Improving Protocol Adherence in Central Line Placements

by

Mathews Roy, Ashley Jones MD, Jennifer Rinqvist MD, Ravi Bhoja MD, Ashley Yager MD, Kristina Goff MD

DISSERTATION

Presented to the Faculty of the Medical School
The University of Texas Southwestern Medical Center
In Partial Fulfillment of the Requirements
For the Degree of

DOCTOR OF MEDICINE WITH DISTINCTION IN
QUALITY IMPROVEMENT AND PATIENT SAFETY

The University of Texas Southwestern Medical Center
Dallas, TX

ACKNOWLEDGMENTS

We acknowledge the guidance and assistance that we have received from the UT Southwestern Department of Patient Safety and Quality improvement.

ABSTRACT

TITLE FOR THE MD WITH DISTINCTION DISSERTATION

Mathews Roy

The University of Texas Southwestern Medical Center, 20XX

Supervising Professor: Kristina Goff, M.D.

Background

The placement of central lines is a very common exercise in medicine. Central lines are required for everything from acute trauma scenarios to long term cancer treatments. However, this ubiquitous procedure has several morbid complications that are not uncommon. Possible complications include infection, catheter misplacement, arterial puncture, hematoma, pneumothorax, and death[1]. Not only are the complications severe they are also quite prevalent with a complication rate of 15 to 25 percent[2].

Local problem

Due to a concern for the rates of central line infections across campuses at the University of Texas Southwestern Medical Center (UTSW) there was a project underway to create a standardized central line placement protocol for all departments in the system. This protocol was taught to all incoming residents on a simulation session day. However, because a significant period of time can pass between central line training and the clinical practice of placing central lines, the rate of resident retention and adherence to the standardized procedure for central line placement is unknown. This report describes the results of a QI experiment meant to reduce the rate of catheter associated blood stream infections and ensure better resident protocol adherence at UTSW medical center using checklists and visual aids to ensure implementation of the standardized protocols.

Methods

The study was split into three phases. The first phase examined the baseline knowledge of UTSW residents regarding the placement of central lines and found the nursing position regarding possible interventions. The residents were interviewed regarding the standardized UTSW protocol and asked to detail the steps of placing a central line. The results were used to analyses areas of weakness in protocol adherence. Based on the results of the interviews, a checklist and visual aid were created highlighting key steps to ensure the adherence to the protocol. In phase two, to evaluate the feasibility of incorporating a checklist and CVA into the original CVC insertion methodology, a simulated pilot was conducted, and a survey was completed by the participants to determine how staff perceived the use of these new tools. In phase three after analyzing the ability to integrate the checklist and visual aid in a simulated setting, the utility of using a checklist to improve CVC insertions was tested by conducting a pilot study on real patients. During the pilot, CVCs placed in the ICU were observed by a medical student with the bedside nurse's participation and real time completion of the checklist

Results

Phase 1:

It was found that there were significant variations in the average adherence between departments and training years. On average, post graduate year (PGY)3s did better than PGY2s. Furthermore, it was found that 50% of missed steps were caused by only 8 out 36 questions and 75% of mistakes were caused by just 15 out of 36 questions.

Phase 2: Simulated pilot

Survey results showed that all participants felt that their team successfully followed the standardized placement method. The participants also said that the implemented huddle helped to create teamwork and organization, and that it could easily be incorporated into the normal workflow.

Phase 3: In-practice pilot

All trial participants were asked for feedback regarding the perceived benefit of the process. Results were very positive with most participants saying that they thought that the new

workflow was helpful and easy to implement. Analysis of the completed checklists show that participants were able to complete the forms without issue ensuring that complete adherence to the standardized protocol was possible.

Conclusions

By interviewing residents to understand areas of difficulties and going through a multistep approach to ensure safety and efficacy of interventions, this project provides insight into the possible gaps in resident procedure adherences and retention of the UTSW protocol. It then also provides an intervention that strengthen the memory of the preforming physician and a layer of oversight to ensure that even if a mistake is made it is quickly corrected. The general concepts of simulation trials prior to clinical application and utilization of a checklist and cognitive visual aid can be applied not only to central lines at UTSW, but to many different procedures across multiple hospital systems.

Contents

CHAPTER 1 Introduction

Problem Description

More than 5 million central lines are placed annually in the United States[3]. Although it is a common procedure, placing a central line can result in many complications including infection, catheter misplacement, arterial puncture, hematoma, pneumothorax, and death[1]. The rates of such complications are estimated to be between 15 and 25% [2].

Central line associated blood stream infections (CLABSI) are present in all UTSW affiliated hospitals and present a significant risk to patient morbidity, and treatment length. Because they delay the administration of important treatments, introduce life threatening infections in the most vulnerable populations, and extend patient stays, CLABSI's represent a significant threat to both patients and the hospital system.

UTSW chose to standardize its central venous catheter insertion process as it has been shown that standardization reduces patient harm, errors, and costs, while improving process quality, consistency, and efficiency [4]. Furthermore, standardization is considered an effective method to implement further process improvements. However, increasing rates of central line associated infections within the institution, despite the implementation of a training program to teach the standardized protocol, generated interest in introducing a best practice clinical protocol for central lines. The central line associated blood stream infection (CLABSI) committee data shows that there were 56 CLABSI's in 2015, 35 CLABSI's in 2016, 23 in 2017, 32 in 2018, 52 in 2019, and 61 in 2020. Ensuring proper adherence and knowledge of the UTSW protocol would reduce rates of central line infections positively affecting patients, staff, and the system however it is difficult to ensure that the protocol is always being followed.

Available knowledge

In their landmark paper, 'To Err is Human', Kohn et al. point out that every year more than a million injuries and 100,000 deaths occur in the United States due to physician error[5]. These findings led to a national discussion and an evidence report for best practices to be published.

Leape shows us that the focus of medical innovation was mostly on creating new "biomedical interventions" and that error prevention is a new, untapped and productive field[6]. We see a success story and model of the effectivity for error reduction research in how the field of anesthesia achieved the six-sigma level of safety. Anesthesiologists reached this lauded goal not by a single innovation or biomedical creation, but by the implementation of a series of changes to prevent, compensate for, and ameliorate human fallibility by means of "standardization, simplification, and use of protocols and checklists[5]." These changes increased the quality and decreased the cost of healthcare, making treatments safer and improving patient outcomes. Patterson et al. point out another efficient way to identify where changes are needed[7]. It is known that an effective way to improve safety is by removing potential failures to patient health. In their study, they found that nurses identified half of these potential failures and a third were found by the simulation participants. This shows us that an effective way to improve patient outcomes is to have a shared mental model and multidisciplinary team working together in ensuring patient safety.

Rationale

Our team chose to focus on how development and implementation of checklists, visual aids, and safety-focused workflows promote a safer healthcare system. It has been shown that safety systems are the modus operandi of highly reliable programs. Reason et al. describes two ways of modeling physician failings in healthcare: the person approach and the system approach[8]. The person approach places the blame for accidents squarely on the feet of the operator while the systems approach looks at the conditions the operator is in and tries to build barriers that prevent errors or reduce their effects. The systems approach is often described with the "swiss cheese model" which illustrates how error prevention mechanisms in most systems are not solid walls but have holes in them like swiss cheese. An error occurs when the holes within all these prevention systems overlap and allow for an error to slip through. Our project focuses on providing more redundancies to the system and involving more group members so that we could efficiently prevent these errors from slipping through the cracks to create a safer system.

As the protocol training program has not yet reached the desired effectivity there must first be research done into how effectively the process was standardized and how well residents adhere

to the standardized protocol. Therefore, the first step in this project is to identify how well residents retain their knowledge of the protocol. If there are lapses in protocol retention, it has been shown that checklists can significantly improve patient safety and so a checklist could be greatly beneficial in addressing such a potential issue[9]. Because of this, the second step in this project is to take the identified gaps in knowledge and create a checklist that will be tested for usefulness in a high-fidelity simulation. The final step is to implement the finalized checklist in real patient encounters and test for effectivity and practicality.

Recognizing the strong evidence base demonstrating that checklists, multiple redundancies, and a culture of safety can improve safety outcomes, we seek to investigate the current familiarity and adherence of trainees with the standardized protocol and to identify which - if any - aspects are lacking. Using that knowledge, we created and implemented a cognitive visual aid and a checklist which included a structured pre-procedure huddle. We also instituted a periprocedural workflow to ensure best practice. This multidisciplinary, team-centered, systems-based approach was developed to provide as many redundancies as possible to prevent errors from occurring and mitigate complications from errors if they occur.

Specific Aims

Create and test a workflow to ensure full adherence to the UTSW protocol by 2022

i. Measure the level of protocol adherence among medical trainees.
ii. Create a checklist and memory aid that will promote protocol adherence.
iii. Test the feasibility of these tools in a high-fidelity simulated setting.
iv. Test the feasibility of these tools in actual patient care in the ICU setting.

CHAPTER 2 Methods

Context

This project is part of an ongoing initiative to improve resident training and patient outcomes through simulation-based training. It takes place at Clements University Hospital and involves medical trainees in internal medicine, emergency medicine, surgery and anesthesiology who have gone through the central venous catheter (CVC) simulation training, the UTSW High Reliability Team, as well as the Surgical Intensive Care Unit, the Medical Intensive Care Unit and the Cardiovascular Intensive Care Unit.

As a variety of dangerous complications can arise from the placement of central lines, it is important that lines are always placed properly. To ensure proper line placement, in 2017 the University of Texas Southwestern Medical Center (UTSW) created a multidisciplinary group including the six departments most commonly responsible for central line placement – Internal Medicine, Emergency Medicine, Anesthesiology, Cardiovascular and Thoracic surgery, Interventional Radiology, and General Surgery –to create a standardized protocol for the placement of triple lumen internal jugular central lines. A simulation-based training program was developed for residents and fellows from each of these departments to familiarize them with the standardized protocol, and beginning in 2018, every resident was required to complete this program prior to placing lines in the clinical setting. Unfortunately, without a mechanism in place to assess adherence to the training protocol in clinical practice, the efficacy of the training program remained uncertain. Given the potential for a long latency period between the instruction of this protocol and its clinical implementation, it is reasonable to assume that residents may not adhere to the protocol optimally. These various issues coupled with an increasing number of central line infections marked the need to understand the baseline level of adherence to the protocol and creation of a new system to reduce central line infections.

There are several important stakeholders. UTSW strives for patient centered care and considers patients to be an important stakeholder in all interventions. The end goal is to reduce complications for the patients and so their interests are very important to consider. Residents are the primary group affected by the intervention. As the providers who place the central line this

intervention directly changes the way they practice and so their opinions are also critically important. Nurses are another key player in this intervention as the implemented checklists are being marked off by the nurses. Considering the needs of these three groups is critically important for the success of this project.

Intervention

The intervention was broken up into 3 phases corresponding to the collection of baseline data, the implementation of an initial intervention in simulation, and the implementation of the intervention in live patients

Phase 1: Identifying adherence and checklist creation.

The primary phase was centered around understanding resident retention of the standardized UTSW protocol. To gather this data a survey was created containing all the relevant steps in the CVC placement process. A medical student would then ask residents to recite all the steps for placing a central line during one-on-one interviews with a medical student. Points were awarded for citing specific steps during the interview and results were compared amongst the groups. After this several nurses on different floors were interviewed to assess their attitudes regarding the implementation of a checklist. Based on the results of the interviews in phase one, a checklist and visual aid were created highlighting key steps to ensure the adherence to the protocol.

Phase 2: Simulated pilot

To evaluate the feasibility of incorporating a checklist and huddle into the original CVC insertion methodology, a simulated pilot was conducted. The pilot involved residents inserting CVCs into mannequins using the visual aid with observation and checklist usage by the bedside nursing staff. After the simulation, a survey was completed by the participants to determine how staff perceive the use of these new tools and whether it helped to ensure the correct placement protocol.

Phase 3: In-practice pilot

After analyzing the ability to integrate the checklist with preprocedural huddle and visual aid in a simulated setting, the utility of using a checklist to improve CVC insertions was tested by conducting a pilot study on real patients. During the pilot, CVCs placed in the ICU were observed by a medical student with the bedside nurse's participation and real time completion of the checklist. All trial participants were asked for feedback regarding the perceived benefit of the process. Correct completion of the procedure and the nurse's completion of the checklist were evaluated by the observing medical student.

Measures

Phase 1:

This phase measures the resident's retention of the steps involved in the CVC placement protocol taught during their training. There are 36 different points of the procedure that are measured by the interview tool. Unfortunately, as there has been no previous attempts to quantify resident retention of the protocol after it was initially taught there was no similar study to compare interview results with. Nurse perception towards authority gradients and fear of backlash were also assessed through a freeform interview.

Phase 2:

In phase two, residents and nurses were asked to fill out a post procedure 29 item survey to measure the effectiveness of the cognitive visual aid and checklist, the ease in which the aids could be implemented, and the culture of safety within the unit. As the primary purpose is to assess for difficulties in implementation for nurses and residents a survey of multiple participants renders the most complete information

Phase 3:

During the pilot, the residents and nurses were evaluated to measure how checklist implementation affects proper completion of all steps and whether the checklist itself was completely implemented. Just as in phase 2, the residents and nurses were asked to fill out pre and post procedure surveys. The survey collected data on workplace culture of safety and the perceived benefit of using the new workflow with the goal of measuring acceptability, appropriateness, fidelity, feasibility, and implementation cost of the new workflow. However, in

addition to that, nurse checklists were collected to ensure that they were filled out. Furthermore, a medical student was in the room to ensure that all steps were completed by the procedure preforming resident. This was to ensure that not only was the new workflow practical from the participants point of view but that it was also being executed properly.

Analysis

Phase 1

As the purpose of this phase is to understand which steps of the standardized protocol were most forgotten. The results of several interviews were analyzed primarily by identifying which steps were most missed by all overall residents. Afterwards, results were split into groups by resident specialty and year and analyzed for trends.

Phase 2

As there was a small sample size results will be analyzed by the percentage of participants who reported that the new checklist was easy to implement. If over 80% of participants said that the checklist was useful and that they would implement the checklist in their practice, then it was considered a success.

Phase 3

In this phase the survey results were analyzed to see what percentage of patients reported that the procedure was easy or difficult to use. Similarly, the medical student observations and nurse checklist completion were analyzed by simply looking at the average completion per item. If there was 100 percent completion of all central line steps and 90% completion of the checklist then the implementation was considered a success.

Ethical Considerations

While studies have shown that checklists improve patient safety the increased workload on the nurses may limit response to sudden patient complications. Furthermore, while the checklist asks as a safeguard for younger staff members it may also cause frustration in the nurse-resident power dynamic.

CHAPTER 3 Results

Phase 1:

The raw data on the surveys was turned into a quantitative number indicating correct steps recalled by the trainee. These samples were then divided by post-graduate year and department. The protocol adherence data was then analyzed to identify whether there was any variability between these groups and which group had the highest average adherence level. Pareto charts were used to analyze which steps were most forgotten to tailor-make effective memory tools. Data was also analyzed across both residency program and year as time since initial training as well as recent and overall procedure exposure widely varied. Nurses were interviewed about their perceptions regarding the implementation of a possible new checklist and the results of the interviews were arranged into a fish bone diagram.

It was found that there were significant variations in the average adherence between departments and training years. On average, PGY3s did better than PGY2s. However, certain departments' PGY2s did better on average than their PGY3s. Anesthesia PGY3s had the highest score overall but anesthesia PGY2s did worse than their EM and IM PGY2 counterparts. It was found that 50% of missed steps were caused by only 8 out 36 questions and 75% of mistakes were caused by just 15 out of 36 questions.

Phase 2:

A quantitative analysis was preformed using the qualitative data by tallying the percentage of "Agree" or "Strongly Agree" vs "disagree" and "strongly disagree" responses for each question. A table was then constructed to identify overall sentiments of the implementation of the proposed interventions. The surveys revealed that both nurses and residents found the checklist and visual aid useful and easy to implement in their practice. Additionally, it was discovered that while many older nurses were willing to speak up to doctors, many newer and younger nurses felt they were not in the position to correct doctors if they saw something that endangered patient safety. The surveys also suggested that the CVA and checklist should be more aesthetically simple and easy to read.

Phase 3:

Provider reception of the new workflow was analyzed via the breakdown of responses to each question on the survey that was taken after the central line was placed similarly to what was done in phase two. A number was generated from the survey tool and the nurse's completed checklist and the distribution was mapped.

Results show that nurses and residents were comfortable with the checklist and that they found it helpful and feasible. Quantitative metrics show that the checklist was used effectively by the nurses and that it ensured the completion of all steps.

PDSA cycle

- Plan: Initially evaluate solely on post-procedure surveys
- Do: Conducted the procedures
- Study: Realized that we did not ensure completion of the checklist
- Act: Added check boxes next to the procedure and asked the nurses to check off the boxes

CHAPTER 4 Discussion

Summary

This study presents a preliminary model for how to develop possible solutions for systemic issues in hospitals. Although there was a standardized protocol in place at UTSW, it was previously unknown how well residents would retain their knowledge of the procedure. This study presents a way to evaluate knowledge retention and then furthermore creates a workflow to ensure that it is followed.

Interpretation

Phase 1:

The survey results indicate that most mistakes were caused by a minority of steps (Figure 1a.). These common omissions included performing the pre-procedure time out, using best practices for sterile procedure, confirmation of line placement, and using appropriate dressing techniques. The results also showed while there were several common mistakes between all the groups, there were significant differences in the level of adherence (defined by the percentage of points received in the survey tool) between the departments and within the departments based on the year of the resident. Differences in the accuracy of resident's recollection of CVC insertion protocol can be explained by each department's training and residency timeline.

Figure 3i shows that residents often will skip smaller but still important steps once they insert a certain number of lines and form bad habits. Because the issue involves recall, this suggests a checklist and CVA would be very useful to help ensure that these small steps are not forgotten. As the inclusion of such a tool could change the work dynamic between physicians and nurses it was important to understand the nurse perspective. The addition of this item to the workflow was also supported by the nursing staff addressing their reluctance to provide real time feedback to the physicians during the actual placement of the lines. There was a wide variety of responses from the nurses, but they could be arranged into five basic categories as shown in Figure 1B. They suggested that the checklist could help improve patient safety, improve task completion, improve standardization, improve communication, and improve comradery. The positive feedback from the nurses indicated that implementing a CVA and checklist would receive support from all parties and therefore be practical.

There was no cost of implementation aside from the use of resident time in this step as there were not additional materials needed.

Phase 2:

A new workflow, checklist, and CVA were made from the results of phase 1. The new workflow included looking over the CVA before the procedure and following the checklist during the placement, including having a group huddle before the time out, and having the nurses observe and approve the placement of the final dressing. A hard stop was included in the pre-procedure huddle to ensure all participants had a shared mental model of the situation. Nursing feedback also indicated that the current dressing method was inadequate as physicians would commonly place the dressing improperly. As a result of this, nurses would have to redress the line very soon after the initial dressing resulting in wasted time and resources. Because the results indicated that the dressing may have been an issue of concern, the new workflow was designed to include a two-person dressing application ensuring proper procedure at the initial placement.

The survey results from the trial implementations show that the group huddle, CVL checklist, and visual aid were considered a major help to health care workers and could easily be added to the established workflow (Figure 2A). This shows that the issue of omission of steps can be easily addressed with the use of a checklist. The proceduralists found the changes to the workflow helpful, including the communication tools integrated into the checklist. The nurses supported the new dressing application protocol as it will reduce the frequency of immediate post procedure dressing changes, and they supported the checklist as it helped to address power gradients within the hospital that interfere with patient safety measures. Nurses who are often pressured by power disparities to avoid voicing their concerns about patient safety lapses promoted the new “3 sticks or 20 minutes” cut-offs in the new workflow as an improvement for patient safety. Both the nurses and the physician/advanced practice providers agreed that this change to the workflow would improve patient care.

As the group huddle, CVA, and checklist have been validated as effective tools to prevent the lapses that we have identified in phase 1 without significantly interrupting the placement of

central line insertions in simulation tests, the next phase will attempt to validate the application in patient care in the ICU.

Additional support was provided from the CLABSI committee whom we worked with to understand the current difficulties and issues associated with central line placements in the hospital system. They showed that rates of central line infections had increased in the hospital system. As data shows that standardization reduces the rates of adverse effects[7], the successful implementation of the new workflow shows promise in reducing these rates.

Phases 1 and 3 had little to no additional cost. Phase 1 involved short interviews with residents during clinic down time and phase 3 was conducted during scheduled procedures with the only additional materials being sheets of paper. Phase 2 however did require the input of extra hospital resources in the form of nonreusable CVL kits and high-fidelity mannequins. These costs could be reduced by using reusable mannequins that are meant for hospital wide training, as we did, and by using reusable CVL training kits.

Phase 3:

The results of the final phase echoed that of the second phase in that both the nursing and physician staff found the new workflow and tools helpful. When evaluating for acceptability, 100% of surveyed nursing staff indicated that they were comfortable using the checklist (Fig. 3a) and 92.9% of surveyed nursing staff said that the checklist was feasible or very feasible to use (Fig. 3b). Similarly, when evaluating for appropriateness 100% of physicians said that patient safety would improve by utilization of the CVA and checklist (Fig. 3h) and 85.7% of nurses said that they felt patient safety would be improved (Fig. 3d). 87.7% of nursing staff and 100% of surveyed physicians described the new huddle as either very beneficial or beneficial (Fig. 3c and Fig. 3g). 90% of physicians said that the CVA was either helpful or very helpful in solidifying key steps (Fig. 3e). 100% of physicians felt that the checklist was either helpful or very helpful during placement of the central line (Fig. 3f).

To evaluate the thoroughness of the checklist, we found that while being asked to recite the steps, residents would only recite 76.13% of steps correctly. However, when asked to perform

the procedure with a checklist, no steps were missed by the resident (Fig. 3j). As an example, in Phase 1 several residents forgot to order an X-ray, in Phase 3 however, residents who had forgotten to make the order were quickly reminded to do so by the nurse with the checklist and were thus able to complete all the steps of the procedure. When evaluating the nurse's completion of the checklist, it was found they had a 94% completion rate. This is a great sign because it suggests that with little direction nurses can easily implement this process. Furthermore, the costs of implementation for all three phases of our project are negligible as they only require a change in policy and the creation of a checklist in a software program rather than any change in physical materials or significant training of staff, and interviewing residents.

Results indicate that the new workflow, CVA, and checklist are very well received by the practitioners involved in central line placements. The changes have also been shown to ensure that all steps are conducted and that they are easy and inexpensive to implement.

Limitations

The direct results of this project are largely limited to UTSW as the training of residents vary not only between UTSW and other hospitals but within UTSW itself. However, the general concepts of using an interview tool to gauge the level of protocol retention among residents and implementation of a checklist to prevent errors and improve patient safety can be applicable elsewhere.

Another possible limitation of the study was the small sample size. As the study revolved around implementing a new workflow it was not possible to trial on patients who required an emergency central line. Because central lines are often placed in acute settings the number of possible trials were limited.

There were also significant time lapses between the phases of this project because of the COVID-19 pandemic. This could have decreased the efficacy of our phased approach, as staff buy-in may fade over time despite having participated in the trial.

There is also the issue of limitations to the assessment approach used in Phase 1, in which we used interviews rather than observed procedures that we used in the other phases. This method was implemented as it would allow for the assessment of a much larger number of residents and so would give a much better picture of the understanding of the residents.

Conclusions

Usefulness of the work

This project provides insight into the possible deficits in resident understanding and retention at UTSW, provides targets for improvement through simulation as well as development of interventions to ensure consistent and high-quality patient care. It creates an effective team that offers many layers of error protection and compensates for any real or perceived nurse-physician power gradients allowing all providers to work together. The general concepts of simulation trials prior to clinical application and utilization of a checklist and cognitive visual aid can be applied not only to UTSW, but across multiple hospital systems. The sustainability of the study has been augmented by turning the checklist into a memory aid as well as a data collection program. This provides further longevity of the intervention because it provides a secondary benefit. Further steps would involve using the results of the checklist documentation to determine trends in CVC complications and catheter related infections to create an even safer protocol.

Sustainability

Ensuring the continued use of the checklist is dependent on institutional and individual factors. Individual providers must find it beneficial and keep it as part of their practice. Post procedure survey results (insert here) provide a strong sign that practitioners find the new workflow beneficial and will continue to use it. Furthermore, the project was founded through institutional support and is currently being rolled out too many different departments. These trends are assuring that the implementations made by this project will be used well into the future.

Potential for spread to other contexts

The project was conducted at Clements university hospital and implemented in the medical ICU and surgical ICU settings however it can easily be spread to other departments where central lines are placed and other hospitals.

Implications for practice and for further study in the field

This project suggests that implementing checklists for a variety of procedures can positively impact patient safety and will be positively received by doctors and nurses. This does not have to be limited to central lines but can also be implemented for other procedures with high complications rates such as pleural drainage and to ensure all supplies are present before surgeries.

Suggested next steps

The next steps for this project include creating an online epic checklist that would assist in procedure completion and data collection to improve patient safety. Other steps include rolling out this workflow into other hospital systems.

Sources of funding that supported the work.

This study was funded by the UTSW Department of Quality Improvement and Patient Safety

LIST OF FIGURES

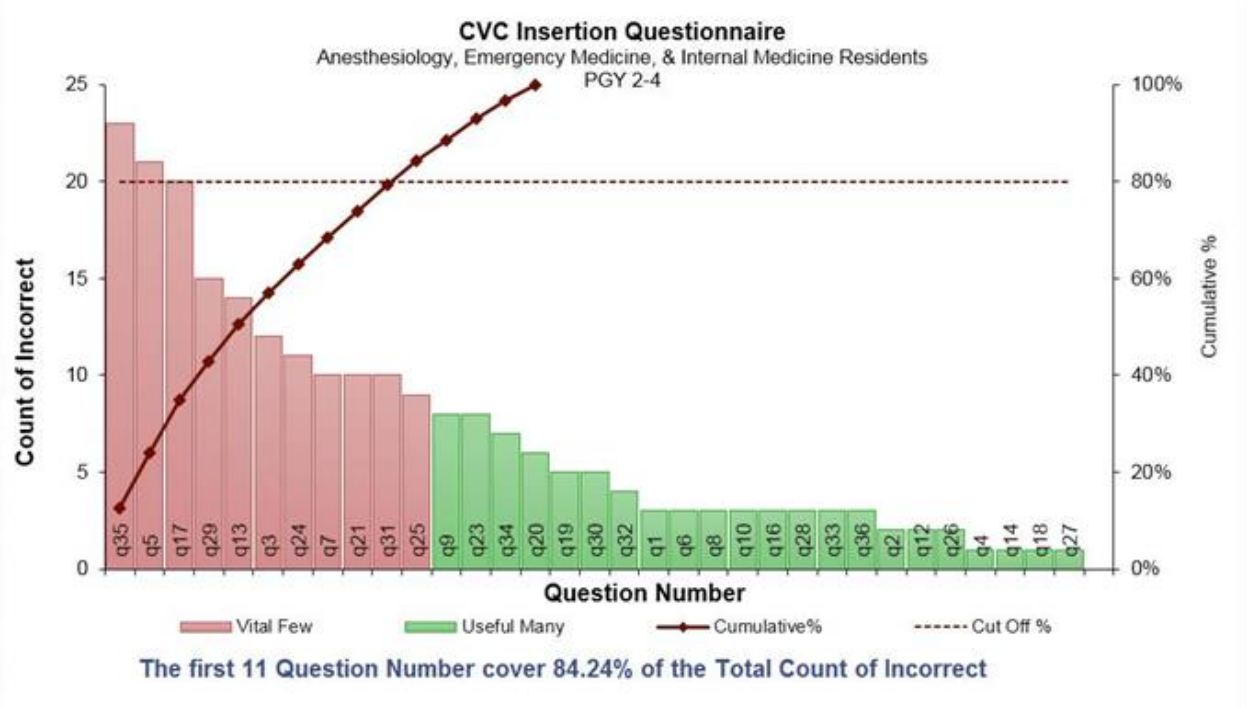


Figure 1A

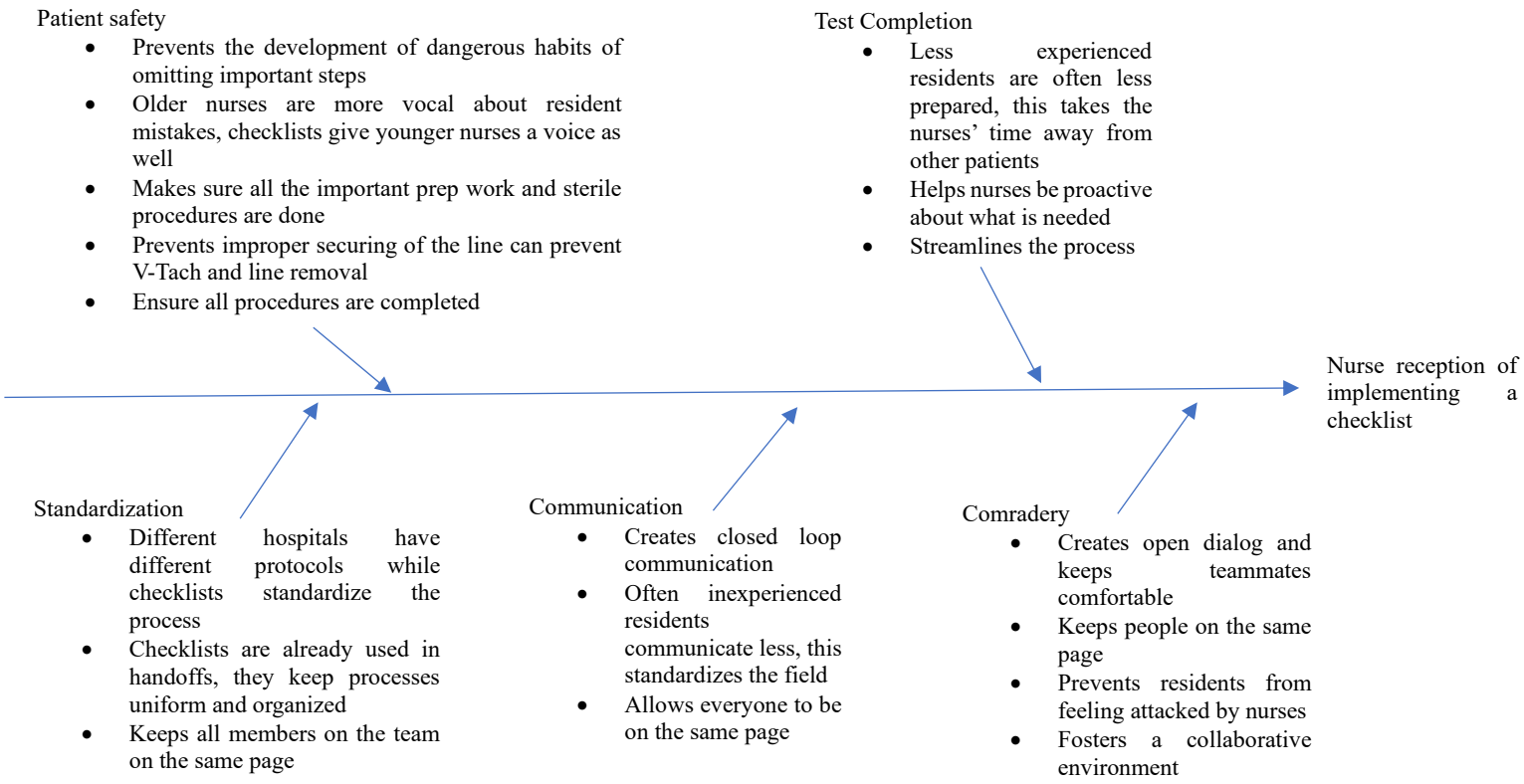
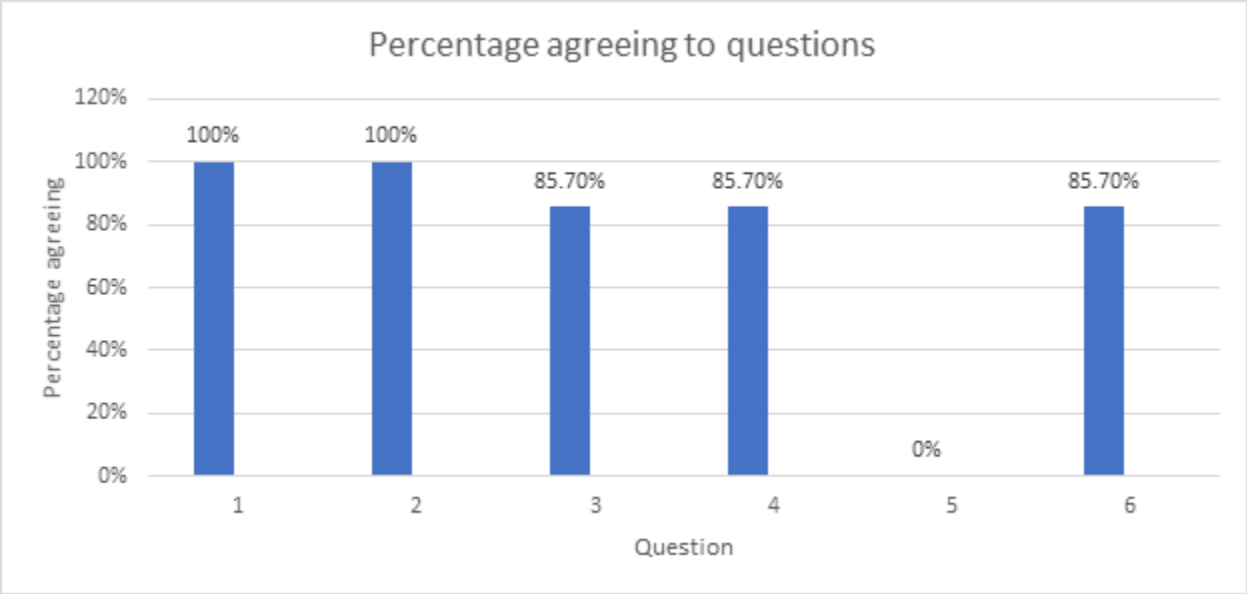

Patient safety
Prevents the development of dangerous habits of omitting important steps
Older nurses are more vocal about resident mistakes, checklists give younger nurses a voice as well
Makes sure all the important prep work and sterile procedures are done
Prevents improper securing of the line can prevent V-Tach and line removal
Ensure all procedures are completed
Test Completion
Less experienced residents are often less prepared, this takes the nurses' time away from other patients
Helps nurses be proactive about what is needed
Streamlines the process
Nurse reception of implementing a checklist
Standardization
Different hospitals have different protocols while checklists standardize the process
Checklists are already used in handoffs, they keep processes uniform and organized
Keeps all members on the team on the same page
Communication
Creates closed loop communication
Often inexperienced residents communicate less, this standardizes the field
Allows everyone to be on the same page
Comradery
Creates open dialog and keeps teammates comfortable
Keeps people on the same page
Prevents residents from feeling attacked by nurses
Fosters a collaborative environment

Figure 1B

Figure 2:



Question number	Question
1	On reviewing the cognitive aid post-procedure, did you feel that your team successfully followed the standardized CVL placement method
2	The pre-procedure huddle helped to create teamwork and organization during the procedure
3	The pre-procedure huddle could be easily incorporated into normal workflow.
4	The CVL checklist could be easily incorporated into normal workflow.
5	In this unit staff are afraid to ask questions when something does not seem right.
6	When staff in this unit see someone with more authority doing something unsafe for patients, they speak up.

Figure 2a

Figure 3:

Nurse post survey:

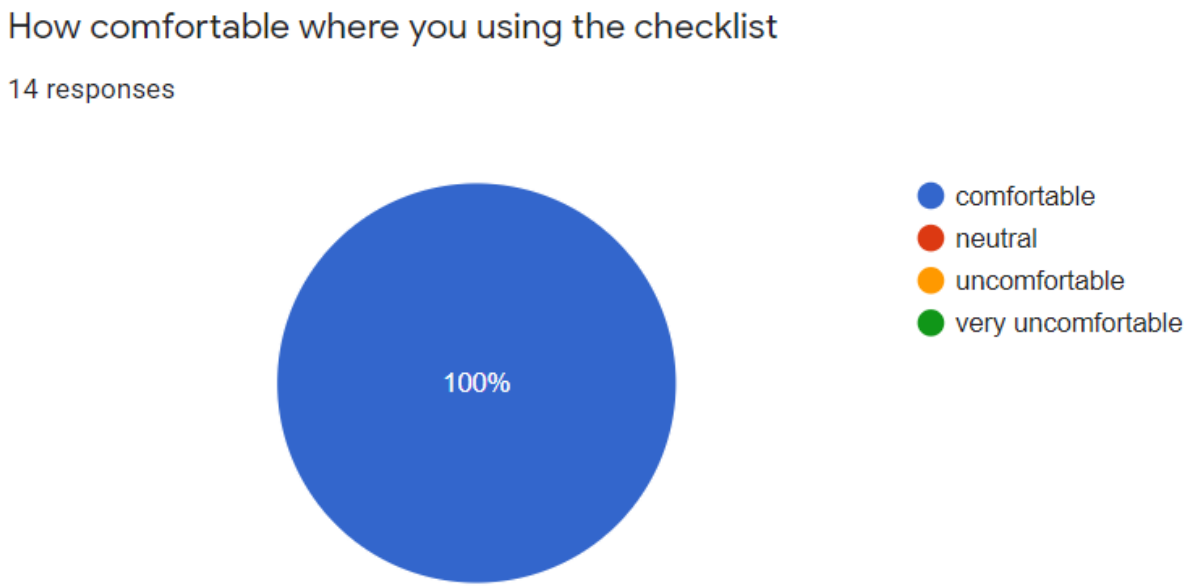


Fig 3a. Nurse post survey comfort

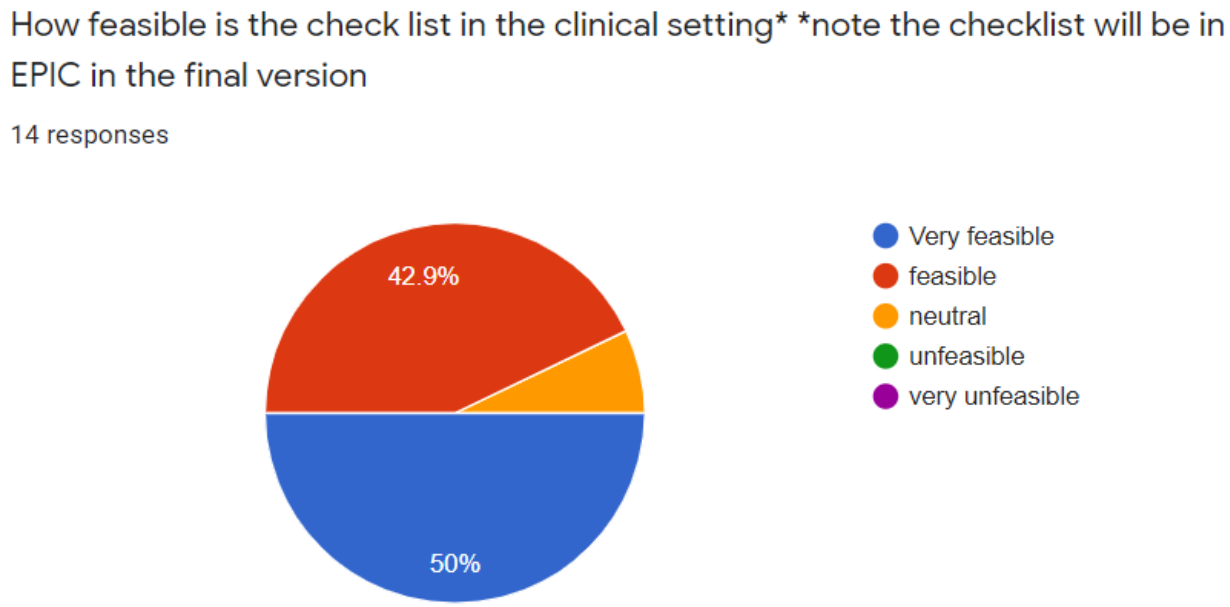


Fig 3b. Nurse post survey feasibility

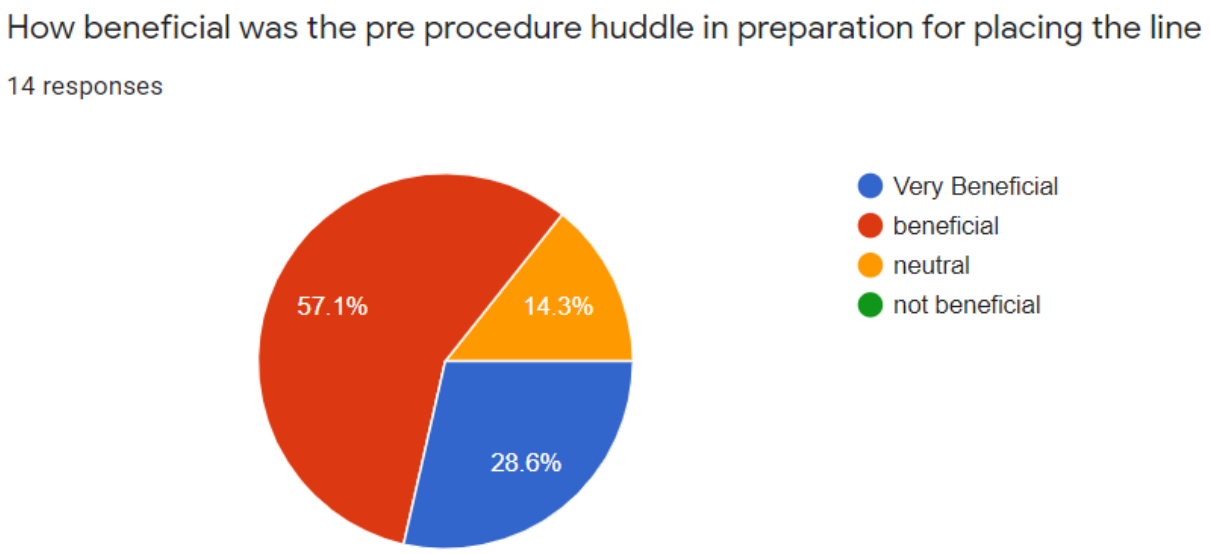


Fig 3c. Nurse post survey huddle

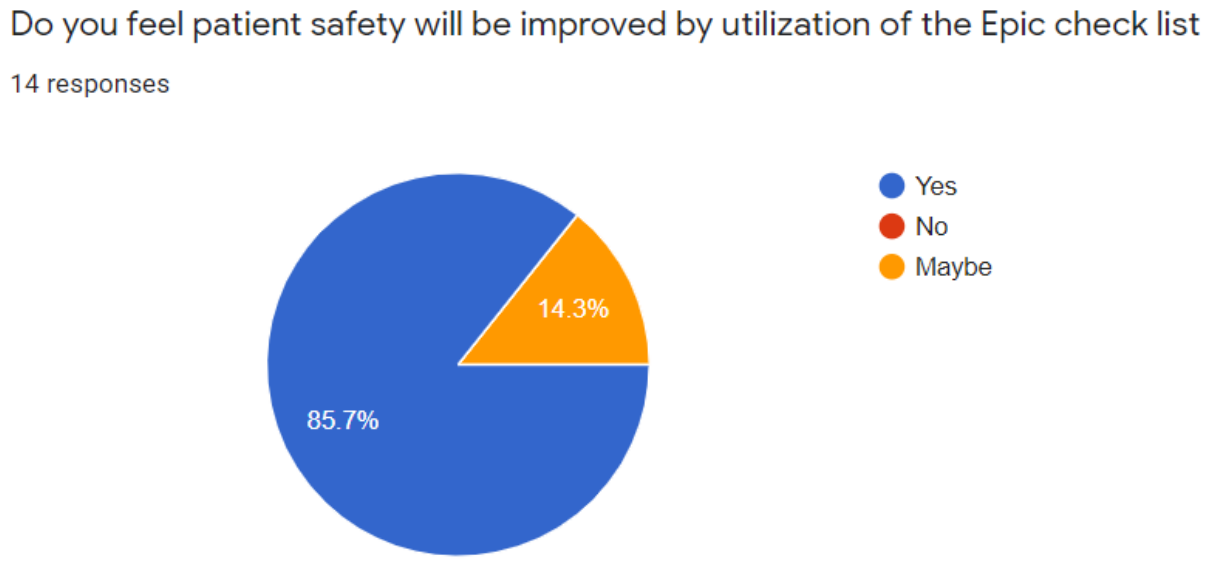


Fig 3d. Nurse post survey safety

Physician post survey

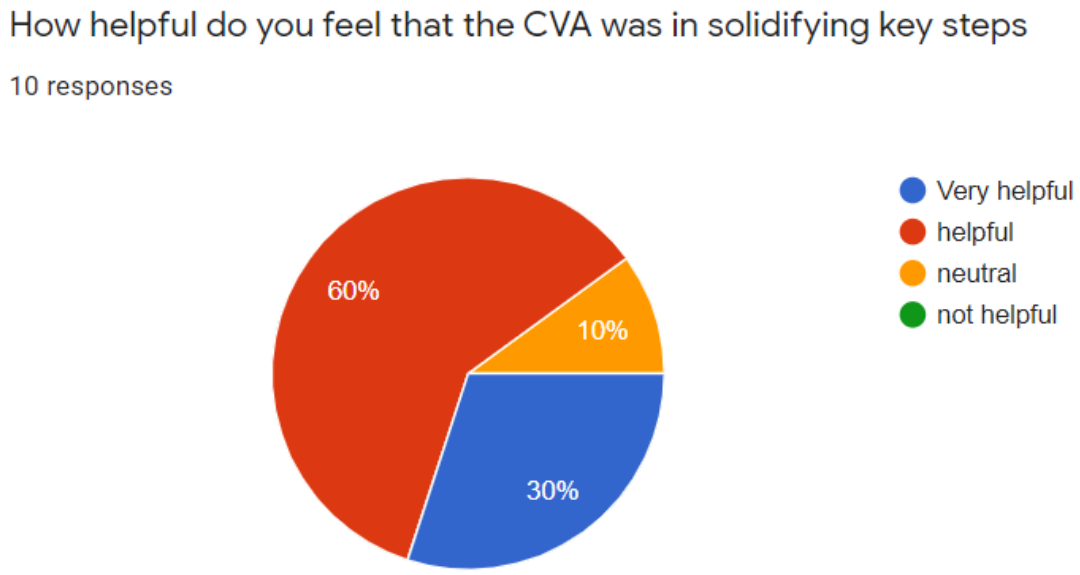


Fig 3e. Physician post survey CVL helpfulness

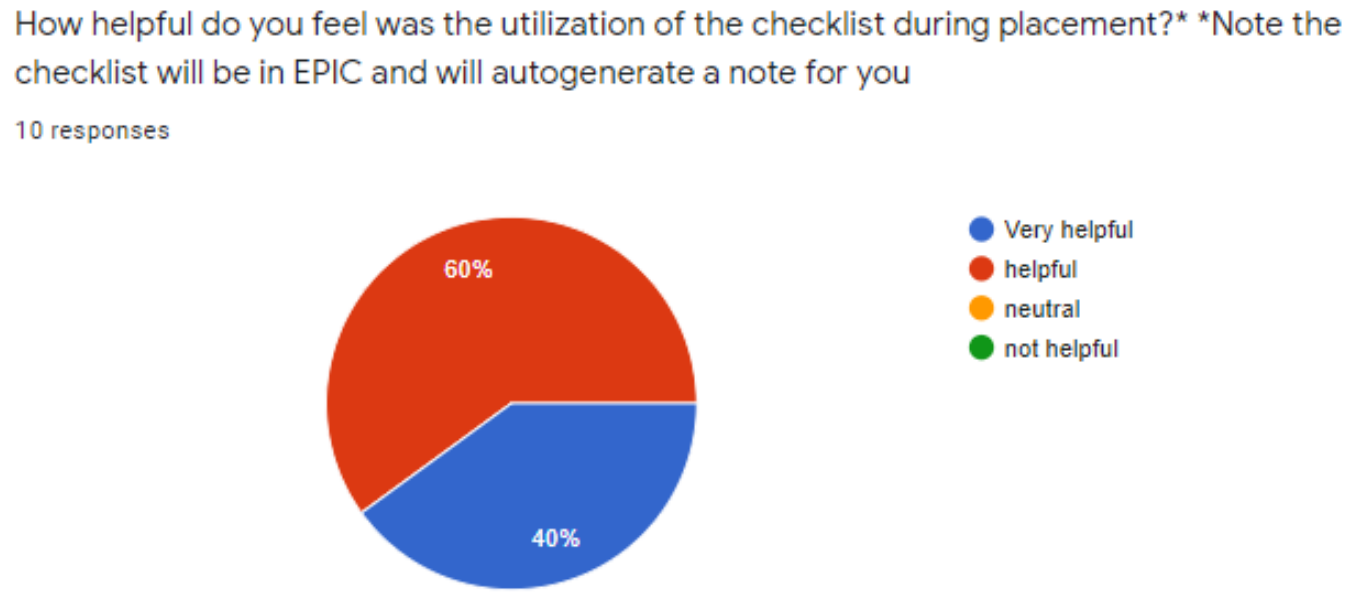


Fig 3f. Physician post survey checklist helpfulness

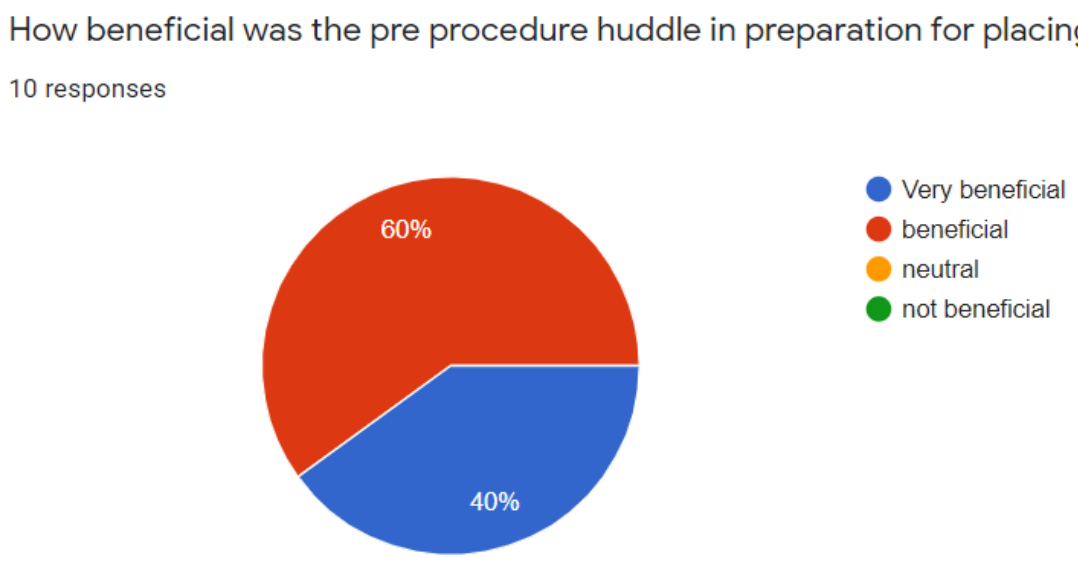


Fig 3g. Physician post survey huddle

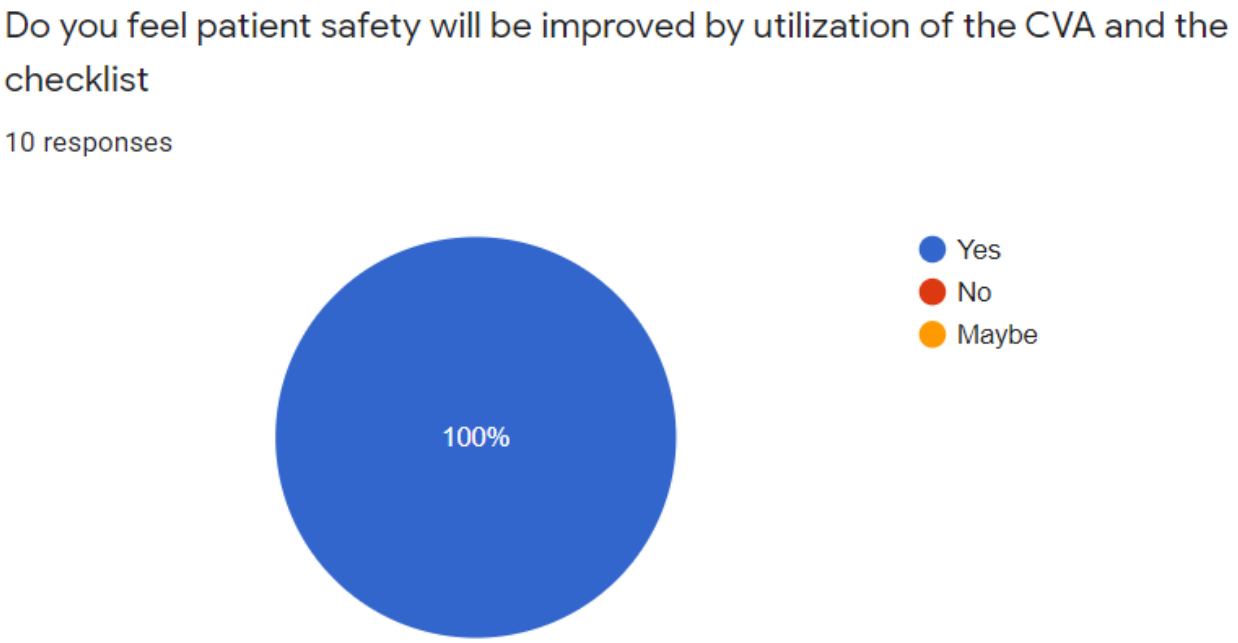


Fig 3h. Physician post survey safety

Checklist step	Step number	patient 1	patient 2	patient 3	patient 4	patient 5	patient 6	average
Pre procedure huddle	q1	1	1	0	1	1	0	0.666667
Introductions	q2	1	1	0	1	1	0	0.666667
Indication for procedure	q3	1	1	1	1	1	0	0.833333
What is our plan	q4	1	1	1	1	1	0	0.833333
Location of line	q5	1	1	1	1	1	1	1
Type of catheter	q6	1	1	1	1	1	1	1
Patient comfort	q7	1	1	1	1	1	1	1
Need anesthetic?	q8	1	1	1	1	1	1	1
Do we have the supplies	q9	1	1	1	1	1	1	1
Consent signed	q10	1	1	1	1	1	1	1
Patient concerns	q11	1	1	0	1	1	1	0.833333
Dressing considerations	q12	1	1	1	1	1	1	1
contingency plan	q13	1	1	1	1	1	1	1
Reviewed cognitive aid	q14	1	1	1	1	1	1	1
Trendelenburg	q15	1	1	1	1	1	1	1
Time -out performed	q16	1	1	1	1	1	1	1
Don full ppe	q17	1	1	1	1	1	1	1

Scrub patients' skin	q18	1	1	1	1	1	1	1
Drape ultrasound	q19	1	1	1	1	1	1	1
Vein visualized	q20	1	1	1	1	1	1	1
3 sticks?	q21	1	1	1	1	1	0	0.833333
Line placement verified	q22	1	1	1	1	1	0	0.833333
Catheter advanced over guidewire	q23	1	1	1	1	1	0	0.833333
Document catheter skin depth	q24	1	1	1	1	1	0	0.833333
Wire removed	q25	1	1	1	1	1	1	1
All ports aspirated	q26	1	1	1	1	1	1	1
2-person dressing application	q27	1	1	1	1	1	1	1
Sharps disposed	q28	1	1	1	1	1	1	1
Chest XR ordered	q29	1	1	1	1	1	1	1
Document duration	q30	1	1	1	1	1	1	1

Fig 3i. Which the steps in the nurse's checklist were filled out / marked completed

Steps	patient 1	patient 2	patient 3	patient 4	patient 5	patient 6
q1	y	y	y	y	y	y
q2	y	y	y	y	y	y
q3	y	y	y	y	y	y
q4	y	y	y	y	y	y
q5	y	y	y	y	y	y
q6	y	y	y	y	y	y
q7	y	y	y	y	y	y
q8	y	y	y	y	y	y
q9	y	y	y	y	y	y
q10	y	y	y	y	y	y
q11	y	y	y	y	y	y
q12	y	y	y	y	y	y
q13	y	y	y	y	y	y
q14	y	y	y	y	y	y
q15	y	y	y	y	y	y
q16	y	y	y	y	y	y
q17	y	y	y	y	y	y
q18	y	y	y	y	y	y
q19	y	y	y	y	y	y
q20	y	y	y	y	y	y
q21	y	y	y	y	y	y
q22	y	y	y	y	y	y
q23	y	y	y	y	y	y
q24	y	y	y	y	y	y
q25	y	y	y	y	y	y
q26	y	y	y	y	y	y
q27	y	y	y	y	y	y
q28	y	y	y	y	y	y
q29	y	y	y	y	y	y

q30	y	y	y	y	y	y
q31	y	y	y	y	y	y
q32	y	y	y	y	y	y
q33	y	y	y	y	y	y
q34	y	y	y	y	y	y
q35	y	y	y	y	y	y
q36	y	y	y	y	y	y

Fig 3j. In all the observed cases in Phase 3 all the procedures were completed

REFERENCES

1. Kornbau, C., et al., *Central line complications.* Int J Crit Illn Inj Sci, 2015. **5**(3): p. 170-8.
2. Evans, L.V., et al., *Simulation training in central venous catheter insertion: improved performance in clinical practice.* Acad Med, 2010. **85**(9): p. 1462-9.
3. Alsaad, A.A., et al., *Central Line Proficiency Test Outcomes after Simulation Training versus Traditional Training to Competence.* Ann Am Thorac Soc, 2017. **14**(4): p. 550-554.
4. Leotsakos, A., et al., *Standardization in patient safety: the WHO High 5s project.* Int J Qual Health Care, 2014. **26**(2): p. 109-16.
5. in *To Err is Human: Building a Safer Health System*, L.T. Kohn, J.M. Corrigan, and M.S. Donaldson, Editors. 2000: Washington (DC).
6. Leape, L.L., D.M. Berwick, and D.W. Bates, *What practices will most improve safety? Evidence-based medicine meets patient safety.* JAMA, 2002. **288**(4): p. 501-7.
7. Patterson, M.D., et al., *In situ simulation: detection of safety threats and teamwork training in a high risk emergency department.* BMJ Qual Saf, 2013. **22**(6): p. 468-77.
8. Reason, J., *Human error: models and management.* BMJ, 2000. **320**(7237): p. 768-70.
9. Walker, I.A., S. Reshamwalla, and I.H. Wilson, *Surgical safety checklists: do they improve outcomes?* Br J Anaesth, 2012. **109**(1): p. 47-54.

VITAE

Mathews Roy (October 4th 1996-present) is a 4th year medical student applying into the field of internal medicine. He is from the Dallas area and perused a degree in biomedical engineering at UT Austin. He returned to Dallas for medical school and was very interested in QI for its potential to drastically and quickly change healthcare. Mathews enjoys lifting weights, playing sports and listening to history podcasts.