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

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**Highlights:**

- Forty-three participants from 22 countries (46 hospitals, 85 ICUs) responded to the survey.
- Eight (17.4%) hospitals had no surveillance system for CLABSI.
- Approximately 7.1 % (n=6) had no CLABSI bundle and twenty ICUs (23.5%) had no dedicated checklist.
- The proportion of using ultrasonography during catheter insertion, transparent semi-permeable dressings, needleless connectors and single-use sterile pre-filled ready to use 0.9% NaCl were significantly higher in higher and middle higher countries.

**ABSTRACT**

**Background:** Because central line-associated bloodstream infections (CLABSIs) are a significant complication of central venous access, it is critical to prevent CLABSIs through the use of central line bundles. The purpose of this study was to take a snapshot of central venous access bundles in various countries.

**Methods:** The participants in intensive care units (ICUs) completed a questionnaire that included information about the health center, infection control procedures, and central line maintenance. The countries were divided into two groups: those with a low or low-middle income and those with an upper-middle or high income.

**Results:** Forty-three participants from 22 countries (46 hospitals, 85 ICUs) responded to the survey. Eight (17.4%) hospitals had no surveillance system for CLABSI. Approximately 7.1 % (n=6) ICUs had no CLABSI bundle. Twenty ICUs (23.5%) had no dedicated checklist. The percentage of using ultrasonography during catheter insertion, transparent semi-permeable

dressings, needleless connectors and single-use sterile pre-filled ready to use 0.9% NaCl were significantly higher in countries with higher and middle-higher income ( $p < 0.05$ ).

**Conclusions:** Our study demonstrated that there are significant differences in the central line bundles between low/low-middle income countries and upper-middle/high-income countries. Additional measures should be taken to address inequity in the management of vascular access in resource-limited countries.

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

## BACKGROUND

Sepsis caused by central line-associated bloodstream infections (CLABSIs) is a significant complication of central venous access, increasing morbidity, mortality, length of stay, and hospital costs [1–3]. Central venous access, on the other hand, is critical in critically ill patients for a variety of reasons, including blood transfusion, inotropic agent administration, and parenteral nutrition [4–6]. The Infectious Diseases Society of America, the Infusion Nurse Society, the International Nosocomial Infection Control Consortium, and the Centers for Disease Control and Prevention (CDC) have all developed CLABSI prevention guidelines [7–10]. They advocated for the use of care bundles, which have been widely implemented in hospitals to reduce CLABSIs in a variety of clinical settings. These central line bundles include all and four or more of the following steps: chlorhexidine gluconate skin preparations, maximal sterile barriers during insertion, preference for the subclavian or internal jugular vein over the femoral vein, strict hand hygiene, and daily review of the central line's necessity. While studies have evaluated the efficacy of CLABSI bundles on a national level in various countries [10–12], there is a dearth of data in the literature comparing infection control procedures for CLABSIs to the economic status of the countries involved [13]. Given that CLABSIs have been reported to be 3-

5 times more prevalent in resource-limited countries than in high-income countries [12], the available data is only a drop in the bucket.

Thus, we sought to capture a snapshot of the bundle approach to central venous access devices and ongoing infection control practices for the prevention of CLABSIs in countries with varying levels of income.

## **MATERIAL AND METHODS**

Participants from adult, pediatric, and neonatal intensive care units who agreed to complete a 38-question questionnaire were included in this study. Originally, the questionnaire was written in English. The questionnaire covered three major topics: the health center's demographic characteristics, the infection control committee's routine procedures, and information about central line maintenance. The maintenance questions included bundle steps, central line bundle monitoring, flushing, the use of unnecessary connectors or three-way stopcocks, and the use of a sponge or transparent dressing. Some of the questions used multiple-response categorical variables, while others used open-ended questions.

The Local Ethical Committee of Dr. Behcet Uz Children's Training and Research Hospital approved this study with protocol number 593 and an approval date of 08/07/2021.

### **Data collection and analysis**

The questionnaire link was distributed via e-mail to members of the platform Infectious Diseases International Research Initiative (<https://infectdisiri.com/>). Between July and November

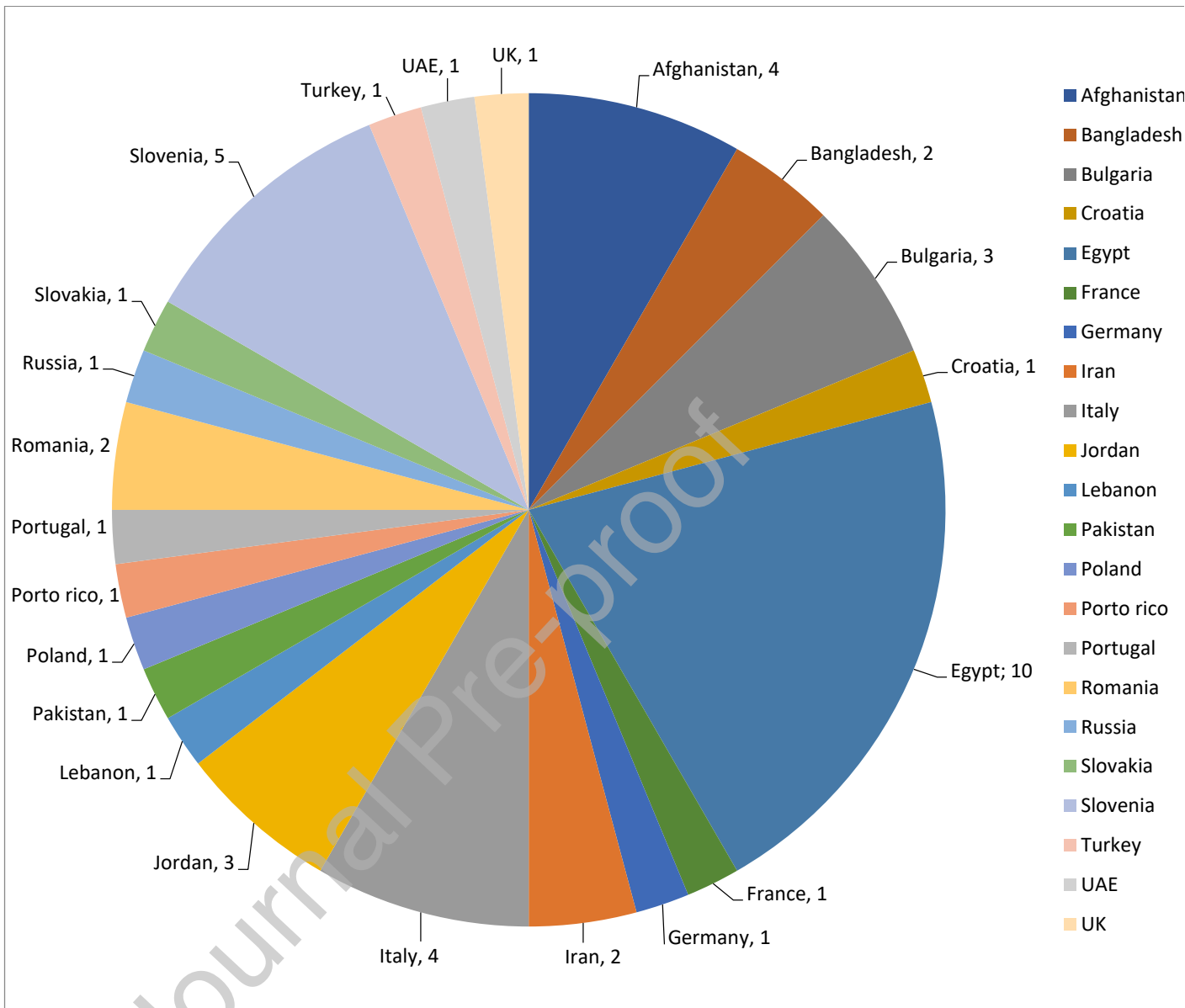
2021, data were collected via the survey platform. The survey was entirely voluntary. An investigator collected the data, and the country and hospital names were coded to maintain anonymity for subsequent analysis. Google Drive was used to collect the responses/database solely to ensure data security. Repeated emails were sent to participating centers to confirm their responses and to fill in any gaps in data.

The countries and intensive care units of the participants were classified by the "World Bank" and classified into two groups [14]. Group I comprised low- and lower-middle-income countries, while Group II comprised upper-middle- and high-income countries.

SPSS Statistical Software was used to conduct the statistical analysis (version 22; SPSS, Chicago, IL, USA). Pearson 2 and Fisher's exact tests were used to compare categorical variables. Statistical significance was defined as a p-value of 0.05.

## **RESULTS**

The survey was distributed to 72 potential participants. Our response rate was 59.7% (n=43). The respondents came from 22 countries, 46 different hospitals, and 85 intensive care units responded to the survey (ICUs). 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 are the countries represented by the participating centers. Figure-1 illustrates the number of participating hospitals by country.



**Figure-1.** Participant ICUs in accordance with the countries

The survey collected data from 23 surgical intensive care units (27.1%), 12 neonatal intensive care units (14.1%), 11 high-dependency units (13.9%), ten pediatric intensive care units (11.8%), nine coronary intensive care units (9.6%), six post-anesthesia care units (7.1%), six intensive



care units (7.1%), four traumatic intensive care units (4.7%), two pediatric cardiovascular surgery ICUs (2.4%), one pediatric surgical (1.2%), and one adult ICU (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. Every hospital was equipped with 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). Table-1 summarizes the remaining ICUs and their frequencies.

**Table-1:** The distribution of the ICUs that the participant hospitals have during the study

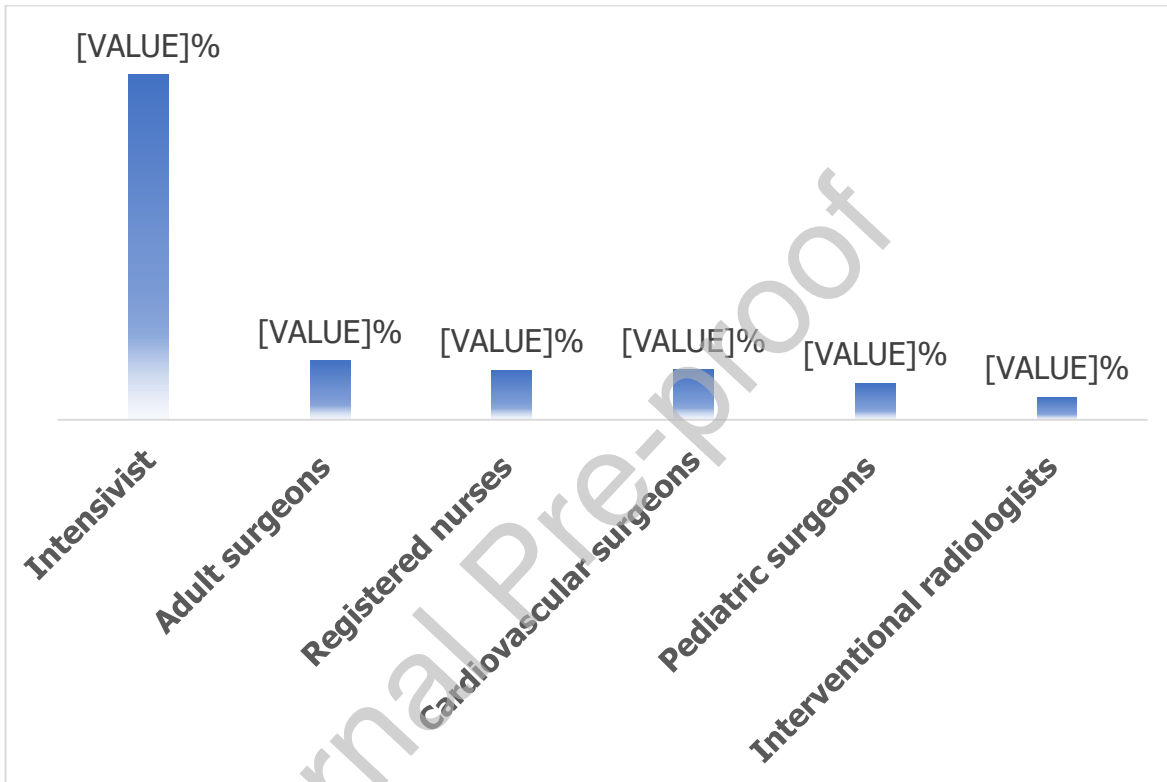
The type of ICUs	Number	Percentage (%)
Surgical intensive care unit	34	73.9
Neonatal intensive care unit	25	54.3
Coronary care unit	20	43.4
Pediatric intensive care unit	18	39.1
Post-anesthesia care unit	17	36.9
Neurological intensive care unit	13	28.2
Traumatic intensive care unit	12	26.8
High dependency unit	7	15.2
Pediatric surgical intensive care unit	6	13.0
Pediatric cardiovascular unit	3	6.5
Geriatric intensive care unit	2	4.3
Adult intensive care unit	1	2.1
Infectious diseases intensive care unit	1	2.1
Adult cardiovascular surgical intensive care unit	1	2.1
Adult surgical step-down intensive care unit	1	2.1

**Infection control committee and surveillance data:** The infection control committee (ICC) met on a variable schedule, including weekly at 1 (2.2%) hospital, monthly at 21 (45.7%) hospitals, every three months at ten (21.7%) hospitals, every six months at eight (17.4%) hospitals, and once a year at four hospitals (8.7 %). Two hospitals (4.4 %) did not conduct ICC meetings on a regular basis but did so when necessary. Eight (17.4 %) of the participating hospitals lacked a CLABSI surveillance system, while 38 hospitals (82.6 %) had a surveillance system in place. Only one center (2.2 %) made surveillance data publicly available, while 21 hospitals (45.6 %) shared surveillance data with related hospital staff, such as ICU chiefs. CLABSI surveillance reports were submitted on a monthly basis to 41.3 % (19) of hospitals and on a three-monthly basis to 8.7 % (4). Along with the eight hospitals that lacked active surveillance systems for CLABSI, five hospitals (10.9 %) did not routinely report CLABSI surveillance data to ICUs, whereas five hospitals reported surveillance data annually (10.9 %).

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

**Catheter bundle for CLABSI prevention:** Approximately 93.0 % (n=79) of ICUs had a CLABSI care bundle for ICU use, while 7.1% (n=6) did not have one. Sixty-five ICUs (76.5%) had a dedicated checklist, whereas twenty ICUs (23.5%) did not. In the 65 ICUs, the bundle compliance checklist was completed by a dedicated nurse (n =26, 40.0%), an ICU nurse (n = 33, 50.8%) , an infection control nurse (n =5, 7.7%) and any nurse (n =1, 1.5%). Compliance with 79 bundles was monitored directly (n=52, 65.8%) and through software (n=21,24.7 %), but monitorization was not performed in six (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**).



**Figure-2.** The percentage of staff responsible from central catheter insertion

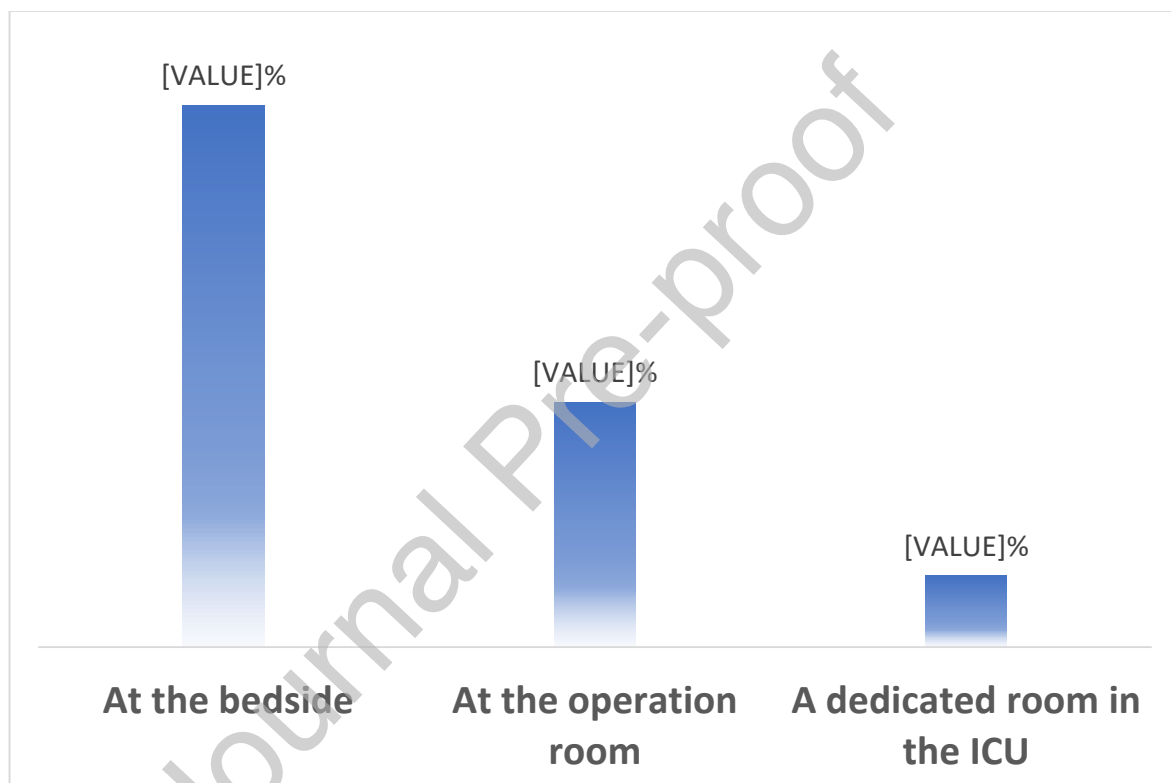
Ultrasonography-guided catheter insertion was preferred at 42.4% (n=36) and blinded insertion at 55.3% (n=47) and both techniques were used in one center depending on the patient (1.2%).

- 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

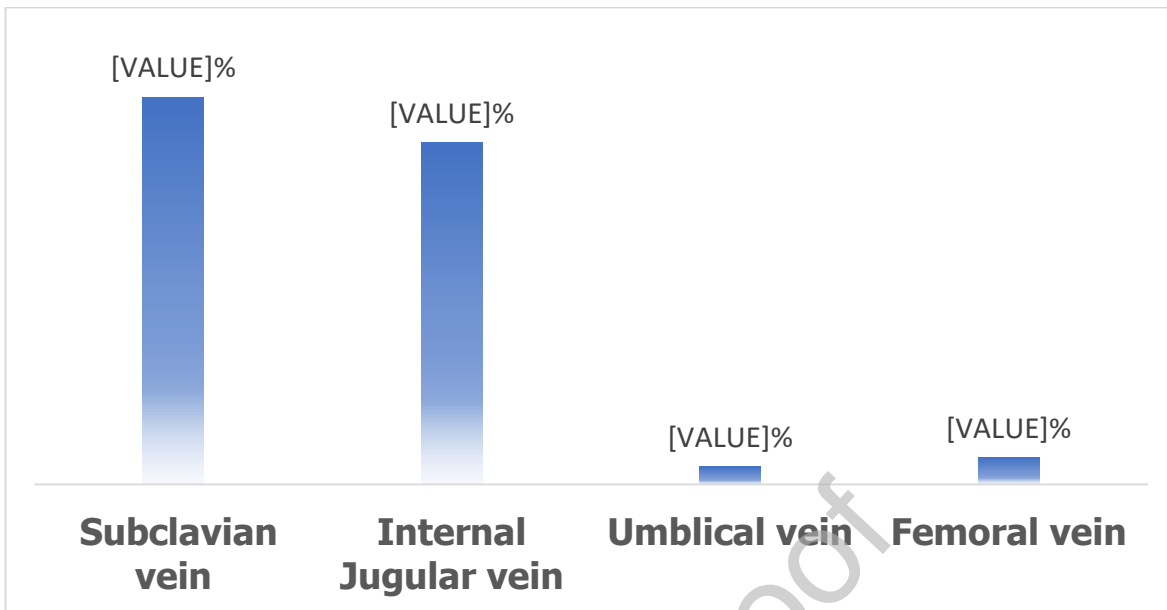
d) 8.2% (n=7) preferred midline catheters.

**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**).



**Figure-3.** The percentage of catheter insertion area in the ICU

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**).



**Figure-4.** Catheter insertion site

Maximal 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 during inserting the catheter.

While inserting a catheter, 90.6% of individuals wore a cap (n=77), 98.8% wore a mask (n=84), 98.8% wore sterile gowns (n=84), and 100% wore sterile gloves (n=85).

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 needleless 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 80.0% (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 located in lower-middle-income countries (Group-I) and twenty-nine (63.0%) were located 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.

**Table-2:** Comparison of the bundle procedures and hospital features according to economic status

	<b>LMI Countries (Group I) N (%)</b>	<b>High &amp; HMI Countries (Group II) N (%)</b>	<b>P-value</b>
<b>Type of Intensive Care Unit</b>			
• Adult	2 (6.9)	11 (19.6)	NA
• Pediatric	2 (6.9)	6 (10.7)	
• Adult and pediatric (mixed)	25 (86.2)	39 (69.6)	
<b>Active surveillance for CLABSI</b>			
• Present	28 (96.6)	49 (87.5)	<b>p&gt;0.05</b>
• Absent	1 (3.4)	7 (12.5)	
<b>Use of PICC</b>			
• Present	5 (17.2)	37 (66.1)	<b>p&lt;0.001</b>
• Absent	24 (82.8)	19 (33.9)	
<b>Use of CVC</b>			
• Present	28 (96.6)	54 (94.4)	<b>p&gt;0.05</b>
• Absent	1 (3.4)	2 (5.6)	
<b>Use of US during catheter insertion</b>			
• Yes	5 (17.2)	31 (55.4)	<b>p=0.003</b>
• No	24 (82.8)	25 (44.6)	
<b>Using transparent semi-permeable dressings ((with or without chlorhexidine) or sterile sponge</b>			
• Transparent semi-permeable dressing	12 (41.3)	44 (78.2)	<b>p=0.002</b>
• Sterile sponge	11 (37.9)	5 (9.1)	
• Both	4 (13.8)	6 (10.7)	
<b>Use of needleless connectors</b>			
	1(3.4)	16 (28.6)	<b>p=0.023</b>
<b>Flushing of the vascular access device</b>			
• Single-use sterile pre-filled ready to use NaCl %0.9 syringe	5 (17.9)	39 (76.5)	<b>p&lt;0.001</b>
• Manually prefilled saline syringes for flushing	23 (82.1)	12 (23.5)	

LMI: Low-middle income, HMI: High-Middle Income, US: Ultrasonography, NA: None applicable (the number of case(s) for this variable is too low to calculate)

The percentage of using ultrasonography during catheter insertion, PICCL, transparent semi-permeable dressings, needleless connectors and single-use sterile pre-filled ready to use 0.9% NaCl were significantly higher in countries with higher and middle-higher income ( $p < 0.05$ ). The percentage of using the sterile sponge and manually prefilled saline syringes for flushing were significantly higher at low-middle income countries ( $p < 0.05$ ). **Table-2** compares the presenting ICUs and central line bundles in Groups I and II.

## DISCUSSION

This study surveyed 85 intensive care units (ICUs) from 46 different hospitals in 22 different countries. Briefly, 17.4 % of participating hospitals lacked a CLABSI surveillance system, and half lacked a well-defined algorithm, which both indicate a lack of compliance with infection control and prevention guidelines, as previously reported[15]. Additionally, 7.1 % of hospitals lacked a CLABSI care bundle, and a quarter of intensive care units lacked a dedicated CLABSI checklist. At 9.4 % of the participant ICUs reported that at least one of the maximal barrier elements was missing during catheter insertion. In countries with limited resources, the use of new technologies for vascular access such as PICCL, ultrasound guidance during catheter insertion, transparent semi-permeable dressings, unnecessary connectors, and single-use sterile pre-filled syringes were significantly lower.

Committees on infection control play a critical role in advancing the field of infection control. While all of the centers in our survey had infection control committees, 4.4 % did not have a regular meeting schedule and met only as needed. According to a previous multicenter study involving 29 hospitals, 6.8% of hospitals lacked established infection control committees [13]. Additionally, one-quarter of ICUs were unaware of their CLABSI rates, owing to the absence of active surveillance systems and routine reporting of CLABSI rates. This finding corroborated a



previous multinational study that found that 27% of hospitals in middle-income countries did not conduct CLABSI surveillance [13]. Maintaining active surveillance and being aware of CLABSI rates (prior to implementing the CLABSI bundle) is critical for establishing a successful CLABSI bundle, activating all components, and evaluating the bundle's effectiveness. As a result, it appears as though enhanced awareness is necessary for surveillance.

CLABSI bundles were installed in 93% of ICUs in this study. However, one in four intensive care units (ICUs) lacked a dedicated checklist, and 11.4 % failed to monitor CLABSI bundles. To reduce CLABSI rates, having a checklist and adhering to the CLABSI bundle are critical [16]. However, one study involving adult intensive care unit patients found that, despite the fact that 17.6 % of checklists were incomplete, the bundle's success was unaffected [17]. Additionally, Mongolia reported that compliance with the CLABSI bundles was as low as 68.5 % [18], despite the country's limited resources. Other studies [19,20] indicate that developing countries have low compliance rates. Our findings support the notion that either implementing the CLABSI bundle or monitoring compliance are critical components of the CLABSI bundle's success.

The CLABSI bundle is the most widely used prevention strategy worldwide, basically consisting of five steps based on CDC recommendations [9]. While these steps are simple to follow and adhere to, Rosenthal argued that they would be insufficient in hospitals in low-resource countries due to the absence of basic infection control structures [19]. Additionally, we found that in countries with limited resources, the proportion of new assistive techniques such as bedside ultrasonography, PICCL, and additional costly bundle steps such as the use of transparent semi-

permeable dressings, needleless connectors, and single-use sterile pre-filled ready to use NaCl % 0.9 was lower. The Infusion Nurse Society, recommends using single-use, sterile, pre-filled, and ready to use NaCl%0.9 syringes as well as needleless 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 self-evident that the additional materials used in catheter care, which improve patient care cannot be used due to economic concerns in countries with limited resources, resulting in patient care disparities between countries with varying income levels.

Several limitations apply to this study. While not all countries were represented equally in this study, we made an effort to include centers in low-, middle-, and high-income countries. Additionally, ICUs were not distributed uniformly based on their type and patient population served. Additionally, because we included participants based on their willingness to participate in the study, the study contains a selection bias. Nonetheless, this study provides a comparative analysis of low- and middle-income countries.

## CONCLUSIONS

Our study revealed significant disparities in the insertion and maintenance of bundles used to prevent CLABSIs between low-, middle-, and high-income countries. Further actions should be taken and include raising awareness on a national and international level, providing necessary materials and good practices in health, and allocating funds to improve health care in countries with limited sources.

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