. 2). Proving that as the length of stay in the ICU increased the risk of developing HAI became highly significant.

Discussion

Evidence based interventions for prevention of HAI are well established.⁴ In spite of the knowledge of the interventions required for minimization of HAI, they continue to be a major problem especially in the ICU setting. Difficulties in implementation of these guidelines have been found at the unit level and have been termed as change implementation failure.^{5–7} The impact of teaching interventions involving the ICU staff regarding hand hygiene and the various HAI prevention

bundles has been shown to decrease HAI's.⁸ A comprehensive systems approach targeted at efforts involving both process improvements and culture change, has been identified to enable sustainable change at the unit level.⁹

The service setting with a structured regimented work force is unique as regards implementation of interventions. However, the frequent turnover of staff and the shortage of trained nursing staff in the ICU with a nurse to patient ratio of 1:3–1:5 at the best of times can be quite challenging. Consequently, we adopted a multi-pronged approach to this problem. We liaised with the administration of the nursing services and minimised the turnover of staff to the bare essential. Interactive sessions with the nursing and paramedical staff outlining the current evidence based recommendations were started. All fresh nursing and paramedical staff in the ICU were made to read and understand the infection control protocols in place. Interventions aimed at increasing awareness about hand washing were also implemented.

Recognising the fact that our nurse to patient ratio at the best of times would be far from ideal we instituted interventions that would be less labour intensive like use of closed suction catheters and continuous subglottic suction of secretions. The closed suction catheters were replaced after a week¹⁰ or in case they were visibly soiled.

The VAP rates declined by nearly 70% from 32/1000 to 9.7/1000 ventilator days as compared to the previous study,¹ the CRBSI rates by nearly 61% from 16/1000 to 6.54/1000 central line days and the CAUTI rates by nearly 70% from 9/1000 to 2.8/1000 urinary catheter days (Table 3, Fig. 3)

We achieved a more rapid turnover of patients in the present study as compared to the previous one, 34.78% in the present study as compared to 69.6% patients in the prior study stayed for more than 48 h in the ICU.¹ Thus part of the results achieved may have been because the stay of patients in the ICU was minimized. Since a number of interventions had been instituted at the same time, we cannot postulate the effect of each specific intervention towards the final result.

This brings us to the more pertinent question of sustenance of the gains achieved. This is possible by ensuring that the interventions become part of the protocol and are firmly embedded in the day to day functioning of the ICU.

Needless to say, the elephant in the room too needs to be addressed at an administrative level which is the model of service ICU's. There is enough evidence supporting the fact that closed and semi closed ICUs have better outcomes in terms of HAI, mortality and morbidity.^{11–13} Indian Society of Critical Care Medicine (ISCCM) in their guidelines discourages the adoption or continuance of open ICUs.¹⁴ To monitor

Fig. 1 – Length of stay.

Table 2 – Length of stay and HAI.

Serial no	No of patients	Patient staying <5 days	No of infections less than 5 days stay	Patients staying 5–10 days	No of infections 5–10 days stay	Patient staying more than 10 days	No of infections more than 10 days stay
Neuro	99	78	–	19	2	4	2
Onco	41	39	–	2	1	–	–
GI	43	32	1	7	–	2	1
Gynae	4	4	–	–	–	–	–
Uro	11	10	–	1	–	–	–
Ortho	8	8	–	–	–	–	–
Vasc	1	1	–	–	–	–	–
Gen Sx	33	26	–	4	–	3	–
ENT	3	3	–	–	–	–	–
RSC	10	8	–	2	–	–	–
Total	253	209	1	35	3	9	3

Fig. 2 – HAI as compared to length of stay.

standards of quality of care in ICUs as per national guidelines, it is imperative that the “ownership” of service ICUs is clearly defined ensuring that a specific team has full control and more importantly, therefore, also the responsibility to deliver the quality and outcomes desired.¹⁵

More so, in view of the fact that hospital acquired infections constitute preventable or never events which are serious, largely preventable patient safety incidents that should not occur if the available preventative measures have been implemented.¹⁶ Hospitals in the US are now mandated by the Centers for Medicare and Medicaid to report central line-associated bloodstream infections and selected surgical site infections (e.g., colon surgeries, hysterectomies, and cesarean delivery), these requirements are expected to expand

to all other hospital acquired infections in the near future.¹⁷ Recently, the Centers for Medicare and Medicaid Services (CMS) announced its decision to cease paying hospitals for some of the care made necessary by “preventable complications” which includes some HAI’s.¹⁸ This has raised concerns that patients experiencing complications listed as non-reimbursable serious hospital acquired conditions will be inaccurately told that those never events are based on negligence or medical errors, leaving medical practitioners open to the attendant risk of litigation for negligence.¹⁹

The limitation of the study is that there was a lack of a concurrent comparison group with the intervention group. Although the study settings are similar and measurement bias has been effectively taken care of since the present study was done on the same lines as the previous one with which the results are being compared.¹ However, since it would not have been ethical to subject one group of patients to inadequate care as compared to the interventions being implemented we decided to use the previous study for comparison. Moreover, even though the interventions instituted are known facts, there is hardly any data regarding the incidence of nosocomial infections in service ICU’s or the effect of infection control interventions in the service setting.

In conclusion, our study demonstrated that by meticulously following relevant infection control protocols especially tailored to the service setting the incidence of HAI’s can be reduced. It is feasible to implement specific interventions. However, the challenge is in maintaining the momentum in view of the rapid turnover of manpower and lack of a structured ICU design model.

Table 3 – Comparison of data May 2010 vs Dec 2012.

Type of infection	Total no. & (%)		Infections per 1000 intervention days		95% Confidence interval	
	2010	2012	2010	2012	2010	2012
Total admissions to ICU	293	253				
Admitted for more than 48 h	204	88				
Pneumonia	18 (8.8%)	2 (2.3%)	32/1000	9.7/1000	22, 45	3.54, 15
Blood stream infection	10 (4.9%)	3 (3.4%)	16/1000	6.54/1000	9, 26	0.87, 8.99
Urinary catheter infection	8 (3.9%)	2 (2.27%)	9/1000	2.86/1000	4, 18	0.38, 7.3
Total infections	36 (17.64%)	7 (7.95%)	31/1000	5.13/1000		

Fig. 3 – Incidence of HAI Dec–May 09 Vs Jun–Dec 12.

Conflicts of interest

All authors have none to declare.

Acknowledgement

The authors acknowledge Dr. SR Patrikar, Lecturer in Biostatistics & Demography, Dept of Community Medicine, Armed Forces Medical College, Pune 40.

REFERENCES

- Singh S, Chaturvedi R, Garg SM, Datta R, Kumar A. Incidence of healthcare associated infection in the surgical intensive care unit of a tertiary service hospital. *Med J Armed Forces India*. 2013;69:124–129. <http://dx.doi.org/10.1016/j.mjafi.2012.08.028>.
- Vincent JL. Give your patient a fast hug (at least) once a day. *Crit Care Med*. 2005 Jun;33(6):1225–1229.
- Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care–associated infection and criteria for specific types of infections in the acute care setting. *Am J Infect Control*. 2008;36:309–332.
- Dellinger RP, Levy MM, Rhodes A, et al. Surviving sepsis campaign: International guidelines for management of severe sepsis and septic shock: 2012. *Crit Care Med*. 2013;41(2):580–637.
- Landrigan C, Bones BB, Goldman DA. Temporal trends in rates of patient harm resulting from medical care. *N. Engl J Med*. 2010;363(22):2124–2134.
- Agency for Healthcare Research and Quality. HHS Awards \$17 Million to Fight Health Care-associated Infections; 2009. Retrieved from www.ahrq.gov/news/press/pr2009/haifund.htm.
- Nembhard I, Tucker AL, Edmondson AC. Implementing new practices: an empirical study of organizational learning in hospital intensive care units. *Manag Sci*. 2007;53(6):894–907.
- Zingg W, Imhof A, Maggiorini M, Stocker R, Keller E, Ruef C. Impact of a prevention strategy targeting hand hygiene and catheter care on the incidence of catheter-related bloodstream infections. *Crit Care Med*. 2009;37:2167–2173.
- Pronovost PJ, Goeschel CA, Colantuoni E, et al. Sustaining reductions in catheter related bloodstream infections in Michigan intensive care units: observational study. *Br Med J*. 2010;340:309.
- Stoller JK, Orens DK, Fatica C, et al. Weekly versus daily changes of in-line suction catheters: impact on rates of ventilator-associated pneumonia and associated costs. *Respir Care*. 2003;48(5):494–499.
- Topeli A, Laghi F, Tobin MJ. Effect of closed unit policy and appointing an intensivist in a developing country. *Crit Care Med*. 2005;33:299–306.
- Carson SS, Stocking C, Podsadecki T, et al. Effects of organizational change in the medical intensive care unit of a teaching hospital: a comparison of ‘open’ and ‘closed’ formats. *JAMA*. 1996;276:322–328.
- Multz AS, Chalfin DB, Samson IM, et al. A closed medical intensive care unit (MICU) improves resource utilization when compared with an open MICU. *Am J Respir Crit Care Med*. 1998;157:1468–1473.
- Divatia JV, Baronia AK, Bhagwati A, et al. Critical care delivery in intensive care units in India: defining the functions, roles and responsibilities of a consultant intensivist Recommendations of the Indian Society of Critical Care Medicine Committee on defining the functions, roles and responsibilities of a consultant intensivist. *Indian J Crit Care Med*. January–March 2006;10(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*. October–December 2009;13(4).
- Milstein A. Ending extra payment for “never events”—stronger incentives for patients’ safety. *N Engl J Med*. 2009;360:2388–2390.
- Hospital-acquired Conditions (HAC) in Acute Inpatient Prospective Payment System (IPPS) Hospitals; May 2012. Available at: <http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalAcqCond/downloads/HACFactsheet.pdf>. Accessed 11.06.12.
- Medicare program: changes to the hospital inpatient prospective payment systems and fiscal year 2008 rates. *Fed Regist*. 2007;72:47379–47428.
- Lembitz A, Clarke TJ. Clarifying “never events and introducing “always events”. *Patient Saf Surg*. 2009;7:26. <http://dx.doi.org/10.1186/1754-9493-3-26>.