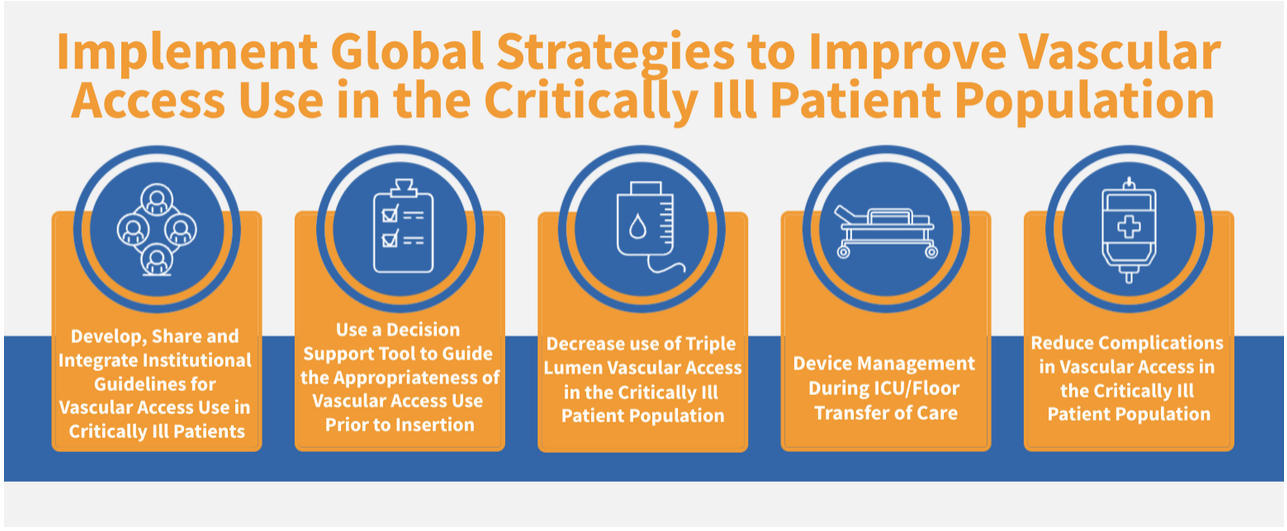
HMS PICC Critical Care Toolkit



HMS
MICHIGAN HOSPITAL MEDICINE SAFETY CONSORTIUM

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This toolkit is a live document and will continually be updated as new tools are developed. Please visit the HMS website for the most up-to-date toolkit. If you have tools to be added to the toolkit, please see the HMS contact information below.

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1. Develop, Share and Integrate Institutional Guidelines for Vascular

Access Use in Critically Ill Patients

Background, Rationale, and Suggested Implementation Strategies

Background/Rationale:

- Establishing clear guidelines for vascular access use ensures consistency in the quality of care across departments and practitioners. This reduces variability, which is often associated with increased rates of complications.
- Developing guidelines based on the latest research and clinical evidence ensures patients receive care that is in line with current best practices, reducing the likelihood of adverse events.
- Standardized protocols can lead to better patient outcomes by minimizing complications related to vascular access, such as infections or thrombosis, thereby improving overall safety and patient satisfaction.
- Guidelines serve as a valuable educational resources for all staff, ensuring that all healthcare providers are knowledgeable about the best practices in vascular access management.
- Instituting guidelines provides a framework for continuous quality improvement initiatives. Data on vascular access outcomes can be collected, monitored, and used to refine guidelines over time.

Suggested Implementation Strategies:

- Customize by leveraging national or international guidelines and tailoring recommendations to address specific institutional needs, such as patient demographics or logistical constraints
- Conduct workshops, seminars, and hands-on training sessions to educate staff about the guidelines. Ensure educational materials are accessible and that there are opportunities for staff to ask questions and seek clarifications.
- Incorporate guidelines into the institution's electronic health records (EHR) system, providing prompts or checklists to support adherence during the clinical decision-making process.

Resources

- ACI Central Venous Access Device: Post Insertion Management (2021)
  - See Table 4: Central Venous Access Devices – Device Selection Options
- National Kidney Foundation. 2006 updates clinical practice guidelines and recommendations. Hemodialysis adequacy, peritoneal dialysis adequacy and vascular access
- Anesthesiology Practice Guidelines for Central Venous Access 2020
  - See Table 2: Provides guidelines for vascular access recommendations
  - See Appendix 3: Provides an example checklist for insertion of central venous catheters

References

- Chopra, V. et al. The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): Results From a Multispecialty Panel Using the RAND/UCLA Appropriateness Method *Annals of Internal Medicine* 2015.
  - Criteria for the use of PICCs was developed, adopting the RAND/UCLA Appropriateness Method. After a review of 665 scenarios, 43% of PICCs were flagged as inappropriate. Applying these criteria as a guide can help decrease the likelihood of an inappropriate catheter, improve care, and inform quality improvement efforts.
- Timsit, J. et al. Expert Consensus-Based Clinical Practice Guidelines Management of Intravascular Catheters in the Intensive Care Unit. *Annals of Intensive Care* 2020.
  - The French Society of Intensive Care Medicine established 36 guidelines for managing central venous, arterial, and dialysis catheters in ICUs using the GRADE methodology, emphasizing infection prevention through subclavian vein use and one-step chlorhexidine-alcohol disinfection. Recommendations suggest avoiding antiseptic or antibiotic-impregnated CVCs and advise using ultrasound guidance to minimize complications, while also proposing specific pediatric strategies and future areas for investigation. A NEJM randomized trial that included both critically ill and non-critically ill adults and children assigned 1098 individuals undergoing PICC placement to receive a hydrophobic PICC, a chlorhexidine PICC, or a standard polyurethane PICC (1:1:1 ratio). The risk of device failure due to noninfectious or infectious complications similar for hydrophobic or chlorhexidine PICCs compared with standard polyurethane PICCs. Device failure occurred in 5.9 percent of the hydrophobic group, 9.9 percent in the chlorhexidine group, and 6.1 percent in

the standard-polyurethane group. However, more complications from any cause occurred for chlorhexidine compared with standard polyurethane catheters (OR 2.35, 95% CI, 1.68 to 3.29).

- Takashima, M. et al. Complication and Failures of Central Vascular Access Device in Adult Critical Care Settings *SCCM* 2018.
  - The study systematically reviewed 63 studies to examine failure rates and complications of central venous access devices in adult ICUs, finding a 5% overall failure rate, with hemodialysis catheters experiencing the highest failure and non-tunneled devices showing the highest infection rates. Despite relatively low rates of bloodstream infections, a significant proportion of devices were removed due to suspected infections, highlighting the need for more comprehensive guidelines to better inform the decision-making process in suspected infection cases.

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2. Use a Decision Support Tool to Guide the Appropriateness of Vascular Access Device Use Prior to Insertion in Critically Ill Patients

Background, Rationale, and Suggested Implementation Strategies

Background/Rationale:

- A decision support tool provides structured guidance that can support clinicians in selecting the most appropriate vascular access device based on the patient's clinical condition, duration of therapy, and risk factors.
- Proper selection of vascular access devices can reduce complications such as catheter-related bloodstream infections and thrombosis, improving patient safety and outcomes.
- By guiding appropriate device selection, a decision support tool can optimize resource use, reducing unnecessary procedures and the need for device

changes, ultimately leading to cost savings.
- A device selection tool can help standardize decision-making processes across different healthcare providers and departments, ensuring consistent, high-quality care.
- The use of a device selection tool can serve as a learning tool for less experienced clinicians, providing them with a framework to improve their knowledge and skills in vascular access device selection.

Suggested Implementation Strategies:

- Form a team comprised of intensivists, infection prevention specialists, vascular access nurses, information technology specialists, and other relevant stakeholders to develop and customize the device selection tool framework.
- Base the decision support tool on the latest clinical guidelines and evidence-based practices. Consider factors such as patient-specific requirements, anticipated duration of therapy, and the risk for complications.
- Integrate the tool in the clinical workflow: Embed the device selection tool within the EHR system to enable automatic prompts and guidance at the point of care. Ensure it aligns seamlessly with clinical workflows to encourage adoption.
- Train healthcare providers on how to effectively use the decision support tool through workshops, demonstrations, and online modules. Highlight the benefits of the tool in optimizing patient care and outcomes.
- Create a system for ongoing feedback from users to ensure the tool remains relevant and user-friendly. Encourage collaboration and communication among users to share experiences and best practices.
- While vasopressors are a common indication for central venous access in the ICU, though peripheral administration may be safe with proper monitoring and protocols. However, a recent study showed that practices for the peripheral administration of vasopressors sometimes do not match hospital policies. Work with your teams to update your vasopressor protocols to match practice and facilitate safe peripheral administration of vasopressors (e.g. monitoring and extravasation protocols, IV requirements, dose and duration limits).

Resources

General Appropriateness:

- The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): Annals of Internal Medicine. 2015.

- Making The MAGIC: Guiding Vascular Access Selection for Intensive Care – a Summary of Michigan Appropriateness Guide for Intravenous Catheters (MAGIC)
  - Video: The Michigan MAGIC, PICC Appropriateness & Mindful Medicine
  - App: ImprovePICC MAGIC App
  - Badge Card

Peripheral Use of Vasopressors:

- Example tool for Treatment of Vasoactive Medication via PIV Access Extravasation

References

General References:

- Iachkine, J. et al. Development and Validation of a Multivariable Model Predicting the Required Catheter Dwell Time Among Mechanically Ventilated Critically Ill Patients in Three Randomized Trails. *Annal of Intensive Care* 2023.
  - The study developed and validated the CVC-IN score to predict the required catheter dwell time for critically ill, mechanically ventilated patients, helping to identify those at a higher risk of intravascular complications based on factors such as immunosuppression, high creatinine levels, vasopressor use, obesity, and age. Though the score showed modest discrimination ability, favoring subclavian site insertion may reduce the complication risk, particularly in patients with a higher CVC-IN score. However, insertion of a subclavian device must be performed by a skill operator to avoid insertion-related complications (e.g., pneumothorax)
- Miller, D. et al. Guidelines for the Prevention of Intravascular Catheter-Related Infections: Recommendations Relevant to Interventional Radiology for Venous Catheter Placement and Maintenance *Journal of Vascular and Interventional Radiology* 2012.
  - In the U.S., CRBSIs significantly impact ICU costs and hospital stays, prompting updates in CDC guidelines to improve prevention, with key recommendations including maximum sterile barrier precautions, the use of chlorhexidine-alcohol for skin antisepsis, and targeted use of impregnated catheters. Despite advancements laid out in the 2011 revised guidelines, which emphasize education, proper catheter maintenance, and evidence-based practices, implementation remains suboptimal, as many hospitals

continue to omit crucial preventative measures such as maximum sterile precautions and avoid unnecessary routine catheter changes.

Peripheral Use of Vasopressors

- Cardenas-Garcia, J. et al. Safety of Peripheral Intravenous Administration of Vasoactive Medication. *J of Hosp Med* 2015.
  - Administration of norepinephrine, dopamine, or phenylephrine by peripheral intravenous access was feasible and safe in this single-center medical intensive care unit. This study was the first to suggest that use of vasoactive medication may not need to be an automatic indication for central venous access in environments where the peripheral IV can be closely monitored and there are protocols in place that allow teams to respond to extravasation quickly to prevent tissue injury.
- Munroe, E. et al. Use and Outcomes of Peripheral Vasopressors in Early Sepsis-Induced Hypotension Across Michigan Hospitals: A Retrospective Cohort Study. *CHEST* 2023.
  - Peripheral vasopressor initiation was common across Michigan hospitals and had practical benefits, including expedited vasopressor administration and avoidance of central line placement in one-third of patients. However, the findings of wide practice variation that was not explained by patient case mix and lower use of first-line norepinephrine with peripheral administration suggest that additional standardization may be needed.
  - Associated Podcast Episode: CHEST Journal Podcast - April 2024
- Yerke, J. R. et al. Peripheral Administration of Norepinephrine: A Prospective Observational Study. *CHEST* 2024.
  - A prospective observational cohort study assessing the use of a protocol for peripheral norepinephrine administration in medical ICU patients. The primary outcome was number of days of CVC use avoided and secondary outcome was incidence of extravasation events. The study suggests that implementing a protocol for peripheral norepinephrine administration can safely avoid 1 CVC day in the average patient and result in few extravasation events causing minimal or no tissue injury. Protocols for close peripheral IV monitoring is key to catch extravasations early and prevent tissue injury.
- Munroe, E. A Case for the Evidence-Based Use of Peripheral Vasopressors. *CHEST* 2024.
  - Recent studies, including one by Yerke et al. in an ICU setting, demonstrate that peripheral vasopressor administration, specifically norepinephrine, can effectively reduce the need for central venous catheters (CVCs) while

maintaining a low rate of manageable extravasation events. Despite potential protocol variability and challenges in developing standardized guidelines, the findings support the safe integration of peripheral vasopressors into clinical practice, highlighting the importance of close monitoring and rapid response mechanisms to minimize complications.

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3. Decrease Use of Triple Lumen PICCs in the Critically Ill Patient Population

Background, Rationale, and Suggested Implementation Strategies

Background/Rationale:

- Triple lumen PICCs have a more lumens, increasing the potential for catheter-related bloodstream infections. Using single or double lumen PICCs or more temporary triple lumen lines (triple lumen central venous catheters [CVCs]) when clinically appropriate can reduce this risk.
- Create or share educational materials regarding the importance of lumens and risk of complications associated with triple lumen PICCs.
- Educating staff about the appropriate indications for each type of catheter supports evidence-based practice and enhances the quality of care delivered.

Suggested Implementation Strategies:

- Create and/or use guidelines based on evidence that outline the scenarios in which single, double, or triple lumen PICCs are appropriate, ensuring alignment with national safety standards.
- Establish a feedback loop where healthcare workers can share experiences, challenges, and successes in reducing triple lumen PICC use to continuously improve and adapt practices.
- Engage with key stakeholders, including nurses, physicians, and administrators, to secure buy-in and support for reducing triple lumen PICC use, highlighting the

benefits for patient safety and cost savings.

Resources

General Appropriateness:

- Less Lumens = Less Risk
- The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): Annals of Internal Medicine. 2015.
  - Video: The Michigan MAGIC, PICC Appropriateness & Mindful Medicine
  - App: ImprovePICC MAGIC App
  - Badge Card

References

- Govindan, S. et al. Peripherally Inserted Central Catheter in the ICU: A Retrospective Study of Adult Medical Patients in 52 Hospitals. *SCCM* 2018.
  - The study examined over 27,000 patients to evaluate the use and complications of PICCs in ICUs versus general wards, revealing that PICCs in the ICU are more frequently multilumen and associated with higher complication rates compared to those on the general ward. Additionally, significant variation in PICC use and outcomes across hospitals and frequent use in circumstances deemed inappropriate according to published criteria suggest a need for further investigation into vascular access decision-making in the ICU setting.
- Trerotola, S. et al. Triple-Lumen Peripherally Inserted Central Catheter in Patients in the Critical Care Unit: Prospective Evaluation. *Radiological Society of North America* 2010.
  - The study evaluating the use of triple-lumen PICCs in ICU patients was halted prematurely after an interim analysis revealed a high rate of venous thrombosis, affecting 58% of patients, with 20% being symptomatic. Despite the high thrombosis rate, there was no incidence of catheter-related bloodstream infections and a low rate of colonization, indicating that while the triple-lumen PICC design has issues with thrombosis, it presents a low infection risk in a high-risk ICU setting.
- Govindan, S. et al. To PICC or not to PICC? A Cross-Sectional Survey of Vascular Access Practices in the ICU. *Journal of Critical Care* 2021.

- The study surveyed ICU clinicians across 13 Michigan hospitals to understand their practices and perceptions regarding the shift from CVCs to PICCs, finding significant variability in the use of ultrasound and specification of catheter lumens. The results suggest that local protocols could enhance adherence to guidelines and highlight the need for further research on vascular access and patient safety in the ICU

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4. Device Management During ICU to Floor/Ward Transfer of Care

Background, Rationale, and Suggested Implementation Strategies

Background/Rationale:

- Transitions between care teams and units create opportunities for communication errors and omissions. Establishing clear guidelines for managing medical devices can reduce these risks.
- Proper device management ensures that patients continue to receive necessary treatments without interruption, supporting effective recovery.
- Effective management and assessment of the continuing need for devices can prevent complications such as device-associated infections and thrombosis.
- Providing structured guidelines ensures that all healthcare providers, including new staff and trainees, are aligned in terms of expectations and responsibilities during patient transfers.

Suggested Implementation Strategies:

- Create detailed protocols outlining the steps for device management during ICU-to-floor transfers, specifying actions for each type of device and clinical scenario.
- Involve a multidisciplinary team, including ICU and floor/ward nurses, physicians, and allied health professionals, in the development of these protocols to ensure all perspectives are considered.
- Use validated handoff communication tools, such as SBAR (Situation, Background, Assessment, Recommendation) or checklists, to structure

communication and ensure detailed information exchange regarding device management.

Resources

- ATS ICU PAUSE Tools - The ICU Pause program aims to educate health care providers around patient safety and equity in diagnosis at the time of ICU discharge.
  - Informational Packet see page 5
  - Sample ICU to Ward dotphrase (EPIC)
  - ICU Pause Example Implementation in Electronic Documentation
- CDC Presentation: Maintenance and Removal of Central Venous Catheters
- Open Critical Care: ICU Rounding Daily Check List

References

- ICU Transfer Summary Consensus Panel. Identifying essential elements to include in Intensive Care Unit to hospital ward transfer summaries: A consensus methodology *Journ of Crit Care* 2019.
  - Panel identified 63 distinct information elements identified as essential for inclusion in an ICU transfer summary tool to facilitate communication between providers during the transition of patient care from the ICU to a hospital ward.
- Lekshmi, S. et al. Cocreating the ICU-Pause Tool for Intensive Care Unit-Ward Transitions. *ATS Scholar* 2022.
  - Group created a novel, more user-friendly electronic ICU–ward transfer tool, ICU-PAUSE, alongside Internal Medicine trainees.
- Saint, S. et al. Enhancing the Safety of Critically Ill Patients by Reducing Urinary and Central Venous Catheter-related Infections *Am J Respir Crit Care Med* 2002.
  - Evidence-based overview of preventative measures both for CVCs and Urinary Catheter infections.

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5. Reduce Complications in Vascular Access in the Critically Ill Patient

Population

Background, Rationale, and Suggested Implementation Strategies

Background/Rationale:

- Complications from vascular access device use can significantly impact patient outcomes. Focusing on reducing these complications directly improves patient safety and quality of care.
- Complications often lead to increased healthcare costs due to prolonged hospital stays, additional treatments, and interventions. Reducing complications can lead to significant cost savings.
- Utilizing evidence-based strategies and guidelines helps in standardizing care, reducing variability in practice, and ultimately improving outcomes.
- Educating staff on best practices can not only reduce complications but also reduce staff workload related to managing complications, allowing for more focus on proactive care measures.

Suggested Implementation Strategies:

- Establish evidence-based protocols for the insertion, maintenance, and removal of vascular access devices. Ensure guidelines align with national and international standards and best practices.
- Involve a multidisciplinary team, including infection control specialists, to oversee vascular access practices and provide regular feedback on performance and outcomes.
- Ensure thorough patient assessments to guide the selection of the most appropriate vascular access devices, considering factors such as the intended duration of use and patient-specific risks.

Resources

- CDC Guidelines for Prevention of IV Catheter-Related Infections, 2011
- CDC Checklist for Prevention of Central Line Associated Blood Stream Infections

- SHEA Strategies to Prevent Central Line Associated Bloodstream Infections in Acute-Care Hospitals: 2022 Update

References

- Timsit, J. et al. A State of the Art Review on Optimal Practices to Prevent, Recognize, and Manage Complications Associated with Intravascular Devices in the Critically Ill. *Intensive Care Medicine* 2018.
  - Review offers current insights into the epidemiology, diagnosis, and optimal treatment of complications such as infections and thrombosis related to central vein and arterial catheters in the ICU. It highlights that preventing these complications requires a multidisciplinary approach, combining care process improvements and new technologies, while also identifying key prevention strategies and suggesting areas for future research.
- Alonso-Echanove J. et al. Effect of Nurse Staffing and Antimicrobial-Impregnated Central Venous Catheters on the Risk for Bloodstream Infections in Intensive Care Units. *Inf Cont & Hosp Epi* 2015.
  - Antimicrobial-impregnated CVCs reduced the risk of CVC-associated BSI by 66% in patients receiving TPN. Limiting the use of float nurses for ICU patients with CVCs and the use of PICCs may also reduce the risk of CVC-associated BSI.
- Bernholtz, S.M. et al. Eliminating catheter-related bloodstream infections in the intensive care unit. *CCM* 2004.
  - The study aimed to eliminate CRBSIs by implementing a multifaceted intervention that included staff education, a catheter insertion cart, daily catheter necessity assessments, a compliance checklist, and empowering nurses to halt insertions if guidelines were violated. These interventions resulted in a near-elimination of CRBSIs in the surgical ICU by ensuring adherence to evidence-based infection control practices.
- Toor H. Prevalence of Central Line-Associated Bloodstream Infections (CLABSI) in Intensive Care and Medical -Surgical Units. *Cureus* 2022.
  - The study reviewed 1,125 CVC insertions at a healthcare institution and found specific practices that contributed to CLABSIs, such as prolonged catheter use. To reduce CLABSI rates, recommendations include strict adherence to central line insertion practice documentation for all CVCs and timely catheter changes for patients exhibiting abnormal white blood cell counts or temperatures and those with certain CVC types or prolonged use.

- Nolan, M. et al. Complication Rates Among Peripherally Inserted Central Venous Catheters and Centrally Inserted Central Catheters in the Medical Intensive Care Unit. *Journal of Critical Care* 2016.
    - The study, conducted in a medical ICU, evaluated complication rates of PICCs and CVCs in 400 cases, finding that both thrombotic and infectious complications were uncommon with no significant difference between the two catheter types. Notably, half of the PICC related DVTs occurred after transfer to the general floor, indicating that PICCs, like all central catheters, should be promptly removed when no longer necessary to minimize risks.
- Pronovost, P. et al. An Intervention to Decrease Catheter-Related Bloodstream Infections in the ICU. *New England Journal of Medicine* 2006.
    - The collaborative cohort study conducted in Michigan ICUs implemented an evidence-based intervention that significantly reduced catheter-related bloodstream infections, with infection rates dropping from a median of 2.7 per 1,000 catheter-days at baseline to 0 within three months and a sustained decrease to 1.4 infections at 16 to 18 months. The intervention demonstrated a substantial and lasting impact, reducing infection rates by up to 66% over the 18-month study period.
- Ullman, A. et al. A Comparison of Peripherally Inserted Central Catheter Materials. *New England Journal of Medicine* 2025.
    - In a randomized trial involving 1,098 participants across three Australian hospitals, PICCs made of hydrophobic and chlorhexidine materials did not show a lower risk of device failure from infectious or noninfectious complications compared to standard polyurethane PICCs. Throughout the 8-week follow-up, device failure rates were similar across groups, and no adverse events were linked to the catheter materials, indicating that the newer materials did not provide superior outcomes.