ANALYZING CENTRAL-LINE ASSOCIATED BLOODSTREAM INFECTION PREVENTION BUNDLES IN 22 COUNTRIES: THE RESULTS OF ID-IRI SURVEY

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ABSTRACT

Central line-associated bloodstream infections (CLABSIs) leading to sepsis is an important complication of central venous access. In this study, we aimed to take a snapshot of the bundle approach for central venous access in countries with different economic incomes. Participant intensive care units (ICUs) submitted a questionnaire including three topics; details of the ICU, routine infection control procedures, and information on maintenance of central lines. The countries were classified into two groups with low and lower-middle-income countries and upper-middle and high-income countries. 43 participants from 22 countries (46 hospitals, 85 ICUs) responded the survey. 8 (17.4%) hospitals had no surveillance system for CLABSI. 93.0% (n=79) of the ICUs had a CLABSI care bundle while 7.1 % (n=6) had no CLABSI bundle. 65 (76.5%) ICUs had a dedicated checklist while 20 ICUs (23.5%) had none. Use of ultrasonography during catheter insertion, transparent semi-permeable dressings, needless connectors, and single-use sterile pre-filled 0.9% NaCl were significantly higher in upper-middle and high-income countries. There were significant differences between rich countries and countries with limited resources for insertion and maintenance of bundles used to prevent CLABSIs. Further actions should be taken to reduce injustice in vascular access management in countries with limited resources.

Key words: CLABSI, Central line, bundle, sepsis, catheter, infection

INTRODUCTION

Central line-associated bloodstream infections (CLABSIs) leading to sepsis is an important complication of central venous access resulting in increased morbidity, mortality, length of hospital stay, and increased hospital costs [1–3]. On the other hand, central venous access is vital in critically-ill patients for several indications including blood transfusion, administration of inotropic agents, and parenteral nutrition [4–6]. Major health authorities including the Infectious Diseases Society of America, Infusion Nurse Society, International Nosocomial Infection Control Consortium, and Centers for Disease Control and Prevention (CDC) have developed guidelines for the prevention of CLABSIs [7–10]. They recommended care bundles, which have been widely implemented in hospitals to decrease CLABSIs in different clinical settings. These central line bundles include all and 4 or more steps including chlorhexidine gluconate skin preparations, maximal sterile barriers during insertion, preferring the subclavian or internal jugular vein instead of the femoral vein, strict hand hygiene, and daily review of the necessity of central line. Though studies are reporting the efficiency of CLABSI bundles on a national basis in different countries [10–12], limited data existed in the literature in comparing infection control procedures for CLABSIs in accordance with the economic statuses of the countries involved [13]. Since CLABSIs were reported to be 3-5 times higher in resource-limited countries compared to high-income settings [12], the available data is only the tip of the iceberg.

Thus, we aimed to take a snapshot of the bundle approach for central venous access devices and the ongoing infection control practices in the prevention of CLABSIs in countries with various income levels. Furthermore, we aimed to evaluate and compare the bundle steps during catheter insertion and maintenance, too.

MATERIAL AND METHODS

In this study, the participants from adult, pediatric and neonatal intensive care units who agreed to fill the form composed of a 38-question questionnaire were included. The questionnaire was originally written in English. The questionnaire included three main topics including demographic features of the health center, the routine procedures of the infection control committee, and the information about the maintenance of the central lines. The questions of the

maintenance included bundle steps, monitoring of the central line bundle, presence of flushing, use of needless connectors or 3 -way stopcocks, use of a sponge or transparent dressing. Some of the questions were in the form of multiple-response categorical variables, while some were in the opened form.

Ethics approval for this study was obtained from the Institutional Review Board of Dr. Behcet Uz Children's Training and Research Hospital.

Data collection and analysis

The questionnaire link was sent via e-mail among the members of the Infectious Diseases International Research Initiative platform (https://infectdisiri.com/). The data were collected between July 2021 and November 2021 via the survey platform. Participation in the survey was voluntary.

Data included catheter care, and institutional data registries were reported through Google Drive. The data was collected by an investigator and country and hospital names were coded to provide anonymity for further analysis. The responses/database were collected through Google Drive solely to ensure data security. Repetitive emails were sent to participating centers to verify their responses and complete missing data if existed. The authors will provide the relevant database if the journal demands it.

The countries and the participant intensive care units were classified according to the "World Bank" and expressed as two groups [14]. Group I included low income and lower-middle-income countries and Group II included the countries with upper-middle-income and high-income.

Statistical analysis was performed using SPSS Statistical Software (version 22; SPSS, Chicago, IL, USA). Categorical variables were compared using Pearson $\chi 2$ and Fisher's exact tests. A *p*-value of ≤ 0.05 was considered statistically significant.

RESULTS

The survey was responded to by 43 participants from 22 countries, 46 different hospitals, and 85 intensive care units (ICUs). The countries of the participating centers are as follows: Afghanistan, Bangladesh, Bulgaria, Croatia, Egypt, France, Germany, Iran, Italy, Jordan, Lebanon, Pakistan,

Poland, Puerto Rico, Portugal, Romania, Russia, Slovakia, Slovenia, The United Arab Emirates, The United Kingdom, and Turkey. The number of participant hospitals per country is presented in **Figure-1**. The responses to the survey included the data of 23 surgical ICUs (27.1%), 12 neonatal ICUs (14.1%), 11 high-dependency units (12.9%), 10 pediatric ICUs (11.8%), 9 coronary ICUs (10.6), 6 post-anesthesia care units (7.1%), 6 ICUs (7.1%), 4 traumatic ICUs (4.7%), 2 pediatric cardiovascular surgery ICUs (2.4%), 1 pediatric surgical (1.2%) and 1 adult ICUs (1.2%).

Demographic features of the participant hospitals: Among the 46 hospitals, 35 hospitals (76.1%) were adult and children's hospitals while 8 (17.4%) were only adults and 3 (6.5%) were only pediatric hospitals. Twenty-one hospitals (45.7%) were university hospitals, 10 (21.7%) were research and training hospitals, 5 (10.9%) were public hospitals, 9 (19.5%) were private and 1 (2.2%) was a military hospital. All hospitals had at least one intensive care unit. Approximately 73.9% (n=34) of the participant centers had surgical ICUs, 54.3% (n=25) had neonatal ICUs, 43.4% (n=20) had coronary ICUs, 39.1% (n=18) pediatric ICUs and 36.9% (n=18) had post-anesthesia care unit (n=17). The remaining ICUs and their frequencies were shown in **Table-1**.

Infection control committee and surveillance data: The infection control committee (ICC) had variable routine meeting periods, including every week at 1 (2.2%) hospital, every month at 21 hospitals (45.7%), every 3 months at 10 hospitals (21.7. %), every 6 months at 8 (17.4%) hospitals and once a year at 4 hospitals (8.7%). Two hospitals (4.4%) had no regular ICC meetings but performed when required. Among the participant hospitals, 8 (17.4%) had no surveillance system for CLABSI, and 38 (82.6%) had surveillance systems. Only in one center (2.2%), the data was open to the public, and in 21 hospitals (45.6%), surveillance data was shared with the related hospital staff such as the chiefs of the ICUs. The surveillance reports on CLABSI were reported monthly basis at 41.3% (n=19) and on a 3-monthly basis at 8.7% (n=4) of the hospitals. In addition to 8 hospitals without active surveillance systems for CLABSI, in 5 hospitals (10.9%), surveillance data of CLABSI were not routinely reported to the ICUs while surveillance data were reported annually at 5 hospitals (10.9%).

Selection of vascular access devices: Twenty-two (47.8%) of the participant hospitals had well-defined algorithms or decision-making trees for the selection of vascular access devices while twenty-four hospitals (52.2%) did not have an algorithm.

Catheter bundle for prevention of CLABSI: Approximately 93.0% (n=79) of the hospitals had a CLABSI care bundle for use in the ICUs, while 7.1 % (n=6) had no CLABSI bundle. Sixty-five ICUs had a dedicated checklist (76.5%) while twenty ICUs (23.5%) had no dedicated checklist. In 26 (40.0%) participant hospitals, a dedicated nurse responsible for compliance of the bundle filled the checklist while in 33 (50.7%) nurses assisting the procedure or response from the patient care filled the form. In the remaining (7.6%, n=5), infection control nurses or any nurse (1.2%, n=1.5) at the shift filled the form. The compliance to 79 bundles performed was monitored via direct observation (n=52, 65.8%) and by using software (n=21;24.7%) while no monetarization was performed at 6 (11.4%) ICUs.

Catheters and insertion procedures: The catheters were mostly inserted by intensivists (n=73; 84.9%), followed by registered nurses (n=11, 12.9%), interventional radiologists (n=5, 5.9%), cardiovascular surgery specialists (n=11, 13.0%), adult surgeons (n=13, 15.3%) and the pediatric surgeons (n=8, 9.5%) (**Figure-2**). Ultrasonography-guided catheter insertion was preferred at 42.4% (n=36) and blinded insertion at 55.3% (n=47) and in one center both techniques were used depending on the patient (1.2%).

a) The most commonly used catheter type was a central venous device with a percentage of 85.9% (48 participants responded as always plus 25 participants responded as often)

b) 23.5% of participants preferred a peripherally inserted central line (11 responded as always plus 9 participants responded as often)

c) 11.8% (n=10) of participants used tunneled central vascular access device

d) 8.2% (n=7) preferred midline catheters.

Catheter insertion area: Among the 85 valid answers, catheters were inserted at the bedside in 62.4% (n=53) of the ICUs followed by 28.2% (n= 24) inserted at the operation rooms and in 8.2% (n=7) at dedicated rooms in the ICUs (**Figure-3**). The catheters were mostly inserted by intensivists (n=73; 84.9%), followed by registered nurse (n=8, 9.5%). Most commonly preferred catheter site was subclavian (n=43/83, 51.8 %) and jugular (n=38/83, 45.7 %) sites followed by femoral (n=2/83; 2.4%) and umbilical veins (n=3/83; 3.6%) (**Figure-4**).

Barrier precautions: Among the 85 ICUs, 8 (9.4%) of the participants declared that at least one of the elements of the maximal barrier was missing while inserting the catheter. During skin antisepsis before catheter insertion (83 valid answers), povidone-iodine was used at 23 ICUs (27.7%), 2% chlorhexidine gluconate in 70% isopropyl alcohol was used at 35 ICU's (42.1%), 70% isopropyl alcohol solution was used at 8 ICU's (9.6%), a single-use application of 2% chlorhexidine gluconate in 70% isopropyl alcohol was used at 16 ICU (19.2%) and single-use 2% chlorhexidine swab was used at one ICU (1.2%).

Procedures at maintenance: There were 83 valid answers, forty-two ICUs (50.6%) used transparent, semi-permeable dressings with chlorhexidine, 14 ICUs (16.8%) used transparent semi-permeable dressing without chlorhexidine, and 16 ICUs (19.2%) used sterile gauze. At the ten of the ICUs, one of the three dressings was used according to the availability of the membrane. The insertion site was evaluated during every shift at 28 ICUs (%33.3), daily at 39 ICUs (46.4%), and during each dressing change at 17(20.2%) ICUs. Antibiotic lock treatment was not routinely done at 47 ICUs (55.6%) while it was performed at 17 ICUs (20.2%) for high-risk patients, and it was applied in the presence of catheter-related bloodstream infections at 19 ICUs (22.6%).

Types and maintenance of the connectors: Among the 83 ICUs with valid answers, only 3-way stopcocks were used at 21 ICU (25.3%) and only needless connectors at 17 ICUs (20.4%), and 25 ICUs (30.1%), both devices were used. In 20 ICUs (24.1%), the participants did not know the type of connectors. In 80% (n=68) of the ICUs flushing was routinely done, while at the 17 ICUs (20%), no flushing was performed. Among the available 79 responses, flushing was done with 35 (44.3%) manually prefilled saline syringes, in 15 (18.9%) with single-use sterile pre-filled ready to use NaCl 0.9% with heparin, and in 29 (36.7%) with single-use sterile pre-filled ready to use NaCl 0.9%.

Comparison of the procedures according to country economic incomes: According to the "World Bank" criteria [14], 17 (37.0%) of the participant hospitals were in lower-middle-income countries (Group-I) and twenty-nine (63.0%) were in high-upper middle-income countries (Group-II). Twenty-nine ICUs (34.1%) were in Group-I and 56 ICUs (65.9%) were in Group-II. The presenting ICUs and the patient groups were similar between Group-I and Group-II and reviewed at **Table-2**.

The ratio of the absence of active surveillance in CLABSI in Group I was 3.4% (n=1) and in Group-II was 12.5% (n=7), and no significance was observed between these two groups ($p>0.05$). The rate of using PICCL was significantly higher in Group-II (37/56; 66.1%) compared to Group-I (5/29; 17.2%) (**$p<0.001$**). The rate of CVC was 96.6% (28/29) at Group-I and 94.4% (54/56) at Group-II. The ratio of using ultrasonography during catheter insertion was 55.4% (n=31) at Group II and 17.2% (n=5) at Group-I, and significantly higher in Group-II (**$p=0.003$**). The rate of using transparent semi-permeable dressings (with or without chlorhexidine) was significantly higher at Group-II compared to Group-I [80.0%(n=44) versus 41.3% (n=12), **$p=0.002$**], and the sterile sponge was more significantly used at Group-I (40.7% vs 9.1%; **$p=0.002$**). The rate of using needless connectors was significantly higher in Group-II (28.6%) compared to Group-I (3.4%) (**$p=0.023$**). The ratio of using manually prefilled saline syringes for flushing was significantly higher in Group-I (n=23, 82.1%) compared to Group-II (n=12, 23.5%), and the ratio of using single-use sterile pre-filled ready to use 0.9% NaCl was significantly higher in Group-II (76.5%, n=39) compared to Group-I (17.9%, n=5) (**$p<0.001$**)

DISCUSSION

This survey included 85 intensive care units (ICUs) from 46 different hospitals and 22 countries. Among the participant hospitals, 17.4% had no surveillance system for CLABSIs, and half of the hospitals didn't have a well-defined algorithm, which both indicate poor adherence to infection control and prevention guidelines. Unfortunately, this is a long-standing debate in routine medical practices [15]. In addition, 7.1 % of the hospitals had no CLABSI care bundle and one-fourth of the ICUs had no dedicated checklist for the CLABSI bundle. Among the ICUs, 9.4% of the participants declared that at least one of the elements of the maximal barrier was missing while inserting the catheter. The use of new technologies for vascular access like peripherally inserted central catheter line (PICCL), ultrasonography during catheter insertion, transparent semi-permeable dressings, needless connectors, and single-use sterile pre-filled syringes were significantly lower in countries with limited resources.

Infection control committees have long been playing critical roles in the implementation and maintaining bundles for central lines. In our survey, although all the participant centers had infection control committees, 4.4% had no regular schedule and the meetings occurred when

required. A previous multicenter study including 29 hospitals reported that 6.8% had no established infection control committees [13]. Moreover, one-quarter of the ICUs were not aware of their CLABSI rates due to a lack of active surveillance systems and absence of routine reporting of CLABSI rate. This finding supported a previous multinational study reporting that 27% of the hospitals in middle-income countries had no surveillance for CLABSI [13]. Having active surveillance and knowing the CLABSI rates (before implementation of the CLABSI bundle) is the key step for establishing a successful CLABSI bundle, activating all the components, and evaluating the effectiveness of the bundle. Hence, increased awareness is seemingly needed for the surveillance.

In this study, 93% of the ICUs had CLABSI bundles. However, one of four ICUs had no dedicated checklist, and 11.4% did not monitor the CLABSI bundles. Having a checklist and adherence to the CLABSI bundle are the priorities to decrease CLABSI rates [16]. However, one study including adult ICU patients reported that although 17.6% of the checklists were incompletely filled, the success of the bundle was not affected [17]. In addition, as a country with limited resources, Mongolia reported that compliance to the CLABSI bundles was as low as 68.5% [18]. There are other studies indicating the low compliance rates in developing countries [19,20]. Our findings point in the same direction that either implementing the CLABSI bundle or following the adherence are crucial parameters in the success of the CLABSI bundle.

The CLABSI bundle is the most widespread in the world and is composed of five prevention steps based on CDC recommendations [9]. These steps are easy to follow and adhere to, however, Rosenthal put forward that these steps would be insufficient in hospitals in countries with limited resources because of the lack of basic infection control structures [19]. Furthermore, we found that the rate of new assistive techniques such as bed-side ultrasonography, PICCL, and additional costly bundle steps such as using transparent semi-permeable dressings, needless connectors, and single-use sterile pre-filled ready to use NaCl %0.9 were lower in countries with limited sources. The Infusion Nurse Society, recommends using single-use, sterile, pre-filled, and ready to use NaCl%0.9 syringes as well as needless connectors [7]. In addition, several studies supporting the inclusion of these steps in the bundle were successful in decreasing CLABSI rates [1,21,22]. Moreover, manual preparation of flushing syringes and 3-way stop-cocks were reported to be associated with increased catheter infections [23,24]. It is obvious that the expensive

materials used in catheter care, which improves patient care cannot be used for economic reasons in countries with limited resources causing injustice in terms of patient care between the countries with various income levels.

This study has several limitations. Although all countries were not represented in this study equally, we did our best to include centers from low, middle, and high-income countries. In addition, the ICUs were not homogeneously distributed according to the type of ICUs and the patient group they served. In addition, we included the participants according to their willingness to participate in the study, thus there is a selection bias in the study. Nevertheless, this study provides a comparison for low and high-income countries.

In conclusion, our study showed that there are significant differences between the low, middle-income, and high-income countries for insertion and maintenance of bundles used to prevent CLABSIs. Further actions should be taken to reduce injustice in vascular access management in countries with limited resources.

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