Sustained Low Incidence Rates of Central Line-associated Blood Stream Infections in Intensive Care Unit

Waleed Abdulmotalib Mazi (waleedmazi@yahoo.com)
King Faisal Medical Complex
Amir M. Saeed
University of Hail
Mohammed H. Abdulwahab
King Faisal Medical Complex-Taif
Mahmood A. Al Ashqar
King Faisal Medical Complex-Taif
Yvonne S. Aldecoa
King Faisal Medical Complex-Taif
Zaheda R. Bahat
King Faisal Medical Complex-Taif
Jennifer L. Suaking
King Faisal Medical Complex-Taif
Osama S. Yassin
King Faisal Medical Complex-Taif

Research

Keywords: Health Care Associated Infections, Antibiotic, Bacterial Resistance

Posted Date: July 9th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-40620/v1

Abstract

The health care associated infections (HAIs) have become a global health problem and need to establish effective infection prevention and control strategies. HAIs increase mortality, length of hospital stay, cost of care, bacterial resistance, antibiotic use and other adverse in intensive care units (ICUs), particularly in developing countries (1, 2). The International Nosocomial Infection Control Consortium showed that the incidence rate for central line-associated bloodstream infection (CLABSI) in ICUs in developing countries was 3-fold higher than the United States (3). It has been proved that implementation on CLABSI bundle prevention can significantly reduce HAIs (4-7).

Introduction:

The health care associated infections (HAIs) have become a global health problem and need to establish effective infection prevention and control strategies. HAIs increase mortality, length of hospital stay, cost of care, bacterial resistance, antibiotic use and other adverse in intensive care units (ICUs), particularly in developing countries (1, 2). The International Nosocomial Infection Control Consortium showed that the incidence rate for central line-associated bloodstream infection (CLABSI) in ICUs in developing countries was 3-fold higher than the United States (3). It has been proved that implementation on CLABSI bundle prevention can significantly reduce HAIs (4-7).

Recently, Mazi *et al* demonstrated the basic Society Healthcare Epidemiology of America combined with Infectious Diseases Society of America (SHEA/ISDA) basic practice recommendation is an effective prevention model for 58% the reduction of CLABSIs in the medical/surgical ICU in King Abdulaziz Specialist Hospital (8). We introduced SHEA/IDSA CLABSI prevention model to reduce CLABSI incidence rate in our institutional ICU.

Methods

This prospective study was conducted in the 27-bed medical-surgical ICU of King Faisal Medical Complex in Taif from January 2016-December 2019, Saudi Arabia. King Faisal Medical Complex is a referral undergraduate teaching hospital with 800-bed capacity and catchment population of approximately 2 million.

Bacterial identification and determination of CLABSI

Bacterial identification and antimicrobial susceptibility of isolates were determined according to Clinical Laboratory Standards Institute guidelines (9). Laboratory-confirmed CLABSI was identified using the Centers for Disease Control and Prevention and National Healthcare Safety Network (NHSN; formerly the National Nosocomial Infection Surveillance System) criteria (10). Incidence rate, ratio, benchmarking, and statistical analysis were carried out using the NHSN recommendations (11). A P value <.05 (2 tailed) was considered statistically significant.

Implementation of SHEA/IDSA guidelines

In the pre-intervention period, the basic CLABSI bundle program, which included hand hygiene, maximal barrier precautions, chlorohexidine skin antisepsis, and daily review of line necessity with prompt removal of unnecessary lines, was being implemented in the study hospital. Infection rates were regularly monitored. No CLABSI prevention team, baseline risk assessment, or formal educational activity had been performed prior to 2017. Preventive measures using basic SHEA/IDSA practice recommendations were introduced in January 2017 (12).

With the introduction of the SHEA/IDSA guidelines in 2017, briefly, a CLABSI prevention team was assembled. It included the head of infection control, an infectious diseases physician, an intensive care consultant, an intensive care link nurse and an infection preventionist. A baseline risk assessment was performed in January 2017 using the Wirral Primary Care Trust tool (13). Any practice did not met SHEA/IDSA basic recommendation will be considered as risk of CLABSI. Action plan agreement was approved to address risk infection accordingly.

Only one risk factor was identified which is formal training and education program and resolved by February 2017. We organized a full-day formal educational course and workshop on CLABSI prevention measures in February 2017 as a first step to formally provide the education needed. The CLABSI educational program was conducted in collaboration with physicians and nurses in the ICU, microbiology, infection control and quality and patient safety departments. The educational program included a presentation of the clinical manifestations and complications of bloodstream infections, indicators and benchmarking guidelines, SHEA/IDSA practice recommendations, guidelines for optimal blood cultures, open discussion forum, and practical exercises workshop. All recommendations and SHEA/IDSA guidelines were fully implemented from March 2017-December 2019.

Compliance to hand hygiene was observed by trained infection preventionists using the World Health Organization My 5 Moments for Hand Hygiene recommendations (14). The CLABSI prevention bundle program was monitored using Institute for Healthcare Improvement guidelines (15). Regular meetings and feedback for stakeholders and hospital management were implemented and documented.

External validation

External validation surveillance was conducted by reviewing all blood culture results in patients under central line device and case definition of CLABSI (16).

Results:

Institutional risk assessment revealed formal educational program as a potential area need for improvement. Bundle compliance rate was 100% during the study period. Observation of hand hygiene compliance revealed that the compliance rate ranged from 70%-80%, and the alcohol hand rub consumption rate was sustained at 50% during the study period.

The total number of reported CLABSI cases was fifteen cases representing incidence rate 0.63/1000 central-line days with utilization ratio 0.45 during the study period. Pre-intervention incidence rate of CLABSI was 1.12/1000 central-line days with 0.51 in utilization ratio representing 50 – 75 and 50 percentile benchmarking to NHSN, respectively. Post-intervention incidence rate of CLABSI was 0.46/1000 central line days with 0.44 in utilization ratio representing sustained within the 25-50 percentile benchmarking to NHSN. Table 1 shows incidence rate and ratio of CLABSI reported during pre- and post-interventions the benchmarking with the NHSN ICU. The CLASBIs were caused predominantly by multidrug resistant bacteria, namely extended spectrum beta-lactam (ESBL) and carbapenem resistance (CPR) *Klebsiella pneumoniae*, multi-durg resistance (MDR) *Pseudomonas aeruginosa*, *Proteus merabilis* and *Acinetobacter baumanii* (Table 2). No outbreak was observed during the study period.

Discussion:

CLABSI is an important cause of increased morbidity, mortality, duration of hospital stay, and excess health care costs in ICUs. In Kingdom of Saudi Arabia, CLABSI compromised 14% -38.5% of healthcare device associated infection with incidence rates ranged from 2.2 to 29.7 per 1000 central-line days ICUs during 2011-2018 (17-19). In our hospital, the hospital CLABSI incidence rate to percentile the NHSN benchmarking in 2016 indicated the need to improve patient care practice in the ICU. Therefore, we decided to introduce a strategic plan to reduce CLABSI and deliver high quality performance and patient safety. Mazi *et al* demonstrated 58% the reduction of CLABSIs in the ICU after implementation of SHEA/ISDA practice recommendation (8). Therefore, we decided to introduce SHEA/IDSA as a prevention model to reduce and control CLABSI in medical-surgical ICU. In addition, the basic SHEA/ISDA practice recommendations were written in concise format and applicability in our setting, with measurable elements.

No significant difference in the incidence reduction rate of CLABSI was noted when compared before and after resolving risk factors because of the statistically low numbers of CLABSI. However, a significant reduction of incidence rate was observed

in 2017 and maintained less than the NHSN pooled mean (25-50 percentile) through the post intervention period of 2017-2019 (Fig 1).

Device-associated infection rates and device utilization ratios should be examined together; therefore, preventive measures may be appropriately targeted (11, 20). Incidence CLABSI rate of the 75th percentile with utilization ratio 50th NHSN benchmarking indicate the prevention measures should be focused on before and during insertion the central line. After intervention period, CLABSI incidence rate and device utilization ratio were declined and maintaining below the mean of NHSN percentile (25-50th) assuming annual formal educational program was an important issue for prevention measures. The lack of familiarity with practice guidelines by health care workers has been identified as a main barrier in the proper implementation of these guidelines. Alfonso *et al* (20) observed significant reduction (35%) of CLABSI in ICUs after education interventions and noted that an updated educational program is the first step toward achieving adherence to guidelines. Validation is an important step toward assuring for action and motivates infection control efforts rather than strategies to avoid accounting for HAIs. Official external validation can help assure adherence to MOH guidelines specifications for CLABSI reporting (16). The external validation report showed totally agreement in data surveillance results between the hospital data and the agency. Members of external agency of regional directorate for infection prevention and control were authorized from local ministry of health, well-trained and have good experience in hospital infection control surveillance.

Regular meetings with the CLABSI prevention team and ICU department were held with dissemination of feedback to all stakeholders. Despite regular reminders about the importance of hand hygiene, the compliance rates were variable (70%-80%; average rate, 73%), with low alcohol hand rub consumption rates of 50% (P =0.15). This is perhaps caused by the fact that the ICU is a very busy care area. The significant reduction in CLABSI in our ICU indicates the positive impact of addressing bundle compliance (Table 2) and annual formal education.

As a limitation of this work, we could not specify which of risk factor was responsible for the significant reduction observed. No bundle data was available in 2016 with almost 100% compliance to CLABSI bundle in 2017-2019.

Conclusion

We observed reduction and sustained in low incidence rate CLABSI benchmarking to NHSN after implementation of the basic SHEA/IDSA practice recommendation. Therefore, the basic SHEA/ISDA practice recommendation is an effective prevention model for the reduction of CLABSI in the ICU.

Abbreviations

CPR: carbapenem resistance, CLABSI: central line-associated bloodstream infection, ESBL: extended spectrum beta-lactam,

HAI: Healthcare associated infection, ICU: Intensive Care Unit, IDSA: Infectious Diseases Society of America, MDR: multi-durg resistance, NHSN: National Healthcare Safety Network, USA, SHEA: Society Healthcare Epidemiology of America.

Declarations

Competing interests

The authors (Waleed A. Mazi; Amir M. Saeed; Mohammed H. Abdulwahab; Mahmood A. Al Ashqar; Yvonne S. Aldecoa; Zaheda R. Bahat; Jennifer L. Suaking and Osama S. Yassin) declare that they have no personal or financial relationship which may constitute a conflict of interest.

Authors' contributions

All authors have made substantial intellectual contribution to this work as follows: WAM: Conception and design of the study, data acquisition and analysis as well preparation of the manuscript draft and critical revision of final manuscript. AMS:

Conception and design of study, data analysis and interpretation, preparation of manuscript draft and critical revision of manuscript. MHA: critical revision of manuscript. MAA: Study design, Data acquisition and critical revision of manuscript. YSA: data collection and analysis with interpretation. ZRB: data collection and analysis with interpretation. JLS: data collection and analysis with interpretation. OSY: Conception and design of study, data analysis and interpretation. All authors read and approved the final manuscript.

ACKNOWLEDGMENT

We would like to thank to Regional Directorate for Infection Prevention and Control for conducting blinding validation surveillance, especially to Dr. Masood Ahmad Shah, who is expert in hospital infection prevention and control program.

The project was presented in part as a poster presentation at The 5th International Conference of Prevention and Infection Control, Geneva, Switzerland, 10-13 September 2019.

Author details

[1]Infection Prevention and Control, King Faisal Medical Complex. Taif, Kingdom of Saudi Arabia

[2]Collage of medicine and laboratory sciences, Hail University, Kingdom of Saudi Arabia

[3]Intensive Care Unit, King Faisal Medical Complex-Taif, Kingdom of Saudi Arabia

References

1. Centers for Disease C, Prevention. Monitoring hospital-acquired infections to promote patient safety–United States, 1990-1999. MMWR Morb Mortal Wkly Rep 2000;49(8):149-53.
2. Siddiqui S, Saeed M, Faisal SM, Akhtar A, Sarim KM, Khan M, et al. Molecular and phenotypic characterization of the vancomycin-resistant gene in bacterial isolates acquired from catheter tips. Cell Mol Biol (Noisy-le-grand) 2017;63(12):63-67.
3. Rosenthal VD, Bijie H, Maki DG, Mehta Y, Apisarnthanarak A, Medeiros EA, et al. International Nosocomial Infection Control Consortium (INICC) report, data summary of 36 countries, for 2004-2009. Am J Infect Control 2012;40(5):396-407.
4. Prakash SS, Rajshekar D, Cherian A, Sastry AS. Care bundle approach to reduce device-associated infections in a tertiary care teaching hospital, South India. Journal of laboratory physicians 2017;9(4):273.
5. Pogorzelska M, Stone PW, Furuya EY, Perencevich EN, Larson EL, Goldmann D, et al. Impact of the ventilator bundle on ventilator-associated pneumonia in intensive care unit. Int J Qual Health Care 2011;23(5):538-44.
6. Menegueti MG, Ardison KM, Bellissimo-Rodrigues F, Gaspar GG, Martins-Filho OA, Puga ML, et al. The Impact of Implementation of Bundle to Reduce Catheter-Related Bloodstream Infection Rates. J Clin Med Res 2015;7(11):857-61.
7. Crolla RM, van der Laan L, Veen EJ, Hendriks Y, van Schendel C, Kluytmans J. Reduction of surgical site infections after implementation of a bundle of care. PLoS One 2012;7(9):e44599.
8. Mazi W, Begum Z, Abdulla D, Hesham A, Maghari S, Assiri A, et al. Central line-associated bloodstream infection in a trauma intensive care unit: impact of implementation of Society for Healthcare Epidemiology of America/Infectious Diseases Society of America practice guidelines. Am J Infect Control 2014;42(8):865-7.
9. Wayne P. Clinical and Laboratory Standards Institute: Performance standards for antimicrobial susceptibility testing: 20th informational supplement. CLSI document M100-S20 2010.
10. 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(5):309-32.

11. Dudeck MA, Horan TC, Peterson KD, Allen-Bridson K, Morrell G, Pollock DA, et al. National Healthcare Safety Network (NHSN) Report, data summary for 2010, device-associated module. Am J Infect Control 2011;39(10):798-816.
12. Marschall J, Mermel LA, Classen D, Arias KM, Podgorny K, Anderson DJ, et al. Strategies to prevent central line-associated bloodstream infections in acute care hospitals. Infect Control Hosp Epidemiol 2008;29 Suppl 1:S22-30.
13. Officer NR, Policy G, Assessment I, Assessment FI. WIRRAL PRIMARY CARE TRUST INFECTION PREVENTION AND CONTROL STRATEGY 2008–2011. Policy 2008.
14. Sax H, Allegranzi B, Chraiti MN, Boyce J, Larson E, Pittet D. The World Health Organization hand hygiene observation method. Am J Infect Control 2009;37(10):827-34.
15. bundle. IfHIltcl. http://www.ihi.org/resources/Pages/Changes/ImplementtheCentralLineBundle.aspx Accessed April 1, 2009.
16. Toolkit NHSNNEVGa. https://www.cdc.gov/nhsn/pdfs/validation/2017/2017-nhsn-ev-guidance.pdf. 2017.
17. Al-Abdullah N. Epidemiology of Central Line-Associated Bloodstream Infection (CLABSI) Among Patients in the Intensive Care Units (ICUs) at a Teaching Hospital in Saudi Arabia from Year 2011-2016. J Intensive & Crit Care 2018;4(1):2.
18. Gaid E, Assiri A, McNabb S, Banjar W. Device-associated nosocomial infection in general hospitals, Kingdom of Saudi Arabia, 2013-2016. J Epidemiol Glob Health 2018;7 Suppl 1:S35-S40.
19. Khan RM, Subhani J, Arabi YM. Central line-associated bloodstream infections in the Kingdom of Saudi Arabia. Saudi Critical Care Journal 2019;3(1):43.
20. Perez Parra A, Cruz Menarguez M, Perez Granda MJ, Tomey MJ, Padilla B, Bouza E. A simple educational intervention to decrease incidence of central line-associated bloodstream infection (CLABSI) in intensive care units with low baseline incidence of CLABSI. Infect Control Hosp Epidemiol 2010;31(9):964-7.

Tables

Table1

Incidence rate and ratio of CLABSI reported during pre- and post- interventionsat thestudy hospital compared with NHSN hospitals, DA Module 2013

Intervention/Year	No. of HAIs	Device-days	Patient-days	Incidence Rate/ 1000 device - days	Benchmarking to NHSN-2015		Utilization Ratio	Benchmarking to NHSN-2015	
					Pooled Mean	Percentile		Pooled Mean	Percentile
Pre-intervention/2016	7	6218	12155	1.12	0.8	50 – 75 %	0.51	0.49	50 %
Post-intervention/2017-2019	8	17377	39471	0.46	0.8	25 – 50 %	0.44	0.49	25 - 50 %

Abbreviations: CLASBI, central line-associated bloodstream infection; DA, deviceassociated; NHSN, National Healthcare Safety Network-USA.

Table 2

Number of microorganisms causing CLABSIs during the study period

Microorganism	Number of isolate per year			
	2016	2017	2018	2019
Klebsiella pneumonia	7	0	2	1
Acinetobacterbaumanii	0	0	1	0
Proteus merabilis	0	0	0	1
Pseudomonas areuginosa	0	1	0	1
Enterococcus Fecalis	0	0	1	0

Abbreviation: CLASBI, central line-associated bloodstream infection.