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Implementing Educational Initiatives to Decrease Contamination and Costs in the Blood Culture Specimen Collection Process

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Abstract

Background: The diagnosis of sepsis in a patient presenting with symptoms includes the collection of blood cultures which identifies the presence of specific infectious agents. The culture result will identify the organism as well as report sensitivity to various antimicrobial agents to allow the healthcare provider to determine the specific set of treatments, specifically antibiotics, that will be included in the medication regimen in combating the infection. When blood specimens become contaminated in the collection process, it hinders the success of rapidly treating these patients as repeat cultures will likely need to be completed for accurate treatment. This becomes a difficult task if broad spectrum antibiotics have already been started after the initial blood culture. Once antibiotics are started the blood culture may be further skewed making it difficult to successfully treat the patient. This makes proper initial blood culture collection imperative for the care plan. With patients at the center of our healthcare system, it is important to be as accurate as possible from the beginning to avoid any contaminated results which could lead to a delay in patient care. Research has shown that continuing education is beneficial to nurses in refreshing their skill set, and in turn, allowing them to be successful and accurate (Dargere, Cormier, and Verdon, 2018).

Local Problem: It is imperative to monitor blood culture specimen contamination rates to identify opportunities for improvement. With the results obtained after education, and based on staff response, the sepsis committee and team leads can make further decisions on how to proceed. This information allows them to review what works best in order to continue to improve the rate of contamination and make changes accordingly in the future.

Methods: With the assistance of facility staff members, educational information was posted in areas of the microsystem that are frequented by nurses responsible for collecting blood cultures.

The goal of the posted information was to remind staff of the existing protocols and small steps that should be taken to reduce contamination.

Results: Over a short period of time, and comparing previous rates to those after educational information was introduced, it was obvious that contamination rates had decreased even with a high volume of blood culture collections. The average contamination rate for the first two quarters of 2022 were noted to be 1.9% and 2.5%. 47 staff were noted to have at least one occurrence for a contaminated specimen with 20 staff having multiple occurrences. The site most frequently contaminated was the Right Antecubital. After the introduction of education there was a decrease in contamination with a rate of 0.7% for that month.

Conclusions: After reviewing both the literature and results of this quality improvement project, it appears that continuing education is of benefit to reducing contamination rates. By reducing contamination rates of blood cultures, patients will receive timely and efficient care. The facility will also benefit in terms of reducing cost of supplies for repeat cultures and testing.

Keywords: blood culture, contamination, education, healthcare costs, microorganisms in blood, protocol, specimen collection, professional development, SIRS criteria, rates of contamination

Introduction

Proper specimen collection is important to ensure patients receive efficient treatment. When blood cultures are collected properly from the start it reduces costs associated with repeat cultures. It is necessary to follow the protocol that the hospital had created so that blood cultures reveal the information necessary to make an accurate diagnosis. So long as specimens are collected properly from that start, the healthcare team can proceed accordingly with a diagnosis and treatment plan. If the culture presents any type of contamination this would mean that care is delayed as more cultures are collected and start of a targeted medication is postponed until more cultures are taken to show which microbes are at the source of infection. Repeat cultures may not be beneficial if broad spectrum antibiotics are started before the repeat culture.

Problem Description

The microsystem and mesosystem that participated in this quality improvement project are part of a macrosystem joining multiple hospitals together. The recent merge of these hospitals has been cause for many changes throughout the facilities, and especially with protocols. Each mesosystem has a set of protocols that help to guide their staff on providing care and interventions specific to various diagnoses. When these systems merge, the protocols are reviewed and fit to the standard of the macrosystem. The positions of leadership and management throughout the systems were also reviewed and redesigned in a way to facilitate good communication throughout and meet expectations regarding operational excellence. For example, the structure of clinical leadership and those monitoring the collection of data and metrics has been redesigned. With these changes have come an organizational structure that includes *champions* for different areas that involve key metrics.

The focus for this project was the emergency department of the larger mesosystem. One of the key metrics that is currently being considered and championed at the facility is adherence to the sepsis protocol. Sepsis is a life-threatening infection throughout the body. To diagnose sepsis, a patient must meet 2 of the systemic inflammatory response syndrome (SIRS) criteria and have a known source of infection. The SIRS criteria include a fever more than 38.0 degrees Celsius, tachycardia greater than 90 beats per minute, tachypnea or greater than 20 breaths per minute, or leukocytosis greater than twelve billion (Comstedt, Storgaard, and Lassen, 2009). More than 80% of patients that are diagnosed with sepsis are admitted through the emergency department (Clinical nurse lead, personal communication, 2022). The standard of care includes metrics for the first and third hours of emergency services. In the first hour, metrics for timely assessments and interventions include measuring a lactate level, obtaining blood cultures, administering antibiotics, administering crystalloids and applying vasopressors. The blood cultures are very important in the plan of care for these patients as it helps providers to identify what type of organism is present, and therefore which antibiotic is going to work best in fighting off the infection. Sepsis champions have found that blood cultures are commonly contaminated, about 1.5% on average over the past three years (Lakes Region Healthcare, personal communication, 2022). When results are contaminated as such it makes it difficult to identify what the organism is, and it cannot be appropriately treated. At this point, a new set of cultures being drawn would not be indicated as a broad-spectrum antibiotic has already been administered and the results would again be inaccurate. Therefore, having accurate blood cultures from the beginning of the admission is vital in successful treatment as one of the final steps in patient care. When there are contaminated results, they are tracked based on the mesosystem of occurrence, who collected them, the phlebotomy site, and what type of organism

was produced. The results are observed on a quarterly basis, and there is contamination happening each quarter. These results do fluctuate, at one point they were 0.6% and reached up to 1.9% and 2.5% for the first two quarters of 2022 (Lakes Region Healthcare, personal communication, 2022). With these inconsistencies and rise in contamination it's important to conduct a root cause analysis to find where the contamination stems from. While the percentage of contaminated specimens is under the threshold of 3.0%, there has been an increase of contamination recently. The leadership and champion team for sepsis would like to decrease the overall contamination rate. Ideally, there should be no contamination with protocol being followed correctly to avoid this from happening. It is possible that healthcare professionals taking these cultures may not be aware of the appropriate protocol to be followed, and therefore are making these mistakes. While the laboratory is a part of the sepsis alert, if they don't arrive in a timely manner, the nurse will typically obtain the blood specimen for efficient, timely care. The rise in contamination percentages highlight an opportunity for education and review of the protocol. This aligns with various nursing competencies involving patient-centered care, evidence-based practice, and quality improvement strategies. As the next generation of clinical nurse leaders, thinking about quality improvement for the benefit of our patients is going to be a primary scope of our practice and something that we should begin thinking of now. The identification of this problem highlights an opportunity to focus on the educational process necessary for adherence to the Sepsis protocol.

Available Knowledge

The purpose of the following literature review was to understand the appropriate protocol and procedures that are in place for blood culture specimen collection. This review would also allow us to see where in the protocol there are typically mistakes that may cause contamination.

This search highlighted several aspects such as the importance of blood cultures, what was causing the contamination, and finally, how we can take steps to prevent contamination.

Importance of Blood Cultures

When infections enter the bloodstream through the lymphatic system and are unable to be resolved with the body's natural response of the immune system it causes a bloodstream infection (Ombelet etl. al., 2019). Blood cultures are used in the healthcare setting to identify the specific types of infection in the bloodstream (Ombelet et. al., 2019). There are certain criteria that should be met which will indicate when a blood culture is appropriate. These indicative criteria are referred to as the systemic inflammatory response syndrome or "SIRS" (Ombelet et. al., 2019). SIRS criteria include a fever paired with any of the following: hypotension, confusion, increased respiratory rate, known site or occurrence of infection (Ombelet et. al., 2019). In a 2020 article, it was stated that having a rapid and accurate profile of the type of infection is important so that providers may not only identify the specific infection but also select an appropriate antibiotic for the treatment of it as well (Gonzalez, Chao, and Pettengill, 2020). The sooner that an appropriate antibiotic is selected the better because the treatment may be started to kill bacteria which may be causing a blood stream infection. Blood cultures give us information about the bloodstream infections that help to guide the treatment of patients. Not only are they giving us the specific information regarding the type of infection but also their antimicrobial susceptibility (Gonzalez, Chao, and Pettengill, 2020). Sepsis is commonly diagnosed with blood cultures and is actually a leading cause of morbidity/mortality at a rate of about 19 million cases annually (Wilson, 2020). These types of statistics make blood cultures an important identifier for next steps in septic patients. Most times a broad-spectrum antibiotic is started initially, however the culture results allow providers to prescribe something more specific to the pathogen that

exists within the bloodstream. While it may seem an obvious step to some, remembering to take blood cultures prior to administering any type of antimicrobials is very important. If the culture is taken after the antimicrobial agent is initiated, the results that you are collecting will not give an accurate picture of what type of infection you are dealing with (Sinha et. al., 2018). Contamination of blood cultures has a prevalence rate from 0.6% to 17% of which may be influenced by various factors including improper skin preparation, poor collection technique, and administration of an antimicrobial prior to collection (Dargère, Cormier, and Verdon, 2018). It is very important to have no contamination so that blood cultures accurately represent the infection that is present. Not only is it of value to clinicians, but additionally, for the patient's safety and well-being. Contaminated results are not of benefit to the patient and the clinical outcomes for them (Lamy et. al., 2018). As caregivers, the goal is to have the care be patient-centered. Ensuring that results are not contaminated is keeping the patient at the center of care so that we can provide them with the best care and accurate treatment of their infection (Lamy et. al., 2018). These are a very important diagnostic test that should be completed accurately and efficiently to better help the patient and help to reduce unnecessary costs (Doern et. al., 2019). When blood cultures are contaminated, clinicians are forced to repeat the specimen collection which does not benefit the patient or the hospital from a clinical and economic standpoint (Doern et. al., 2019).

Causes of Contamination

Contamination of a blood culture is when foreign bacteria have been introduced to the specimen collection vial and misrepresent the results. There are various ways that a blood culture may become contaminated. The type of hospital, the staff, and the type of patients may influence contamination rates (Dargère, Cormier, and Verdon, 2018). For example, research has found that teaching hospitals, in emergency departments especially, see the highest rates of contamination

as well as facilities with high turnover and decreased training (Dargère, Cormier, and Verdon, 2018). The most common time for contamination to occur is during the collection of the blood culture specimen as opposed to the actual processing of the sample (Dargère, Cormier, and Verdon, 2018). This makes blood culture specimen collection a very important step of the process, and one where increased precautions are necessary to produce accurate results. Without accurate results, the blood cultures become a costly waste. A common practice in hospitals, especially the emergency department, is the placement of ultrasound intravenous catheter (IV). Ultrasound IVs are placed when providers need quick access to veins for medication administration or drawing labs, but a standard IV isn't working well. Ultrasound IVs use a gel which has been found to be responsible for carrying infectious agents (Solaimalai et. al., 2019). One example of this was in a 2016 study at a pediatric ICU where the ultrasound gel was found to be the responsible agent for transmission of Burkholderia cepacian complex (Solaimalai et. al., 2019). Another common cause of contamination is improper skin disinfection. When correct steps are not taken to prepare the skin for blood culture specimen collection it can lead to contamination of the cultures (Wilson, 2020). The skin preparation is included with correct procedures as well. When the individual responsible is not using appropriate technique overall (beyond the cleansing prep of the area) it can leave room for error and contaminated results (Doern et. al., 2019). The collection vials themselves may also be responsible for some contamination as the media that is within them contains a resin that is antibiotic-binding and in some studies was shown to not only increase growth of pathogens in question but the contaminants as well (Doern et. al., 2019). One study looked at the following variables to understand the impact they have had on contamination rates: difficult extraction, hemodynamic instability, recently inserted line vs direct venipuncture, glove use, ethanol use, chlorhexidine

use, povidine-iodine use, cleansing in concentric circles, waiting 30 seconds, preparation of bottle top, arterial extraction, help by a colleague, butterfly-needle use, department, professional experience time, professional experience time in the department, age, and intervention group (Cervero et. al., 2019). This specific study found that factors which influenced a higher contamination rate include a recently implanted intravenous device such as peripheral venous access and those that were associated with lower rates of contamination were drawn through a butterfly needle (Cervero et. al., 2019). This same study found that clinicians with more experience in the field were associated with fewer contaminated specimens (Cervero et. al., 2019).

Prevention of Contamination

As leaders in healthcare, it is important to recognize where there are flaws in the system and brainstorm methods on how they may be corrected. Contamination of blood cultures has a huge impact on patient-centered care and cost analysis in healthcare as those with contaminated results require further consultations and treatment (Dargere, Cormier, and Verdon, 2018). Studies show that contaminated blood cultures result in an additional $1,000-$8,000 in costs, along with increased lengths of stay which further increase costs (Dargere, Cormier, and Verdon, 2018). In cases where there is concern with contamination through ultrasound gel, it is possible to use a sterile gel instead of the standard bottle that belongs with the ultrasound machine (Solaimalai et. al., 2019). Using a new and sterile container for an IV that is expected to be used for blood culture specimen collection can be a great way to avoid contamination. There are, however, instances where rapid access is required and the steps to use sterile gel may not be followed and the cultures may potentially be contaminated. It could be worthwhile to find a way to include sterile gel in normal proceedings as a routine step. After thorough research and testing it has

been found that chlorhexidine followed by iodine, povidone-iodine, and alcohol is the best series of preparation to avoid contamination (Wilson, 2020). However, alcohol swabs are recommended for children under the age of 2 years old (Wilson, 2020). The site of venipuncture is also important in avoiding contamination. The recommended collection site is the antecubital fossa because of its size and ease for venipuncture (Wilson, 2020). With ease of access from a large vein, it is easier to obtain a larger volume of blood which is helpful in review of specimens and removal of pathogens that contaminate the specimens (Wilson, 2020). The volume of specimens also includes getting multiple collections of blood cultures at separate sites or separate times (Wilson, 2020). Out of all of the variables in a trial completed, the extraction through a recently placed line and those who have more than 9 years of clinical experience were associated with fewer contaminations (Cervero et. al., 2019). Following the univariate analysis, there was a multivariate analysis completed which further showed researchers that the butterfly-needle specifically produced results with reduced contamination results (Cervero et. al., 2019). In other studies it has been shown that phlebotomists specifically have lower contamination rates in comparison to other healthcare workers (Dargere, Cormier, and Verdon, 2018). This may seem interesting but makes sense when you consider a phlebotomist's scope of practice and advanced training with this specific skill set. Phlebotomists often use butterfly-needle technique which also has a low contamination rate. Education has been widely considered and implemented in other settings. Studies have shown that implementing some type of education about blood culture contamination has actually been able to decrease contamination rates through establishment of specific protocols, skills tests, demonstrations, etc. (Dargere, Cormier, and Verdon, 2018). In some cases, an initial specimen diversion device has been used to catch the initial blood from a draw (about 0.5 mL or slightly greater) and divert it into a small collection/tube device (Lalezari

et. al., 2019). The blood from the vein will follow and a sample may be collected. The thought behind using this device is that contaminated blood will be diverted away and not collected as part of the specimen. This has shown to reduce contamination significantly (Rupp et. al., 2018). While this is a great option for reducing contamination, it does carry a concern for increased expenses and can also be a source for further contamination if it is not sterile or handled/used correctly (Lalezari et. al., 2019). This device has specifically been shown of benefit in the emergency department setting and is something to consider at specific sites to see how it benefits an individual microsystem (Rupp et. al., 2018).

Evidence Synthesis

Research has shown that there are various factors regarding the source of contamination. With multiple potentials, it's important to consider all possibilities and address them when attempting to improve the quality of contamination results. There are also various ways that this improvement may be made, and this has been found through multiple research studies. Some studies have shown that something as simple as additional education is beneficial. Beyond the contamination rate itself, the microsystem is also considering which staff members have the most frequently contaminated specimens and if there are specific methods or draw sites that seem to have the most problems. It may seem to be an overwhelming task to review as there are multiple variables, however taking it step by step beginning with less invasive interventions, there is a better chance of success.

Rationale

Following a framework such as Plan-Do-Study-Act (PDSA) was beneficial for this QI project as it is a straightforward method to identifying a problem in the microsystem, creating and implementing an intervention based on what we have seen so far, and then analyzing our

work to see how we could make further improvements (Plan-do-study-act, 2022). The PDSA framework allows the project to follow a cycle of trial and error. As different interventions are implemented, results may be reviewed and next steps will be determined based on the information that is found. As the literature has presented a variety of influences and factors associated with contamination, it is difficult to focus on one specific source. PDSA framework is the opportunity to review a variety of factors and find which one has more influence than others as well as which intervention reveals the best outcomes. In this case, the PDSA cycle will help the microsystem to understand which factor may be causing contamination. In this quality improvement project, it is ideal to begin with a less invasive approach and begin with something such as education. From there it may be determined if a next step is required.

Specific Aims

The purpose of this project was to encourage a successful routine for collecting blood culture specimens, especially for potentially septic patients. In order to properly diagnose and treat a patient it is necessary to obtain accurate blood culture results. There is a procedure that must be followed to ensure that the specimen collected provides an accurate representation of any infectious agent growing in the blood (Beaumont, 2019). When the infectious agent is identified, the appropriate antibiotic may be selected. There has been a rising issue with people who are trying to collect these specimens as they are not following correct procedures which leads to contamination. The goal of this project was to identify where the procedure was faulting and helping to correct it so that results may be accurate. There are quarterly reports that share the number of collected specimens that are contaminated, and these also identify the staff member who was responsible for it. These results are able to be continuously reviewed and monitored so we can track either improvement or continued decline (Lakes Region Healthcare, 2021). Having

access to these metrics allowed us to track the performance and monitor how our interventions made an impact. The specific aims of this project include reducing the percentage of contaminated specimens below 1.0% by the month end following release of educational information for review of protocol by staff members.

Methods

Context

Performing a quality improvement intervention for the collection of blood culture specimens would not result in many costs to the organization as many of the resources necessary are already available. Labor would likely be the largest expense. The goal was for this to be a multilayer process with various interventions that would contribute to the eradication of contaminated blood cultures. The data collection and measures that were included in this study were current metrics collected by the facility so there was no need to adapt additional materials in order to track this. Information also existed within the organization in regards to policies or protocols on blood culture specimen collection so it was not necessary to outsource or develop any type of new systematic piece unless there was need identified during the process. However, it may have been necessary to update the protocol based on findings during this project which would require the cost of staff members time spent during sepsis committee meetings. The estimated labor for updating a protocol if necessary would have been about 10 hours total. The potential for having any type of cost associated with this quality improvement project heavily depended on findings throughout. For example, if initial interventions were unsuccessful in reducing contamination rates, there may have been a need for a more direct approach that involved the use of some type of device, materials, etc. In this case, it would have been of cost to the organization. One intervention that was found through research involved the use of

something called an initial specimen diversion device which reportedly costs about $15 per unit/device (Buzard, Evan, & Schroeder, 2021). Depending on what the rates of contamination were within a given facility, it may have been of cost benefit to use such a device. The cost of some office supplies used in bulletins and educational material were around $15-$20. The project lead will spend approximately 200 hours working on this project. Estimates for staff time would be for 25 hours total. Some of this estimate came from time spent in sepsis champion meetings, as well as in collaboration for the QI project. Additionally, time dedicated to staff education is important with an educational session, estimated at about 5 hours. An educational session for this type of protocol would likely last about 1 hour. Multiple sessions may have needed to be offered to accommodate for different staff schedules and availability.

Interventions

Reinforcement of knowledge by re-educating was the staple piece of this quality improvement. There were appropriate protocols in place, however refreshing people with the knowledge and information they likely were familiar with could be beneficial in ensuring they were being thorough in their collection of specimens. In a fast-paced environment, there are opportunities for mistakes or forgetting a step. By taking the time to review the procedures expected of staff, they might have been able to reflect on what they were doing correctly or incorrectly and make improvements as an individual. Lifelong learning is a huge part of the registered nurse's career (Price and Reichert, 2017). The initial educational step included some type of bulletin board posted in a common area that all the staff frequent. It needed to be easy to understand and review quickly so that people were not deterred from reading. A great area for this was in the staff lounge. This is where the team meets before each shift and talks about other important topics happening within the organization. This illuminated the topic and need for

improvement, giving an opportunity for people to discuss and ask questions they may have had. The bulletin did not need to be too detailed or lengthy, it could be a brief overview that highlighted essential evidence to support the psychomotor skills. For example, we wanted to stress the importance of appropriate skin prep and collection methods. General office supplies which were available could be used to create this visual. There is an educational center in the facility staffed with clinical educators who provide materials and educational sessions for various hospital protocols. Almost all organizations already require continuing education for their staff members and there have been studies to show the added benefit of refreshing nurses on material over time (Price and Reichert, 2017). If it was apparent that there were partial improvements, we may consider a more direct communication with staff members who were struggling more. This communication could possibly have been a reminder through their email that included supplemental educational materials. Team chats are sent out weekly and email communication is very popular throughout the organization. Supplemental materials would include more detailed information about the standard protocol for blood culture specimen collection and reminders of how to do it correctly, or even mentioning common ways that they may become contaminated. By communicating with staff members in this manner, we avoid singling anyone out in front of their peers, but also ensure that we are addressing problem areas. If it was apparent that staff members still had not made any type of progress, it may have been conducive to have a one on one conversation with them to review their skill set and refresh them on protocol to make sure they were comprehending the information and could make improvements. This more direct communication ensured that people were not only being provided the information but were actually reviewing it and understanding it. Professional communication is extremely important in having a successful team (O'Daniel and Rosenstein, 2008). Having strong and clear

communication sets the ground for achieving goals and creating a safe patient environment with positive outcomes (O'Daniel and Rosenstein, 2008). Setting this specific time aside to address the situation would give the individual time to ask specific questions and also make them aware of the importance in doing this task correctly. Another option or intervention that could have been included to improve results would be to set a reminder in the electronic health record. When a staff member proceeded to collect a blood culture specimen, having a protocol review pop-up may have allowed them to recall the steps they should follow and ensure that they proceeded accordingly and collect an accurate specimen. Having these types of reminders automatically embedded into a system are valuable in consistent patient care and assisting nursing in completing their jobs successfully (Chen et. al., 2016). In the case that rates were exceedingly high, reaching over the threshold of a 3.0% organizational tolerance, there may have been an indication for use of a tool called the initial specimen diversion device. This device is designed to catch the initial 1.5-2 mL of blood that is collected to avoid any contamination from reaching the specimen and ensures that it is the cleanest catch possible (Snyder et. al., 2012). This device can be of cost to an organization in the case that they decide to implement the tool (Buzard, Evans, & Schroeder, 2021). However, there has been evidence through research to show that this is a cost-benefit depending on the rate of contamination found to occur. For example, the higher the contamination rate, the more cost-benefit is likely to be found as contaminated results can cost the organization even more than the device itself would (Buzard, Evans, & Schroeder, 2021). This would have been a final intervention step that would hopefully be avoided with the other interventions that have been explained. If necessary however, this device could be made available in situations where there is concern for contamination, but a clean catch is indicated for important culture results. An example of a situation where this may

be applicable is for a potentially septic patient who requires a placement of an ultrasound IV. Research shows that ultrasound IVs increase the risk of contamination through the gel that is used. In the case that a blood culture specimen is drawn off a patient with a recently placed ultrasound IV, this device may be helpful so that they are able to identify an appropriate antibiotic without having to redraw once other broad-spectrum antibiotics have been started. If this were to happen the culture could be further compromised by any antibiotics that have been started.

Study of Interventions

The main method of observing the success of each intervention performed was to monitor the contamination rates. This type of data is already collected and was accessible as interventions were initiated. With ease of access to this data it should not have been difficult to understand the association of each intervention and their impact on the rate of contamination of blood culture specimens. There should not necessarily have been a concern about misunderstanding any changes in rates and they should be solely attributed to interventions because there were not other changes initiated during that time. If for some reason there were other changes that came up during the study of these improvements, they were made of note and also compared so that potential attribution could be explained. Changes were defined as anything that becomes different about the blood culture specimen collection which would otherwise alter the rate of contamination or results of data. Future PDSA cycles can be determined following review of the results following the educational element. If there was a great change across the board we could continue to monitor and see what the trends were. This may have meant that occasional educational check-ins to remind staff of appropriate procedures would be necessary to keep them up to date on their skill set.

Measures

Upon processing of blood culture specimens, the lab recorded whether or not there was contamination. This data was tracked along with the staff member who completed the collection, the date/time it was collected, the site, and the type of collection (i.e. butterfly needle, IV, ultrasound IV). This additional information allowed us to determine if there was a trend beyond just regular contamination. It was possible that ultrasound IVs were a continuing problem, or perhaps a person was repeatedly drawing contaminated specimens. Having all of this data was valuable in not only seeing changes but also identifying other factors that play a role in specimen collection which may not have been further considered. This type of data collection is routine to this organization as it is metrics that they already track currently. Therefore, it did not cost us to pull or track the data and monitor it during a period of time. By monitoring this data it helped us to understand what direction to take next and which intervention in our process would be best fit based on results.

Analysis

There was a large amount of data to analyze and monitor for this quality improvement project and it was important to have a clear plan set out ahead of time. It was determined that graphs and tables that represented changes over time would be the best option for reference and analysis of the data. We hoped to understand trends and changes that occurred over the course of time, amongst various interventions that were implemented. In order to be successful in determining an appropriate intervention, viewing the changes in contamination rates in accordance to times was very valuable. We aligned these data tables and graphs with the dates or period of time in which a change was implemented and compared the rates to before and after this change. This would be a great visual representation to track information based on our

actions. A line graph specifically would show any drastic changes or trends that occurred in our data set and were notable for our progress.

Ethical Considerations

The largest ethical consideration with this quality improvement project was the concern of protecting the privacy of staff members. Their names did appear on data reports which showed how many contaminated blood cultures they had resulted. However, in order to keep their privacy a priority, it was not included in any write up or report of the project. If necessary, staff member names would be correlated with a numerical identifier rather than their name itself. This eliminated any concern for their work being exposed. No information was posted publicly which showed the contamination results specific to any staff member individually. While monitoring the quality improvement, it was also valuable to maintain morale and encourage people to be involved and interested in making this improvement. By shaming or placing guilt on anyone, it would likely have decreased morale and not have been of benefit to this project. The sepsis committee was specifically impacted by this quality improvement project and they had a say in how to review the methods and procedures in order to monitor for ethical liability. If there were concerns that were brought up on their behalf they would have been addressed and managed appropriately to fit the needs of patients, staff, and others involved. The integrity of the project was to improve results for patient outcomes and not to inhibit the work of staff members. Participation was not necessarily mandatory but this was already something that people voluntarily participate in as employees of the organization. There was no conflict of interest in this quality improvement project. This proposal was reviewed by the University of New Hampshire Quality Review Committee to affirm that it meets the criteria for quality improvement which is exempt from IRB review.

Results

Results

While the data is tracked over each quarter, there is raw data that is released on a month to month basis as well. The lowest average for a single quarter was 0.7% in the third quarter of 2021 and the highest being 2.5% in the second quarter of 2022 (Appendix B). At the end of the month of July, data was released and showed that the contamination rate was only 0.7%. This is a decrease in contamination from the most recent quarter which showed a 2.5% contamination rate. It is also tied for lowest contamination rate, with the third quarter in 2021. This is also below our goal of 1.0% and well below the threshold outlined by the organization of 3.0%. It is important to note that again this is only one cycle of the PDSA format and there is hope to continue improving and maintaining a low, to no contamination rate.

During the three year period leading up to implementation of education, the amount of staff members with a specific number of occurrences was recorded. There were 27 staff members who had only a single contaminated result, 13 staff members who had two contaminated results, two staff members with three contaminated results, and finally 5 staff members with four occurrences (Appendix C).

Another factor that is recorded in the data collected by the organization is the site on the patient's body where the blood culture was actually collected. Again, the number of occurrences was tracked over the past three years leading up to the implementation of education (Appendix D). The site with the highest number of contaminated results was the right antecubital fossa (RAC), with 26 contaminated cultures. The neck, shoulder, thumb, port, and wrist were all sites tied with just a single contaminated culture.

Implementation

This specific quality improvement project is designed to be adaptive to staff response and results that occur over time. There is not one set intervention that this project revolves around. There was an infographic (Appendix A) that was developed and shared in the microsystem. After the release of the blood culture collection protocol infographic, staff were encouraged to review the information and proceed accordingly. While these protocols were already in place, it was a reminder to be cautious and accurate with attention to detail. The infographic was posted in the microsystem on an educational bulletin that is updated routinely. The information may also be discussed and brought to their attention during the pre-shift huddles. The blood culture collection data is reviewed on a monthly and quarterly basis and includes information about from which site the contaminated specimen was obtained, the staff member performing it, and the technique that they used.

This project is becoming increasingly important as in the recent month of May, contamination had increased much more than others at 2.8%, nearing the 3.0% threshold. This is a valuable project not only for a student to learn from, but also something of benefit for the microsystem where these blood cultures reveal important information that aids in excellent patient care.

Demographics

Blood culture contamination data is collected routinely at the facility. It includes all staff members who complete these collections, however the data reviewed for this project includes only those with contaminated results. There are 27 registered nurses that work on the unit and comprise 26% of all full time employees in the emergency department, however they are not the only ones who complete venipuncture and blood culture collections. There are times when nurses

from other units will float to their unit, and there are also instances where a staff member from the lab will obtain the culture. The presentation of the data does not include the position or title of the staff member responsible for a specific collection. Therefore, it would have been difficult to focus strictly on nurses and it was important that we focused on the emergency department as a whole. Privacy and professionalism of staff members was upheld during the project which included the importance of not strictly focusing on nurses but all staff who are responsible for blood culture specimen collection.

Discussion

Summary

Key Findings

Again, the specific and global aims of this project include reducing the percentage of contaminated specimens below 1.0% by the month end following release of educational information for review of protocol by staff members. Prior to the release of educational material, the rates were averaging 2.2% in the year of 2022, and following the material they decreased to 0.7%. The intent behind the creation of this quality improvement project was to educate and remind staff of proper procedures for collecting blood culture specimens. It was determined that the most appropriate approach would be to introduce continuing education that would refresh or remind nurses of the protocol that is in place for completing blood culture collections. At the start of the quality improvement project, there was intent to go further beyond the educational component. However, after implementing the project it was apparent that processes take longer to complete in a healthcare setting than what someone may plan for. It can be difficult to perform as many tasks as hoped for as changes and availability to perform them are constantly fluctuating. These factors have shown that the “Do, Study, and Act” portion of the “Plan, Do,

Study, Act" (PDSA) cycle may take longer than anticipated or require additional PDSA cycles, and in the case of this specific quality improvement project it is only the first cycle in what will become an ongoing learning process for the microsystem. While this may have been difficult to work with initially, it has been a learning lesson for how processes flow in the workplace, specifically in a healthcare setting. This quality improvement project has allowed for a better understanding of how priorities operate within a hospital and that patients are truly at the center of care.

While the project may not have progressed as quickly, and accomplished a multitude of interventions as initially planned, it has certainly brought more attention and awareness to the blood culture collection process. There is an educational board in the staff meeting room which all clinical staff in the microsystem visit at least once during each shift. When a new board is created, or edited the shift leader will typically bring attention and alert staff to the new information. Reminding staff that there is a specific protocol in place for blood culture collection and refreshing them on what this protocol entails is beneficial to the unit alone. The goal is that the next time they go to complete a blood culture, they will think back to the protocol and remind themselves that there are certain steps they should follow to ensure successful collection. Ideally, having seen information regarding the collection process, clinical staff will take the time to exercise caution by completing the collection process as the protocol dictates and in turn the rate of contamination should decrease. Eventually, the protocol may even be posted at the bedside to further guide staff as they perform the sequences of the skill. While this initial quality improvement project provides a small snapshot of time, the goal is that this will be something that is continually improved upon with future PDSA cycles. From this initial intervention, results may be analyzed and further action and intervention may be determined to continue progress.

This represents one key finding of the project in which making change is something that does take time and is a learning process. It truly is a cycle of understanding what works and what does not work. As time continues, the microsystem has a base for understanding what direction to go and how they can create a positive impact on the contamination rate of blood culture collection.

Once the educational material was presented to the microsystem, staff members were encouraged and reminded the importance of this topic. Clinical leads and sepsis committee champions brought specific attention to the information and policies that exist within the facility. This material was released at the beginning of the month so that data could be evaluated at the end of the month. The contamination rates for the years prior are reported by quarter (Appendix B). Here, one can see that the trends range but have been on the rise over the past three quarters. While this is a small snapshot from education introduced in a single month-long period, it shows a significant decrease in contamination rates.

There is a lot to learn from this quality improvement project thus far. In higher education and academia there is a regimented schedule for assignments, courses, and projects. Syllabi keep students on track and on target for finishing specific tasks in a timely fashion and within a certain frame. While there are also schedules and deadlines in the real-world, I have observed that other things may take precedent. This is especially true in healthcare where patients are at the central focus. Patients and ongoing healthcare events take precedent over tasks and sometimes even quality improvement. This is simply the reality and nature of this field of work. An administrator may have a set schedule but end up having to make changes because of unpredicted emergencies that happen. This experience has allowed me to understand that being flexible and understanding of other people's schedules is a huge part in accomplishing tasks in the healthcare field. While you may set deadlines or goals in advance, it's not guaranteed for them to proceed on the

timeline that you had initially expected. However, I will say that I am impressed at how supportive the staff at this microsystem has been during the quality improvement project thus far. They are curious to hear what I am doing and interested to learn about the information that I have found in research prior to starting the project. Having the support of staff makes completing a project such as this much smoother and effective. It's important to have stakeholders buy in. The sepsis committee has also been supportive and open to my ideas, they also helped to guide me in which direction I should take my project based on what they were simultaneously looking to improve. This project would not have ended up being successful without support of the microsystem and sepsis committee. Having their support will create receptiveness among staff and willingness to listen and participate in our attempt to reduce contamination rates.

Interpretation

With the establishment of committees and champions for areas of importance in the hospital setting, there has been an increase in focus and thought going into blood culture technique. However, there has not been any specific intervention or education released. The educational component created during this quality improvement project was a way to bring together the conversation and present nurses with material. In just a one-month period, the rate of contamination for blood cultures significantly decreased. It should also be noted that this was also an exceptionally high-volume period of time. Results were received favorably by the sepsis committee, noting that of 413 blood culture specimens collected, only 3 were contaminated, making it a rate of 0.7%. This is the lowest contamination rate for the current year. Typically with higher volume of collections, the facility has more room for contamination to occur. However, even during this month of high volume, and with education initiated, the staff were successful in maintaining a low rate of contamination. This is an important finding, because it

shows that with a less invasive intervention such as the infographic, staff were cognizant of their actions and it was effective in achieving our goal of reducing blood culture contamination rates. Similar to findings in the literature, introducing continuing education is of benefit to nurses for their success and accuracy of completing skilled tasks in the field (Dargere, Cormier, and Verdon, 2018). Not only does education reduce the volume of contamination but also the cost associated with them (Dargere, Cormier, and Verdon, 2018). The literature suggested the implementation of a protocol, however with a well-written protocol in place already this PDSA cycle focused on refreshing staff on the current material rather than recreating it (Dargere, Cormier, and Verdon, 2018).

This data is beneficial in understanding the additional factors that influence contaminated blood culture results. It shows that there isn't necessarily one specific factor that leads to contamination. This information has also helped to give direction with the quality improvement project. With so many factors, it can be difficult to pinpoint one specific thing that is the overarching problem. It is likely that different contributing factors each play some type of role in the contaminated results that occur. This information has led to the decision that education surrounding the process of blood culture collections is the biggest component of a quality improvement project. In addition to the initial infographic that is released, small posted reminders in patient rooms would have been beneficial to reducing contamination results. These reminders would have been located near the IV/blood draw cart and materials used specifically for blood culture collection. Having these additional reminders is supplemental to the infographic education reminding the staff of the important blood draw protocol that exists within the macrosystem.

Opportunity Costs

In terms of opportunity costs, money was actually saved during this period. Materials used for collecting blood cultures are of cost to the facility, as are running tests to analyze them. If tests must be repeated for reasons of contamination, this is of additional cost to the organization. By avoiding contamination from the initial culture collection, additional costs may be avoided. The infographic that was used is also of very little to no cost for the organization as the office supplies used for printing and posting them are already factored into regular facility costs. Considering the educational infographic was successful, it can also be appreciated that other costs for further interventions were avoided. For example, one of the interventions that was reviewed prior to the quality improvement project was a specimen collection device that diverts the initial collection of blood specimens. This device was determined to only be necessary with higher levels of contamination and in the case that less invasive interventions did not work. An intervention like this would also create higher costs for the organization. It is a great sign that decreases in contamination were achieved with a less expensive intervention.

While it does not necessarily come as a surprise that the educational piece was successful, one can never be sure as each microsystem is unique in its own way. Education has proven to be successful in other settings as a means to improve or reinforce skills (Dargere, Cormier, and Verdon, 2018). Dargere, Cormier, and Verdon (2018) have also suggested in their findings that reviewing and updating protocols in place can be beneficial. However, in this specific quality improvement project, no changes were made to the current protocol in place. The infographic was created using what already exists within the organization and microsystem for specific routines regarding blood culture collections. This is reassuring in the fact that the organization has created a proper protocol, but reinforcing the protocol and ensuring that staff are

following it may be a routine necessity. It will be of value for the microsystem to continue monitoring contamination rates and instituting educational resources as shown by the data being collected. A future step would be to implement competency evaluation which will reinforce proper technique without singling out those with numerous contamination instances. The staff members and leadership that serve on the committee expressed their satisfaction with the results after this past month. They were happy to see a decrease in the contamination rate, and are feeling motivated to continue focusing on maintaining a low rate.

Limitations

The idea in this cycle of the PDSA format quality improvement project was to initiate education for staff members to improve the outcomes of blood culture specimen collections. To improve these specimens would mean to reduce the rate of contamination. The method for distributing this educational material was to post it in a common area on an informational board and to reference this material during team meetings that happen before each shift. However, there is no guarantee and no way of knowing whether or not all staff members responsible for venipuncture and blood culture collection reviewed this information. It is possible that some people never saw the educational tool (Appendix A), and those who did not review it could also be responsible for some of the contaminated cultures. However, there is no way to be certain of this and would want to be considered during further cycles of the PDSA, such as providing competency training and evaluation for staff with numerous instances of contamination.

As previously mentioned, the proposal differed from the implementation and this was a major learning process. The original goal was to have multiple layers of interventions that would be established throughout the duration of the project, however implementing the first intervention proved to take longer than expected. This proved that within the timeline of the

course it would not be feasible to complete multiple interventions while also collecting the data to support results from multiple interventions. While the staff and sepsis committee were in support of implementing education and taking some form of action, they did not necessarily provide feedback or suggestions. There was some freedom with the quality improvement project however, specific aims might not be congruent with leadership goals.

Another factor that placed a constraint on including various interventions is the method of data collection. Raw data is released at the end of each month, and more detailed data/information is released at the end of each quarter. Waiting for data to be released has also slowed down the process as it makes most sense to do only a single intervention in the span of one month. If more than one intervention were to be started or completed within the same month it would be unclear which intervention is having an impact on the results being reviewed. One of the specific aims of the quality improvement project was to consider the staff members who repeatedly collect contaminated blood cultures. While data is released at the end of each month, this portion of the data is only included in the quarterly report making it difficult to take this component into consideration when revising plans for consulting with staff. Therefore, this is something that can be considered further down the road, but is not realistic to be included in the initial steps and education during the quality improvement project. This has limited the scope of project goals but will be useful to consider once educational tools are implemented. After discussions with the preceptor of the project, who serves on the committee that reviews blood culture results, it was decided that individual discussions are something that will be appropriate at the right time amongst these team leads/champions and staff members who repeatedly have such results.

One of the interventions that was outlined included embedding a notification or reminder that would appear in the electronic health record. This reminder would prompt staff members to recall appropriate steps of blood culture collection. While this was decided to be a beneficial tool, it proved to be a difficult task. Any type of alteration and change to the electronic health record is challenging due to the various steps that must be taken. The time that it would take to make such a small change was not found necessary at this time. However, this is an idea that has potential for future implementation.

Yet another intervention that was of interest to the committee members was the use of an initial specimen diversion device. This device was something most of the members had not heard of before. While it can be extremely useful in some settings, there has not yet been cause to initiate the use of such a device. Again, this is something that they may consider in the future if there is a proven cost benefit. Currently, the cost of this device is not within the budget given the lack of necessity. If there were to be a larger increase in contamination results they may consider implementing it at some point.

The initial plan was revised by the student and preceptor to accommodate for these limitations of the project. It was decided that education should be the main focus of the quality improvement project, and reviewing the results after the education would be beneficial in determining future plans for the microsystem and the team that monitors these results routinely. This quality improvement project paired well with the plans that the team was already considering and will help to start them in the right direction of not only monitoring results, but now taking action to make a change. Based on results, the team may consider having conversations with specific staff members based on performance, and even having educational conferences in the education rooms available at the facility.

Conclusions

The original goal of this project was to have ongoing adaptations based on how we saw fit from results and staff perception. This was only a beginning step to see what type of impact basic education may have. Depending on how it is perceived and the type of impact it has on data, another intervention such as direct communication between clinical/nurse leaders and staff on the unit based on individual performance.

While the information is not available at this time, it would be beneficial to the committee to review which staff members resulted the contaminated results. If in fact they have repeatedly done so, it may be beneficial for one on one counseling and education for these members. A table was created that shows how many times staff members have repeatedly resulted in contaminated cultures (Appendix C). While it would violate privacy concerns to include specific staff information in this project, this is something that the committee and leadership does have access to and can review. For those staff members who have higher numbers of contaminations, and have also produced contamination after recent educational material, it may be suggestive of some type of further education or communication. However, it could be beneficial to institute refresher education regularly. This infographic has proved to be of benefit to reducing contamination rates and depending on how the patterns continue, it could be helpful to routinely implement something similar.

Performing this quality improvement project was beneficial as a first step in taking action on the up and coming work with the sepsis committee and their focus on blood culture contamination. While it did not turn out to have multiple layers of interventions, it did prove that a single, less invasive approach, was successful and did have an impact. It was valuable to start with education and realize that it can have a large impact to avoid further interventions. While

there is still contamination, it is far below the accepted threshold. The data that is collected allows for leadership to explore further what may be causing the still existing contamination. For example, the reports show what the draw site was for each contaminated culture (Appendix D). This may be a factor that staff consider further down the road to review what role it plays. Moving forward, leadership may also decide to communicate directly with staff members who repeatedly result in contaminated cultures. If they continue to do so both before and after interventions have been initiated, it may be proof of a deeper problem that should be targeted at the root.

Maintaining a low to no contamination rate is a sustainable task for the microsystem. They have proved that it is possible with consideration of facility protocol and proceeding with care during blood culture draws. The results and interventions also translate to other potential areas of interest to improve. By focusing on protocols through renewing education or even in-service meetings for staff, it may be possible to create success across the board. While this quality improvement project focuses on the contamination of blood cultures in relation to septic patients, it has shown that similar interventions could be of use in other departments or committees in both the microsystem or macrosystem at large.

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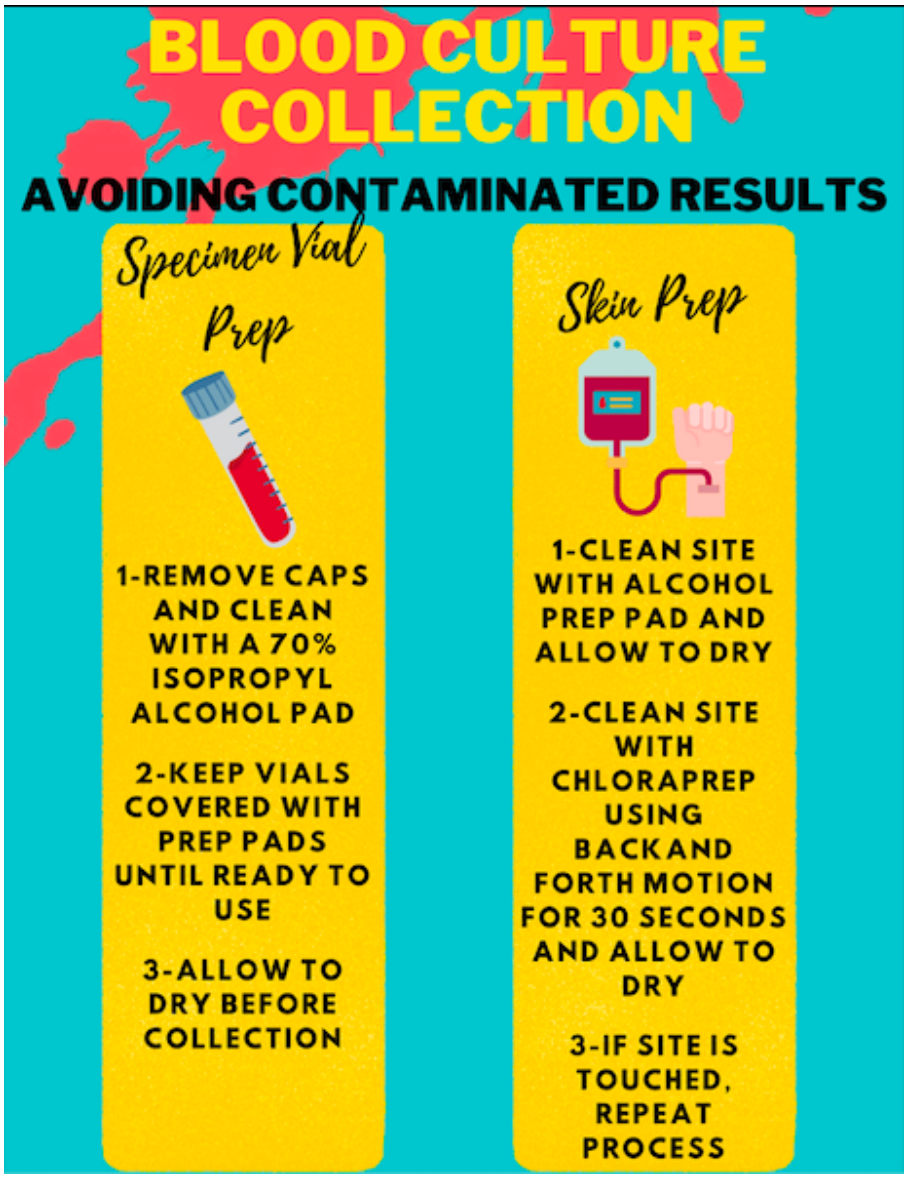
Appendices

Appendix A



Appendix B

AVERAGE CONTAMINATION RATE EACH YEAR AND QUARTER				
	2019	**2020**	**2021**	**2022**
Q1	1.70%	1.00%	1.10%	1.90%
Q2	1.30%	2.30%	1.00%	2.50%
Q3	2.00%	0.90%	0.70%	
Q4	1.10%	1.90%	1.50%	

Appendix C

AMOUNT OF STAFF WITH NUMBER OF OCCURRENCES	
# of Occurrences	**Total Staff**
One	27
Two	13
Three	2
Four	5

Appendix D

OCCURRENCE BY COLLECTION SITE	
RAC	26
R. HAND	5
R. ARM	11
NECK	1
LAC	16
L. HAND	4
L. SHOULDER	1
L. ARM	9
R. NECK	2
RFA	1
SHOULDER	1
L. THUMB	1
PORT	1
R. WRIST	1