

Bundle of the International Nosocomial Infection Control Consortium (INICC) to Prevent Central and Peripheral Line-Related Bloodstream Infections



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Forward

Prevention of catheter-related bloodstream infections (CR-BSI) should be a high priority for clinicians in all countries of the world. Recent data from developed or resourced countries shows that a very high percentage of CR-BSIs can be prevented with relatively simple insertion and maintenance bundles. The elements of these bundles are derived from well-designed evidence-based studies. The pathophysiologic mechanisms for CR-BSI, i.e., extraluminal and intraluminal colonization followed by infection, are the same for all patients worldwide who have an indwelling intravenous catheter--whether central or peripheral--inserted. Thus, the degree to which these complications can be prevented should be the same worldwide. Obviously, the resources required to accomplish this goal vary widely at healthcare facilities from resourced vs. resource-limited countries.

The International Nosocomial Infection Control Consortium (INICC) scientific activity worldwide since 2002 was crucial to find that CR-BSI rates were significantly higher in settings with lower resources, and also provided tools for measuring those rates, and consequences such as extra length of stay, extra cost, extra mortality, as well as mechanisms to effectively reduce these rates. Data from the INICC and other publications have documented also that there often are substantial differences in the degree to which CR-BSIs are prevented in resourced vs. resource-limited countries.

In addition to failure to fully implement available insertion and maintenance bundles for the prevention of CR-BSI, the INICC Bundle document describes a large number of practices which were commonly practiced in the United States in past decades before evidence demonstrated their increasing the risk of CR-BSI, however many of them are still being applied in limited resources settings. These include: (1) over-crowded and understaffed wards/intensive care units (ICUs); (2) wards/ICUs with neither sinks for handwashing nor alcohol-based hand rubs available; (3) use of contaminated water for hand washing; (4) use of cloth towels--often wet and contaminated--for hand drying; (5) use of open systems--three-way stop-cocks, open glass intravenous containers with air filter; open, semi-rigid, plastic intravenous container with inserted needles; open burette intravenous containers with air filter; use of open semi-rigid intravenous containers with administration set and 3-way stopcock for intravenous solution preparation; or admixture of medications or intravenous fluids at the bedside (often without sterile technique); (6) use of cotton balls already impregnated with antiseptic--that can be extrinsically contaminated; (7) insertion of central lines without use of maximal barrier precautions or

November 4, 2016

peripheral lines without adequate skin antisepsis; (8) placement of catheters in high risk locations; central lines in femoral or internal jugular or peripheral catheters in flexion areas, such as the antecubital fossa; (8) peripheral or central lines in place with either no dressing or a damp, soiled or loose dressing; (9) use of single-dose vials which are used multiple times, have needles inserted in them, or and covered with contaminated tape; and (10) single-dose vials that are used multiple times and open to the air. This list is not all inclusive, but virtually all of these practices have been eliminated over the past 5 decades in U.S. healthcare facilities.

Several factors may ultimately lead to potentially higher rates of CR-BSI in resource-limited countries over the next decade. First, as the use of more “invasive” or higher risk catheters--such as central lines instead of peripheral lines--becomes more common, many will witness a concomitant increase in their CR-BSI rate. In addition, as higher and higher risk patients--e.g., transplant, very low birthweight neonates, highly immunocompromised patients--become more prevalent in the healthcare facility, higher risk and longer duration intravenous catheters will be used and the CR-BSI rate will increase. Thus, it is imperative that we all learn from one another and implement all the evidence-based CR-BSI prevention practices.

The INICC Multidimensional Approach (IMA), should be adopted. The IMA includes (1) a bundle of infection control interventions, which, include insertion and maintenance bundles, for the prevention of CR-BSIs, adapted to resource limited countries situation, (2) education, (3) outcome surveillance, (4) process surveillance, (5) feedback on CR-BSI rates, and (6) performance feedback on infection control practices. We should all have zero tolerance for CR-BSIs. The full implementation of this INICC bundle can help us all realize our goal of preventing CR-BSIs worldwide.



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Bundle of the International Nosocomial Infection Control Consortium (INICC) to Prevent Central and Peripheral Line-Related Bloodstream Infections

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Justification

There are available comprehensive and detailed evidence-based recommendations for preventing catheter-related bloodstream infection (CRBSI) previously edited and published by organizations from high income industrialized countries, such as the Centers for Disease Control and Prevention (CDC) in 2011,¹ Joint Commission International (JCI) in 2012,² Society of Health Care Epidemiology of America (SHEA) and the Infectious Diseases Society of America (IDSA) in 2014,³ National Evidence-Based Guidelines for Preventing Healthcare-Associated Infections in National Health Service (NHS) Hospitals in England (EPIC 3) in 2014,⁴ Infusion Nurses Society (INS) in 2016⁵ and also from Asia Pacific Society of Infection Control in 2016.⁶

However, as identified in assessments undertaken by the International Nosocomial Infection Control Consortium (INICC) team at health care facilities worldwide during the last 25 years, there is a significant gap between the contents of the above-mentioned available recommendations and the feasibility of their implementation at hospitals in resource-limited countries, due to the actual structure, supplies, technology, knowledge, skills and practices at their disposal. It was commonly observed that hospitals in resource-limited countries apply the five classic components of the Institute for Health Improvement (IHI) bundle along with its check list—which are, undoubtedly, significantly effective in industrialized countries.⁷ However, their effectiveness is hindered by the existence of unfavourable situations, including overcrowded intensive care units (ICUs), insufficient rooms for isolation, lack of sinks, lack of medical supplies, including but not limited to, alcohol hand rub products, antiseptic soap, paper towels, chlorhexidine solutions, single-use flush syringes, prefilled syringes (leading to manual admixture of all saline solutions and drugs), closed intravenous systems (replaced with vented intravenous containers) and needleless connectors devices (which are replaced with three-way stop cocks). (Figure 1) It was also observed that limited supplies serve as an obstacle to applying maximal barriers precautions during catheter insertion. (Figure 1) Moreover, adopting unsafe practices, such as using cotton balls already impregnated with antiseptic and placed in a contaminated container, not covering an insertion site with sterile dressing, using drugs in already-open single-dose vials, reusing single-dose vials, leaving needles inserted in multiple-dose vials, and taking fluids from a 500-ml container for dilution of parenteral solutions, were also common practices. (Figure 2)

As a result of this situation, although healthcare workers (HCWs) in limited-resource settings may comply with a comprehensive bundle perfectly well, CLABSI rates at their health care facilities continue to be above 10 CLABSIs per 1000 central line (CL) days, instead of 1 CLABSI per 1000 CL days—that is, 10 times higher CLABSI rates than US CDC's National Healthcare Safety Network (NHSN) rates—causing frustration and disappointment among HCWs, and leading to higher morbidity and mortality rates. (Table 1)

In light of these findings, there still exists a compelling need to bridge the gap between infection prevention theory and practice in health care facilities with limited resources. Thus, the specific objective of this publication is to select, highlight and comment on a few practical and essential components of a bundle to counteract those adverse differences in practice and use of outdated supplies and technologies that are evident when comparing health care facilities in high-income and resource-limited countries. The publication of the following abridged set of recommendations as part of a Bundle edited by INICC in collaboration with a group of 27 international experts from 25 countries of the 6 World Health Organization (WHO) regions is, therefore, justified as an attempt to assist hospitals worldwide—but with special emphasis on limited resources settings—in implementing and prioritizing effective efforts to prevent CRBSI associated with CLs and peripheral lines (PLs).

Initial Findings on Healthcare-Acquired Infections in Resource-Limited Countries

One of the central premises of healthcare-acquired infection (HAI) prevention and control is that thorough surveillance and data on the occurrence of HAIs are essential to effectively address this public health burden.

Unfortunately, however, HAI prevalence is frequently underestimated, and its actual impact on countries worldwide is difficult to assess.^{8,9} Furthermore, research on the incidence of CRBSI was, for many years, mainly restricted to studies carried out in high-income countries.

As noted in 2008, in a review conducted by the WHO¹⁰ to identify CLABSI rates per 1000 CL days from resource-limited countries, applying definitions and methods recommended by the US CDC's NHSN,¹¹ its authors referred to data from a multinational multicenter study published by INICC in 2006 to show that HAI rates in resource-limited countries were higher than in industrialized economies, meaning that the first international communication showing that CLABSI rates were higher in limited-resources countries compared with high income countries was published by INICC in 2006.¹²

The estimated international HAI prevalence was found to be at least twice the rates published by the European Centre for Disease Prevention and Control, and triple of those found in the USA. (Table 1)¹³⁻¹⁵ Likewise, the estimated pooled prevalence of overall HAIs for the South-East Asia Region of the WHO was 9.0% (95% confidence interval [CI], 7.2%-10.8%), according to a recent systematic literature review and meta-analysis of the burden of HAIs conducted by Ling et al and published in 2016.¹⁶

In addition, research on the negative impact of HAIs in resource-limited countries, also published by INICC,¹⁷⁻²⁹ has shown that attributable mortality,^{12, 30-46} prolonged length of stay (LOS), extra hospital costs,^{31, 33-37, 39-48} and increased bacterial resistance,^{35, 37, 44} are significantly higher than in the developed world. (Table 1)

Central Line-Associated Bloodstream Infection Rates

There is a consensus among researchers that device utilization ratio (DUR) is a major independent risk factor for development of HAIs.⁴⁹ In terms of device-associated healthcare-associated infections (DA-HAIs), INICC found that the international DUR was analogous or even lower than the one reported in U.S. ICUs by the NHSN System.^{50 48-57} However, pooled mean CLABSI rates identified in ICUs worldwide by the INICC were found to be exceedingly higher, thereby suggesting the need for further thorough research on DA-HAI risk factors in resource-limited countries.^{11, 12, 14, 15, 17-48, 51} In this respect, the results of the last INICC report, with a data summary of 50 countries conducted from January 2010-December 2015 in 703 intensive care units (ICUs) in Latin America, Europe, Eastern Mediterranean, Southeast Asia, and

Western Pacific, showed that although DUR in INICC ICUs was similar to that reported from CDC-NHSN ICUs, DA-HAI rates were higher in the INICC ICUs: in the INICC medical-surgical ICUs, the pooled rate of central line-associated bloodstream infection, 4.1 per 1,000 central line-days, was nearly 5-fold higher than the 0.8 per 1,000 CL-days reported from comparable US ICUs.⁵² (Table 1)

Therefore, to determine the incidence of CLABSI and its adverse effects in resource-limited countries, a systematic review was done and published by INICC in 2009.³⁸ According to this review, CLABSI was associated with significant extra mortality, and the CLABSI rate ranged from 1.6 to 44.6 cases per 1000 CL days in adult and paediatric ICUs and from 2.6 to 60.0 cases per 1000 CL days in neonatal ICUs.^{12, 14, 15}

Over the past decade, a number of studies conducted in Latin America have shown rates of CLABSI per 1000 CL days were ranging from 3.1 to 34.³⁸ In Peru, Becerra et al. reported that the CLABSI rate in adult ICUs was 18.1 per 1000 CL days.⁵³ In Argentina, according to recent data from the Annual Report for 2014 published by the Argentinian Hospital Infection Surveillance Programme (VIHDA, by its acronym in Spanish), the mean CLABSI rate in medical surgical adult ICUs was 4.10.⁵⁴ However, much higher CLABSI rates were found in hospitals from Argentina, such as the CLABSI rate of 11.4 per 1000 CL days, determined by Bantar et al.⁵⁵ Similarly, in a study conducted in Brazil, Abramczyk et al. reported a CLABSI rate of 10.2 per 1000 CL days in a paediatric ICU.⁵⁶ In other studies conducted in Brazil, the identified CLABSI rates per 1000 CL days in adult ICUs were significantly higher, as determined by Santucci et al., who found a 34.0 CLABSI rate,⁵⁷ by Brito et al., who found a 17.3 CLABSI rate; and by Porto et al., who found a 17.9 CLABSI rate.⁵⁸ Conversely, the rates of CLABSI per 1000 CL days found in neonatal ICUs in Brazil were much lower, as exemplified by the 3.1, 3.94 and 17.3 CLABSI rates found by Couto et al.,⁵⁹ Hocevar et al.⁶⁰ and Pesssoa-Silva et al.,⁶¹ respectively.

Similar rate variation was found in the South-East Asia Region of the WHO, such as in India, as shown in a study conducted by Singh et al.⁶² who found a rate of 0.48 CLABSIs per 1000 CL days. Other studies showed CLABSI rates of 27.0⁶³ and 16.0⁶⁴, such as Chopdekar et al.⁶³ and Singh et al.,⁶⁴ respectively. According to a recent systematic literature review and meta-analysis conducted by a Ling et al., at this region, the pooled incidence density of CLABSI was 4.7 per 1000 catheter-days (95% CI, 2.9-6.5).¹⁶

In relation to the Eastern Mediterranean WHO Region, 2 studies from Iran showed 29.3 CLABSIs per 1000 CL days⁶⁵ and 147.3 CLABSIs per 1000 patient-days⁶⁶ (Johnson et al.⁶⁵ and Askarian et al.,⁶⁶ respectively.) In Saudi Arabia, Balkhy et al.,⁶⁷ found a CLABSI rate per 1000 CL days of 8.2, which is similar to the 10.0 CLABSI rate found by Al-Tawfiq et al.⁶⁸ In Tunisia in two studies conducted by Ben Jaballah et al the CLABSI rates per 1000 CL days were 15.3 and 14.8.^{69, 70} In the European WHO Region, the CLABSI rates found in Turkey were diverse and ranged from 2.8 and 3.8 CLABSIs per 1000 CL days, as found in the studies conducted by Tutuncu et al.,⁷¹ and Yalaz et al.,⁷² respectively, to 7.69 and 11.8, as found by Huang et al.⁷³ and by Dogru et al.,⁷⁴ respectively.

Peripheral Line-Associated Bloodstream Infection Rates

Peripheral line-associated bloodstream infection (PLABSI) is considered an increasingly common iatrogenic complication.⁷⁵ According to a review conducted by Maki et al. in 2006,⁷⁶ in which the risk of BSI in adults with different intravascular devices was analysed, the point incidence rate of PLABSI was 0.5 per 1000 catheter days. In a French study, the rate of PLABSI was reported to be 2.3% (9 out of 390 catheters).⁷⁷ In a point-prevalence study on HAIs conducted in England, Wales, Northern Ireland, and the Republic of Ireland in 2004, primary PLABSIs were reported in 264 out of 28 987 (0.9%) patients, whereas the highest CRBSI rates were due to CLABSI (5%).^{77, 78}

In a prospective randomized controlled trial, Gonzalez Lopez et al. looked at the indwell time without complications in closed-system peripheral lines (CS-PLs) vs. open-system peripheral lines (OS-PLs), during which catheters were removed based on clinical indications only, as opposed to the standard practice of routine catheter change.⁷⁹ This study showed a reduction in the risk of both phlebitis and infection with CS-PLs at a cost of only € 0.09/day. It also showed that when catheters are removed based on clinical indications and not routinely, CS-PLs can last up to 144 hours while OS-PLs can last up to 96 hours with significant cost savings (€ 786,257/year/1000 beds) and no increased risk. Furthermore, as pointed out by Tamura et al. in a study conducted in Japan, unfavourable PL replacements can be reduced using an integrated Closed Intravenous Catheter System, and the longer survival rate for this system may offset the higher initial catheterization costs.⁸⁰

Extra Mortality of Catheter-Related Bloodstream Infection

CLABSI is associated with a significantly increased risk of death, as highlighted in a recent systematic review and meta-analysis on attributable mortality of CLABSI.⁸¹ In different publications worldwide, it was reported that mortality attributable to CLABSI can range from 3 to 75.1%.^{12, 31-46} In a review focused on CLABSI in limited-resource countries, it was also demonstrated that the CLABSI rate was associated with significant extra mortality, with an odds ratio ranging from 2.8 to 9.5.⁴¹ In this respect, Rosenthal et al. showed that mortality due to CLABSI in hospitals from resource-limited economies ranges from 4 to 75.1%.^{36, 38, 82-87}

Extra Length of Stay and Cost of Catheter-Related Bloodstream Infection

A number of authors have considered the adverse outcomes of CRBSI. Prolonged lengths of stay (LOS) and correlated extra hospital costs have been shown to cause a high impact at both hospital and national levels.^{43, 88}

To calculate the cost of CLABSI, a prospective nested case-control study was conducted in 6 adult ICUs from 3 member hospitals of INICC in Argentina, where 142 patients with CLABSI and 142 patients without CLABSI were matched for hospital, type of ICU, year of admission, LOS, gender, age, and average severity of illness score.⁴³ Compared to the controls, patients with CLABSI showed the following: a mean extra LOS of 11.90 days, a mean extra antibiotic defined daily dose of 22.6, a mean extra antibiotic cost of \$1,913, a mean extra hospitalization cost of \$4,888.42 and an excess mortality of 24.6%.⁴³

A significant analysis on this subject was presented in an 18-month prospective nested case-control study undertaken in 4 ICUs at 3 INICC member hospitals in Mexico City. Fifty-five patients with CLABSI (cases) and 55 patients without CLABSI

(controls) were compared by analysing hospital, type of ICU, year of admission, LOS, gender, age, and average severity of illness score. The results indicated that, when compared to controls, CLABSI patients had an extra LOS of about 6.05 days. Furthermore, the mean extra cost of antibiotics amounted to \$598, the mean extra cost of other drugs was \$25.77, and the mean extra cost of hospitalization was \$8,326. The mean extra cost for cases (compared to the controls) was \$11,591. Finally, the extra mortality attributable to CRBSI was 20%.⁸⁸ Similarly, in a study conducted in Brazil, Pessoa-Silva et al., reported that delayed CRBSI prolonged LOS by 25.1 days.⁸⁹

Another major study was conducted in 2007 to estimate the excess LOS in an ICU due to CLABSI in member hospitals of INICC in 3 Latin American countries (Argentina, Brazil and Mexico). An analysis was made by means of a statistical model that accounted for the timing of infection in a cohort of 3,560 patients hospitalized in 11 ICUs who were followed for 36,806 days. It was concluded that the average excess LOS due to CLABSI increased and varied between -1.23 days to 4.69 days.⁹⁰

Central Line-Associated Bloodstream Infection Impact in Neonatal Intensive Care Units

In several studies, researchers have highlighted the mortality attributable to bloodstream infection of neonates hospitalized in neonatal ICUs, including CRBSI, with mortality rates ranging from 24% in the pre-surfactant era to 11% in the post-surfactant era in the developed countries.^{89, 91-93} The burden of CLABSI in the NICU is probably not limited to mortality alone, as newborn sepsis in general is also associated with adverse consequences in the central nervous system, longer duration of mechanical ventilation, and higher incidence of hepatic fibrosis and chronic lung disease.^{82, 92, 94-100} However, in developing countries, data on device-associated healthcare-associated infections including CRBSI is scarce, and there is an insufficient recognition of the importance of surveillance for measuring the risks of infection and outcomes concerning NICU patients.⁴² In this respect, a recent study was performed to evaluate the impact of country socioeconomic status and hospital type on DA-HAIs in 30 NICUs, from member hospitals of INICC in 15 countries. Its findings revealed that CLABSIs were significantly lower in private than academic hospitals (10.8 vs. 14.3 CLABSIs per 1,000 CL days [$p < 0.03$]), but not different in public and academic hospitals (14.6 vs. 14.3 CLABSIs per 1,000 CL days [$p = 0.86$]). Furthermore, CLABSI rates found in NICUs enrolled from low-income countries were significantly higher than in lower-middle-income countries or upper-middle-income countries.⁴²

Common Practices in Public Hospitals from Limited-Resources Countries

A considerable number of common practices have been observed at many hospitals which interfere with an effective implementation of infection control programmes, and neutralize HCWs' efforts to reduce CLABSI rates at their institutions despite their compliance with the available guidelines.^{11, 12, 14, 15, 17-48, 51}

As pointed out in a number of studies conducted by the INICC team, the most common adverse practices and situations observed at hospitals both in the public sector and at some in the private sector of limited-resource countries, included the following: insufficient rooms for isolation; overcrowded ICUs; lack of sinks; inadequate chlorination of water for hand washing leading to external contamination of the intravenous administration set;^{101, 102} lack of a microbiology laboratory with reasonable quality and the possibility of taking blood cultures during entire day; lack of medical supplies in general, including but not limited to, insertion of CLs without one or many of the components of the maximal sterile barrier precautions, such as sterile gloves and gown, cap and mask, and a full-body sterile drape; lack of skin antisepsis with chlorhexidine in alcohol at the insertion site before CL insertion and prior to changing the catheter's dressing; use of a single pair of gloves for taking care of more than 1 patient; use of femoral vein in adults for insertion of a CL; CL kept in place without clear indication; change of CLs and PLs at fixed intervals; lack of use of sterile dressing to cover the intravascular insertion site; sterile dressing in bad condition such as, damp, loosened or soiled; lack of use of chlorhexidine impregnated dressing at insertion site of central line; lack of scrub and disinfection of catheter hubs, ports and needleless connectors; use of three-way stop cock as intravenous connection devices; manual admixture of IV medications; lack of use of prefilled single use syringes with sterile normal saline for injection to flush and lock catheter lumens; use of IV solution containers (e.g., bags or bottles) as a source for obtaining flush solution; dilution or reconstitution of an IV flush or push medication performed outside the pharmacy, often performed several days prior to administration, and in a common area, without drug information and sterile equipments and supplies; dilution or reconstitution of IV push medications by drawing up the contents into a commercially prefilled flush syringes; withdrawal of IV push medications from commercially available, cartridge-type syringes into other syringes for administration; IV push medications without labels; multiple-dose vials dedicated to all patients of the unit; lack of disinfection of connection surfaces (i.e., needleless connectors, injection ports) before flushing and locking procedures; use of a multi-dose vial for more than 28 days after opening or puncture; multi-dose vials without labels, such as products' date; access of bottle with rubber cap without disinfection of the cover; using same needle for taking fluids from a multi-dose vial and administering them to a patient; reprocessing and reuse of single-use medical devices;¹⁰³ lack of disinfection before each entry into the vial septum or the neck of a glass ampoule; IV medication bottles with rubber caps with and inserted needles; single-dose vials used several times after the first entry and first use; lack of disposal of labelled medication syringes; use of containers, with IV solutions intended for infusion, as common-source containers (to dilute or reconstitute medications for 1 or more patients in clinical care areas; addition of medications to infusing containers of IV solutions; administration of an "immediate-use" compounded sterile product many hours after preparation; use of plastic, semi-rigid, vented open IV fluid containers; use of glass vented open IV fluid containers; inserted needle to vent IV fluid containers; use of administration sets continuously for more than 4-5 days; use of administration sets for blood and blood components or lipid containing parenteral nutrition for more than 24-48 hours; lack of daily bath with 2% chlorhexidine; lack of available guidelines to prevent CRBSI; lack of surveillance of CRBSI; lack of process surveillance; and lack of use of antimicrobial impregnated CL.^{11, 12, 14, 15, 17-48, 51} (Figure 1 and 2)

These findings clearly confirm the need for specific recommendations, as part of a bundle, for limited-resource settings that take into consideration the mentioned observed common practices in order to effectively reduce the burden of CRBSI.^{7, 104}

Impact of Closed Intravenous Needleless Connectors and Closed IV Fluid Containers on CRBSI rates

A stopcock is a valve or turning plug that controls the flow of fluid from a container through a tube. A three-way stopcock (3WSC) can be used on intravenous (IV) tubing to turn off one solution and turn on another. It is open to the air without a membrane when cover is not in place, and for that reason it is considered an open IV system. On the other hand, needleless connectors (NC) are considered closed IV connectors.

Tabak et al conducted a meta-analysis to determine the risk for CLABSI associated with the use of a new NC with an improved engineering design. They reviewed MEDLINE, Cochrane Database of Systematic Reviews, Embase, Clinical Trials.gov, and studies presented in 2010-2012 at infection control and infectious diseases meetings. Studies reporting the CLABSIs in patients using the positive-displacement NC (study NC) compared with negative- or neutral-displacement NCs were analyzed. They estimated the relative risk of CLABSIs with the study NC for the pooled effect using the random effects method. Seven studies met the inclusion criteria: 4 were conducted in intensive care units, 1 in a home health setting, and 2 in long-term acute care settings. In the comparator period, total central venous line (CL) days were 111,255; the CLABSI rate was 1.5 events per 1,000 CL days. In the study NC period, total CL days were 95,383; the CLABSI rate was 0.5 events per 1,000 CL days. The pooled CLABSI relative risk associated with the study NC was 0.37 (95% confidence interval, 0.16-0.90). The NC with an improved engineering design is associated with lower CLABSI risk.¹⁰⁵

To assess the association between NC change frequency and CLABSI rate, Sandora et al modelled monthly paediatric stem cell transplant (SCT) CLABSI rate in 3 periods: baseline period during which NC were changed every 96 hours regardless of infusate (period 1); trial period in which NC were changed every 24 hours with blood or lipid infusions (period 2); and a return to NC change every 96 hours regardless of infusate (period 3). Data on potential confounders were collected retrospectively. Autocorrelated segmented regression models were used to compare CLABSI rates in SCT patients in each period, adjusting for potential confounders. CLABSI rates were also assessed for a non-equivalent control group (oncology unit) in which NC were changed every 24 hours with blood or lipid use in periods 2 and 3. CLABSI rates in SCT patients were 0.41, 3.56, and 0.03 per 1,000 central line-days in periods 1, 2, and 3, respectively. In multivariable analysis, the CLABSI rate was significantly higher in period 2 compared with both period 1 (P .01) and period 3 (P .003). In contrast, CLABSI rates on the oncology unit were not significantly different among periods. In paediatric SCT patients, changing needleless connectors every 24 hours when blood or lipids are infused is associated with increased CLABSI rates. National recommendations regarding NC change frequency should be clarified.¹⁰⁶

Pohl et al. conducted a study looking at the difference in labour and material costs between NC devices and 3WSCs, which showed that the average process costs (i.e., labour and material costs) was significantly lower for the NC (Euro 2.55) than the 3WSC (Euro 3.92). Regarding the contamination rate, the 3WSC system showed a rate of 8% vs. 0% rate with the NC.¹⁰⁷

The first randomized controlled trial (RCT) to compare infection rates in NC + single use flush (SUF) vs. 3WSC + manual admixture (MA) was conducted by the INICC in India, in which a significantly lower incidence of CLABSI and higher cost-effectiveness were observed in the NC +SUF group compared with the 3WSC+MA group.⁸⁷ Coincidentally, the use of the NC +SUF device significantly improved the cumulative infection-free catheter survival compared with the 3WSC+MA. It is worth noting that the protocol for management and care of CL was the same for the 2 ICUs, from which the patients were recruited over the whole trial period, and that patients' characteristics, such as age, gender, average severity of index score, and underlying diseases were similar in both case and control patient groups.⁸⁷

Regarding IV fluid containers, there is a high risk of contamination of IV fluids during setup, admixture preparation and administration.¹⁰⁸ There are two types of IV fluid containers in use worldwide: a glass or semi-rigid plastic bottle or burettes, which must be externally vented to ambient air in order to allow fluid egress (open system), and a collapsible plastic bag, which does not require external venting to empty (closed system). Open systems have been superseded by closed systems all over North America and Western Europe. During the 1970s, outbreaks of infusion-related bacteraemia in North American hospitals were traced to contamination of infusate in open infusion systems.¹⁰⁹⁻¹¹² More recently, the same problems have arisen in hospitals in Mexico, Brazil, and Greece.¹¹³⁻¹¹⁵ Different studies have proved that the extrinsic or in-use contamination plays the most important role in bacterial contamination of the infusion system.^{113, 114, 116-121} The clinical impact and cost effectiveness of closed infusion systems was studied for the first time in a study conducted in Argentina.¹⁰⁸ In this study, it was shown that switching from open to closed systems resulted in a significantly lower incidence of CLABSI, and a 64% rate reduction in central venous catheter-associated bacteraemia secondary to gram-negative bacilli. These findings were later confirmed in similar studies conducted in Brazil, Mexico, Italy, and in one meta-analysis.¹²²⁻¹²⁶

Flushing and Locking

Vascular access devices (VADs) are flushed and aspirated for a blood return prior to each infusion to assess catheter function and prevent complications. VADs are flushed after each infusion to clear the infused medication from the catheter lumen, thereby reducing the risk of contact between incompatible medications. The VAD is locked after completion of the final flush to decrease the risk of intraluminal occlusion and catheter-related bloodstream infection (CR-BSI), depending on the solution used.⁵

Catheter-Related Bloodstream Infection Prevention

There are several measures to be considered as basic recommendations of a Bundle for the implementation of an infection control program, which should be consistent with the actual capabilities of the healthcare facility and personnel.^{1, 3, 4, 7, 9, 104, 127-132} The initial step is the organization of a surveillance system, as it permits the identification of local problems, distinctively specific to a particular institution, serving as guide for subsequent changes. Targeted surveillance and calculation of DA-HAI rates per 1000 device-days also allows benchmarking with other similar institutions. In this respect, "Outcome Surveillance" developed by INICC includes the systematic standardized measurement of DA-HAI rates and their associated effects: mortality, morbidity, extra LOS, extra hospital costs, and bacterial resistance. These data are essential to

have an accurate knowledge of the burden of HAI and focus efforts on the areas that need more attention. Hospitals, internationally, should start surveillance in critical areas, such as ICUs, where DA-HAI pose the most threatening risks for patient safety.

It is to be noted that a reduction in DA-HAI rates cannot be expected to derive from surveillance by itself without feedback, and such educational efforts may be short-lived if regular reinforcement is absent. For this reason, in a context of lack of financial resources, it is compelling to find and show the information on the incidence and magnitude of the burden of HAI at the hospital level. The collection of this data must be used for improvement of patient care practices, higher adherence to published infection control guidelines, and performance feedback.

Additionally, as reported in different studies internationally, disseminating data on morbidity and mortality due to HAI, and the resulting avoidable patient suffering and economic impact, is a necessary approach to move the hospital administration and healthcare workers into supporting the infection control program.^{35, 83, 133-137}

Outcome surveillance needs to be followed by the surveillance and monitoring of processes. Process Surveillance is necessary to monitor compliance with infection control prevention guidelines and basic measures, such as hand hygiene, vascular catheter care, urinary catheter care, and measures to prevent ventilator-associated pneumonia (VAP).

Furthermore, a continuing education program on HAI control and prevention must be available to healthcare-workers, particularly nurses and physicians.¹³⁸

Although the recommendations described in the guidelines published by the SHEA, IDSA,³ CDC,³ EPIC 3,¹ JCI,⁴ and IHI,^{2, 7, 104} provide evidence-based and cost-effective preventative measures applicable to infection control programs in developing countries, some supplies and technologies that are available and widely applied in developing countries are not considered in those recommendations, thereby limiting their effectiveness.^{38, 126, 128, 137, 139-145}

There are several experiences published by HCWs from limited-resources countries, evaluating the effect of implementing guidelines on the rate of CRBSI. In Argentina, a study conducted by Kurlat et al. showed that after implementing institutional guidelines on hand hygiene, catheter care and aseptic techniques, the overall bacteraemia rate in a NICU dropped from 20 to 12.4 per 1000 patient-days ($P < 0.003$).¹⁴⁶ In Brazil, Lobo et al. showed that an educational program developed by a multidisciplinary task force to highlight correct practices for CL care showed a reduction in the CLABSI rate from 20 per 1000 CL days to 11 per 1,000 CL days ($P 0.07$), although this decrease did not attain statistical significance.¹⁴⁷ Similarly, in another study conducted in Brazil by Resende et al., which included bundled interventions, the rate of CLABSI decreased from 24.1 to 14.9 per 1000 CL days ($P 0.05$).¹⁴⁸ Recently, in Colombia, Alvarez-Moreno et al, showed that through the implementation of the INICC multidimensional approach (which included: 1- a bundle of infection prevention practice interventions, 2- education, 3- outcome surveillance, 4- process surveillance, 5- feedback on CLABSI rates and consequences and 6- performance feedback of process surveillance), the rate of CLABSI was decreased from 12.9 to 3.5 CLABSIs per 1000 CL-days.⁸⁶

In Turkey, a study was conducted to analyse the effect of education on the rate of CLABSI. During the pre-education period, the CLABSI rate was 8.3 infections per 1,000 CL-days, and during the post-education period, the CLABSI rate was 4.7 infections per 1,000 CL-days.¹⁴⁹ In another study conducted in Turkey, 133 patients requiring CL were chosen at random to receive either an antiseptic-impregnated triple-lumen line ($N=64$) or a standard triple-lumen line ($N=69$).¹⁵⁰ The CLABSI rates were 5.3/1,000 CL-days for the antiseptic line group and 1.6/1,000 CL-days for the standard line group ($P=0.452$). The results of this study indicated that the use of antiseptic-impregnated central lines had no effect on the incidence of either line colonization or CLABSI in critically ill patients.

In the WHO South-East Asia Region, a study conducted by Apisarnthanarak A. in a Thai tertiary care centre showed a CLABSI rate of 14 per 1000 catheter-days before the implementation of an infection-control bundle. After the enforcement of the bundle, the rate dropped by 54.1% (6.4 per 1000 CL days; $P<0.001$). An additional 78% rate reduction (1.4 per 1000 CL days; $P < 0.001$) was seen when intensified hand hygiene was applied along with the bundle.¹⁵¹ Nevertheless, in Thai hospitals many of the prevention practices for DA-HAIs, including CLABSI, are infrequently applied, as illustrated in a study conducted in Thai hospitals which showed only 6% adherence to CLABSI bundle practices.¹⁵²

In the Eastern Mediterranean region, a randomized, controlled trial was conducted in Tunisia by Abdelkefi et al., studying the effect of decreasing fibrin deposition inside catheters on CRBSI rates. In this study, 246 patients with non-tunnelled CLs were randomized into two different groups, with the first group receiving heparin-coated catheters, continuously flushed with 50ml/dL normal saline solution, while the second group receiving non-coated catheters, continuously flushed with low-dose unfractionated heparin. CLABSI rates were 0.9 per 1000 CL-days and 3.5 per 1000 CL-days in the heparin coated and noncoated groups, respectively ($P= 0.027$).¹⁵³ The conclusion of this study stated that the use of heparin-coated lines could be a safe and effective approach to prevent CLABSI in patients with hemato-oncologic disease.¹⁵³ In the Kingdom of Saudi Arabia, in a study conducted by Al-Abdely et al, the results of implementation of the INICC multidimensional approach showed a 56% reduction of the CLABSI rate from 6.9 to 3.1 CLABSIs per 1000 CL days (incidence-density rate: 0.44; 95% CI 0.28–0.72; $P 0.001$).¹⁵⁴

In a time-sequence analysis of the effectiveness of a multi-dimensional approach in reducing rates of CLABSI in 15 countries from INICC, it was concluded that after implementing the infection control program, the infection control compliance significantly improved, the CLABSI incidence was reduced by 54% (16.0 to 7.4 CLABSIs per 1000 CL-days; RR 0.46, 95% CI 0.33 - 0.63, $P < 0.001$) and the number of CLABSI-associated deaths decreased by 58%.¹³⁷

Another key study was conducted recently by INICC on paediatric ICUs (PICUs) of 5 developing countries to analyse the impact of the INICC Multidimensional Approach (IMA) on CLABSI rates. The IMA included (1) a bundle of infection control interventions, (2) education, (3) outcome surveillance, (4) process surveillance, (5) feedback on CLABSI rates, and (6) performance feedback on infection control practices. After intervention, CLABSI was reduced from baseline by 52% (10.7 to 5.2 CLABSIs per 1000 CL-days; RR 0.48; 95% CI 0.29 – 0.94; $P 0.02$).¹⁵⁵

A similar multidimensional approach for CLABSI reduction was adopted in another study conducted by INICC in NICUs of 4 developing countries. During baseline, the CLABSI rate was 21.4 per 1000 CL days, and after intervention, the CLABSI rate decreased to 9.7 per 1000 CL days [RR 0.45 (95% CI 0.33 – 0.63)], showing a 55% CLABSI rate reduction.¹⁵⁶

At national levels, studies assessing the implementation of the IMA showed a 76% reduction in the CLABSI rate in Argentina (46.63 vs. 11.10 CLABSIs per 1000 CL-days);⁸² a 58% reduction in Mexico (46.3 vs. 19.5 CLABSIs per 1000 CL-days);⁸³ a 47% reduction in Turkey (22.7 vs. 12.0 CLABSIs per 1000 CL-days);⁸⁵ a 39% reduction in India (6.4 vs. 3.9 CLABSIs per 1000 CL-days);⁸⁴ a 73% reduction in Colombia (12.9 vs. 3.5 CLABSIs per 1,000 CL-days; RR, 0.27; 95% CI, 0.14-0.52; P=.002);⁸⁶ and a 56% reduction in the Kingdom of Saudi Arabia (6.9 vs. 3.1 CLABSIs per 1000 CL-days; incidence-density rate: 0.44; 95% CI 0.28–0.72; P 0.001).¹⁵⁴

The extracted findings from the available trials are representative and consistent evidence of the effectiveness that multi-faceted infection control strategies can have internationally. Within the broad spectrum of infection control, to successfully address the burden of HAI internationally, it has been key to implement surveillance of DA-HAI rates and of processes related to appropriate use and care of devices, educate healthcare workers, assesses their practice, and provide them with feedback on observed processes, and ensure adequate observations of the recommendations set forth in published guidelines. These findings reveal that the reduction of DA-HAIs is feasible and cost-effective internationally; therefore, this valid evidence should lead to the mandatory organization of multi-dimensional infection control programs at every hospital.

INICC Methodology

Prospective surveillance is conducted by infection preventionists (IPs) through an online platform called INICC Surveillance Online System (ISOS), whose effective impact on DA-HAI rates reduction was shown in several studies. The ISOS allows the classification of prospective, active, cohort surveillance data into specific module protocols within the INICC IMA, which applies U.S. CDC/NHSN's definitions published in January 2016.^{82-85, 155-172}

INICC Multidimensional Approach

The IMA comprises the simultaneous implementation of the following 6 components for HAI control and prevention: 1- a bundle of infection prevention practice interventions, 2- education, 3- outcome surveillance, 4- process surveillance, 5- feedback on HAI rates and consequences, and 6- performance feedback.¹⁷³

The contents of the IMA include CDC/NSHN's surveillance definitions and methodology, but it also includes the collection of other data essential to increase IPs' sensitivity to detect HAIs, and avoid underreporting.¹⁷⁴ According to standard CDC/NSHN methods, numerators are the number of each type of HAI, and denominators are device-days collected from all patients, as pooled data, that is, without determining the number of device-days related to a particular patient, and without collecting characteristics per specific patient.¹³⁸ This differs from the IMA in that the design of the cohort study through the INICC methods also includes collecting specific data per patient from *all* patients, both those with and those without HAI, and collecting risk factors of HAIs, such as invasive devices, and surrogates of HAIs, which include, but are not limited to, high temperature, low blood pressure, results of cultures, antibiotic therapy, LOS and mortality. By collecting data on all patients in the ICU, it is possible to match patients with and without HAI by several characteristics to estimate extra LOS, mortality and cost.¹⁷²

The data concerned in the IMA is registered and uploaded to the ISOS. The ISOS comprised 15 modules: (1) Cohort HAI surveillance in adult and paediatric ICU patients, (2) Cohort HAI surveillance in neonatal ICU patients, (3) Cohort HAI surveillance in step down units and inpatient wards, (4) Aggregated HAI surveillance in ICU for adult and paediatric patients, (5) Aggregated HAI surveillance in ICU for neonatal patients, (6) Microbiology for adult and paediatric patients, (7) Multi Drug Resistant Organisms and *Clostridium difficile* Infections, (8) Monitoring hand hygiene, (9) Monitoring bundle for CRBSI, (10) Monitoring bundle for urinary tract infection, (11) Monitoring bundle for pneumonia, (12) Surgical procedures: outcome surveillance, (13) Surgical procedures: process surveillance, (14) Antimicrobial consumption, and (15) Needlestick injuries.¹⁷²

1. Bundle of Infection Prevention Practice Interventions

The bundle of infection prevention practice interventions used by INICC is designed following the recommendations published by IHI in 2006,⁷ CDC in 2011,¹ JCI in 2012,² SHEA and IDSA in 2014,³ EPIC 3 in 2014,⁴ INS in 2016,¹⁷⁵ and other international publications, including those from limited resources countries.^{82-86, 154, 155, 169, 172, 176}

2. Education

Education sessions and training are provided to all HCWs in participating ICUs on training about the infection control measures contained in the INICC Infection Control Bundle for CLABSI prevention. During the first phase, at baseline period, the INICC team locally trains the IPs at each hospital on how to conduct surveillance and upload surveillance data to the ISOS. Later on, during intervention, the INICC team locally provides education and training sessions to IPs on the components of the INICC Infection Control Bundle for CLABSI Prevention (training the trainers). In turn, on a monthly basis, IPs at hospitals train the ICU teams on basic knowledge of CLABSI prevention including CLABSI impact, ISOS criteria for CLABSI diagnosis, blood sample collecting method and the implementation of the mentioned bundle components.^{82-86, 154, 155, 172, 176}

3. Outcome Surveillance

Prospective, active outcome surveillance through the ISOS allows the classification of cohort surveillance data into specific module protocols that apply U.S. CDC/NHSN's definitions published in January 2016.¹⁷² The site-specific criteria include reporting instructions and provide information integral to their adequate application.^{15, 173} Outcome surveillance also includes the measurement of patients' characteristics, such as age, gender and severity illness score, and HAI consequences, such as extra mortality, extra LOS, extra cost, microorganism profile, and bacterial resistance.^{12, 15, 17-48, 51, 172}

4. Process Surveillance

The process surveillance is performed through the ISOS modules, which include the monitoring of compliance with the following components of the INICC Infection Control Bundle for CLABSI Prevention: 1) hand hygiene compliance before CL insertion or manipulation; 2) insertion of CL using maximum sterile barrier precautions; 3) skin antisepsis with single use applicator with alcohol 70% and chlorhexidine 2%; 4) evaluation of the place of insertion; 5) daily assessment of the need of a CL, and CL DUR; 6) compliance with date on the administration set; 7) compliance with placed sterile dressing, either transparent dressing or gauze, and compliance with its optimal condition; 8) type of IV connection devices; 9) type of IV fluid containers; 10) use of single use flush; 11) daily bath with 2% chlorhexidine-impregnated washcloth; 12) use of antimicrobial impregnated catheters, and others; and 13) scrubbing and disinfection of catheter hub, ports and connectors with appropriate antiseptic.¹⁷²

5. Feedback on DA-HAI Rates and consequences

The IPs generate reports through the ISOS. The ICU HCWs receive feedback on DA-HAI rates and their consequences at monthly meetings held by IPs, who share and discuss the results of ISOS. These reports contain several charts and tables that show a running record of the monthly cohort surveillance data, including patients' characteristics, such as age and sex, proportion of DA-HAIs, such as CLABSI, VAP and catheter-associated urinary tract infection, along with their pooled means and the DURs of CL, mechanical ventilator and urinary catheter, microorganisms profile, bacterial resistance, extra LOS, extra cost, extra mortality attributable to DA-HAIs, and benchmarking of these rates against rates from the CDC-NHSN report of 2013, the last INICC Report of 43 countries,¹⁵ and against rates at local and country levels, such as INICC reports from Turkey, India, Colombia, Mexico, Saudi Arabia, and others.¹⁷²

Benchmarking is an important tool to increase HCWs' level of awareness of patient outcomes at their ICUs in comparison with other national and international standards, and to enable the IPs and ICU team to focus on the necessary issues and apply specific strategies for the reduction of CLABSI rates.^{172, 177}

6. Performance Feedback

At monthly meetings, performance feedback is provided by IPs to ICU HCWs by communicating and reviewing the resulting rates of process surveillance; that is the assessment of practices performed by them in the ICU related to the components of the INICC Infection Control Bundle for CLABSI prevention. The IPs show a report of 32 charts generated through the ISOS, which contain data regarding compliance with the elements of the bundle, including, by way of example, compliance with hand hygiene pooled by month, and stratified by gender and by HCW category, proportion of hand hygiene observed opportunities stratified by 5 moments of WHO, by used product, technique and work shift, and by compliance per month of the above-mentioned bundle components. This infection control tool is essential to enable the infection control team to be aware if there is room for improvement in low compliance rates, and through the influence of the "observer effects" on HCWs' behaviour, as strength of the method, to shape their practices so that they are more efficiently performed.¹⁷²

Conclusion

To conclude, it is necessary to highlight that in order to reduce the hospitalized patients' risk of HAIs internationally, a multidimensional approach is essential. It is fundamental that surveillance is implemented along with the monitoring of infection control practices (process surveillance), education, presence of practice bundles, performance feedback, and feedback of DA-HAI rates and consequences. INICC has shown that the high incidence of DA-HAI and mortality in several hospitals of the six WHO regions has been reduced by carrying out a multidimensional approach, with targeted performance feedback programs for hand hygiene and central line care.^{82-86, 154, 155, 165, 172, 176}

Searching for the Best Evidence

A literature review was conducted for each of the standards of practice using key words and subject headings related to each of the standards. Search was limited to English-language, peer-reviewed journals published between 2000 and July 2016. Databases included, but were not limited to, Cochrane Library, and Pubmed. The references of retrieved articles were reviewed for relevant literature. Additional sources of evidence included, but were not limited to, professional organizations' website. US sites included the US Department of Health and Human Services for national centres, such as the Agency for Healthcare Research and Quality (AHRQ), the CDC, and the US Food and Drug Administration (FDA) and the US Department of Labor (e.g., Occupational Safety and Health Administration [OSHA]).

Evaluating the Evidence

Each item of evidence was evaluated from many perspectives, and the highest, most robust evidence relating to the standards of practice was used. For research evidence, the study design was the initial means for ranking. Other aspects of evaluation of quality included sufficient sample size based on a power analysis, appropriate statistical analysis, examination of the negative cases, and consideration of threats to internal and external validity. We included randomized clinical trials, cohort and case control studies, and research on research, such as meta-analyses and systematic reviews.

Grading of the Quality of Evidence

Each infection prevention recommendation of this Bundle is given a quality-of-evidence grade based on Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) and the Canadian Task Force on Preventive Health Care.¹⁷⁸

Grading of the Quality of Evidence

Grade	Definition
I. High	Highly confident that the true effect lies close to that of the estimated size and direction of the effect. Evidence is rated as high quality when there is a wide range of studies with no major limitations, there is little variation between studies, and the summary estimate has a narrow confidence interval.
II. Moderate	The true effect is likely to be close to the estimated size and direction of the effect, but there is a possibility that it is substantially different. Evidence is rated as moderate quality when there are only a few studies and some have limitations but not major flaws, there is some variation between studies, or the confidence interval of the summary estimate is wide.
III. Low	The true effect may be substantially different from the estimated size and direction of the effect. Evidence is rated as low quality when supporting studies have major flaws, there is important variation between studies, the confidence interval of the summary estimate is very wide, or there are no rigorous studies, only expert consensus.

Note. Based on Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) and the Canadian Task Force on Preventive Health Care.¹⁷⁸

Recommendations to prevent CRBSIs

• Use a Multidimensional Approach including Bundle, Education, Outcome and Process Surveillance, and Feedback on burden of CRBSI and on performance (quality of evidence: II)^{4, 82-86, 104, 154, 155, 169, 172, 176, 179-182} ▪ Use a Multidimensional approach in order to support the appropriate use and management of vascular access devices (VADs), such as programs including: ◆ Adapted bundles, ◆ Education and training of healthcare personnel (quality of evidence: I)¹⁸³ ◇ Educate healthcare personnel regarding indications for VAD use, proper procedures for insertion and maintenance, and appropriate infection control measures to prevent catheter-related blood stream infections (CRBSI). ◇ Periodically assess knowledge of and adherence to guidelines among personnel involved in the insertion and care of VADs. ◆ Outcome surveillance. ◇ Performance of active surveillance for VAD related complications. ◇ Benchmark of CRBSI rates and DUR with international, regional, and national standards, and adverse consequences, such as extra LOS, cost and mortality. ◆ Process surveillance, ◆ Feedback on outcome surveillance, ◆ Performance feedback.^{4, 82-86, 104, 154, 155, 169, 172, 176, 179-182}	
• Hand Hygiene Before Insertion and Manipulation of a VAD (quality of evidence: II)^{1-4, 104, 128, 184-186} ▪ Alcohol-based hand rub should be made available at the point of care in all healthcare facilities. ▪ Perform hand rub, with 70% alcohol, or alcohol plus 2% chlorhexidine if hands are free of dirt and organic material.¹ ▪ Perform hand hygiene with 2% chlorhexidine or wash them with soap and water if hands are soiled or potentially contaminated with blood or body fluids. ▪ Regular audits should be undertaken on health care workers' (HCW) adherence to hand hygiene guidelines, whose results should be fed back to HCWs to improve and sustain high levels of compliance.	
• Central lines • Wear Maximal Sterile Barrier Precautions During Insertion and Removal of a Central Line (quality of evidence: II)^{1-4, 104, 185-191} ▪ During central line (CL) insertion, both the inserter and the assistant need to wear sterile gloves and gown, cap and mask, and use a full-patient body sterile drape.¹ ▪ During CL removal, both the operator and the assistant need wear mask and gloves, at least.¹	• Peripheral lines • Use Appropriate Personal Protective Equipment and Aseptic Technique During Insertion of Peripheral Lines (quality of evidence: II)¹⁷⁵ ▪ Use a new pair of disposable, nonsterile gloves in conjunction with a "no-touch" technique for peripheral line (PL) insertion, meaning that the insertion site is not palpated after skin antisepsis. ▪ Maintain aseptic technique for the insertion and care of PLs. Consider labelling PL inserted under suboptimal aseptic conditions. e.g. "Emergent. Remove and insert a new PL as soon as possible, preferably within 24 to 48 hours".

• Skin Antisepsis with Single Use Application or Sterile Single Use Applicator of 2% Chlorhexidine Gluconate in 70% Isopropyl Alcohol at Insertion Site Prior to Insertion and Prior to Changing Dressing of a VAD (quality of evidence: I)^{1-4, 104, 185, 186, 192-199} ▪ Perform skin antisepsis with a single-use application of 2% chlorhexidine gluconate in 70% isopropyl alcohol (or povidone iodine in alcohol for patients with sensitivity to chlorhexidine)¹⁸⁶ during 30 seconds for dry sites, non-groin areas, and 2 minutes for groin areas, and allow to dry: ◆ Prior to the insertion of a VAD, ◆ Prior to dressing changes at VAD insertion site, ▪ No recommendation can be made for the safety or efficacy of chlorhexidine in infants aged <2 months.¹	
• Insertion Site Selection for CL (quality of evidence: I) ▪ To reduce risk of CRBSI with a non-tunnelled VAD in adult patients, the subclavian vein is favoured, rather than the jugular or femoral veins.^{1-4, 104, 173, 175, 185, 187, 200-216} ▪ For patients with chronic kidney disease, consider the risks of central vein stenosis and venous occlusion when the subclavian vein is used; weigh the benefits and risks that accompany each access site.^{1-4, 104, 173, 175, 185, 187, 200-216} ▪ Avoid areas of wounds or infections, Hemodialysis Vascular Access Devices, Central Vascular Access Device Occlusion.^{1-4, 104, 173, 175, 185, 187, 200-216} ▪ To minimize the risk of catheter-related thrombotic complications with a non-tunnelled CVAD, the subclavian vein is recommended in adult patients, rather than the femoral vein.²⁰¹ ◆ If the patient has chronic kidney disease, consider the internal jugular vein or, secondarily, the external jugular vein, weighing benefits and risks for each access site.²¹⁷ ▪ There is no preferred venous insertion site for a non-tunnelled VAD in infants and children to minimize the risk of infection.¹	• Insertion Site Selection for PLs (quality of evidence: I)¹⁷⁵ ▪ Review patient's medical record for appropriate VAD and ordered therapy¹⁷⁵ ▪ Perform venous palpation to evaluate vein quality¹⁷⁵ ▪ Avoid the use of veins in the following sites: ◆ Ventral surface of the wrist, areas of flexion and areas of pain on palpation; and upper extremity on the side of breast surgery with axillary node dissection, with lymphedema, with AV fistula / graft, after radiation therapy to that side of the body, affected extremity from a CVA ▪ For adult patients: ◆ To minimize the risk of CRBSI and phlebitis, it is preferable to use an upper extremity site for inserting a PL in adults.^{1-4, 185} ◆ Use the venous site most likely to last the full length of the prescribed therapy; i.e., use the forearm to increase dwell time, decrease pain during dwell time, promote self-care, and prevent accidental removal and occlusions. ◆ Consider veins found on the dorsal and ventral surfaces of the upper extremities, including the metacarpal, cephalic, basilic, and median veins.^{1, 106, 200, 203, 217-221} ◆ Do not use veins of the lower extremities unless necessary due to risk of tissue damage, thrombophlebitis, and ulceration.^{1, 219, 222} ▪ In paediatric patients: ◆ For inserting a PL, the upper or lower extremity and the scalp (in young infants) can be used.^{1-4, 185, 223, 224} ◆ Use the venous site most likely to last the full length of the prescribed therapy, considering veins in the hands, forearms, and upper arms below the axilla. ◆ Avoid the ante-cubital area, which has a higher failure rate. ◆ Consider that in paediatric patients, femoral catheters have a low incidence of mechanical complications and might have an equivalent infection rate to that of non-femoral catheters.² ▪ For infants and toddlers: ◆ Consider veins of the scalp, and if the

	patient is not walking, then veins of the feet could also be considered. ◆ Avoid the hand or fingers, especially the thumb/finger used for sucking. ◆ Avoid any arm of infants and children used as entry site for procedures treating congenital cardiac defects that may have decreased blood flow to the subclavian artery.^{220, 222, 225-227} ▪ Peripheral Arterial Lines: ◆ Include as selection criteria from physical assessment the presence of a pulse and presence of distal circulation.^{219, 228} ◆ For adults, ◇ The radial artery is the most appropriate access for percutaneous cannulation, with the brachial artery followed by the dorsalis pedis as alternative sites. ◆ For paediatric patients, ◇ Use the radial, posterior tibial, and dorsalis pedis arteries. ◆ For adults and children, ◇ These sites are preferred over the femoral or axillary sites to reduce the risk of infection. ◇ The brachial artery is not used in paediatric patients due to the absence of collateral blood flow.²²⁹⁻²³¹ ◇ Prior to puncture of the radial artery, assess circulation to the hand. Review the medical history (e.g., trauma, previous radial artery cannulation, radial artery harvesting); assess for the use of anticoagulants; and perform a physical examination of hand circulation such as assessing radial and ulnar pulses, and performing the Allen test, pulse oximetry, or Doppler flow study. ◇ Do not administer infusion therapy in peripheral arteries via peripheral arterial lines; these catheters are used only for hemodynamic monitoring, blood gas analysis, and obtaining blood samples.^{219, 232} Use ultrasound in arterial identification and selection to increase first-attempt success.^{172, 233, 234}
• Consider use of local anesthetic agents (quality of evidence: II)¹⁷⁵ ▪ Consider local anesthetic agents for painful VAD placement or access including, but not limited to topical vapocoolant sprays, topical transdermal agents, intradermal lidocaine, and pressure accelerated lidocaine.²²⁶⁻²²⁸ ▪ Use the most effective and available local anesthetic method and/or agent, considering time to peak effectiveness, as well as adjunctive and less invasive anxiolytic, cognitive, behavioral, and complementary therapies, to reduce pain and discomfort prior to each painful VAD puncture or procedure in children, some adults, and for large-bore vascular access in the hand (eg, 16 gauge).^{226, 227}	
• Consider use of visualization technology for patients with difficult to find veins (quality of evidence: II)¹⁷⁵ ▪ For CL, use ultrasound for vein identification and selection to decrease risks of cannulation failure, arterial puncture, hematoma, and hemo-thorax.^{221, 222, 225} ▪ For PL use special vein finder machines with light or infrared technology for patient with weak veins,	

particularly kids or overweight patients, if technology is available. ^{221, 222, 225}	
• Remove CL When Not Needed (quality of evidence: II)^{1-4, 75, 104, 185, 235-238} ▪ CLs should be removed when complications occur or as soon as it is no longer required.^{1-4, 75, 104, 185, 235-238} ▪ Criteria for justification of continued use of a CVAD include but are not limited to: ◆ Hemodynamic monitoring. ◆ Clinical instability of the patient. ◆ Prescribed continuous infusion therapy, such as parenteral nutrition. ◆ Documented history of difficult peripheral venous access.²²⁹⁻²³²	• Remove PLs when Not Needed (quality of evidence: II)^{1-4, 75, 104, 185, 235-238} ▪ PLs should be removed when complications occur or as soon as it is no longer required.^{75, 238}
• Do Not Routinely Replace CLs (quality of evidence: II)^{1-4, 75, 185, 235-237} • PLs should be removed when complications occur or as soon as it is no longer required	• Do Not Routinely Replace PLs (quality of evidence: II)^{1-4, 75, 185, 235-237} ▪ PLs should be re-sited when clinically indicated and not routinely. ▪ PLs insertion sites should be inspected at a minimum during each shift, and a Visual Infusion Phlebitis (VIP) score should be recorded. • The insertion site should be inspected at each shift change and the catheter removed if signs of inflammation, infiltration or blockage are present.^{75, 238} • Identify and select appropriate short PL device type and gauge¹⁷⁵ ▪ Consider the infusate characteristics (e.g., irritant, vesicant, osmolarity) in conjunction with anticipated duration of infusion therapy (e.g., less than 6 days) and availability of peripheral vascular access sites. ▪ Do not use peripheral lines for continuous vesicant therapy, parenteral nutrition, or infusates with an osmolarity greater than 900 mOsm/L ▪ The VAD selected is of the smallest outer diameter with the fewest number of lumens and is the least invasive device needed for the prescribed therapy. • Safety-engineered devices are selected and consistently activated and/or used
•	• Use VAD systems that minimize manipulations and reduce components (PLs with integrated extension and needleless access ports) to achieve longer dwelling time, and to reduce need for replacement of PLs more frequently, with minimum complication. (quality of evidence: II)^{2, 79, 80, 87, 185, 239-244}
• Use Sterile Dressings to Cover the VAD Insertion Site (quality of evidence: I)^{1-4, 185, 245-248} ▪ Consider the use of a chlorhexidine impregnated sponge dressing or chlorhexidine-impregnated transparent dressing in adult patients.^{1-4, 75, 185, 249-251} ▪ Sterile transparent, semi-permeable polyurethane dressings (with or without chlorhexidine) should be routinely changed every 7 days, or sooner, if they are no longer intact or if moisture collects under the dressing.^{1-4, 185} ▪ Use sterile gauze if a patient has profuse perspiration or if the VAD insertion site is bleeding or leaking, and change when inspection of the insertion site is necessary or when the dressing becomes damp,	

loosened or soiled. - Replace sterile gauze with a transparent semi-permeable dressing as soon as possible.⁴ - Sterile gauze dressings should be routinely changed every 2 days, or sooner, if they are no longer intact or if moisture collects under the dressing.^{1-4, 185}
Integration of Needleless Connectors as IV Connection Devices (quality of evidence: II)^{2, 79, 80, 87, 105-108, 185, 240-244} - Use needleless connectors (NC) as IV connection devices.^{2, 87, 105-108, 185, 240-243} - Use a luer-lock mechanism to ensure a secure junction when attaching NC to a VAD or access site.¹⁰⁵⁻¹⁰⁸ - Avoid three way-stop cocks as IV connection devices.^{2, 87, 185, 240-243, 252} - Disinfect NC prior to each entry into the device. - Use aseptic no-touch technique to change NC connectors. - Access NC connectors only with a sterile device.^{2, 87, 185, 240-243, 252} - Consider the use of an extension set between the line and needleless connector to reduce line manipulation.²³⁹
Scrub and Disinfect Catheter Hub, Ports and Needleless Connectors (quality of evidence: II)^{1-4, 185, 253-266} - A single-use application 70 % isopropyl alcohol alone or with 2 % chlorhexidine gluconate (or povidone iodine in alcohol for patients with sensitivity to chlorhexidine) should be used to decontaminate the access port, catheter hub, and needleless connectors. - The access port, catheter hub, and needleless connectors should be cleaned for a minimum of 15 seconds and allowed to dry before accessing the system.
Replacement of IV administration Sets (quality of evidence: II)^{1-4, 82-86, 154, 155, 169, 176, 185} - Administration sets in continuous use do not need to be replaced more frequently than every 96 hours, unless they become disconnected or the VAD is replaced.^{1-4, 185} - For blood and blood components, the set should be changed when the transfusion episode is complete or with 24 hours (whichever is sooner).^{1-4, 185} - When used for lipid containing parenteral nutrition, the set should be changed within 24 hours of initiating the infusion.^{1-4, 185} - Replace tubing used to administer propofol infusions every 6 or 12 hours or when the vial is changed (whichever is sooner).¹⁻⁴ - Label date and hour of intravenous administration sets.^{82-86, 154, 155, 169, 176}
Use Closed IV Fluid Containers (quality of evidence: II)¹²²⁻¹²⁶ - Use plastic, flexible, collapsible, non-vented, closed IV fluid containers.¹²²⁻¹²⁶ - Avoid use of plastic, semi rigid, vented, open IV fluid containers.¹²²⁻¹²⁶ - Avoid use of glass, vented, open IV fluid containers.¹²²⁻¹²⁶ - Avoid inserting needles to vent the IV fluid containers.¹²²⁻¹²⁶ - Avoid use of an air filter to vent the IV fluid containers.¹²²⁻¹²⁶

- **Flushing and Locking of VADs**
- **Use single-dose systems (eg, single-dose vials or prefilled labeled syringes) for all VAD flushing and locking.**
 - Do not use intravenous (III) solution containers (eg, bags or bottles) as a source for obtaining flush solutions.^{5, 106, 175, 200, 201} (III)
 - Prefilled syringes may reduce the risk of CR-BSI and save staff time for syringe preparation.^{5, 106, 267, 268} (III)
 - If multiple-dose vials must be used, dedicate a vial to a single patient.^{5, 200} (III)
- **Perform disinfection of connection surfaces (ie, needleless connectors, injection ports) before flushing and locking procedures.**
- **Flush all VADs with preservative-free 0.9% sodium chloride (USP).**
 - Do not use sterile water for flushing VADs.^{5, 269} (III)
 - Use a minimum volume equal to twice the internal volume of the catheter system (eg, catheter plus add-on devices).
 - Larger volumes (eg, 5 mL for peripheral VAD, 10 mL for central vascular access devices [CVADs]) may remove more fibrin deposits, drug precipitate, and other debris from the lumen.
 - Factors to consider when choosing the flush volume include the type and size of catheter, age of the patient, and type of infusion therapy being given. Infusion of blood components, parenteral nutrition, contrast media, and other viscous solutions may require larger flush volumes.^{5, 217} (III)
 - If bacteriostatic 0.9% sodium chloride is used, limit flush volume to no more than 30 mL in a 24-hour period to reduce the possible toxic effects of the preservative, benzyl alcohol.^{1, 5} (III)
 - Use only preservative-free solutions for flushing all VADs in neonates to prevent toxicity.^{5, 270} (III)
 - Use 5% dextrose in water followed by preservative-free 0.9% sodium chloride (USP) when the medication is incompatible with sodium chloride.
 - Do not allow dextrose to reside in the catheter lumen as it provides nutrients for biofilm growth.^{5, 271} (III)
- **Assess VAD functionality by using a 10-mL syringe or a syringe specifically designed to generate lower injection pressure (ie, 10-mL-diameter syringe barrel), taking note of any resistance.**
 - Do not use prefilled flush syringes for dilution of medications.^{5, 106, 156} (III)
 - During the initial flush, slowly aspirate the VAD for blood return that is the color and consistency of whole blood, which is an important component of assessing catheter function prior to administration of medications and solutions.
 - Do not forcibly flush any VAD with any syringe size. If resistance is met and/or no blood return noted, take further steps (eg, checking for closed clamps or kinked sets, removing dressing, etc.) to locate an external cause of the obstruction. Internal causes may require diagnostic tests, including, but not limited to, a chest radiograph to confirm tip location and mechanical causes (eg, pinch-off syndrome), color duplex ultrasound, or fluoroscopy to identify thrombotic causes.^{1, 5} (III)
 - After confirmation of patency by detecting no resistance and the presence of a blood return, use syringes appropriately sized for the medication being injected. Do not transfer the medication to a larger syringe.^{5, 106, 272} (III)
- **Following the administration of an IV push medication, flush the VAD lumen with preservative-free 0.9% sodium chloride (USP) at the same rate of injection as the medication. Use an amount of flush solution to adequately clear the medication from the lumen of the administration set and VAD.**^{5, 106} (III)
- **Use positive-pressure techniques to minimize blood reflux into the VAD lumen.**
 - Prevent syringe-induced blood reflux by leaving a small amount (eg, 0.5-1 mL) of flush solution in a traditional syringe (ie, not a prefilled syringe) to avoid compression of the plunger rod gasket or by using a prefilled syringe designed to prevent this type of reflux.^{5, 217, 227} (III)
 - Prevent disconnection reflux by using the appropriate sequence for flushing, clamping, and disconnection determined by the type of needleless connector being used.
 - Consider using pulsatile flushing technique. In vitro studies have shown that 10 short boluses of 1 mL interrupted by brief pauses may be more effective at removing solid deposits (eg, fibrin, drug precipitate, intraluminal bacteria), compared to continuous low-flow techniques. Clinical studies are needed to provide more clarity on the true effect of this technique.^{5, 217, 273} (III)
 - When feasible, consider orienting the bevel of an implanted port access needle in the opposite direction from the outflow channel where the catheter is attached to the port body.^{5, 274} (III)
- **Lock short peripheral catheters immediately following each use.**
 - In adults, use preservative-free 0.9% sodium chloride (USP) for locking.^{5, 85, 160, 172, 217, 232, 233} (I)
 - In neonates and pediatrics, use heparin 0.5 units to 10 units per mL or preservative-free 0.9% sodium chloride (USP). Outcome data in these patient populations are controversial.^{5, 171, 234} (II)

- For short peripheral catheters not being used for intermittent infusion, consider locking once every 24 hours.^{5, 275} 27 (III)
- **There is insufficient evidence to recommend the solution for locking midline catheters.**
- **Lock CVADs with either heparin 10 units per mL or preservative-free 0.9% sodium chloride (USP), according to the directions for use for the VAD and needleless connector.**
 - Establish a standardized lock solution for each patient population, organization-wide.^{5, 276, 277} (III)
 - Randomized controlled trials have shown equivalent outcomes with heparin and sodium chloride lock solutions for multiple-lumen non-tunneled CVADs, peripherally inserted central catheters (PICCs), and implanted ports while accessed and when the access needle is removed. There is insufficient evidence to recommend one lock solution over the other.^{5, 155, 163, 164, 170} (I)
 - Use heparin or preservative-free 0.9% sodium chloride (USP) for locking CVADs in children.^{5, 277} (II)
 - Consider using heparin 10 units per mL for locking PICCs in home care patients.^{5, 278} (III)
 - Volume of the lock solution should equal the internal volume of the VAD and add-on devices plus 20%. Flow characteristics during injection will cause overspill into the bloodstream. Lock solution density is less than whole blood, allowing leakage of lock solution and ingress of blood into the catheter lumen when the CVAD tip location is higher than the insertion site.^{5, 217, 279-281} (III)
 - Change to an alternative locking solution when the heparin lock solution is thought to be the cause of adverse drug reactions from heparin; when heparin-induced thrombocytopenia and thrombosis (HITT) develops; and when there are spurious laboratory studies drawn from the CVAD that has been locked with heparin. High concentrations of heparin used in hemodialysis catheters could lead to systemic anticoagulation.^{1, 5, 282} (II)
 - Monitoring platelet counts for HIT is not recommended in postoperative and medical patients receiving only heparin in the form of a catheter lock solution due to a very low incidence of HIT of 1% or less (see Standard 52, Central Vascular Access Device [CVAD] - Associated Venous Thrombosis).^{5, 282} (II)
 - Because of conflicts with religious beliefs, inform patients when using heparin derived from animal products (eg, porcine, bovine), and obtain consent. Use preservative-free 0.9% sodium chloride (USP) instead of heparin when possible.^{5, 283} (III)
- **Lock hemodialysis CVADs with heparin lock solution 1000 units/mL, 4% citrate, or antimicrobial lock solutions. Use recombinant tissue plasminogen activator to lock hemodialysis catheters once per week as a strategy to reduce CR-BSI.**^{5, 20, 162, 284, 285} (I)
- **Lock apheresis CVADs with heparin 100 units/mL, 4% citrate, acid-citrate-dextrose Formula A, or other antimicrobial lock solutions.**^{5, 162, 284-287} (III)
- **Use solution containing heparin (eg, 1 unit per mL of 0.9% sodium chloride [USP]) or preservative-free 0.9% sodium chloride (USP) as a continuous flow to maintain patency of arterial catheters used for hemodynamic monitoring. The decision to use preservative-free 0.9% sodium chloride (USP) instead of heparin infusion should be based on the clinical risk of catheter occlusion, the anticipated length of time the arterial catheter will be required, and patient factors such as heparin sensitivities.**^{5, 48, 288, 289} (II)
- **Apply the following recommendations for neonates and pediatrics.**
 - Use a continuous infusion of heparin 0.5 units per kg for all CVADs in neonates.
 - Use continuous infusion of heparin 0.25 to 1 unit per mL (total dose of heparin 25-200 units per kg per day) for umbilical arterial catheters in neonates to prevent arterial thrombosis.
 - Use heparin 5 units per mL, 1 mL per hour as a continuous infusion for neonates and children with peripheral arterial catheters.^{5, 277} (II)
- **Use antimicrobial locking solutions for therapeutic and prophylactic purposes. Use in patients with long-term CVADs, patients with a history of multiple CR-BSIs, high-risk patient populations, and in facilities with unacceptably high rates of central line associated bloodstream infection (CLABSI), despite application of other methods of CLABSI reduction.**^{5, 123, 125, 285, 290, 291} (I)
 - Antibiotic lock solutions contain supra-therapeutic concentrations of antibiotics and may be combined with heparin. Anticipate the chosen antibiotic to be based on the specific infecting organism or on prevalent organisms within the organization when prophylaxis is the goal. For therapeutic use, start the antibiotic lock solutions within 48 to 72 hours of diagnosis; however, the duration of use remains controversial.^{5, 100, 291} (II)
 - Antiseptic locking solutions include ethanol, taurolidine, citrate, 26% sodium chloride, methylene blue, fusidic acid, and ethylenediaminetetra- acetic acid (EDTA) used alone or in numerous combinations.^{5, 100} (I)
 - Follow catheter manufacturers' instructions for intraluminal locking with ethanol. Changes in CVADs made of polyurethane material, but not silicone, have led to catheter rupture and splitting. Monitor for thrombotic lumen occlusion as ethanol has no anticoagulant activity, hemolysis, and hepatic toxicity.

Irreversible precipitation of plasma proteins that could add to CVAD lumen occlusion is associated with ethanol concentrations greater than 28%.^{5, 280, 292-294} (I)

- Monitor sodium citrate, an anticoagulant with antimicrobial effects, for systemic anticoagulation, hypocalcemia that could produce cardiac arrest, and protein precipitate formation with concentrations greater than 12%.^{5, 20, 280} (I)
- Monitor taurolidine, an amino acid with antimicrobial effects, for thrombotic lumen occlusion and protein precipitation, which could cause lumen occlusion.^{5, 163, 169, 291} (I)
- Use standardized formulations and licensed independent practitioner (LIP)-approved protocols for all antimicrobial lock solutions to enhance patient safety. Consult with pharmacy when combinations of antimicrobial solutions are planned so that correct information about compatibility and stability of the solution are addressed.^{5, 41, 100} (II)
- The length of time that antimicrobial lock solutions should reside inside the CVAD lumen is unclear; up to 12 hours per day may be required. This will limit use in patients receiving continuous or frequent intermittent infusions.^{5, 100} (II)
- Aspirate all antimicrobial locking solutions from the CVAD lumen at the end of the locking period. Do not flush the lock solution into the patient's bloodstream, as this could increase development of antibiotic resistance and other adverse effects.^{5, 285, 295} (II)

IV Push

- ◆ Administer IV push medications in a safe manner: When it is necessary to prepare more than 1 medication in a single syringe for IV push administration, limit preparation to the pharmacy.^{46, 276}
- ◆ In adults, use IV push medications in a ready-to administer form (to minimize the need for manipulation outside the pharmacy sterile compounding area).^{46, 276}
- ◆ If dilution or reconstitution of an IV push medication becomes necessary outside the pharmacy sterile compounding area, perform these tasks immediately prior to administration in a clean, uncluttered, and functionally separate location using organization-approved, readily available drug information resources and sterile equipments and supplies.^{46, 276, 277, 285}
- ◆ Do not dilute or reconstitute IV push medications by drawing up the contents into commercially available, prefilled flush syringes of 0.9% sodium chloride.^{46, 276, 277, 285}
- ◆ Do not withdraw IV push medications from a commercially available, cartridge-type syringe into another syringe for administration.⁴⁶
- ◆ If preparing several IV push medications at a time for sequential IV push administration, label each syringe as it is being prepared and prior to the preparation of any subsequent syringes.

Multi-Dose Vials

- ◆ If multi-dose vials must be used, dedicate a vial to a single patient.^{46, 276, 287}
- ◆ Perform disinfection of connection surfaces (i.e., needleless connectors, injection ports) before flushing and locking procedures.
- ◆ Use a multi-dose vial up to a maximum of 28 days from opening or puncture (except for vaccines or when original manufacturer's expiry date is shorter) or until the manufacturer's expiry date is reached.^{277, 285-288, 290}
- ◆ Label a multi-dose vial with the beyond-use date and store the vial according to the manufacturer's recommendations.
- ◆ Discard if the vial lacks a beyond-use date, the sterility is compromised or questionable, and after the beyond-use date has been met.^{277, 285, 286, 288, 290}
- ◆ Each time you access a bottle with rubber cap, disinfect the cover with disinfectant, alcohol or chlorhexidine, then insert a sterile needle for single use; after taking fluids discard the needle, and use a new sterile needle for the patient.²⁹⁶⁻²⁹⁹
- ◆ Disinfect the vial septum before each entry and the neck of a glass ampoule prior to breaking the ampoule, and allow the disinfectant to dry prior to entry.^{276, 277}
- ◆ In IV medication bottles with rubber caps, avoid leaving a needle inserted in a vial.³⁰⁰
- ◆ Use a filter needle or filter straw to withdraw medication from an ampoule, and discard any leftover medication.^{46, 277, 285, 286, 288, 290}

Single-Dose Vials

- ◆ Discard a single-dose vial after a single entry.^{46, 276, 277, 285, 287}
- ◆ Avoid reuse of single use IV medication vials.²⁴⁰
- ◆ It is preferable to use single-use, ready-to-use IV medication.²⁴⁰

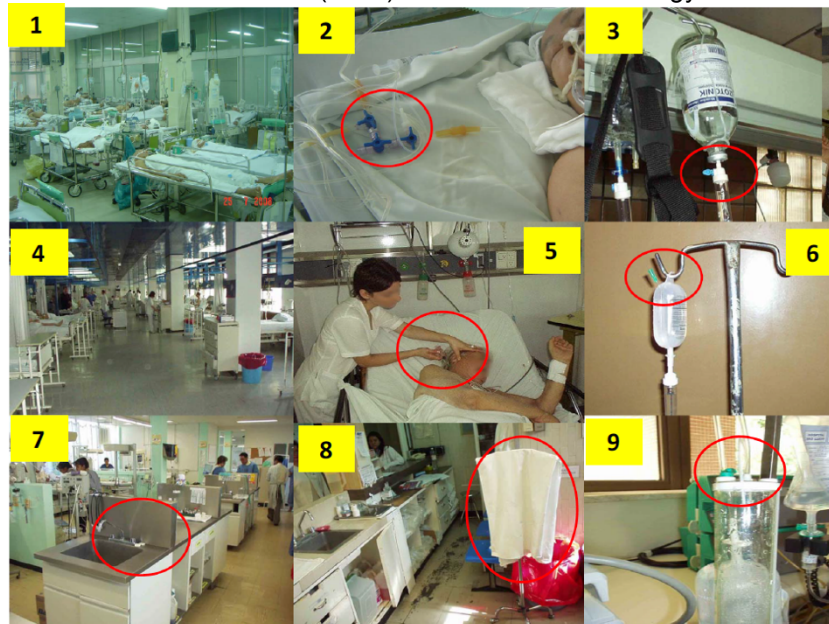
- ◆ Disinfect the vial septum before each entry and the neck of a glass ampoule prior to breaking the ampoule, and allow the disinfectant to dry prior to entry.^{46, 285}
- **Syringe Medication**
 - ◆ If more than 1 syringe of medication or solution to a single patient needs to be prepared at the bedside, prepare each medication or solution separately, and immediately administer it before preparing the next syringe.
 - ◆ If 1 or more medications or solutions needs to be prepared away from the patient's bedside, immediately label each syringe, 1 at a time, before preparing the next medication or solution.^{46, 276}
 - ◆ Discard and do not use any medication syringes that are unlabeled unless the medication is prepared at the patient's bedside and immediately administered without a break in the process.^{46, 276, 277, 285, 289, 290}
 - ◆ Do not use IV solutions in containers intended for infusion, including mini-bags, as common-source containers (multi-dose products) to dilute or reconstitute medications for 1 or more patients in clinical care areas.^{46, 285, 287}
 - ◆ Practice safe injection: Use a new sterile, single use needle and syringe for every injection.^{285, 287}
- **Compounding**
 - ◆ Preparation, administration and disposal of hazardous drugs, may expose pharmacists, nurses, physicians and other health care workers to potentially significant workplace levels of these chemicals.³⁰¹
 - ◆ In addition to double gloving and a protective gown, an engineering control such as a biological safety cabinet (BSC) or compounding aseptic containment isolator (CACI), possibly supplemented with a closed system drug transfer device (CSTD), is required to protect the drug, environment, and health care worker.³⁰¹
 - ◆ Use sterile medications that were compounded in a pharmacy environment that meets state pharmacy rules and regulations, American Society of Health-System Pharmacists guidelines or other internationally accepted recommendations.
 - ◆ Do not withdraw IV push medications from commercially available, cartridge-type syringes into other syringes for administration.²⁷⁶
 - ◆ Do not use IV solutions in containers intended for infusion, including minibags, as common-source containers (multiple-dose products) to dilute or reconstitute medications for 1 or more patients in clinical care areas.^{276, 277, 287}
 - ◆ Practice safe injection: Use a new sterile, single use needle and syringe for every injection.^{277, 287}
 - ◆ Do not add medications to infusion containers of IV solutions.
- **Labelling**
 - ◆ Label medications that are prepared and not immediately administered (e.g., perioperative, procedural settings) as soon as prepared with the medication name, strength, quantity, diluent/volume, expiration date, and preparer's initials.^{46, 276, 277, 285, 289, 290}
 - ◆ Begin the administration of an "immediate-use" compounded sterile product within 1 hour after the start of the preparation, or discard.^{46, 276, 277, 285, 286, 289, 290}

Perform Daily Bath with 2% Chlorhexidine-Impregnated Wash Cloth in patients with CL (quality of evidence: I)^{1, 3, 4, 185, 302} Consider daily cleansing with chlorhexidine in adult patients with CL.^{1, 3, 4, 185, 302}

VAD, vascular access devices; IV, intravascular; CRBSI, catheter-related blood stream infections; DUR, device utilization ratio; LOS, length of stay; HCW, health care worker; CL, central line; PL, peripheral line

Disclosure: INICC received a Grant from BD in order to research the scientific literature for this bundle

Figure 1. Limited resource intensive care units (ICUs) with outdated technology:



(1) Crowded ICUs; (2) three-way stop-cock, open intravenous connector; (3) open glass intravenous container with air filter; (4) ICU with 42 beds and neither sinks nor alcohol hand rub; (5) central line insertion with no maximal barrier; (6) open, semi-rigid, plastic intravenous container with inserted needle; (7) sinks at a neonatal ICU with no antiseptic soaps; (8) wet cloth towel; (9) open burette intravenous container with air filter.

Figure 2. Limited resource intensive care units (ICUs) with outdated technology



(1) Cotton balls already impregnated with contaminated antiseptic; (2) central line in place with no dressing; (3) open semi-rigid intravenous container with administration set and 3-way stopcock for intravenous preparation; (4) Single-dose vials used multiple times and covered with contaminated tape; (5) peripheral line in a newborn with no sterile dressing; (6) multi-use vials used with an inserted needle; (7) single-dose vials used multiple times and open to the air; (8) peripheral line in an adult patient with no sterile dressing; (9) semi-rigid plastic container used for intravenous preparation.

Table 1. Central line-associated bloodstream infection rates per 1000 device days, extra length of stay and attributable mortality in limited-resource countries

Country	ICU Type	CLABSI per 1000 CL days	Attributable extra Length of Stay (days)	Mortality attributable to CLABSI %	Year	Ref
1. Albania	Adult, PICU, NICU	-	-	-	2008	28
2. Argentina	Adult	11.4	-	-	2002	55
3. Argentina (INICC)	Adult	44.61	12	25.3	2003	35
4. Argentina (INICC)	Adult	-	11.9	24.6	2003	35
5. Argentina (INICC)	Adult	30.3	-	-	2004	27
6. Argentina	Adult	4.1	-	-	2015	54
7. Argentina	NICU	10.39	-	-	2015	54
8. Brazil (INICC)	Adult	9.1	7.3	27.8	2008	31
9. Brazil	NICU	17.3	-	-	2010	58
10. Brazil	PICU	34.0	-	-	2003	57
11. Brazil	PICU	10.2	-	-	2003	56
12. Brazil	NICU	3.1	-	-	2007	59
13. Brazil	NICU	17.3	-	-	2004	61
14. Brazil	NICU	3.94	-	-	2012	60
15. Brazil	PICU	17.9	-	-	2012	26
16. China (INICC)	Adult	3.1	-	-	2011	25
17. China (INICC)	Adult	7.66	-	14	2012	24
18. China	Adult	11.0	-	-	2013	303
19. China	NICU	5.4	-	-	2015	304
20. China	NICU	7.35	-	-	2015	305
21. China	Adult	5.3	-	-	2016	306
22. Colombia (INICC)	Adult	11.3	-	18.5	2006	32
23. Colombia (INICC)	Adult	3.5	-	-	2016	86
24. Cuba (INICC)	Adult	2.0	18.3	17.0	2011	33
25. Egypt (INICC)	Adult	22.5	-	-	2013	23
26. Egypt (INICC)	PICU	18.8	-	-	2013	23
27. Egypt	Adult	1.25	-	-	2013	307
28. Egypt	Adult	-	-	45.7	2012	308
29. El Salvador (INICC)	PICU	10.1	12.9	11.4	2011	42
30. El Salvador (INICC)	NICU	16.1	21.0	25.7	2011	42
31. India (INICC)	Adult	7.9	5.0	4.0	2007	36
32. India	Adult, PICU, NICU	0.48	-	-	2010	62
33. India	NICU	27.0	-	-	2011	63
34. India	Adult	16	-	-	2014	64
35. India (INICC)	Adult, PICU	5.1	14.7	16.3	2015	22
36. Iran (INICC)	Adult, PICU	5.84	-	-	2015	17
37. Kuwait (INICC)	Adult, PICU	3.5	14.7	19.9	2016	21
38. Kuwait (INICC)	NICU	3.9	27.1	30.9	2016	21
39. Kuwait	Adult	11.08	-	-	2016	309
40. Kuwait	Adult	5.5	-	-	2008	310
41. Lebanon (INICC)	Adult	5.2	6.5	40.9	2012	20
42. Malaysia (INICC)	Adult	9.4	6.4	53.1	2016	311
43. Mexico (INICC)	Adult	23.1	-	-	2006	19
44. Mexico (INICC)	Adult	-	6.1	20	2007	37
45. Mongolia (INICC)	Adult	19.7	15.1	18.6	2015	51
46. Morocco (INICC)	Adult	15.7	9.0	75.1	2009	38
47. Peru (INICC)	Adult	7.7	9.1	15.0	2008	39
48. Peru	PICU	18.1	-	-	2010	53
49. Philippines (INICC)	Adult	4.6	11.9	3.2	2011	40
50. Philippines (INICC)	PICU	8.23	11.4	46.3	2011	40
51. Philippines (INICC)	NICU	20.8	15.4	19.4	2011	40
52. Poland (INICC)	Adult	4.01	3.1	-	2011	47
53. Saudi Arabia	NICU	8.2	-	-	2009	67
54. Saudi Arabia	Adult	10.0	-	-	2013	68
55. Saudi Arabia (INICC)	Adult	3.1	-	-	2016	154
56. Saudi Arabia (INICC)	Adult	4.5	14.8	38.4	2016	29
57. South Africa	Adult	5.7	-	-	2015	312
58. Tunisia	Adult	15.3	-	-	2006	69
59. Tunisia	Adult	14.8	-	-	2007	70
60. Turkey (INICC)	Adult	17.6	-	-	2007	18
61. Turkey	Adult	11.8	-	-	2010	74
62. Turkey	Adult	2.8	-	-	2011	71

63. Turkey	NICU	3.8	-	-	2012	⁷²
64. Turkey	NICU	7.69	-	-	2013	⁷³
65. Turkey (INICC)	Adult, PICU	11.1	11.5	12.0	2014	⁴⁸
66. Turkey (INICC)	NICU	21	13.1	15.4	2014	⁴⁸
67. INICC 8 countries: Argentina, Brazil, Colombia, India, Mexico, Morocco, Peru, and Turkey (INICC)	Adult, PICU, NICU	18.5	-	18.0	2006	¹²
68. 15 countries: Argentina, Brazil, Colombia, Dominican Republic, India, Jordan, Malaysia, Mexico, Morocco, Peru, Philippines, El Salvador, Thailand, Tunisia, Turkey (INICC)	NICU	13.7	-	27.7	2011	⁴²
69. 18 countries: Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, India, Kosovo, Lebanon, Macedonia, Mexico, Morocco, Nigeria, Peru, Philippines, El Salvador, Turkey, Uruguay (INICC)	Adult, PICU,	9.2	-	14.3	2008	³⁰
70. 18 countries: Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, India, Kosovo, Lebanon, Macedonia, Mexico, Morocco, Nigeria, Peru, Philippines, El Salvador, Turkey, Uruguay	NICU	14.8	-	25.4	2008	³⁰
71. 25 countries: Argentina, Brazil, China, Colombia, Costa Rica, Cuba, Greece, India, Jordan, Kosovo, Lebanon, Lithuania, Macedonia, Mexico, Morocco, Pakistan, Panama, Peru, Philippines, El Salvador, Thailand, Tunisia, Turkey, Venezuela, Vietnam	Adult, PICU,	7.6	12.1	23.6	2010	²⁹⁴
72. 25 countries: Argentina, Brazil, China, Colombia, Costa Rica, Cuba, Greece, India, Jordan, Kosovo, Lebanon, Lithuania, Macedonia, Mexico, Morocco, Pakistan, Panama, Peru, Philippines, El Salvador, Thailand, Tunisia, Turkey, Venezuela, Vietnam (INICC)	NICU	13.9	22.2	25.7	2010	²⁹⁴
73. 36 countries: Argentina, Brazil, Bulgaria, China, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Egypt, Greece, India, Jordan, Kosovo, Lebanon, Lithuania, Macedonia, Malaysia, Mexico, Morocco, Pakistan, Panama, Peru, Philippines, Puerto Rico, El Salvador, Saudi Arabia, Singapore, Sudan, Sri Lanka, Thailand, Tunisia, Turkey, Uruguay, Venezuela, Vietnam (INICC)	Adult, PICU,	6.8	10.9	14.7	2012	¹⁷¹
74. 36 countries: Argentina, Brazil, Bulgaria, China, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Egypt, Greece, India, Jordan, Kosovo, Lebanon, Lithuania, Macedonia, Malaysia, Mexico, Morocco, Pakistan, Panama, Peru, Philippines, Puerto Rico, El Salvador, Saudi Arabia, Singapore, Sudan, Sri Lanka, Thailand, Tunisia, Turkey, Uruguay, Venezuela, Vietnam (INICC)	NICU	12.2	26.2	26.2	2012	¹⁷¹
75. 43 countries: Argentina, Bolivia, Brazil, Bulgaria, China, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Egypt, Greece, India, Iran, Jordan, Kosovo, Lebanon, Lithuania, Macedonia, Malaysia, Mexico, Morocco, Pakistan, Panama, Peru, Philippines, Poland, Puerto Rico, Romania, El Salvador, Saudi Arabia, Serbia, Singapore, Slovakia, Sri Lanka, Sudan, Thailand, Tunisia, Turkey, United Arab Emirates, Uruguay, Venezuela, Vietnam (INICC)	Adult	4.8	13.37	17.0	2014	¹⁵
76. 43 countries: Argentina, Bolivia, Brazil, Bulgaria, China, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Egypt, Greece, India, Iran, Jordan, Kosovo, Lebanon, Lithuania, Macedonia, Malaysia, Mexico, Morocco, Pakistan, Panama, Peru, Philippines, Poland, Puerto Rico, Romania, El Salvador, Saudi Arabia, Serbia, Singapore, Slovakia, Sri Lanka, Sudan, Thailand, Tunisia, Turkey, United Arab Emirates, Uruguay, Venezuela, Vietnam (INICC)	NICU	5.17	12.46	11.4	2014	¹⁵
77. 50 countries: Argentina, Bahrain, Brazil, Bulgaria, Costa Rica, Dominican Republic, Ecuador, Egypt,	Adult	4.11	17.36	38.4	2016	⁵²

India, Iran, Kingdom of Saudi Arabia, Kuwait, Lebanon, Lithuania, Macedonia, Malaysia, Mexico, Mongolia, Pakistan, Panama, Philippines, Poland, Romania, Singapore, Thailand, Turkey and Vietnam. (INICC)						
78. 50 countries: Argentina, Bahrain, Brazil, Bulgaria, Costa Rica, Dominican Republic, Ecuador, Egypt, India, Iran, Kingdom of Saudi Arabia, Kuwait, Lebanon, Lithuania, Macedonia, Malaysia, Mexico, Mongolia, Pakistan, Panama, Philippines, Poland, Romania, Singapore, Thailand, Turkey and Vietnam. (INICC)	NICU	16.37	37.82	29.7	2016	⁵²

CLABSI, central line-associated bloodstream infection; CL, central line; ICU, intensive care unit; Ref., reference; NICU, neonatal intensive care unit; PICU, paediatric intensive care unit.

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Glossary of terms:

A

- **Add-on Device.** Additional component which is added to the administration set or vascular access device, such as an inline filter, stopcock, Y-site, extension set, manifold set, and/or needleless connector.
- **Administration Set.** A tubing set for infusion delivery, which is composed of plastic components and generally includes a spike, a drip chamber, injection ports, and a male luer-lock end. It may include a Y-set, micro-bore tubing and integrated filter.
- **Admixture.** To combine two or more medications; to mix.
- **Adverse Event.** An unfortunate unplanned event that occurs to a patient who is receiving medical treatment, which is related to a medication, product, equipment, procedure, etc.
- **Air Embolism.** The entry of air into the vasculature, obstructing venous blood flow mainly to the brain or lungs.
- **Allen Test.** A test done on the radial and ulnar artery of the hand before arterial puncture to verify appropriate perfusion.
- **Amino Acids.** Organic compounds that form protein.
- **Ampoule.** A glass medication container that is hermetically sealed. Medication is accessed through the breaking of its neck.
- **Anti-infective CVAD.** Central vascular access device that is impregnated or coated with antimicrobial agents or antiseptic.
- **Antimicrobial Locking Solutions.** Solutions used to lock CVAD lumen during a prescribed period of time, for CRBSI prevention or treatment purposes, through the use of a variety of antiseptic agents or supra-therapeutic concentrations of antibiotic.
- **Antiseptic.** A chemical used to kill or inhibit the growth of microorganisms and thereby reduce the risk of infection.
- **Apheresis.** The process of separating blood into red blood cells, white blood cells, plasma and platelets, by removing 1 of these components and then reinfusing the remaining components.
- **Arterial Pressure Monitoring.** Monitoring of arterial pressure through an electronic monitor to which an indwelling arterial catheter is connected.
- **Arteriovenous (AV) Fistula.** Surgical connection between an artery and a vein.
- **Arteriovenous (AV) Graft.** Surgical structure created between an artery and a vein. It is generally composed of manufactured synthetic material.
- **Aseptic No-Touch Technique.** A framework for secure aseptic practice that follows some fundamental rules pertaining to infection control and staff/patient protection that can be used for the accessing of all VADs regardless of whether they are peripherally or centrally inserted.
- **Aseptic Technique.** An infection prevention procedure used to prevent contamination of objects and areas with microorganisms.
- **Assent.** Approval of or agreement to give legally valid informed consent by a not competent individual.
- **Authorized Agent-Controlled Analgesia.** A competent person who is authorized to activate the analgesic dose in case a patient's inability to do so.

B

- **Bacteria.** Prokaryotic nonpathogenic (normal flora) or pathogenic (disease causing) microorganisms.
- **Biofilm.** A thin layer of microorganisms that coat the surfaces of an implanted or indwelling device, which tends to be resistant.
- **Biologic Therapy.** Disease treatments in which substances are administered to cause a biological reaction in the organism, including the use of tissues, sera, cells, antitoxins, organs, and vaccines.
- **Biological Safety Cabinet (BSC).** A ventilated cabinet used during drug compounding, which has an open front with inward airflow to protect personnel, downward high-efficiency particulate air (HEPA)-filtered laminar flow to protect the product, and HEPA filtered exhausted air to protect the environment.
- **Blood Return.** Blood that is the color and consistency of whole blood upon aspiration; a component of VAD patency assessment.
- **Body Surface Area.** Body surface area calculated and expressed in square metres, which is used to calculate pediatric dosages in paediatric patients, determine radiation and many classes of drug dosages and manage burn patients.
- **Bolus.** Concentrated solution and/or medication given rapidly within a brief period of time.

C

- **C.D.C.** Centers for Diseases Control and Prevention.
- **Catheter.** Fluid line from a container to the patient's veins or arteries.
- **Bundle.** A set of infection prevention practice interventions designed following the recommendations published by international organizations, such as IHI in 2006,⁷ CDC in 2011,¹ JCI in 2012,² SHEA and IDSA in 2014,³ EPIC 3 in 2014,⁴ INS in 2016,¹⁷⁵ and other available in international publications, including those from limited resources countries.^{82-86, 154, 155, 169, 172, 176}
- **Catheter Clearance.** A process followed to reestablish catheter lumen patency by instilling medications or chemicals into the lumen during a certain period of time.
- **Catheter Dislodgment.** Moving the catheter into or out of the insertion site which indicates tip movement to a

suboptimal position.

- Catheter Exchange. Replacement with a new CVAD using the same catheter tract of existing central vascular access device (CVAD) .
- Catheter-Associated Venous Thrombosis (CAVT). A secondary vein thrombosis associated to the presence of a CVAD. It includes the presence of an extra-luminal fibrin sheath encompassing all or part of the CVAD's length, with a mural or veno-occlusive thrombosis overlying the fibrin sheath. When placed for CVAD use, it may be located in deep veins or superficial veins .
- Catheter-Related Bloodstream Infection (CR-BSI). A clinical definition applied when the catheter is identified to be the source of the bloodstream infection through specific laboratory testing .
- Catheter. A hollow tube made of silicone elastomer, thermoplastic polyurethane , or metal that is inserted into the body and used for injecting or evacuating fluids.
- Central line day. Presence of central line (venous or arterial) for 1 to 24 hours. All catheters inserted into each patient are counted. Each catheter is counted separately. If a patient has two or more vascular catheters, the total days of each catheter is counted separately.
- Central Line-Associated Bloodstream Infection (CLABSI). A laboratory-confirmed, primary bloodstream infection in a patient with a central line in place for more than 2 calendar days before the development of the bloodstream infection (BSI), and the BSI is not related to an infection at another site. For the current CLABSI surveillance criteria, refer to the Centers for Disease Control and Prevention's (CDC's) National Healthcare Safety Network (NHSN).
- Central line. A vascular infusion device that terminates at or close to the heart or in one of the great vessels. The following are considered great vessels for the purpose of reporting central-line infections and counting central-line days in the NHSN system: Aorta, pulmonary artery, superior vena cava, inferior vena cava, brachiocephalic veins, internal jugular veins, subclavian veins, external iliac veins, and common femoral veins. NOTE: In newborn patients the umbilical vein/artery is considered a great vessel. NOTE: Neither the location of the insertion site nor the type of device may be used to determine if a line qualifies as a central line. The device must terminate in one of these vessels or in or near the heart to qualify it as a central line. NOTE: Pacemaker wires and other non-infusion devices inserted into central blood vessels or the heart are not considered central lines.
- **Central Vascular Access Device (CVAD) Malposition.** CVAD tip located in an aberrant position and no longer located in the original vena cava or cavo atrial junction: **Extravascular Malposition.** CVAD tip located outside of the vein in nearby anatomical structures such as mediastinum, pleura, pericardium, or peritoneum. **Intravascular Malposition.** CVAD tip located in a suboptimal or aberrant position inside a vein; occurs as primary or secondary malposition. **Primary CVAD Malposition.** CVAD tip positioned in a suboptimal or unacceptable location occurring during the insertion procedure. **Secondary CVAD Malposition.** CVAD tip found to be in a suboptimal or unacceptable location at any time during the catheter dwell time; commonly referred to as tip migration.
- Central Vascular Access Device (CVAD). Catheter inserted into a vein , whether peripheral or centrally located, with the tip residing in the superior or inferior vena cava.
- Chemical Incompatibility. A change in the pharmacological properties or in the molecular structure of a substance. When a solution or medication contacts an incompatible solution or medication within the vascular access device (VAD) lumen, solution container or administration set, the change may or may not be visually observed. .
- Cleaning. The removal of visible soil from surface and objects. It is imperative that cleaning is done thoroughly and carefully and prior to disinfecting and sterilizing so as to avoid that organic or inorganic materials remain on the object surface and interfere with these processes.
- Closed infusion containers. Closed, fully collapsible, plastic containers that do not require external vent (air filter or needle) to empty the solution, and have self-sealing injection ports
- Closed System Drug Transfer Device. A drug transfer device that mechanically prevents the transfer of environmental contaminants into the system and the escape of hazardous drugs or vapor concentrations outside the system. It is used in compounding and administering sterile doses of hazardous drugs, including chemotherapy..
- Closed System Transfer. The transfer of sterile products from one container to another in which the closure system, containers, and transfer devices remain intact during the whole movement. It is compromised only by the penetration of a sterile, pyrogen free needle or cannula through a designated closure or port to effect delivery, withdrawal or transfer..
- Compatibility. Capable of being mixed and administered without undergoing undesirable chemical and/ or physical changes or loss of therapeutic action.
- Compounding Aseptic Containment Isolator (CACI). An isolator used during drug compounding to provide an aseptic environment when compounding sterile preparations and to protect health care workers from exposure to undesirable levels of airborne drugs..
- Compounding. The process of preparing, assembling, mixing, packaging, and labeling a drug, a drug delivery device, or a device based on a professional agreement between the practitioner, patient, and pharmacist or following a practitioner's prescription given for an individual patient..
- Conscious Sedation. Minimally depressed level of consciousness in which the patient retains the ability to respond appropriately to physical stimulation and verbal commands and to maintain a patent airway independently and continuously
- Contact Precautions. Strategies implemented to prevent the transmission of infectious agents that are spread by direct or indirect contact between the patient and environment.
- Contamination. Transference or introduction of infectious material or pathogens from one source to another.
- Cross Contamination. The indirect transfer of harmful substances or pathogens from one patient to another.

- **Cultural Competency.** The level of knowledge-based skills required to provide infusion services and clinical care to patients that are respectful of and responsive to their beliefs, culture, practices, and linguistic needs.

D

- **Dead Space.** In needleless connectors, it refers to the internal space outside the intended fluid pathway into which fluid can move.
- **Decontamination.** To make an object or area safe for handle, use, or discard by unprotected personnel by removing, neutralizing, or destroying pathogenic microorganisms from it.
- **Deep Sedation.** Depression of consciousness induced by drug; the patient responds persistently to repeated or painful stimulation; support to maintain the airway and spontaneous respiration may be required if the capacity to preserve respiratory function results diminished. Cardiovascular function is generally preserved.
- **Delegation.** The process by a person is directed by a registered nurse (RN) to perform activities not commonly performed by that person. The RN is accountable for the outcome of the delegated activity.
- **Density of Use.** The ratio between device days and the bed days.
- **Device associated health care associated infection (DA-HAI).** An infection in a patient with a device (e.g., MV, or CL, or UC) that was used within the 48-hour period before onset of infection. If the interval is longer than 48 hours, there must be compelling evidence that infection was associated with device use. For CAUTI, indwelling urinary catheter must have been in place within 7 days before positive laboratory results or signs and symptoms meeting criteria for CAUTI were evident.
- **Device days.** For each day of the month, at the same time each day, record the number of patients who have the specific device (e.g., central line, ventilator, or indwelling urinary catheter).
- **Difficult Vascular Access.** the need for special interventions to establish venous cannulation based on a known history of multiple unsuccessful venipuncture attempts (ie, maximum of 4) to cannulate a vein and/or difficulty due to diseases or injury.
- **Dilution.** To add a diluent (eg, 0.9% sodium chloride, sterile water) to a solution of medication to reduce its concentration, to decrease the tissue irritation of a medication or to provide additional solution for ease of administration and titration.
- **Disinfectant.** Antimicrobial agent that destroys all microorganisms except bacterial spores.
- **Disinfection Cap.** Plastic cap used to disinfect the surface and provide protection between intermittent uses. It contains an antiseptic solution which is placed on top of the connection surface of a needleless connector.
- **Disinfection.** A process that destroys many or all pathogenic microorganisms --except bacterial spores--, on inanimate objects.
- **Distal.** Opposite of proximal; farthest from the point of attachment, or from the center or midline of the body or trunk; .
- **Doppler Flow Study.** A noninvasive diagnostic imaging test that utilizes sound waves to evaluate blood flow through major vessels.
- **Dose-Error Reduction System.** Electronic infusion devices (EIDs) designed to prevent errors in solution and medication delivery, manufactured with drug libraries containing drug name and soft and hard infusion limits.
- **Droplet Precautions.** A form of isolation precaution to prevent contact with respiratory secretions and minimize the risk of infection from pathogens spread through close respiratory contact.

E

- **Electronic Infusion Device (EID).** An electricity or battery-powered device, which may be a positive-pressure pump or controller (gravity fed), used to regulate the flow rate of the infusion therapy.
- **Embolus.** Mass of undissolved solid, liquid, or gaseous particle or piece of a blood clot that is present in blood or lymphatic vessel.
- **Engineered Stabilization Device.** A system or device specifically designed and engineered to control movement at the catheter hub which is placed topically or subcutaneously.
- **Engineering Controls.** Devices to remove or isolate blood-borne pathogens hazard from the workplace.
- **Epidural Space.** Space surrounding the spinal cord and its meninges that is considered a potential space which is not created until medication or air is injected. It contains fatty tissue, veins, spinal arteries, and nerves.
- **Erythema.** A skin condition characterized by redness along a vein track resulting from capillary congestion in response to irritation or vascular irritation . It may be indication of phlebitis.
- **Evidence-Based Practice.** An approach that integrates the best available synthesis of research results, clinical expertise and patient values to provided high-quality care.
- **Expiration Date.** The date and time after which a product should not be used, which is assigned on the basis of both stability and risk level, whichever is the shorter period. After this date and time, the product should be discarded.
- **Extravasation.** Inadvertent infiltration of vesicant solution or medication into surrounding tissue. It is rated by a regular tool.
- **Extrinsic Contamination.** Contamination which occurs after the manufacturing process of a product.

F

- **Fat Emulsion (Intravenous Fat Emulsion [IVFE]).** Combination of lipid, liquid, and an emulsifying system formulated for intravenous use.
- **Feedback on DA-HAI rates and consequences.** Feedback on the results of outcome surveillance is provided to

HCWs to make them aware of the incidence of HAIs, which can be a most rewarding or consciousness-raising factor for HCWs, which is crucial to ensure the effectiveness of the IMA. HCWs receive feedback on DA-HAI rates and their consequences at monthly meetings held by IPs, who share and discuss the results of the reports generated through ISOS. These reports contain several charts and tables that show a running record of the monthly cohort surveillance data

- **Filter.** A special porous device used to prevent the passage of undesired substances or air. This size of the substances retained is determined by the design of the product.
- **Flow-Control Device.** A device used to regulate the rate of infusion flow. It includes mechanical infusion devices, electronic infusion devices and categories of manual devices).
- **Flushing.** The act of extracting fluids, blood, blood products and medications out of the vascular access device and moving them into the bloodstream. Flushing is used to maintain and assess patency, and to prevent precipitation caused by medication or solution incompatibility.

G

- **Guidewire.** A long, flexible metal structure, composed of tightly wound coiled wire in a variety of designs; contains safety mechanisms that allow it to be inserted into the vein or artery.

H

- **Hazardous Drugs.** Drugs having 1 or more of the following 6 characteristics in humans or animals: developmental toxicity, such as teratogenicity; carcinogenicity; organ toxicity at low doses; reproductive toxicity; genotoxicity and structure; and toxicity profiles of new drugs that mimic existing drugs determined hazardous by the above criteria.
- **Hazardous Waste.** For the purposes of this document, hazardous waste, unlike medical waste, relates to waste generated from the administration of hazardous drugs.
- **Health Care Worker.** Professional healthcare staff hired by the hospital, including physicians, nurse, pharmacist, and paramedical staff.
- **Health Literacy.** The degree to which individuals have the capacity to obtain, process, understand and use healthcare information to make appropriate health decisions and follow instructions for treatment.
- **Healthcare associated infection (HAI).** A localized or systemic condition resulting from an adverse reaction to the presence of an infectious agent(s) or its toxin(s) that a) occurs in a patient in a healthcare setting (e.g., a hospital or outpatient clinic), b) was not found to be present or incubating at the time of admission unless the infection was related to a previous admission to the same setting, and c) if the setting is a hospital, meets the criteria for a specific infection site as defined by the CDC-NHSN.
- **Hemodynamic Pressure Monitoring.** A term used to determine the functional status of the cardiovascular system as it responds to acute stress, such as cardiogenic or septic shock, and myocardial infarction. To directly measure intra cardiac pressure changes, cardiac output, blood pressure, and heart rate, a pulmonary artery catheter is used.
- **Hemolysis.** The rupturing of red blood cells, which results in the release of hemoglobin, which diffuses into the surrounding fluid.
- **Hemostasis.** An arrest of bleeding or of circulation.
- **Heparin-Induced Thrombocytopenia (HIT).** A hypercoagulable state with a strong association to venous and arterial thrombosis. An acute, transient prothrombotic disorder due to heparin-dependent, platelet-activating antibodies..
- **High-Alert Medication.** Medications with a serious risk of causing significant harm to patients if used inaccurately.
- **Hospital Disinfectant.** A disinfectant used in medical-related facilities, such as clinics and hospitals and approved by the Environmental Protection Agency (EPA) .
- **Hypertonic.** Solution of osmotic concentration higher than that of an isotonic solution or a reference solution , which has a concentration greater than the normal tonicity of plasma.
- **Hypo dermoclysis.** The treatment of dehydration by infusing fluids into the subcutaneous tissues at rates greater than 3 mL/hour; solutions are isotonic or near-isotonic.
- **Hypotonic.** Solution of lower osmotic concentration than that of an isotonic solution or of a reference solution , which has a concentration less than the normal tonicity of plasma.

I

- **Immediate-Use Compounded Sterile Preparations (CSPs).** Preparations used in emergencies or in situations in which following low-risk compounding procedures would add additional risk because of the delay in patient care. Garbing and gowning are not required and they do not need to be compounded in an ISO Class 5 environment if the following criteria are met: Aseptic technique is followed. Hand hygiene per Centers for Disease Control and Prevention (CDC) recommendations; No more than 1 hour elapses from the time compounding begins to the time of administration to the patient begins. Only simple transfer of no more than 3 sterile, nonhazardous drugs in the manufacturers' original containers are involved in the compounding, and no more than 2 entries into any 1 container occur. No hazardous drugs are used. (between compounding and administration no intervening steps should occur.) No storage or batching of CSPs occurs. The preparation is labeled with patients' name, identification and amounts of all ingredients, name or initials of preparer, and exact 1-hour beyond-use date (BUD) and time.
- **Immunocompromised.** The condition of having an immune system with diminished capability to react to tissue damage or pathogens.
- **Implanted Pump.** A catheter attached to a subcutaneous reservoir that contains a pumping mechanism for continuous medication administration, which is surgically placed into a body cavity, vessel or organ.

- **Implanted Vascular Access Port.** A catheter attached to a reservoir located under the skin, which is surgically placed into a body cavity, vessel or organ.
- **Incompatible.** Incapable of being used simultaneously or mixed without producing undesirable effects or undergoing physical or chemical changes.
- **Indwelling urinary catheter.** A drainage tube that is inserted into the urinary bladder through the urethra, is left in place, and is connected to a closed collection system; also called a Foley catheter. Does not include straight in-and-out catheters.
- **Infection.** The presence and growth of pathogenic microorganisms with a systematic or local effect.
- **Infiltration.** Inadvertent administration of a non-vesicant medication or solution into surrounding tissue. It is rated by a standard tool.
- **Informed Consent.** A person's voluntary agreement to participate in research or to undergo a diagnostic, therapeutic, or preventive procedure, which is based on appropriate understanding and knowing of related information, .
- **Infusate.** Infusion; Parenteral solution administered into the vascular or nonvascular systems.
- **Infusion Team.** A group of nursing personnel in charge of outcome accountability for the delivery of infusion therapy, which is centrally structured within an acute health care facility. Although they may not be directly providing each infusion, they support the primary care staff by providing advanced knowledge for safe practices.. This team is led by infusion nurse specialists (eg, CRNI@s) and may contain a staff mix of registered nurses, licensed practical nurses, and unlicensed assistive personnel.
- **Instill / Instillation.** Administration of a medication or solution into a vascular access device (VAD) intended to fill the VAD rather than systemic infusion, such as medications/solutions used to dissolve precipitate, locking solutions to maintain catheter patency, and thrombolytic medications..
- **Intensive care unit (ICU).** A nursing care area for adults and/or children who are critically ill that provides intensive therapeutic procedures observation, and diagnosis. An ICU does not include specialty care areas nor nursing areas that provide intermediate care, step-down, or telemetry only. The ICU type is determined by the kind of patients cared for in that unit. That is, if a unit houses almost equal populations of medical and surgical patients, it is designated as a medical/surgical ICU, or if around 80% of patients are of a certain type, such as patients with trauma, then that ICU is designated as that type of unit (in this case, trauma ICU).
- **Inter professional/Inter professional Collaboration.** An approach to patient care that depends upon each professional health team member's cooperation through the overlapping skills, abilities and knowledge.
- **International Nosocomial Infection Control Consortium (INICC).** A nonprofit, open, multi-centric, healthcare-associated infection surveillance network organization founded in 1998, which is comprised of an international board of 33 members from high-income and limited-resources countries and over 3,000-affiliated infection control professionals (ICPs), from 1,000 hospitals in 500 cities of 66 countries from the following six World Health Organization (WHO) regions: Africa, America, Eastern Mediterranean, Europe, South East Asia, and Western Pacific. The INICC has promoted evidence-based infection control by providing hospitals internationally and, particularly, in limited-resource countries with free training and access to free online surveillance platform and tools for outcome and process surveillance, such as the INICC Multidimensional Approach for HAI prevention, and by spreading awareness of the burden of HAIs internationally through 364 publications.
- **Intraosseous (IO).** The spongy, cancellous bone of the medullary cavity of the diaphysis and the epiphysi, which are connected; the vessels of the IO space connect to the central circulation by a series of longitudinal canals that contain an artery and a vein; the Volkmann's canals connect the IO vasculature with the major arteries and veins of the central circulation.
- **Intrathecal.** Within the brain or spinal canal in the space under the arachnoid membrane.
- **Intraventricular Access Device.** An access device consisting of a port or reservoir attached to a catheter which is placed in a lateral ventricle of the brain. It is used to deliver medications into the cerebrospinal fluid (CSF) or for aspiration of CSF.
- **Intrinsic Contamination.** Contamination which occurs during the manufacturing process of a product.
- **Irritant.** An agent capable of producing pain or discomfort caused by irritation in the internal lumen of the vein with or without immediate external signs of vein inflammation.
- **Isotonic.** Having the same osmotic concentration as the solution with which it is compared.

J

- **Joint Stabilization.** The method of using a device to stabilize and support a joint when veins or arteries in or near that joint must be used for VAD placement. It should not be considered as a physical restraint.

L

Laminar Flow Hood. A contained workstation with filtered air flow, which assists in collection of hazardous chemical fumes in the work area and preventing bacterial contamination..

- **Licensed Independent Practitioner (LIP).** A practitioner permitted by law and by the organization to provide care and services within the scope of the practitioner license and consistent with individually assigned clinical responsibilities, without direction or supervision, .
- **Limited resource country.**
- **Locking.** The instillation of a solution into a vascular access device (VAD) used to reduce risk of catheter related bloodstream infection (CR-BSI) and/or to maintain patency in between VAD use.
- **Long-term.** It refers to vascular access devices which are placed for a likely use longer than 1 month.

- Lumen. The bore of a tube, including a catheter or blood vessel.

M

- Manual Flow-Control Device. An instrument to controls the rate of fluid flow by manual adjustment of components (i.e. such as a roller clamp or flow regulator). It is least precise device as it is affected by dislodgment of components or by its distance from the fluid container and needs to be relied on for drop count.
- Maximal Sterile Barrier Protection. It refers to the clothing and equipment used by clinicians and patient to prevent exposure to pathogens (i.e. protective eyewear, gown, mask, gloves, cap, towels, and , full body drapes).
- Mechanical Infusion Device. An infusion device that regulates the rate of flow through a non-electronic method, such as the spring-coil piston syringe device and the elastomeric balloon device..
- Mechanical Ventilator. A device to assist or control respiration continuously through a tracheostomy or by endotracheal intubation. NOTE: Lung expansion devices such as intermittent positive pressure breathing (IPPB); nasal positive end-expiratory pressure (PEEP); continuous nasal positive airway pressure (CPAP, hypoCPAP) are not considered ventilators unless delivered via tracheostomy or endotracheal intubation (e.g., ET-CPAP)
- Medical Adhesive-Related Skin Injury (MARSi). In an area exposed to medical adhesive, tears, skin redness or erosion, or development of bulla or vesicles which lasts for 30 minutes or more after the adhesive was removed.
- Medical Waste (Regulated). Includes liquid or semiliquid blood or other potentially infectious materials; microbiological wastes containing blood or other potentially infectious materials; contaminated sharps; items that are caked with dried blood or other potentially infectious materials and are capable of releasing these materials during handling; and contaminated items that would release blood or other potentially infectious material in a liquid or semiliquid state if compressed .
- Medication Reconciliation. The process of collecting and documenting complete and accurate medication information for each patient, including all medications that the patient is currently taking, including prescribed medications and herbals/nutritional supplements.
- Micro aggregate Blood Filter. Filter that removes micro aggregates (and diminishes the occurrence of non-hemolytic febrile reactions.
- Micron (μ). A unit of length equal to 1 millionth of a meter, or 1 thousandth of a millimeter.
- Microorganism. Extremely small living body which cannot be perceived by the naked eye.
- Mid-arm Circumference. Measurement of upper arm at a predetermined distance above the insertion site of a midline catheter or a peripherally inserted central catheter (PICC).
- Midline Catheter. A catheter inserted into the upper arm via the cephalic, basilic, or brachial vein, with the internal tip located level at or near the level of the axilla and distal to the shoulder.
- Milliosmoles (mOsm). One thousandth of an osmole; osmotic pressure equal to 1 thousandth of the molecular weight of a substance divided by the number of ions that the substance forms in a liter of solution.
- Minimum Inhibitory Concentration (MIC). The lowest concentration of a drug necessary to inhibit bacterial growth.
- Moderate Sedation. Drug-induced depression of consciousness in which a patient is able to persistently respond to light tactile stimulation or verbal commands cardiorespiratory functions are sufficient and also usually preserved, and interventions are not needed to maintain a patent airway.
- Multidrug-Resistant Organism (MDRO). A microorganism resistant to 1 or more classes of antimicrobial agents. MDROs, primarily bacteria, include by way of example, vancomycin-resistant enterococci (VRE), methicillin-resistant Staphylococcus aureus (MRSA), and certain gram-negative bacilli (GNB) that have important infection control implications.

N

- Near-Infrared Light Devices. A device that works by either trans illuminating the extremity and projecting the vessel image to a screen or by capturing an image of the superficial veins and reflecting it to the skin surface. It uses near infrared light, a range of 700 to 1000 nanometers on the electromagnetic spectrum..
- **Needleless Connector (NC).** A device that allows intermittent access to a vascular access device with a syringe or an administration set without the use of needles. NC are classified by description (ie, simple or complex) and by function (ie, negative, positive, or neutral) upon set or syringe disconnection: **Anti-Reflex NC.** It contains a pressure-sensitive internal mechanism designed to prevent blood reflux into the catheter lumen when the flow of infusion solution has stopped. **Complex NC.** It has a variety of moving internal components that allow fluid flow in both directions; eg, mechanical valves. **Negative Displacement NC.** It permits blood reflux into vascular access device (VAD) lumen upon disconnection due to movement of valve mechanism or removal of syringe/set. **Neutral NC.** It contains an internal mechanism designed to prevent blood reflux into the catheter lumen upon connection or disconnection. **Positive Displacement NC.** It allows a small amount of fluid to be held in the device. this fluid is pushed through the catheter lumen to clear any blood that refluxed into the lumen upon set or syringe disconnection. **Simple NC.** It allows a straight fluid pathway through the center lumen without any internal mechanism to control flow, such as a pre pierced septum accessed with either a blunt cannula or male luer device, for example, split septum.
- Needleless Systems. A device that does not include the use of needles for: the administration of medication or solutions; the collection of bodily fluids or withdrawal of body fluids after initial venous or arterial access is established; or any other procedure involving the potential for occupational exposure to blood-borne pathogens because of percutaneous injuries from contaminated sharps.
- Neonate. Referring to the first 4 weeks of life.

- Non critical Equipment. Items that come in contact with intact skin but not mucous membranes.
- Non permeable. Prevents passage of fluid or gases.
- Non tunneled Central Venous Access Device. A vascular or nonvascular access device inserted by puncture directly through the skin and the intended location without a portion of the device allowed to remain in a subcutaneous tract.
- Non vesicant. Solutions and medications that do not produce tissue damage when inadvertently delivered into subcutaneous tissue.
- Nursing Diagnosis. The patient problem identified for intervention by analysis of assessment findings in comparison to what is considered to be normal.
- Nursing Intervention. In the nursing process, the step after planning. It relates to actual patient care and involves full knowledge of assessment and planning stages of the nursing process.

O

- Occlusion. The inability to infuse or inject solution into a catheter; the inability to aspirate blood from a catheter or both; the state of being occluded.
- Older Adult. Greater than 65 years of age, as defined by the American Geriatric Society.
- Open infusion container. IV fluid containers, such as glass, burette or semi-rigid plastic bottle which must be externally vented to allow ambient air to enter in order for the fluid to egress.
- Osmolality. The characteristic of a solution determined by the ionic concentration of the dissolved substances per unit of solvent; measured in milliosmoles per liter.
- Osmolarity. The number of osmotically active particles in a solution.
- Outcome Surveillance. Outcome surveillance is the measurement of patient characteristics, such as age, gender and severity illness score; HAI rates, device utilization ratio, and HAI consequences, such as extra mortality, extra LOS, extra cost, microorganism profile, and bacterial resistance. The results of HAI outcome surveillance allow ICPs to define the magnitude of the problem, identify HAI risk factors, such as devices with the highest risk, and provide the framework for plans to reduce infection risk, including the evaluation of the cost-effectiveness of specific interventions.

P

- Palpable Cord. A vein that is rigid and hard to the touch.
- Palpation. Examination by application of the fingers or hands to the surface of the body for the purposes of detecting evidence of disease or abnormalities in the various organs, or to identify the location of peripheral superficial veins and their condition.
- Parenteral Nutrition. The intravenous provision of total nutritional needs for a patient who cannot take appropriate amounts of food enterally. Typically, it includes carbohydrates, proteins, and/or fats, as well as additives.
- Parenteral. Administered by any route other than the alimentary canal, including the mucosal, intravenous, subcutaneous, or intramuscular route.
- Paresthesia. Pain associated with nerve injury, such as tingling, prickling, or shock-like sensations.
- Particulate Matter. Unwanted matter relating to or composed of fine particles found in intravenous medication and solutions, such as rubber cores, undissolved drugs or precipitate, plastic pieces and glass particles.
- Pathogen. A microorganism or substance capable of producing disease.
- Patient Care Setting. The place where patient care is provided, including hospital, outpatient, or physician office setting, assisted living facility, skilled nursing facility, and the home.
- Pediatric. Newborn to 21 years of age. (Note: the American Academy of Pediatrics states that pediatrics is actually the fetal period to 21 years of age.)
- Percutaneous. Technique performed through the skin.
- Performance Feedback. Providing feedback to HCWs to assess performance levels is an important motivating aspect of the IMA. Knowing the outcome of their efforts reflected by the measurement of their practices and the incidence of HAIs can be a most rewarding or conscious-raising factor for HCWs, which is crucial to ensure the effectiveness of the IMA. The ICPs retrieve those tables and charts from ISOS, with monthly reports, showing bar charts with HH compliance; CL, UC care compliance, measures to prevent pneumonia, and SSIs (See Table 1, for contents of reports). The data are reviewed at monthly meetings of ICU staff, and are also posted in a prominent hospital location.
- Peripheral. Situated away from a center or central structure; pertaining to or situated at or near the periphery; .
- Peripherally Inserted Central Catheter (PICC). In adults and children, a catheter inserted through veins of the upper extremity or neck ; in infants, it may be inserted through veins of a lower extremity or the scalp ; catheter tip is located in the superior or inferior vena cava, with preference to its junction with the right atrium, regardless of insertion site.
- Personal Protective Equipment (PPE). The equipment worn to minimize exposure to a variety of hazards, including blood-borne pathogens.
- pH. The degree of acidity or alkalinity of a substance.
- Phlebitis. Inflammation of a vein which may be accompanied by edema, erythema, pain, streak formation, and/or palpable cord. It is rated by a standard scale.
- Phlebotomy. Extracting blood from a vein by direct venipuncture or via a central vascular access device (CVAD).
- Physical Restraint. Physical, manual or mechanical device that immobilizes or reduces the patient's ability to move head, arms, legs, or body freely.

- Pounds per Square Inch (psi). A measurement of pressure; 1 psi equals 50 mm Hg or 68 cm H₂O.
- Power Injectable. A device capable of withstanding injections pressure used for radiology procedures, usually 300 to 325 pounds per square inch (psi).
- Practice Guidelines. Directions provided about clinical care decisions based on the current state of knowledge about a disease therapy or state.
- Pre analytic Phase. The period of time before a body fluid specimen reaches the laboratory. It includes the time for obtaining, labeling, and transporting the specimen to the laboratory.
- Precipitation. The act or process of a drug or substance in solution to settle in solid particles, which is predominantly caused by a change in pH.
- Preservative-Free. Free of any additive intended to extend the stability, content, or sterility of active ingredients, including bacteriocides emulsifiers, or antioxidants. It contains no added substance capable of inhibiting bacterial growth.
- Priming Volume. Amount of fluid needed to fill the fluid pathway of the vascular access device (VAD), administration set and add-on devices.
- Procedure. A written statement of a series of steps needed to complete an action.
- Process Surveillance. Health care workers are aware that bundle elements are the most adequate practices for effective infection control; however, their actual application may not be consistent in routine patient care. Process surveillance serves as a means to ensure that all bundle interventions are carried out consistently for all patients and at all times. It consists of a standardized collection of data on the regular supervision of a series of routine infection control practices and use of supplies in the healthcare facility. These practices include the monitoring of compliance of HH, and specific measures to prevent PNEU, CLAB, UTI, and SSI. Process surveillance is conducted by an ICP who directly monitors HCWs' practices and supplies utilization, by following a standardized protocol, and conducting specific surveillance at regular intervals. HCWs are not aware of the actual schedule of the monitoring, so to avoid or minimize the observer effect.
- Process. Actual observation of performance and performance related to compliance with procedures, policies, and professional standards.
- Product Integrity. The condition of an intact, uncompromised product suitable for intended use.
- Proximal. The opposite of distal; The closest to the center or midline of the body or trunk, nearer to the point of attachment.
- Psychomotor. Related to behaviors focused on the various degrees of physical skills and dexterity since they are associated to the preceding thought process.
- Pulsatile Flushing Technique. Repetitive injection of short (for example, 1 mL) pushes followed by a brief pause to create turbulence within the vascular access device (VAD) lumen.
- Purulent. Containing or producing pus.

Q

- Quality Improvement. A continuous, progressing systematic process to monitor, evaluate and solve problems.

R

- Radiopaque. Detectable by radiographic examination; impenetrable to x-rays or other forms of radiation.
- Reconstitute. Adding diluent to a powder to create a solution.

S

- Safety-Engineered Device (also known as Sharps with Engineered Sharps Injury Protections). A non-needle sharp or a needle device used for accessing a vein or artery, withdrawing body fluids, or administering medications or other solutions, with a built-in safety feature or mechanism that effectively reduces the risk of an exposure incident. Used to prevent percutaneous injuries and blood exposure before, during, or after use.
- Sentinel Event. See Serious Adverse Event.
- Sepsis. The systemic response caused by the presence of infectious microorganisms or their toxins in the bloodstream.
- Serious Adverse Event. An undesirable experience associated with the use of a medication/ medical product in a patient.
- Sharps. Objects in the health care setting that can be reasonably anticipated to penetrate the skin and to result in an exposure incident; including, but not limited to, needle devices, scalpels, lancets, broken glass, or broken capillary tubes.
- Short-term. When used in reference to a vascular access device, a time frame of less than 1 month.
- Site Protection. Method or product used to protect the external vascular access device (VAD), insertion site, and dressing.
- Smart Pump. Electronic infusion device (EID) with an imbedded computer software designed for the reduction of drug dosing errors through the presence and use of a drug library.
- Standard Precautions. Guidelines designed to protect workers with occupational exposure to blood-borne pathogens, in which blood and body fluids are treated as potentially infectious.
- Standard. Authoritative statement established by the profession by which the quality of service, practice, or education can be determined.
- Statistics. The systematic science of collecting, organizing, analyzing, and interpreting numerical data.

- Sterile. Free from living organisms.
- Stylet Wire. A long wire guide inside the catheter lumen that is used to provide stiffness for advancement of a vascular access device (VAD) into the vein. It may consist of multiple pieces welded together and is not intended for advancement into the vein alone.
- Stylet. A sharp rigid metal hollow-bore object within a peripheral catheter that is designed to facilitate venipuncture and catheter insertion.
- Subcutaneous Infusion. Administration of medications into the tissues beneath the skin.
- Surveillance. The ongoing process of observing actively and systematically the events or conditions that increase or decrease the risk of a disease occurrence and the occurrence and distribution of such disease within a population..

T

- Tamper-Proof. Unable to be altered.
- Thrombolytic Agent. A pharmacological agent capable of lysing blood clots.
- Thrombophlebitis. The inflammation of the vein along with formation of a blood clot (thrombus).
- Thrombosis. The development, formation, or existence of a blood clot within the vascular system.
- Trans illumination. Illuminating with a light a specific body part, such as an extremity, to identify structures beneath the skin.
- Transducer. A device that converts one form of energy into another.
- Transfusion Reaction. Complication of blood transfusion in which there is an immune response against the transfused blood cells or other components of the transfusion.
- Transmission-Based Precautions. The use of Airborne, Droplet, and/or Contact Precautions, which are implemented in addition to Standard Precautions if strategies beyond Standard Precautions are needed to diminish the risk for transmission of infectious agents.
- Transparent Semipermeable Membrane (TSM). A sterile air-permeable, water resistant, dressing that allows visual inspection of the skin surface beneath it.
- Tunneled Cuffed Catheter. A central vascular access device (CVAD) with a segment of the catheter lying in a subcutaneous tunnel with the presence of a cuff into which the subcutaneous tissue grows to offer security for the catheter. The vein entry and skin exit sites are separated by the subcutaneous tunnel.

U

- Ultrasound. A device using sound waves directed into human tissue at frequencies greater than the limit of human hearing to identify and display physical structures on a screen.
- Umbilical Catheter. A catheter that is inserted into 1 of the 2 arteries or vein of the umbilical cord.
- Unusual Occurrence (or Event). An unexpected occurrence or event that results in life-threatening, death or serious injury to a patient which is unrelated to a natural course of the patient's underlying condition or illness, such as an incident resulting in the abuse of a patient.
- USP Chapter < 797 >. Chapter 797 "Pharmaceutical compounding—sterile preparations," in the United States Pharmacopeia (USP) National Formulary (NF) are enforceable sterile compounding standards issued by the USP that describe the procedures, guidelines and compliance requirements for compounding sterile preparations and set the standards that apply to all settings in which sterile preparations are compounded.

V

- Vascular Access Device (VAD). Devices, catheters, or tubes inserted into the vascular system, including bone marrow, arteries, and veins.
- Vesicant. An agent with the ability to cause tissue damage if it escapes from the intended vascular pathway into surrounding tissue.
- Visible Light Devices. A device used to locate superficial veins by trans illuminating an extremity through the use of light from 400 to 700 nanometers, or the middle of the electromagnetic spectrum.
- Visualization Technology. A device allows for the location and identification of blood vessels by employing the use of light or sound waves.