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Michigan Appropriateness Guideline for Intravenous Catheters and the Impact on Utilization and Infection Ratios in Peripherally Inserted Central Catheters

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Submitted in Partial Fulfillment of the Requirements

For the Degree of Doctor of Nursing Practice in

College of Nursing

University of South Carolina

2023

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Abstract

Problem Statement: Adult patients are at increased risk for central line-associated bloodstream infections when central line utilization rates are increased and are inserted inappropriately, based on patient criteria. Purpose: Determine if utilization of the Michigan Appropriateness Guidelines for Intravenous Catheters (MAGIC) will reduce central line utilization ratios (focusing on peripherally inserted central catheters (PICC)) and reduce risk of central line-associated bloodstream infections among an adult population in the Trauma Surgical Care Unit (TSCU) and Medical Intensive Care Unit (MICU) at a tertiary care center in the South Carolina Pee Dee Region. Methods: The Plan Do Study Act (PDSA) quality improvement model was used to determine if implementing MAGIC reduced utilization and infection ratios in the TSCU and MICU at a tertiary care center (Moran, K. et al., 2019). Patients 18 years and older, in the TSCU and MICU prompted for central line placement were included in this DNP project. The intervention included the implementation of MAGIC, prior to insertion of a central line, to determine the appropriateness. Analysis: Pre and Post implementation standard utilization ratios (SUR) and pre and post standard infection ratios (SIR) were compared and no statistically significant change was identified. PICC insertions did decrease during the pilot but did not impact the SUR or SIR in the TSCU and MICU. Implications for Practice: MAGIC will assist the PICC insertion team, bedside staff, physicians, and medical residents to determine if a PICC line is appropriate for the patient prior to insertion. This may reduce the risk of inappropriate insertion, decrease inappropriate utilization, and decrease the risk of infection leading to cost reduction of treating a patient for a hospital-acquired infection from a PICC line.

Introduction

In the United States, central-line associated bloodstream infections (CLABSI) account for 250,000 hospital-acquired infections per year (Haddadin et al., 2022). Central line-associated bloodstream infections can lead to sepsis, an infection of the bloodstream, resulting in 28,000 deaths per year (Central Line-Associated Bloodstream Infections (CLABSI), 2021). The tertiary care center recognized an increase in central line-associated bloodstream infections and utilization ratios, especially in PICC lines, in July, August, and September 2022. Through root cause analysis studies, the infection prevention department determined that, in more than 50% of central line-associated bloodstream infections, criteria for insertion of a central line were unmet. The facility did not utilize a guideline for criteria for the insertion of central lines (K. Medlin & M. King, personal communication, September 15, 2022). In collaboration with the infection preventionist and the director of nursing of the heart and vascular intensive care unit, an evidence-based guideline, Michigan Appropriateness Guidelines for Intravenous Catheters (MAGIC), was initiated as a DNP project to determine if the appropriateness for PICC line insertion will impact utilization ratios and central line-associated bloodstream infections (K. Medlin & M. King, personal communication, September 21, 2022).

Background

More than 4 million PICC lines were placed in 2021 in the United States (Murphy et al., 2021). Since 2020, according to C. Kirven (personal communication, October 5, 2022), the number of avoidable PICC insertions increased by 17% at the tertiary care center and by 18.3% in the United States (Fakih et al., 2021). Patients admitted to the tertiary care center have a PICC line inserted unnecessarily for multiple blood draws, convenience, or if the patient is a difficult stick, according to physician orders in Cerner.

The tertiary care center uses a measurement tracking tool for central line use, advised by National Healthcare Safety Network (NHSN), which is the standard utilization ratio (SUR) and standard infection ratio (SIR). SUR is defined by the number of observed central line days divided by the number of predicted central line days. The number of observed days is defined by the total number of days a central line was used and the predicted is defined by NHSN as pooled data that is risk-adjusted for location, hospital beds, and facility type. The standard infection ratio is defined by the observed number of CLABSIs divided by the predicted CLABSI. The observed is the total number of infections identified and the predicted is defined by NHSN as pooled mean multiplied by the number of procedures or device days (NHSN, 2022). At the tertiary care center, as of August 2022, the year-to-date overall SUR was 0.73 per 1000 patient days and the central line-associated bloodstream infection ratio (SIR) was 0.92 per 1000 patient days. The SUR in the Trauma Surgical Care unit was 0.90 per 1000 patient days with a SIR of 0.89 per 1000 patient days. The SUR for the Medical Intensive Care Unit is 1.23 per 1000 patient days with a SIR of 0.90 per 1000 patient days (King, 2022).

The infection prevention dashboard at the tertiary care center utilizes the 2020 data provided by the CDC to determine areas with opportunities for improvement. The national SUR for 2020 was 0.90 per 1000 patient days and the SIR was 0.86 per 1000 patient days. The South Carolina standard utilization ratio was 0.79 per 1000 patient days and the standard infection ratio was 0.77 In comparison, the TSCU and MICU SUR and SIR, as of August 2022, were greater than the 2020 national and state SUR and SIR (Centers for Disease Control and Prevention [CDC], 2021).

In addition, an evidence-based guideline was not implemented to determine the appropriateness of insertion for central line catheters although the tertiary care center does a root

cause analysis that inquires if criteria for insertion of the central line were met. According to the analysis 50% of the patients had PICC lines that could have had midline catheters inserted instead.

The Michigan Appropriateness Guidelines for Intravenous Catheters (MAGIC) is an evidence-based guideline used to determine if the placement of a central line is appropriate. This DNP project mainly focused on the appropriateness of PICC line insertions. MAGIC was developed using the foundation of RAND's Corporation/University of California Los Angeles (RAND/UCLA) Appropriateness Method, which measures the overuse of medical or surgical procedures. MAGIC establishes clear guidelines for insertion of PICC lines, one of the leading misused devices due to misinterpretation of appropriateness (Chopra et al., 2015). MAGIC defines the appropriateness for a PICC line as shown in Figure 1.

Figure 1.

MAGIC indications for PICC line insertions

Appropriate Indications for PICC Use
Delivery of peripherally compatible infusates for 6 days or greater
Delivery of non-peripherally compatible infusates, regardless of duration of use
Delivery of cyclical or episodic chemotherapy that can be administered through a peripheral vein in patients with active cancer greater than 3 months
Invasive hemodynamic monitoring or requirement to obtain central venous access in a critically ill patient for 15 days or more
Frequent phlebotomy, every 8 hours, in a hospitalized patient for 6 days or greater
Intermittent infusions or infrequent phlebotomy in patients with poor or difficult peripheral venous access for 6 days or greater
Infusions or palliative treatment during end-of-life
Delivery of peripherally compatible infusates for patients residing in skilled nursing facilities or transitioning from hospital to home for 15 days or greater

Note. This table is a representation of MAGIC and the indication for PICC line insertions. (Woller et al., 2015).

Implementation of MAGIC defines appropriate criteria for intravenous catheters to prevent insertion of intravenous devices that are not indicated. Florence Nightingale's Environmental Theory involves scanning the environment to look beyond the patient by assessing their necessities and practice as wise and humane, thereby avoiding harm from infection (Nair, 2020). This DNP project aligns with Nightingale's Environmental Theory as the goal of MAGIC is to determine the appropriateness of intravenous catheter insertion, therefore enforcing the use of critical thinking skills to provide appropriate devices that are necessary for the patient. The use of appropriate guidelines, such as MAGIC, promotes health and a healing environment to decrease the risk of harm to all patients.

In summary and based on the information gathered, the purpose of this DNP student's quality improvement project was to answer the clinical question, will implementation of the Michigan Appropriateness Guidelines for Intravenous Catheters (MAGIC) impact utilization ratios and central line-associated bloodstream infections in the Trauma Surgical Care Unit and Medical Intensive Care Unit at the tertiary care center? This DNP student's project was supported by hospital administration, the corporate infection prevention director, mid-level leadership, the clinical effectiveness team, physicians and the PICC insertion team. The Model for Improvement framework (PDSA) was used to determine whether implementing MAGIC guidelines would lead to a reduction of utilization and central line-associated bloodstream infection ratios in PICC lines (Moran, K. et al., 2019).

Methods

The Plan, Do, Study, Act (PDSA) Model, as shown in Figure 2, was used to implement MAGIC within the Trauma Surgical Care Unit and Medical Intensive Care Unit at the selected tertiary care center. During the Plan phase, a team was recruited and included the corporate

infection preventionist, infection prevention department, Director of the Heart and Vascular Intensive Care Unit, Director of the Trauma Surgical Care Unit, Director of the Medical Intensive Care Unit, PICC line insertion team, and the Chief Medical Officer. The team determined that guidelines for insertion of PICC lines were not utilized, but criteria for use are assessed when reviewing central line-associated bloodstream infections through root cause analysis. The team also identified that PICC line insertions have increased by 17% since 2021 in the Trauma Surgical Care Unit and the Medical Intensive Care Unit (King, 2022). If a patient does not require a PICC line, utilization ratios will decrease and infection ratios will decrease as well. Collectively, it was determined to implement and perform this pilot project in the TSCU and MICU using MAGIC guidelines for the insertion of PICC lines to reduce utilization and infection ratios.

In the Do phase, MAGIC was implemented and used as the measurement tool and a required field with all central line orders and order sets in the new electronic medical record. The department charge nurses, patient care supervisors, and DNP student reviewed all patients with PICC lines, daily, and determined the if indication fields were appropriately selected within the PICC line order using the MAGIC audit created by the DNP student. Department leaders collected line data daily, which was sent to the infection preventionist. The infection preventionist then calculated the utilization ratios and infection ratios and added the data to a dashboard. The updated dashboard was shared with the DNP student monthly. The student collected data twice weekly, Tuesday and Friday, for 90 days. The data collected consisted of age, gender, race, diagnosis, and appropriateness for insertion. The team met weekly to discuss processes that were working well, barriers, and current results of the evidence-based guideline implementation. During the Study phase, data were collected and interpreted by performing a

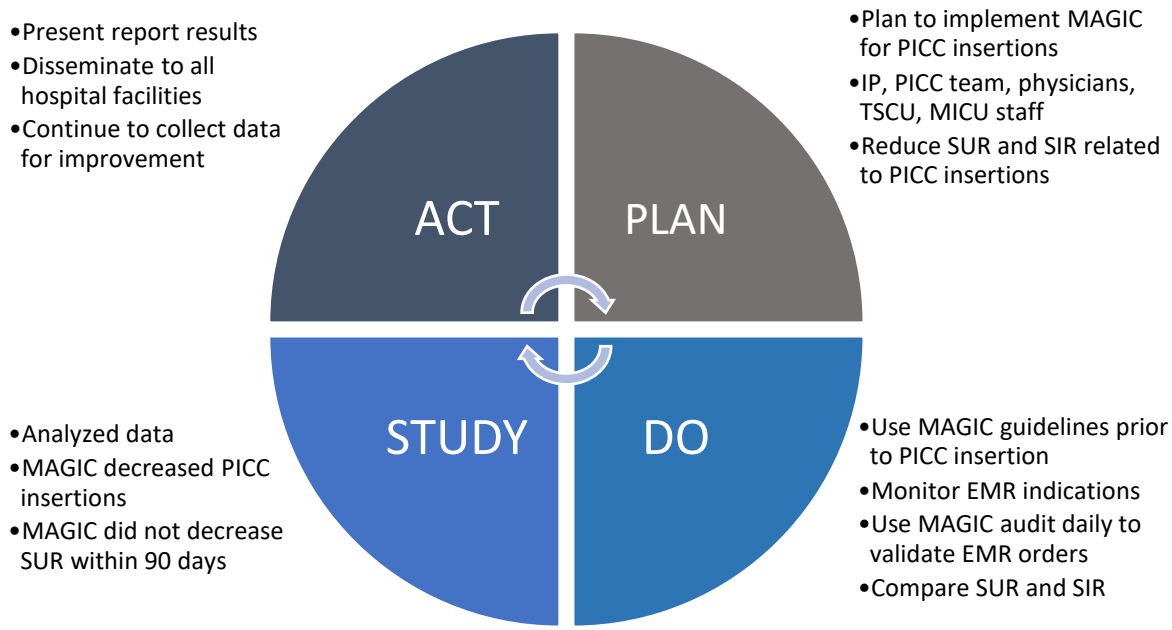
two-tailed paired t-statistic test to determine the statistical significance between utilization ratios and central line-associated bloodstream infections ratios. Compliance with MAGIC and root cause analysis for CLABSI were reviewed also (Moran, K. et al., 2019).

During the Act phase, the implementation of the evidence-based guidelines was reviewed to determine the impact on utilization and infection ratios in patients with PICC lines. In addition to weekly results, project completion results were shared with all team members and departmental stakeholders, including bedside staff employees.

MAGIC required little cost to implement but will generate a return in revenue if the Tertiary care center decreases utilization ratios and infection ratios related to central lines; The average cost of a PICC device is $2,833.00 plus the cost of insertion (Non-tunneled Peripheral Venous Catheter, 2022). The average cost of a central line-associated bloodstream infection is $31,000.00 (Estimating the Additional Hospital Inpatient Cost and Mortality Associated with Elected Hospital-Acquired Conditions, 2017). With decreasing utilization and infection ratios by implementing MAGIC, the hospital has the potential to save more than $2,000.00 per PICC insertion and more than $32,000.00 per CLABSI.

Figure 2.

MAGIC: PDSA- Quality Improvement Model



Note. This diagram is a representation of the Plan, Do, Study, Act (PDSA) quality improvement model (Moran et al., 2019).

Results

Results indicate that there was not a statistically significant change in the SURs pre and post implementation or in the SIRs pre and post implementation over 90 days. Paired t-tests were completed to examine the pre and post SUR and SIR data. In 2020, MICU had higher utilization ratios with no infection ratios prior to the implementation of MAGIC. Post-implementation, MICU continued to sustain an infection ratio of 0. When comparing pre- and post-implementation infection ratios for TSCU, pre-implementation data indicated that the TSCU had one CLABSI that was related to inappropriate placement of a PICC line. Post-implementation

one CLABSI was identified and unrelated to the appropriateness of insertion of a PICC line, but due to maintenance related to non-compliance, according to the root cause analysis.

Age, gender, race, diagnosis, and length of line days were included in data collection but did not impact results. Ages ranged from 22 years of age to 87 years of age, more men than women required PICC line insertions, and races consisted of African American and Caucasian descent. Patients in the TSCU requiring PICC insertions, were admitted for trauma-related surgical indications and required medications. Patient in the MICU requiring PICC insertions, required incompatible medications, glomeruli filtration rate was less than 44 ml/min, and end-of-life care. All patients required a PICC line greater than 6 days and required frequent use of phlebotomy for 6 days or more.

Discussion

During the implementation phase of this DNP project, from March 2023 to June 2023 there was a decrease in SUR in the last 30 days in both departments. The most recent SUR for January 2023 to June 2023, in the MICU, was 1.19 indicating a decrease from the SUR of 1.23 as of August 2022. As of June 2023, SIR for MICU is 0, indicating a decrease from the SIR of 0.90 in August 2022. As of June 2023, SUR for TSCU was 0.91, indicating sustainment when compared to the SUR in August 2022 of, 0.90. As of June 2023, the SIR for TSCU was 0.70 indicating a decrease from the SIR of 0.80 as of August 2022. Although MAGIC had little impact on SUR, PICC insertions alone decreased post-implementation, meaning the appropriateness guidelines did impact PICC insertions as patient days did not decrease during the implementation phase.

The strengths of this DNP project include facility support for quality improvement to decrease the utilization and infection ratios to be at or below the state and national ratios.

Physicians provided input and support by reviewing the criteria and presenting MAGIC to fellow physicians to support the use of MAGIC in all departments. Clinical staff were receptive to MAGIC and appreciative of the guidelines as reduction in utilization and infection ratios were upcoming quality goals for the departments involved. Administration helped make this project successful by supporting MAGIC providing material and human resources for implementation to increase patient safety and promote appropriateness for insertions of PICC lines.

Limitations include the transition of an electronic medical records (EMR) system during the implementation of MAGIC. MAGIC was not initially part of the central line orders or order sets in the EMR, but it was added just prior to data collection. The timeframe for data collection was 90 days and the most noticeable decrease in utilization ratios was in the last 30 days. Staff adaptation and compliance with the newly required field of the order was a barrier to the first 60 days of data collection. Due to the transition to a new electronic medical record system, report validation was planned to take up to six months, therefore during the data collection phase of this project, reports for central lines were not validated through the electronic medical record and were manually validated. Additionally, TSCU and MICU were staffed with agency nursing staff, leading to a barrier as agency staff are not as invested in company quality improvement. Quality managers of the departments were required to resume bedside staffing to decrease the amount of agency nursing staff and financial burden, decreasing an extra layer of management to assist with project compliance, all of which could have impacted the results of this project.

Conclusion

It is recommended that the quality and clinical teams continue with the PDSA quality improvement model and continue to collect data to determine statistical significance over an extended period. MAGIC applies guidelines for all intravenous catheter insertions, not only

PICC lines. Medical residents, physicians, advanced practice providers, and licensed clinical bedside staff can use MAGIC as a resource for the insertion of intravenous catheters in all patients. Medical residents are required to insert a minimum of four central lines per month to remain competent with insertions during their residency program. MAGIC will enhance their knowledge of the appropriateness of intravenous insertions. MAGIC also provides a free mobile app that has limited questions to indicate which intravenous catheter is appropriate for a patient. The data analysis team opted out of this resource during the data collection phase, as raw data was indicated. It was determined that the app would be utilized later when spreading MAGIC to all departments of the facility and outlying facilities. Patient safety was heightened with the implementation of MAGIC and implementation and data will continue to be collected across all outlying facilities of the tertiary care system.

References

Central line-associated bloodstream infections (clabsi). (2021). Agency for healthcare research and quality. https://www.ahrq.gov/topics/central-line-associated-bloodstream-infections-clabsi.html

Centers for Disease Control and Prevention. (2021). Current hai progress report. https://www.cdc.gov/hai/data/portal/progress-report.html#Tables

Chopra, V., Flanders, S. A., Saint, S., Woller, S. C., O'Grady, N. P., Safdar, N., Trerotola, S. O., Saran, R., Moureau, N., Wiseman, S., Pittiruti, M., Akl, E. A., Lee, A. Y., Courey, A., Swaminathan, L., LeDonne, J., Becker, C., Krein, S. L., & Bernstein, S. J. (2015). The michigan appropriateness guide for intravenous catheters (magic): Results from a multispecialty panel using the rand/ucla appropriateness method. Annals of Internal Medicine, 163(6_Supplement), S1–S40. https://doi.org/10.7326/m15-0744

Estimating the additional hospital inpatient cost and mortality associated with elected hospital-acquired conditions. (2017, November). Agency for healthcare research and quality. https://www.ahrq.gov/hai/pfp/haccost2017-results.html

Haddadin, Y., Annamaraju, P., & Regunath, H. (2022). Central line associated blood stream infections. National Library of Medicine.

Intellectus Statistics [Online computer software]. (2023). Intellectus Statistics. https://analyze.intellectusstatistics.com/

King, M. (2022). HAI SUR/SIR dashboard [Unpublished raw data]. standard utilization and infection ratios.

Moran, K. J., Brunson, R., & Conrad, D. (2019). *The doctor of nursing practice project* (3rd ed.). Jones & Bartlett Learning.

Murphy, K., Alsbrooks, K. G., Kokotis, K., & Heath, K. C. (2021, September 24). Optimization of peripherally inserted central catheter placement practices - patient safety & quality healthcare. Patient Safety & Quality Healthcare. https://www.psqh.com/analysis/optimization-of-peripherally-inserted-central-catheter-placement-practices/

Non-tunneled peripheral venous catheter. (2022). MDsave. https://www.mdsave.com/procedures/non-tunneled-peripheral-venous-catheter-picc/d582ffcb#:~:text=How%20Much%20Does%20a%20Non,their%20procedure%20up front%20through%20MDsave.

The NHSN standardized utilization ratio (SUR) - Centers for disease ... (2022, April). https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/nhsn-sur-guide-508.pdf

Woller, S. C., Stevens, S. M., & Evans, R. (2015). The Michigan appropriateness guide for intravenous catheters (magic) initiative: A summary and review of peripherally inserted central catheter and venous catheter appropriate use. Journal of Hospital Medicine, 11(4), 306–310. https://doi.org/10.1002/jhm.2525