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Implementing Change: The use of Minocycline-Rifampin Impregnated Central Venous Catheters in Central Line Associated Blood Stream Infection Prevention in Critically Ill Patients

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Implementing Change: The use of Minocycline-Rifampin Impregnated Central Venous Catheters in Central Line Associated Blood Stream Infection Prevention in Critically Ill Patients

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Abstract

Introduction: At a large academic healthcare facility in the northeast a Gap Analysis was conducted finding quality improvement opportunities for central line associated blood stream (CLABSI) prevention in critically ill patients. Review of literature reveals the use of minocycline-rifampin impregnated (MNRI) central venous catheters (CVCs) as being an effective intervention in CLABSI prevention.

Methods: Several assessments were conducted regarding the implications of updating the facilities practice to reflect this evidence including AHRQ Gap Analysis Tool, a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis, Stakeholder Feedback, and Resource Allocation.

Results: Facilitators and barriers were identified in implementing this practice change as the facility. Themes were identified based on stakeholder feedback, and important multidisciplinary team members were identified in being required to assist in practice change.

Discussion: Implementation of this practice change is feasible at this facility and engagement of more key stakeholders will be necessary to progress. The Gap Analysis provided useful data in planning this practice change and is recommended to be used as a tool when implementing change.

Keywords: Central venous catheter, central line associated blood stream infection, catheter colonization, minocycline-rifampin impregnated, practice change, quality improvement, Gap Analysis

Introduction

Problem Description

At a large academic healthcare facility in the northeast, there is an organization-wide initiative to reduce Healthcare Associated Infections (HAIs) across facilities to reduce costs and improve patient outcomes. One HAI that is of particular focus is central line associated blood stream infections (CLABSIs) in critically ill patients. CLABSIs are costly and deadly HAIs, attributed to 28,000 deaths in critically ill patients annually (AHRQ, 2022) and incurring a cost of $48,108 to the hospital, being the costliest HAI (AHRQ, 2017). This facility has a dedicated committee named the "CLABSI Task Force," to identify interventions to reduce CLABSIs at the facility. Given the focus on CLABSI reduction at this facility, a Gap Analysis was conducted to identify opportunities for improvement.

Available Knowledge

In reviewing literature regarding best practices to prevent CLASBI in critically ill patients requiring a central venous catheter (CVC), multiple interventions were highlighted and evaluated in high quality literature. During this review, one practice recommendation that was of particular interest was the use of antimicrobial impregnated CVCs and their effectiveness in prevention of CLABSI. Given that this intervention is currently not being utilized at this specific facility, review of the literature regarding the use of antimicrobial impregnated CVCs in CLABSI prevention has significant utility for the potential to implement meaningful practice change.

Search Methods, Inclusion/Exclusion Criteria, and Quality Appraisal

The search engine Pubmed was used to conduct this review of literature. The search terms “antimicrobial impregnated central venous catheter” were used with limiters of publication within the last 10 years, English language only, and full text available, which yielded a total of 95 publications for review. Inclusion criteria consisted of studies on adult patients (>18 years-old) in critical care settings. Exclusion criteria consisted of studies that did not review infection prevention, did not evaluate antimicrobial impregnated CVCs (such as peripherally inserted central venous catheters, antimicrobial dressings), did not evaluate effect on CLABSI, occurred in only non-critical care settings, and reviewed non adult patients (<18 years-old). After title and abstract review using these criteria a total of eight publications were selected for in-depth review. A quality assessment was performed using the Joanna Briggs Institute (JBI) Levels of Evidence Grading Tool (JBI Levels of Evidence, 2013). Inclusion criteria based on level of evidence were studies that had a score of one or two, which consisted of four studies including one systematic review, two meta-analyses and a controlled study.

Systematic Review 2013

The first systematic review conducted by Lai et. al. (2013) was a systematic review of 55 randomized control trials (RCTs) consisting of 16,512 catheters evaluating the differences between antimicrobial impregnated CVCs compared to non-impregnated CVCs (NO-I-CVC). The authors found a statically significant difference in development of CLABSI (risk ratio [*RR]*=0.61 [95% CI 0.51 to 0.73]), catheter colonization (*RR*=0.66 [95% CI 0.58 to 0.75]), and catheter colonization per 1,000 catheter days (*RR*=0.70 [95% CI: 0.51 to 0.96]), favoring antimicrobial impregnated CVCs (Lai et al., 2013). The authors then performed a meta-analysis comparing two different types of antimicrobial CVCs, minocycline-rifampicin-impregnated (MNRI) and chlorhexidine-silver sulfadiazine-impregnated (CSSI), with these same metrics and

found MNRI was superior in following metrics; CLABSI (*RR*=0.11 [95% CI 0.02 to 0.5]), CLABSI per 1,000 catheter days (*RR*=0.07 [95% CI 0.01 to 0.43]), catheter colonization (*RR*=0.36 [95% CI 0.25 to 0.5]) (Lai et al., 2013). The authors found no statically meaningful difference between antimicrobial impregnated CVCs and NO-I-CVC in clinically diagnosed sepsis (*RR*=1.0 [95% CI 0.88 to 1.13]) and all-cause mortality (*RR*=0.88 [95% CI 0.75 to 1.05]), although less than 25% of the studies in this review evaluated these metrics (Lai et al., 2013). Limitations to this study include nonblinding in the studies evaluated due to the difference of appearance of impregnated CVCs compared to NO-I-CVCs and a mix of critically ill and non-critically ill patients evaluated. However, >50% of patients were critically ill, and the authors were able to separate these two subgroups and found that antimicrobial impregnated CVCs had a greater effect in the metrics measured in critically patients compared to non-critically ill patients. Additionally, this review has a JBI score of one, reviewed many RCTs (n=55) and catheters (n=16,512), and many consisted of head-to-head trials of different types of CVCs. These findings support the use of antimicrobial impregnated CVCs in reduction of CLABSI, with MNRI being the most effective.

Meta-Analysis 2017

The next study conducted by Chong et. al. (2017) was a meta-analysis of 66 studies focusing on the efficacy of antimicrobial CVCs in reducing CLABSI. Through this analysis a total of 17,255 CVCs were evaluated in the inpatient setting, with >50% being in the critical care setting. Chong et. al. (2017), compared multiple types of antimicrobial CVCs in their effectiveness in reduction of CLABSI. It was found that MNRI CVCs were the most effective in CLABSI and catheter colonization when compared to other CVCs. In CLABSI rate MNRI was superior to NO-I-CVC (*RR*=0.29 [95% CI, .16–.52]), 5FU-impregnated CVCs (5FU-I-CVC;

RR=0.42 [95% CI, .19–.92]), CSS-impregnated CVCs (CSS-I-CVC; *RR*=0.38 [95% CI, .21–.71]), and CHX-impregnated CVCs (CHX-I-CVC; *RR*=0.12 [95% CI, .03–.55]) (Chong et al., 2017). In CLABSI rate per 1,000 catheter days MNRI was superior to NO-I-CVC (rate ratio, 0.28 [95% CI, .11–.74]) and CSS-I-CVC (rate ratio, 0.28 [95% CI, .09–.87]) (Chong et al., 2017). In catheter colonization MNRI was superior to NO-I-CVC (*RR*=0.14 [95% CI, .05–.36]), CSS-I-CVC (*RR*=0.23 [95% CI, .09–.62]), benzalkonium-impregnated CVC (*RR*=0.24 [95% CI, .08–.72]), vancomycin-coated CVC (*RR*=0.18 [95% CI, .06– .54]), silver-platinum-carbon–impregnated CVCs (*RR*=0.15 [95% CI, .06–.42]), and silver impregnated CVC (SIL-I-CVC, *RR*=0.10 [95% CI, .03–.33]) (Chong et al., 2017). Regarding CLABSI rate per 1,000 catheter days an analysis was performed with CSS-I-CVC and found a significant decrease the rate of catheter colonization per 1000 catheter-days when compared with NO-I-CVC (rate ratio, 0.49 [95% CI, .28–.88]) (Chong et al., 2017). Although MNRI was not included in this metric, it had a superior effect in reduction of CLABSI compared to CSSI so it can be assumed that similar findings would be found in comparing MNRI and NO-I-CVCs in this metric. Of note, in non-critically ill patients these findings were not mirrored. There are several limitations to this study, being that there was no blinding in the studies evaluated due to the difference in appearance of impregnated CVCs compared to NO-I-CVCs, there were no head-to-head trials comparing the different types of CVCs, and non-critically ill patients were included although the authors were able to distinguish between critically ill and non-critically ill patients in their analysis. However, this study evaluated many studies (n=66) and catheters (n=17,255) with robust statistical analysis and had a JBI score of one. These findings support the use of antimicrobial impregnated CVCs in reduction of CLABSI, with MNRI being the most effective.

Meta-Analysis 2018

The next study conducted by Wang et. al. (2018) was a meta-analysis of 33 RCTs consisting of 10,464 catheters comparing antimicrobial CVCs to NO-I-CVCs in CLABSI prevention. Wang et. al. (2018), found antimicrobial CVCs to be superior in CLABSI per 1,000 catheter days (*RR*=0.70 [95% CI 0.53–0.91] *p*=0.008]) and catheter colonization (*RR*=0.64 [95% CI 0.55–0.74] *p*<0.0001. The authors also evaluated different types of antimicrobials, comparing antibiotic to anti-infective impregnated catheters using these same metrics. It was found that antibiotic impregnation was superior in CLABSI per 1,000 catheter days (ORs and 95% CrIs: 0.64 [0.40–0.955] and 0.53 [0.25–0.95], respectively) and catheter colonization (ORs and 95% CrIs: 0.44 [0.34–0.56] and 0.30 [0.20–0.46], respectively), when compared to anti-infective impregnation (Wang et al.,2018). Limitations to this study included no blinding in the studies evaluated due to the difference in appearance of impregnated CVCs compared to NO-I-CVCs, lack of verification of antimicrobial concentration in the catheters used in the various studies evaluated, and no comparison in metrics between specific catheter types. However, this study had a JBI score of one, evaluated many RCTs (n=33) and catheters (n=10,464) and only included studies that evaluated critically ill patients specifically. These findings support the use of antimicrobial impregnated CVC in reduction of CLABSI, with antibiotic impregnation being the most effective.

Controlled Study 2017

The last study conducted by Choi et.al. (2017) was a controlled experimental study evaluating the long-term antimicrobial effect of CSSI CVCs. In this study, researchers used a total of 90 CSSI CVCs, subjecting each of them to a total of 120 hours of saline flow, measuring the amount of antimicrobial material on the CVC at 24-hour intervals using energy-dispersive X-ray spectroscopy and scanning electron microscopy. Additionally, CVCs were exposed to

Staphylococcus aureus and optical density testing was used to evaluate level of bacterial colonization. Choi et.al. (2017), found that the weight percentage of silver present on the CVCs decreased to 56.18% within 48 hours and to 18.88% within 120 hours, compared to the initial weight percentage of 78.50%. During the Staphylococcus aureus incubation test it was found that the antimicrobial function of the catheter was lost after 48 hours. Limitations to this study include a flow rate of 5.6 liters per minute of saline used which is more than twice the average cardiac output potentially exaggerating weight percentage of silver lost and reduction in antimicrobial effect, and lack of central pressure monitoring which limited control of the environment in which the catheters were studied. However, this study received a JBI score of two and was conducted in a controlled laboratory setting, adding to its strengths. The results of this study suggest that the use of CSSI CVCs may not be effective past 48 hours for the purpose of antimicrobial function.

Evidence Synthesis

Based on the reviewed literature, it can be determined that antimicrobial CVCs are effective in reducing the risk of CLABSI in critically ill patients when compared to NO-I-CVCs, with MNRI CVCs being the most effective. This literature review consisted of one systematic review, two meta-analyses, and one controlled study. Chong et. al. (2017), Lai et. al. (2013), and Wang et. al. (2018) evaluated many high-quality studies regarding this topic. Consistent metrics were used across these studies, with CLABSI per 1,000 catheter days and catheter colonization being evaluated in each analysis. Additionally, Chong et. al. (2017) evaluated CLABSI rate and Lai et. al. (2013) evaluated catheter colonization per 1,000 catheter days in addition to CLABSI rate. Wang et. al. (2018) evaluated antimicrobial impregnated CVCs compared to NO-I-CVCs and found that antimicrobial impregnation was effective in reducing CLABSI in the metrics

evaluated. Chong et. al. (2017) performed a similar analysis between the two types of CVCs and found similar results, additionally evaluating the effectiveness of different antimicrobials concluding MNRI CVCs performed best in CLABIS prevention. Lai et. al., (2013) found similar results in their analysis finding MNRI CVCs having the greatest reduction in rates of CLABSI. Additionally, analysis of clinically diagnosed sepsis and mortality were evaluated and no statically meaningful difference in this metric was found between antimicrobial CVCs and NO-I-CVCs, although only a small amount of their sample (<25%) measured this outcome (Lai, et. al., 2013). One analysis (Wang, et. al., 2018) exclusively evaluated these metrics in critically ill patients, while the other analysis (Chong, et. al., 2017; Lai et. al, 2013) evaluated a mix of critically ill and non-critically ill patients but were able to differentiate outcomes between the two groups and had >50% on the studies occurring in critically ill patients. These findings unanimously support the use of antimicrobial CVCs for CLABSI prevention with MNRI CVCs being highlighted as the most effective. In support of this finding, Choi et. al. (2017) produced evidence that the antimicrobial effect of anti-infective CVCs (ie CSSI) was lost after 48 hours of use. These findings further suggest that MNRI CVCs are the most effective antimicrobial CVC in reducing CLABSI risk in critically ill patients with CVCs. There are several areas in need of further research for this topic. One would be a similar experimental study to Choi et. al., (2017) conducting a flow test with antibiotic impregnated CVCs (particularly MNRI) to assess the length of time the antimicrobial effect is present. Additionally, evaluation of clinically diagnosed sepsis and mortality should be evaluated in relation to antimicrobial impregnated CVCs as there is a gap in research regarding this outcome. However, based on the most current evidence it can be concluded that antimicrobial (particularly MNRI) impregnated CVCs are effective in risk reduction for CLABSI compared to NO-I-CVCs in the critically ill patients.

Rationale

The theory of clinical microsystems and cascading measures (Nelson et. al., 2011), was utilized in the development of this Gap Analysis. The authors state that overarching goals cascade down to the different levels of systems in healthcare, from the metasystem, macrosystem, mesosystem, down to the microsystem. In using this theory, one can track specific process and outcome measures at the microsystem level back up through to the metasystem, finding a line of connection to the top of the organization. In this case, the governing healthcare organization has a goal to reduce HAIs which can be tracked down to the microsystem specific goal of reducing CLABSIs. Having consistency throughout the different levels of systems within healthcare ensures that all systems are in line with one common goal.

Global Aim

The global aim for this project was to perform a Gap Analysis comparing the current practices of this facility in CLABSI risk reduction in critically ill patients to current evidence-based practices and identify characteristics that facilitate and hinder practice updates.

Methods

Context

This topic for this Gap Analysis was selected based on conversations with one member of the nursing leadership team at a large academic healthcare facility in the northeast. The leadership team at this facility had not identified CLABSI prevention as a specific area in need of quality improvement but is committed to continuous evaluation of CLABSI prevention strategies as evidenced by the use of the CLABSI Task Force meeting monthly. This facility uses Standardized Infection Ratio (SIR) to determine the facilities performance regarding CLABSI

occurrence. A value of 1 in the SIR is the predicted amount of CLABSI specific to the institution based on various factors such as facility size and types of patients treated (CDC, 2022). For the time frame of March 2022 to March 2023 the average score for this facility was 0.81, roughly 19% below the predicted amount of CLABSI occurrence (MGH, 2023, Quality and Safety).

Interventions

Several assessments were conducted using the various steps identified in a Gap Analysis including the Agency for Healthcare Research and Quality (AHRQ) Gap Analysis Tool, a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis, Stakeholder Feedback, and Resource Allocation. The AHRG Gap Analysis Tool assisted in identifying how the facilities current practices differ from best practice guided by evidence and allows for the development of strategies to enhance practices to be in-line with current evidence. This assessment highlighted the facilities current policies for CLABSI prevention including sterility of insertion (MGH, 2023, Non-Tunneled Central Venous Catheter Overview), chlorhexidine patch on insertion site (MGH, 2022), sterile dressing change every seven days (MGH, 2022), needless connector change every 96 hours (MGH, 2022), use of antimicrobial caps on non-accessed needleless connectors and non-accessed ports on infusion lines (MGH, 2021), and unofficially, changing infusion lines every 96 hours (not currently a hospital policy but done in practice).

Measures and Analysis

Of the identified assessments, Stakeholder Feedback will yield reportable data and will be evaluated for themes using a qualitative approach. In this survey a series of 10 questions were asked to assess the following areas of interest regarding the proposed practice change: needs assessment, applicability in defined patient population, contraindications to use, barriers to

implementation, and concerns and endorsement. The obtained data will be categorical nature and descriptive statistical analysis was used for categorical data noting frequency and percentage.

Ethical Considerations

This project was not subject to Internal Review Board (IRB) review, as the Gap Analysis is a specific type of quality improvement and as such is exempt from full IRB review

Results

AHRQ Gap Analysis Tool

The AHRQ Gap Analysis Tool also highlighted barriers to bridging policy to reflect current evidence. Identified barriers included: 1) staff education, 2) no policy regarding the use of MNRI CVCs, and 3) lack of a four-lumen option from current manufacturer used by the facility.

Table 1. AHRQ Gap Analysis Tool

Table 1			
AHRQ Gap Analysis Tool			
Best Practice Strategies	**How Your Practices Differ From Best Practice**	**Barrier to Best Practice Implementation**	**Will Implement Best Practice (Yes/No; why not?)**
Best Practice #1: Identify strategies for CLABSI risk reduction			
Use of MNRI CVC (Chong et. al., 2017; Lai et. al., 2013; Wang et. al., 2018)	Current policy for CVC insertion and maintenance for CLABSI risk reduction include • Sterile technique for CVC insertion (MGH, 2023) • Use of chlorhexidine patch on insertion site under sterile	Staff knowledge regarding efficacy of MNRI CVCs in CLABSI risk reduction. Policy does not indicate use of MNRI CVC as standard of care for critically ill patients.	Yes: education will be provided to staff and policy will be updated to reflect best practice.

	dressing (MGH, 2022) • Changing sterile dressing (MGH, 2022), needleless connector (MGH, 2020) every 96 hours • Changing sterile dressings every 7 days • Use of antimicrobial caps on needless connector when not accessed and on all non-accessed ports on infusion lines (MGH, 2021) • Use of antimicrobial lock therapy to treat CLABSI when CVC not able to be removed (MGH, 2016)	Currently facility only carries 3 lumen MNRI CVC. 4 lumen MNRI CVC are available but not carried and catheter is larger bore.	
Best Practice #2: Improved communication regarding use of MNRI CVC			
Communicate use of MNRI CVC and contraindications to use if not being utilized by means of communication tool/checklist (Wang et al., 2017).	"Time-out" is completed and documented prior to central line insertion. Currently no prompt to discuss or document use of MNRI CVC or contraindications if not used (MGH, 2023)	Documentation system does not provide functionality to indicate the use of MNRI CVC or contraindications to MNRI CVC.	Yes: collaboration with information technology to update documentation system to provide option to indicate if MNRI CVC was sued and contraindication if not used .

SWOT Analysis

The SWOT analysis further assisted in identifying facilitators and limiters in implementing practice change to reflect current evidence regarding the use of MNRI CVCs in CLABSI risk reduction (Table 2). Identified strengths include: 1) existing evidence supporting practice change, 2) large research institution with goals of implementing more robust evidence-based practice, 3) large volume of high acuity patients, 4) highly skilled and educated nursing and provider staff, 5) no need for alteration in insertion techniques, 6) robust education department, and 7) product is already stocked at facility. Identified weakness include: 1) potential costs, 2) culture of resistance to practice change, 3) lack of four-lumen MNRI CVC available, 4) potential allergic reactions to antibiotic coating, 5) need for staff education on practice change, 6) potential for increase in antibiotic resistant infections, 7) potential for increased documentation demand on nursing staff, and 8)change in current practices of stocking product. Identified opportunities include: 1) having a meaningful impact on patient outcomes, 2) adding to existing literature regarding this practice, 3) ability to change policy, 4) fostering multidisciplinary collaboration to an institution wide problem, 5) encouraging a culture of implementing practice based on evidence, and 6) engaging staff in making practice change/professional development opportunities. Identified threats include: 1) non-compliance among staff, 2) supply/stocking issues, 3) potential inability to utilize in patients with significantly high acuity needing >3 lumen catheter, 4) interpersonal conflict among staff enforcing new policy/staff not following new policy, 5) risk of infections that are antibiotic resistant, 6) potential cost outweighing savings, and length of process to change policy/implement change.

Table 2. SWOT Analysis

Table 2

SWOT Analysis		
Internal Origins	*Strengths*	*Weaknesses*
	♦ Existing evidence supporting practice change ♦ Large research institution with goals of implementing more robust evidence-based practice ♦ Large volume of high acuity patients ♦ Highly skilled and educated nursing and provider staff ♦ No need for alteration in insertion techniques ♦ Robust education department ♦ Product already stocked at facility	♦ Potential Costs ♦ Culture of resistance to practice change ♦ Lack of 4 lumen catheter stocked/of the same bore size ♦ Potential allergic reactions to antibiotic coating ♦ Need for staff education on practice change ♦ Potential for increase in antibiotic resistant infections ♦ Potential for increased documentation demand on nursing staff ♦ Change in current practices of stocking product
External Origins	*Opportunities*	*Threats*
	♦ To have meaningful impact on patient outcomes ♦ Add to existing literature regarding this practice ♦ Ability to change policy ♦ Foster multidisciplinary collaboration to an institution wide problem ♦ Encourage a culture of implementing practice based on evidence ♦ Engage staff in making practice change/professional development opportunities	♦ Non-compliance among staff ♦ Supply/stocking issues ♦ Inability to utilize in patients with significantly high acuity needing >3 lumen catheter ♦ Interpersonal conflict among staff enforcing new policy/staff not following new policy ♦ Risk of infections that are antibiotic resistant ♦ Cost outweighing savings ♦ Length of process to change policy/implement change

Stakeholder Feedback

To obtain stakeholder feedback a PowerPoint™ regarding the project was sent to all members of the CLABSI task force with a Qualtrics™ survey, with a total of 10 respondents.

Survey Analysis

Needs Assessment. Two questions were used to assess the perceived need for a practice change regarding CLABSI prevention. All 10 participants responded yes to the question “Do you

believe there is room for improvement in CLABSI prevention at (facility)?" Additionally, the question "Do you believe current CLABSI prevention strategies are sufficient? (if no please explain)," was asked with 60% of participants answering yes and 40% answering no. Two participants provided free text responses to their submission of "no" including: *"Until we have zero CLABSIs, no, our preventative strategies are not yet sufficient. Opportunities for continued improvement include, but are not limited to: Closing the gap between policy and practice; consider transitioning from 70% IPA prep pad to an alcohol-based CHG prep pad for scrubbing/ disinfecting needleless connector; adoption of an antimicrobial/antithrombotic CVC that can be used for high risk patients (e.g., critical care, hx of CLABSI/ bacteremia, etc.),"* *"There may be when there is full compliance but we are working on that."*

Applicability in Defined Patient Population. Three survey items were used to assess perceived applicability to patients in the critical care setting at the facility. The facility currently stocks 3 lumen MNRI CVCs by special order to specific units. The manufacturer produces 5 lumen MNRI CVCs as well but does not produce 4 lumen alternative. To assess the impact of this limitation the question "Is the use of 3 lumen or 4 lumen CVCs more common in your patient population?" was asked to identify how frequently 4 lumen CVCs are currently being utilized. 40% of participants stated that 3 lumen CVCs were most used in their practice environment, 30% stated that 4 lumen CVCs were most common, and 30% stated they were not sure. To further assess how to lack of a 4 lumen MNRI CVC option would impact this practice change the question, "Currently, only 3 and 5 lumen MNRI CVCs are available. Would the lack of 4 lumen MNRI CVC deter you from supporting this practice change?" was asked. 100% of participants responded with a negative response.

Contraindications of Use. Several contraindications to the use of MNRI CVCs in critically ill patients at the facility have been identified including allergy to MNR and need for 4 lumen CVC. To gain additional perspective to potential contraindications to use the question "Identified contraindications are allergy to MNR and need for 4 lumen CVC. Can you identify any other potential contraindications? (if yes please explain)." 80% of participants responded no and 20% responded yes with the following free text; *"Is there a power port?"* and *"Known resistant organisms."*

Barriers to Implementation. Two survey items were used to assess potential barriers to implement. First the question "Do you believe staff would be receptive to this practice change? (if no please explain)." 100% of participants responded with an affirmative response indicating staff would be receptive to this practice change. The participants were then given the opportunity to identify any barriers they perceived via free text with the question "Can you identify any other potential barriers to implementation of this practice change? (if yes please explain) (cost is relatively equal in MNRI and non-MNRI CVCs)." 50% participants responded no and 50% responded yes. The following free text responses were submitted; *"If there wasn't consensus amongst the appropriate stakeholders," "Standardization across (facility) ICUs (Intensive Care Unit) and (organizational) critical care," "Physician preference," "Not sure if these are power injection safe," "Provider education/support."*

Concerns Regarding Practice Change, Endorsement, and General Feedback.

Concerns regarding the practice change were evaluated using the survey item "Would you have any concerns if the use of MNRI CVCs became standard practice? (if yes please explain)." 70% participants responded no and 30% responded yes. For those that responded yes, the following free text was provided; "*This decision should be decided based on risk and CLABSI rates. It may*

not be necessary for all patients. Also, why MNRI and not CHG impregnated catheters?" "*I have concerns using abx beyond active infection and risk for resistance*" "*Resistance potentially*."

Participants also had the opportunity to endorse further investigation into this practice change and provide general feedback via a free text option. To the question "Would you endorse further investigation in this product/practice change?" 100% of participants answered yes indicating they support further investigation into this topic. When given the option to provide general feedback via free text no participants responded.

Resource Allocation

There are several considerations that need to be highlighted when addressing resources that would be needed to support this practice change. First, the proper process would need to be followed to officially change the policy at the facility. Additional literature review would need to be conducted by the facilities research staff to independently verify the evidence supporting this practice. Additionally, the infection control department and managing ICU attending team would need to evaluate the evidence and proposed policy change and grant approval in addition to the CLABSI task force made up of nursing leadership and educational staff. Proper educational support would need to be provided by the facilities professional development department to assist in the creation and dissemination of an online education module for nursing and provider staff in critical care settings. This process would also require assistance from the facilities information technology team to aid in the development of an online module. In addition to supplemental education, unit specific Nursing Practice Specialists (NPS) would need to be engaged to provide real time education at the bedside, ensure compliance with the new policy, and engage staff who are resistant to the practice change. From a data collection perspective, to

assess the efficacy of the practice change at the facility, the research department would be needed to assist with data collection and interpretation.

Currently MNRI CVCs are stocked at the facility via special order for specific units. The involvement of materials management would be required to ensure the product is stocked on all critical care units to ensure reliable access to the product. Cost is also a consideration that would need to be evaluated. In communication with materials management staff at the facility, the cost of the NO-I-CVC is $102, and the cost of the MNRI CVC is $112, and increased cost of $10 per item (Plowright, 2022). However, the typical CLABSI results in an expense of $48,108 to the institution (AHRQ, 2017). Given the marginal price difference between the two products and the efficacy of MNRI CVC in reduction of CLABSI rates, this practice change would result in net savings for the institution.

Discussion

Summary

This Gap Analysis identified a practice area that is not in-line with current evidence, the use of MNRI CVC's in CLABSI prevention in critically ill patients. Review of facilities policies, identifying facilitating and hindering factors to practice change, obtaining stakeholder feedback, and planning resource allocation assisting in developing a strategy to implement practice change at this facility to reflect current evidence.

Strengths

The Gap Analysis encourages the project lead to look to research to find solutions which fosters a culture of evidenced based practice. It engages the project lead to expand their thinking about practice change and synthesize all necessary information regarding practice change.

Additionally, engagement of key stakeholder is a step that enhances the process. Taking one's findings to those that will have investment in the practice change allows for the project lead to evaluate their proposed change and determine if alterations need to be made to engage the support of the key stakeholders. Although implementation of the practice change is not essential to the process, the Gap Analysis provides a very strong foundation to support meaningful change. Having the components of the Gap Analysis completed would enhance the process of a quality improvement project, especially when presenting findings to groups that determine how, when, and if change should occur. The data gathered in through this process bolsters one's argument for a need in practice change and would increase one's chances of successfully implementing meaningful change in practice.

Interpretation

AHRQ Gap Analysis Tool

The AHRQ Gap Analysis Tool was useful in identifying the facilities current practices regarding CLABSI prevention through policy review. This highlighted a lack of policy regarding the use of MNRI CVCs, identifying a gap between practice and evidence. Additionally, this identified potential barriers to implementation and assisted in developing ideas to overcome said barriers such as policy updating and staff education

SWOT Analysis

The SWOT analysis further identified facilitators and barriers to implementing this practice change. This allowed for preparation of potential barriers and development of ideas to overcome them, such as investigating cost of the MNRI CVC compared to the NO-I-CVC.

Characteristics of the facility that would support this practice change were also identified, allowing for engagement planning of key systems within the facility to optimize success

Stake Holder Feedback

Needs Assessment. Although the entire sample agreed that there was room for improvement only 40% agreed that current strategies are insufficient. Additionally, the first free text response stated that sufficiency will be achieved when there is a CLABSI rate of 0. The discrepancies between these two questions and context of the free text response highlight the differences in what the sample believes to be an obtainable goal regarding CLABSI prevention. Although 60% of the sample believed current strategies are sufficient, they indicated there is still room for improvement. Based on this feedback it would be important to set quantifiable goals regarding CLABSI reduction to use as an assessment tool. The goal of decreasing CLABSI rate by x% would be helpful in unifying the expectations of the stakeholders. Nevertheless, these responses indicate that this sample believes that additional measures can be taken to reduce the risk of CLABSI at the facility.

Applicability in Defined Patient Population. Although our sample is small the majority stated that 3 lumen CVCs were most used which would reduce barriers to implementation based on patient needs. Gauging the most used CVC is important in this context as currently only 3 lumen MNRI CVCs are available at the facility. Despite the regular use of 4 lumen CVCs the lack of this option does not seem to be a deterrent for stakeholder endorsement of this practice change.

Contraindications of Use. The two additional contraindications identified based on the survey results were power injection compatibility for computerized tomography (CT) scan with

contrast dye and utility against organisms that are resistant to MNRI. Regarding power ports, further investigation was conducted, and it was found that MNRI CVCs are compatible with power injection for CT scans with contrast dye (Cook Medical, 2013) The topic of resistant organisms is noteworthy, but the use of the MNRI CVC would be preventative in nature, with standard practice being that this type of catheter be placed to prevent CLABSI. Blood cultures would not be available prior to insertion, but if a patient were to test positive for a resistant organism and require placement of a new catheter this may be an indication that a non-antibiotic impregnated catheter could be used.

Barriers to Implementation. Several barriers were highlighted based on survey responses including stakeholder consensus, standardization across the organization, physician preference/education/support, and power injection compatibility. Regarding stakeholder consensus, this would be achieved by following the proper procedures to policy change by receiving the appropriate majority support to officially change the policy. Regarding standardization across the organization, this facility is a part of a multi-hospital umbrella organization. Despite this each facility within the organization has the liberty of having their own independent facility specific policies. This would not present a barrier to practice change as each facility already has their own policies. The concern of physician preference ties in closely with the concern of provider education and support. If this practice change were to become standard of care the expectation would be that providers follow the hospital policy. To ensure compliance education regarding the policy change would need to be disseminated to ensure staff understand the reason and importance of the change. This could be achieved by collaborating with the facilities education department to develop an educational deliverable to disseminate to staff. The

concern of power injectable capabilities was brought up again with this survey item, and as previously stated MNRI CVCs are compatible with power injection (Cook Medical, 2013)

Concerns Regarding Practice Change, Endorsement, and General Feedback

Several concerns were identified from survey responses in relation to the use of MNRI CVCs in CLABSI prevention. Regarding the comment relating to the use of MNRI CVC over chlorohexidine (CHG) education should be provided to staff highlighting the evidence supporting MNRI CVCs as the most effective anti-infective CVC in CLABSI prevention. To the point regarding deciding based on individual patient risk is noteworthy and something that would be useful in discussions for policy development. This would have implications for developing a risk assessment tool which may increase the workload of staff and decrease compliance. Additionally, the decision to implement this practice change on solely critically ill patients (i.e. patient in intensive care) was due to their increased risk of CLABSI and evidence supporting the efficacy of CLABSI risk reduction in this population but not in non-critically ill patients. This again highlights an opportunity to provide further education regarding the thought process and evidence behind the practice change for any educational material that is disseminated. Two participants raised concerns regarding the potential for creating antibiotic resistant organisms from making the use of MNRI CVCs standard in critically ill patients. Upon review of evidence, literature supports that the use of this type of catheter does not increase risk for creating antibiotic resistance pathogens (Reitzel et al., 2020; Rosenblatt et al., 2019). Providing this evidence to staff would be important when educating them about this practice change to help alleviate concerns about antibiotic resistance.

Resource Allocation

Resource allocation was useful in creating a plan for implementation of a practice change. Identifying key staff members and systems that would be required for successful implementation of this practice change assists in the development stage of this process. Additionally, investigating the ability to obtain the materials required (MNRI CVCs) assists in distribution across the facility. Conducting a brief cost analysis also highlights the benefits to the facility and can assist in garnering support.

Limitations

The Gap Analysis allows for a thorough evaluation of current practices and areas for improvement, however there are several limitations to this process. First, there is limited ability to implement practice changes and evaluate outcomes. This process provides the foundation to implement practice change but does not adequately support the measures needed to follow through to the implementation phase. In relation to this limitation, there is a lack of ability to assess the outcomes of the proposed practice change. Without implementation there is no way to know how effective the change will be in achieving the desired outcome. Finally, this process promotes the translation of evidence into practice, but limits the ability for facility staff to drive solutions. The project lead identifies a gap and utilizes research to guide the change, but at no stage in the process is it recommended to assess staff for their perceptions on what would be an effective measure to improve practice. Stakeholder feedback is obtained, but this is in relation to a recommendation that has already been made by the projevt lead, not in the identification phase where quality improvement solutions are being identified.

Conclusion

Nursing leaders who work in quality improvement should familiarize themselves with the process and utilize it when significant change is needed. It ensures that practice is evidence based and promotes success through the engagement of key stakeholders. Having the components of the Gap Analysis completed would enhance the process of a quality improvement project, especially when presenting findings to the groups that determine how, when, and if change should occur. The data gathered through this process bolsters one's argument for a need in practice change and would increase one's chances of successfully implementing meaningful change in practice.

Anticipated Results

After the policy change is implemented and supporting education is completed by staff, the expectation would be that all critically ill patients requiring central venous access would have an MNRI CVC placed unless there is a documented allergy to MNR. After the practice change is implemented, continued assessment will be conducted to assess compliance to the practice change, barriers to adhering to practice, potential complications/contraindications that arise, and the impact on reduction of CLABSI rates in critically ill patients. The Standardized Infection Ratio (SIR) is used to determine the facilities performance regarding CLABSI occurrence. A value of 1 in the SIR is the predicted amount of CLABSI specific to the institution based on various factors such as facility size and types of patients treated (CDC, 2022). For the time frame of March 2022 to March 2023 the average score for this facility was 0.81, roughly 19% below the predicted amount of CLABSI occurrence (MGH, 2023, Quality and Safety). After the implementation of this practice a drop in this value would be expected, with a goal of a reduction of 10% (annual score of 0.71).

Recommendations

Based on available literature and through the process of conducting the Gap Analysis, the recommendation can be made to implement a policy stating that MNRI CVCs be used in all critically ill patients required central venous access unless there is a documented allergy to MNR. Additionally, supplemental education modules regarding this policy should be provided to all applicable staff members involved in the management of CVCs in critically ill patients.

References

Agency for Healthcare Research and Quality. (2022). Central Line-Associated Bloodstream Infections (CLABSI). Retrieved from https://www.ahrq.gov/topics/central-line-associated-bloodstream-infections-clabsi.html#:~:text=As%20many%20as%2028%2C000%20patients,to%20prevent%20and%20reduce%20CLABSI.

Agency for Healthcare Research and Quality. (2017). Estimating the Additional Hospital Inpatient Cost and Mortality Associated With Selected Hospital-Acquired Conditions. Retrieved from https://www.ahrq.gov/hai/pfp/haccost2017-results.html

Center for Disease Control and Prevention (CDC). (2022). The NHSN Standard Infection Ratio. Retrieved from https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/nhsn-sir-guide.pdf

Choi, Y. J., Lim, J. K., Park, J. J., Huh, H., Kim, D.-J., Gong, C.-H., & Yoon, S. Z. (2017). Chlorhexidine and silver sulfadiazine coating on central venous catheters is not sufficient for protection against catheter-related infection: Simulation-based laboratory research with clinical validation. *The Journal of International Medical Research*, *45*(3), 1042–1053. https://doi.org/10.1177/0300060517708944

Chong, H. Y., Lai, N. M., Apisarnthanarak, A., & Chaiyakunapruk, N. (2017). Comparative Efficacy of Antimicrobial Central Venous Catheters in Reducing Catheter-Related Bloodstream Infections in Adults: Abridged Cochrane Systematic Review and Network Meta-Analysis. Clinical Infectious Diseases: An Official Publication of the Infectious

Diseases Society of America, 64(suppl_2), S131–S140. h https://doi.org/10.1093/cid/cix019

Cook Medical. (2013). In-service Guide – Cook Catheter Tray. Retrieved from https://www.cookmedical.com/data/resources/CC-BM-CVCISB-EN-201305-M3.pdf

JBI Levels of Evidence. (2013). Retrieved from https://jbi.global/sites/default/files/2019-05/JBI-Levels-of-evidence_2014_0_.pdf.

Lai, N. M., Chaiyakunapruk, N., Lai, N. A., O'Riordan, E., Pau, W. S. C., & Saint. (2013).Catheter impregnation, coating or bonding for reducing central venous catheter-related infections in adults. The Cochrane Database of Systematic Reviews, 6, CD007878. https://doi.org/10.1002/14651858.CD007878.pub2

Massachusetts General Hospital (MGH). (2023). Quality & Safety – Central Line Associated Blood Stream Infections. Retrieved from https://www.massgeneral.org/quality-and-safety/patient-safety/central-line-bloodstream-infections

Massachusetts General Hospital (MGH). (2023). Non-Tunneled Central Venous Catheter Overview. Retrieved from https://hospitalpolicies.ellucid.com/documents/view/18788

Massachusetts General Hospital (MGH). (2022). Central Venous Catheter Dressing Change with Chlorohexidine Impregnated Foam Disk. Retrieved from https://hospitalpolicies.ellucid.com/documents/view/1097

Massachusetts General Hospital (MGH). (2021). Use of Passive Disinfection Caps for Needleless Connectors and Male Lure (ex. Curos Caps & Tips). Retrieved from https://hospitalpolicies.ellucid.com/documents/view/10299/active/

Massachusetts General Hospital (MGH). (2020). Needleless Connector-Routine Changes. Retrieved from https://hospitalpolicies.ellucid.com/documents/view/10573

Nelson, E. C., Lazar, J. S., Godfrey, M. M., & Batalden, P. B. (2011). Using measurement to improve health care value. In E. C. Nelson (Ed.), Value by design: Developing clinical microsystems to achieve organizational excellence (First ed) John Wiley & Sons, Incorporated.

Plowright, L. (2023, March 16). Personal Communication

Reitzel, R., Rosenblatt, J., Gerges, B., Jarjour, A., Fernández-Cruz, A., & Raad, I. (2020). The potential for developing new antimicrobial resistance from the use of medical devices containing chlorhexidine, minocycline, rifampicin and their combinations: a systematic review, *JAC-Antimicrobial Resistance*, Volume 2, Issue 1. https://doi.org/10.1093/jacamr/dlaa002

Rosenblatt, J., Vargas-Cruz, N., Reitzel, R., & Raad, I. (2019). Assessment of the Potential for Inducing Resistance in Multidrug-Resistant Organisms from Exposure to Minocycline, Rifampin, and Chlorhexidine Used To Treat Intravascular Devices. American Society of Microbiology. https://doi.org/10.1128/AAC.00040-19

Wang, H., Tong, H., Liu, H., Wang, Y., Wang, R., Gao, H., Yu, P., Lv, Y., Chen, S., Wang, G., Liu, M., Li, Y., Yu, K., & Wang, C. (2018). Effectiveness of antimicrobial-coated central

venous catheters for preventing catheter-related blood-stream infections with the implementation of bundles: A systematic review and network meta-analysis. Annals of Intensive Care, 8(1), 71. https://doi.org/10.1186/s13613-018-0416-4