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Reducing CLABSI in the NICU with IV Tubing Competency

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Abstract

Central line-associated bloodstream infection (CLABSI) is a significant problem in a Level IV neonatal intensive care unit (NICU) on the West Coast of California. A clinical nurse leader (CNL) student joined a team consisting of the unit's nursing manager, nursing educator, clinical nurse specialist (CNS), and CNS student. Literature review highlighted the association between the development of CLABSI and the practice of changing central line intravenous (IV) tubing. Five interviews of nurses and 15 observations of nurses performing IV tubing change revealed practice variations within six major steps of the procedure. The team revised the IV tubing change policy to improve comprehension and feasibility and then educated nurses on the changes. The team sought to eliminate variations and standardize practice by designing a competency for IV tubing change that requires all nurses to perform the procedure as an instructor observes for accuracy with every step of the new policy. Evaluation of the competency is ongoing, but follow up questions include: (1) Have all nurses successfully passed the competency? (2) Are nurses maintaining compliance with the new policy after completion of the competency? (3) Has the CLABSI rate decreased in response to the competency?

Keywords: CLABSI, NICU, CNL, practice variations, competency

Statement of the Problem

A central line is a catheter that is placed in an artery or a vein and threaded into the heart. A central line is used to administer fluids, total parenteral nutrition (TPN), and medications and to administer or draw blood. Depending on the type of device used, a central line can be left in place for varying periods of time, from just days to weeks or months. A central line-associated bloodstream infection (CLABSI) occurs when germs enter the bloodstream through the central line. According to the Centers for Disease Control and Prevention (CDC, 2011a), to qualify as a CLABSI the infection must occur in a patient who had a central line at the time of infection or within the 48-hour period prior to development of infection, and the infection must not be related to infection from another site.

CLABSI is the most common, costly, and deadly type of healthcare-associated infection (HAI) in the United States. Approximately 250,000 cases occur annually in hospitals with an estimated per case minimal cost of \$25,000 and mortality rate of 12-25% (CDC, 2002). With a 5% incidence rate, nearly one in every 20 hospitalized patients acquires some type of HAI every year in the United States (CDC, 2011b). HAI account for a significant proportion of healthcare-acquired conditions (HAC).

Under the Deficit Reduction Act, the Centers for Medicare & Medicaid Services (CMS) stopped full reimbursement to hospitals for the cost of treating HAC such as CLABSI (Graves and McGowan, 2008). CMS no longer reimburses healthcare organizations that report higher than predicted rates of CLABSI adjusted for risk of the patient population. The premise of the law is that CLABSI is an expensive sequela of the failure to implement relatively inexpensive infection control measures. The law creates an economic incentive for hospitals to identify cost effective ways to eliminate CLABSI.

CLABSI is a significant problem at a Level I Pediatric Trauma Center on the West Coast of California. The following data was disclosed by Quality Improvement Project Charter during the September 2015 meeting and by Infection Prevention and Control Committee during the October 2015 meeting. CLABSI is the number one HAC at the hospital and comprises 55% of all HACs since 2012. Hospital wide, there is an average of approximately two per month since 2012. In the last two years, the average has accelerated to 2.4 per month. Each infection costs the hospital approximately \$35-55,000. In the hospital's 44-bed Level IV NICU, the rate of CLABSI was six cases in 2013, seven cases in 2014, and eight cases thus far in 2015 (See Appendix A). Of the cases this year, three occurred in August, one in September, and one in October. These cases come in stark contrast to years with no CLABSI, which is the ideal goal for every year.

The upward trend and recent spike in CLABSI underscore the need for intervention through a clinical nurse leader (CNL) project. The purpose of the CNL project is to answer the following questions: why is CLABSI such a predominant problem on the unit and what solution can most effectively reduce CLABSI?

Review of Literature

With any project, the CNL identifies a problem, assesses the microsystem, analyzes the root cause, implements a change, and evaluates the results. Before this process can start, the CNL must first research the problem and support the solution selected to address the problem. The goal of this literature review is to better understand evidence-based practice designed to reduce and eliminate CLABSI. Research shows that the number one solution to the problem of CLABSI is a central line bundle. The Institute for Healthcare Improvement (IHI) first conceptualized the idea of a bundle as a grouping of best practices that individually improve care, but result in greater improvement when applied together.

A central line bundle incorporates many infection control practices into the standard for both insertion and management of central lines. Insertion bundles are directed at healthcare providers who place the central line. Management bundles are directed at healthcare providers who monitor and change central line dressings and intravenous (IV) tubing. Out of all healthcare providers, nurses are most commonly inserting and managing bundles at the bedside. Bundles were first shown to reduce the rates of CLABSI over a decade ago, but recent studies continue to corroborate this finding (Aly et al., 2005; Pronovost et al., 2006; Miller et al., 2010; Schulman et al., 2011; Furuya et al., 2011; Ceballos, Waterman, Hulett, & Makic, 2013).

Aly et al. (2005) conducted a pioneering study on bloodstream infections (BSI) in premature infants. The study took place in the NICU at George Washington University Hospital (GWUH) where there was a recent surge in BSIs. The authors gathered data on BSI rates in 16 other NICUs across the country and determined that Connecticut Children's Medical Center (CCMC) had the lowest infection rate among all the hospitals reviewed. The infection control practices of CCMC were then adopted at GWUH starting in January 2001, and the BSI rate was compared before and after this intervention.

Prior to 2001, the infection control practices of CCMC that differed from GWUH consisted of a closed medication system and strictly sterile procedures for central line insertion and management of both dressings and IV tubing. A closed medication system prevents direct contact of medications and flush solutions with the hub of the catheter, which is important due to the correlation between hub contamination and sepsis development. Prior to intervention, nurses at GWUH performed dressing and tubing changes with sterile gloves on, but the procedure did not necessarily occur in a sterile field because they performed the procedure alone. After intervention, nurses at GWUH always had assistants to help protect the sterile field.

After adoption of GWUH's infection control practices, the incidence of sepsis decreased from 25.4% to 2.2%. The rate of CLABSI decreased from 15.17 to 2.1 per 1000 catheter days. For the first time in the NICU setting, Aly et al. (2005) demonstrated that multiple infection control practices bundled together to guide insertion and management of central lines could decrease sepsis in general and CLABSI in particular. The study underscored the importance of NICUs sharing their practices and data to standardize care and improve outcomes.

Following Aly et al. (2005), the central line bundle gained attention and became the subject of research in adult intensive care units (ICUs) where CLABSI has always been a rampant issue. Pronovost et al. (2006) published a foundational study from data collected in 103 ICUs in the state of Michigan. The study intervention included five evidence-based infection control procedures recommended at the time by the CDC: hand washing, using full-barrier precautions during central line insertion, cleaning skin with chlorhexidine, avoiding the femoral site when possible, and removing unnecessary catheters. In addition, the intervention included education on infection control to healthcare providers, a special central line cart with necessary supplies, and a checklist to ensure adherence to infection control practices.

CLABSI rates were collected at baseline, during the implementation period, and during six three-month intervals occurring up to 18 months after implementation. At baseline, the median rate of infection was 2.7 per 1000 catheter days. Within three months after implementation of the intervention, the median rate of infection reduced to zero. The rate of zero was sustained throughout the remaining 15 months of follow up. By the final interval of the study from 16-18 months after implementation, there was a 66% reduction in the rate of CLABSI. By designing the study to take place over an extensive period of time, Pronovost et al. (2006) demonstrated the lasting benefit of the intervention on eliminating CLABSI.

As discussed above, Pronovost et al. (2006) performed a study in adult ICUs and implemented a central line bundle focused predominantly on insertion procedures. On the other hand, Miller et al. (2010) designed a study in pediatric ICUs (PICUs) with results that underscored the importance of maintenance procedures. Miller et al. (2010) collected data in 29 PICUs across the United States. The intervention comprised of two types of central line bundles: one focused on insertion practices and one focused on maintenance practices.

After implementation of the bundle interventions, the CLABSI rate decreased 43% from 5.4 to 3.1 per 1000 catheter days. The only significant predictor of CLABSI rate decrease was compliance with the maintenance bundle. This result is important because, in contrast to studies of adult ICUs, maximizing insertion bundle compliance alone cannot help PICUs to eliminate CLABSI. Rather, Miller et al. (2010) showed that the most effective way to reduce pediatric CLABSI is to ensure that healthcare providers comply with a bundle focused on daily maintenance of central lines, including sterile changes of dressings and IV tubing.

Using similar methods designed by Miller et al. (2010) for PICUs, Schulman et al. (2011) conducted a study on NICUs to update research pioneered by Aly et al. (2005). Schulman et al. (2011) collected data from all 18 regional referral NICUs in the state of New York after implementation of central line insertion and maintenance bundles and checklists to monitor bundle compliance. Statewide, CLABSI rates decreased 67% from 6.4 to 2.1 per 1000 catheter days. An important finding was the strong association between the maintenance checklist use rate and the CLABSI rate, indicating the greater significance of maintenance checklists compared to insertion checklists.

Schulman et al. (2011) believed that repetitive, structured social interaction designed into their study significantly contributed to standardizing central line care. Through conference calls,

e-mails, and workshops, the healthcare providers became a meaningful part of a community of practice. The authors argued that creating a community of practice was an effective means to disseminate knowledge within organizations. During social interactions, the authors facilitated healthcare providers to share their stories of both success and failure with utilizing the bundles and checklists. The community of practice encouraged healthcare providers to develop and apply their collective expertise toward solving a shared problem.

Furuya et al. (2011) added to the existing body of evidence by gathering data from 415 ICUs. Only 49% of ICUs reported having a written central line bundle policy. Of the ICUs that monitored bundle compliance, only 38% reported compliance rate of 95% or greater. The most significant finding from this study was that CLABSI rates decreased only when an ICU had a central line bundle policy, monitored compliance, and had 95% compliance rate. Stated another way, simply having a central line bundle policy in place did not lower CLABSI rates and likewise having less than ideal compliance of 95% did not lower CLABSI rates either.

Another important finding was that complying with any one of the three central line bundle elements resulted in decreased CLABSI rates. Stated another way, if an ICU that complied with no components of the bundle were to comply with just one component all of the time, then the ICU would experience an estimated 38% decrease in CLABSI rate. Together, these findings underscore the importance of not merely having a bundle policy in place but furthermore enforcing healthcare providers to comply. Furuya et al. (2011) argued that hospitals must target bundle compliance rather than simply instituting policies.

Recently, Ceballos, Waterman, Hulett, and Makic (2013) highlighted the important role that nurses serve in providing care with central line bundles. Along with other members of the healthcare team, nurses from a 50-bed Level III NICU were recruited to serve on a quality

improvement (QI) project targeting CLABSI. The QI team felt that nurses should lead implementation since they were the most consistent providers of care. The QI nurse leaders composed of the nursing educator, outcomes coordinator, and infection-prevention RN. These nurse leaders developed an education module for teaching the CLABSI bundle to all healthcare providers and a checklist to monitor compliance. The education module was computer-based and focused on patient safety, clinical impact of CLABSI, and rationale for each bundle component.

A root cause analysis revealed challenges and barriers to implementation from the nursing perspective. Problems identified included nurses not feeling empowered enough to confront non-adherent providers during line insertion and nurses failing to complete the central-line bundle checklist. Solutions to these problems included encouraging nurses to contact nurse QI leaders if they needed assistance during central line insertion and having nurse QI leaders follow up individually with nurses who did not complete the checklist. Ceballos et al. (2013) emphasized the importance of having nurses at the front lines of identifying problems and creating solutions.

Infection rates were measured and bundle compliance was audited before and after bundle implementation. The 92% reduction in CLABSI translated into 27% reduction in catheter days, 84 fewer hospital days, and an estimated cost savings of \$348,000. Audits showed that individual bundle intervention compliance rates improved over time. Ceballos et al. (2013) argued that empowering bedside nurses to lead the bundle implementation enhanced their personal ownership, thereby improving bundle compliance and patient outcomes. Overall, Ceballos et al. (2013) demonstrated how revising practice guidelines, educating healthcare providers, tracking compliance, and reporting patient outcomes are all essential components to successfully changing practice.

Taken together, the articles selected for literature review provide evidence substantiating the central line bundle as best practice. Aly et al. (2005) was one of the first studies to group multiple infection control practices into a central line bundle for a NICU. Pronovost et al. (2006) designed a study to take place over time to demonstrate the lasting benefit of a bundle on reducing CLABSI. Miller et al. (2010) showed that maintenance bundles had a greater impact on CLABSI than insertion bundles. Schulman et al. (2011) added that complying with maintenance checklists had a greater impact on CLABSI than insertion checklists. Furuya et al. (2011) discovered that it was essential to demand a high degree of compliance with the bundle policy rather than merely put a new policy in place. Lastly, Ceballos et al. (2013) highlighted the important role that nurses play in changing policy and practice of the central line bundle.

The literature review clearly indicates that attention should be focused on maintenance rather than insertion to most effectively combat CLABSI. Data from the NICU corroborates this finding as well. Mermel (2011) discusses the two different types of CLABSI: extraluminal and intraluminal. Extraluminal refers to infections arising from skin at the catheter insertion site. Intraluminal refers to infections arising from catheter hubs, IV tubing, or contaminated IV fluids. Extraluminal infections predominate soon after insertion while intraluminal infections predominate after a more extended catheter dwell time. For this reason, focusing on catheter insertion will help prevent extraluminal CLABSI that occurs within days of catheterization and focusing on catheter maintenance will help prevent intraluminal CLABSI that occurs later.

According to the unit's clinical nurse specialist (CNS), most cases of CLABSI in the NICU are intraluminal rather than extraluminal in origin. This fact indicates the need for designing an intervention that targets central line maintenance rather than insertion. A

microsystem assessment was performed to better understand how central lines are currently maintained on the unit so problems could then be identified through root cause analysis.

Microsystem Assessment

The CNL student assessed the microsystem using input from the unit's nurse manager, nurse educator, CNS, CNS student, and bedside nurses. The topic of IV tubing change was discussed with the nurse manager, nurse educator, CNS, and CNS student in scheduled meetings. Interviews and observations were the main sources of data from bedside nurses. Five nurses were formally interviewed (See Appendix B). Over the course of five shifts, 15 nurses were observed as they changed IV tubing. The Trustees of Dartmouth College (2001) developed the NICU-specific workbook used to guide the microsystem assessment. The workbook instructs how to assess the five Ps: purpose, patients, professionals, processes, and patterns.

Purpose: Designated as a Level IV NICU, the purpose of the unit is to provide care to infants at the highest level of acuity. Level IV NICUs can provide care to infants at the youngest age of life and those that require the widest variety of the most complex surgeries, mechanical ventilation, and extracorporeal membrane oxygenation (ECMO). In essence, Level IV NICUs provide care to the sickest infants. In keeping with the hospital's mission and vision, the NICU strives to promote the safety of its patients and provide the highest quality of care. As an HAC, CLABSI translates to care that is unsafe and poor in quality. The unit's goal is to initially reduce and ultimately eliminate CLABSI.

Patients: CLABSI is an especially critical issue for patients in the NICU. Critically ill and premature infants are particularly vulnerable to infection due to their underdeveloped immune system, poor skin integrity, repeated invasive procedures, and exposure to multiple healthcare personnel and family members in an environment conducive to germ colonization. CLABSI is a

problem on the unit because many of the infants require central lines. Many of the infants have other risk factors for infection such as multiple diagnoses and surgical treatments.

Professionals: The NICU team prides itself in being multidisciplinary and multispecialty in nature and is composed of nearly every type of healthcare professional except for nursing aids. The team mainly includes neonatologists, medical residents, CNSs, bedside nurses, respiratory therapists, and social workers. Many members of the NICU team are involved in the care of central lines. In terms of insertion, there is one nurse practitioner dedicated to vascular access who places many central lines at the bedside. In addition, any bedside nurse who is certified may insert a central line. Infants may also come back from surgery with a central line in place. In terms of management, bedside nurses are primarily responsible for maintaining care of central lines following insertion and are the only members of the healthcare team that change IV tubing.

Processes: The two most common processes that occur in central line management are changing of the dressing that covers the catheter and changing of the IV tubing connected to the central line. While central line dressings are changed only as needed, central line IV tubing is changed on a routine basis. It is important to note that central line IV tubing is changed in the NICU through a unique procedure that incorporates a hybrid of sterile and aseptic techniques. Central line IV tubing change is a particularly appropriate process for a CNL project to target because it occurs so frequently and requires such a high level of precision with technique.

Patterns: The frequency of IV tubing change depends on the type of fluid being run through the line. Lines running clear fluids are changed every 96 hours while lines running TPN, intralipids, and medications are changed every 24 hours. Nurses that work morning shift are responsible for changing clear fluids before the line expires or by the end of the shift, whichever comes first. Nurses that work evening shift are responsible for changing TPN, intralipids, and

medications. TPN and lipids arrive on the unit from pharmacy around 7:00 pm. IV tubing changes take place between 7:00-10:00 pm whenever the nurse is able to fit the procedure into the workflow. On average, each IV tubing change takes approximately 20 minutes. Roughly 5-10 changes occur during each evening shift while 0-5 changes occur during each day shift.

Root Cause Analysis

Root cause analysis revealed three major contributions to the problem of CLABSI: practice, equipment, and time (See Appendix C). Of these, nursing practice was the main issue. Both interviews and observations shed light on the significant amount of variation in the way nurses perform IV tubing change. In order to limit the risk of error that leads to infection, IV tubing change should be a standardized practice done the exact same way by all nurses according to policy. However, interviewees acknowledged that nurses commonly utilize their own unique adaptations to policy for performing IV tubing change rather than complying strictly with policy. This anecdotal evidence was substantiated by practice variations noted during observations.

Variations in practice were observed within six major steps of the procedure (See Appendix D). Nurses executed these steps in different ways, some of which were according to policy while others were adaptations to policy (See Appendix E). The six steps included (1) assembling the line (See Appendix F), (2) connecting the line (See Appendix G), (3) priming the line (See Appendix H), (4) creating a clean field (See Appendix I), (5) programming the IV pump (See Appendix J), and (6) timing to connect patient (See Appendix K). Along with variations in practice, compromises to sterility were also observed. Some nurses used only one pair of sterile gloves during the entire procedure when a second pair needs to be reapplied before connecting the new IV tubing to the patient. Many nurses dropped nonsterile equipment onto the sterile field such as saline flushes, lipid bags, alcohol swab packages, and IV caps.

Along with variations in practice, equipment was also an issue contributing to CLABSI. Interviewees expressed frustration with the frequent changes in equipment used to perform IV tubing change. Nurses felt that as soon as they became familiar with equipment it got changed to a different brand, rendering them less precise in their technique. Nurses stated that the IV tubing change carts were not always adequately stocked with equipment they needed, forcing them to break sterility and start the procedure over, which wastes time and increases the risk of introducing infection. Nurses also pointed out that the IV tubing change carts were stocked with nonsterile equipment, namely saline flushes used to prime the lines.

Time was the other issue contributing to CLABSI. Contrary to the CNL student's expectations, interviewees did not express frustration with how long each IV tubing change takes. Nurses have overwhelmingly taken ownership over the procedure and adapted it into their workflow. However, nurses did express frustration over the frequency of IV tubing change. Many of the nurses can remember times in the past when IV tubing change occurred much less routinely. Some nurses work at other institutions whose policy permits changing IV tubing less frequently. Nurses questioned whether it was more risky to change the IV tubing so frequently. Each line change represents a break in the closed system and presents an opportunity for a break in sterility with consequent introduction of infection.

Redesign of Process

The CNL always works as a member of a team and collaborates with others. For this project, the CNL student joined a team consisting of the unit's nurse manager, nurse educator, and CNS student who is an experienced NICU nurse. Based on literature review, microsystem assessment, and root cause analysis, the central line maintenance bundle was determined to be in need of improvement. The specific component of the bundle targeted by this project was IV

tubing change. IV tubing change was selected because it is a procedure that is done routinely on the floor every evening by all bedside nurses and is subject to a high degree of practice variation.

Implementation

In order to change practice, the CNL student worked with the team to revise policy and educate nurses. The policy and procedure was rewritten in a simplified, step-by-step format so it was easier for nurses to follow. Laminated cards of the new policy were placed on the line carts to guide nurses as they performed the procedure on the floor in real time. The new policy was announced to all nurses on the unit during ten-minute shift-change meetings over the course of a week starting on October 28, 2015. In response to nursing feedback during these meetings, the team created an educational video to demonstrate the new procedure. The policy and video were both uploaded onto the online resource accessed by nurses from bedside computers.

One major change was made to the content of the new policy: TPN is now changed every 96 hours rather than every 24 hours. The nurse manager made this change to reflect recommendations made by CDC (2011a). Nurses indicated frustration over the frequency of changing lines during interviews and observations conducted by the CNL student. The nurse manager was creating a compromise with the bedside nurses. If the policy permits nurses to change IV tubing less frequently, then they must follow every step of the procedure perfectly when they do change lines. The goal was to eliminate variation and standardize practice.

The intervention consists of a competency designed to ensure nursing compliance with the new policy. All nurses will have to perform one line change procedure as an instructor observes for accuracy with every step of the policy. Instructors include the unit's nurse educator and nurses who have successfully passed the competency and volunteer to be trained as instructors. Including nurses as instructors will enhance their ownership of the new policy.

Results

A Gantt chart is used to help track progress of a change project taking place at the level of the microsystem (Nelson, Batalden, & Godfrey, 2007). The CNL student created two Gantt charts, one at the beginning of the project and one at the end of the project, in order to compare the expected timeline with the actual timeline of events that took place (See Appendix L). All evening shift nurses were expected to be competent by the end of the CNL project in mid-December 2015. However, due to unanticipated delays, the competency is just now being introduced to the unit as the CNL project comes to an end.

Delays in the timeline occurred during collection of data, revision of the new policy, and education of nurses. In order to capture an accurate picture of all the variations in practice, a greater number of line changes needed to be observed than predicted by the CNL student. The CNL student and team also underestimated the amount of feedback from nurses related to the content of the new policy. After initial introduction of the new policy, nurses responded with a plethora of ideas for improvement in the steps. One nurse in particular became the mediator between nurses and the team, providing input from the bedside as more and more revisions were made to the policy.

Since the team wanted to take nursing feedback into account, revision of the policy and procedure took place over a much longer period of time than planned. Likewise, educating nurses on the new policy was a more extensive process that continued to evolve as changes were made. The team wanted to ensure that each step of the policy was as logical and feasible as possible and that nurses understood the rationale behind each step, especially if it was designed to protect sterility. Despite some initial resistance to standardizing practice, nurses now understand that adopting the changes and adhering to the new policy will help reduce CLABSI.

Recommendations

Since the intervention is still underway as the CNL student leaves the unit, follow up is especially important for this project to be successful and sustainable. The CNL student has partnered with the nurse educator to create a sustainability plan. There are two major phases of the sustainability plan. The first phase consists of ensuring that all nurses pass the competency. The second phases consists of ensuring that all nurses maintain compliance with the new policy and procedure even after they pass the competency.

The nurse educator will be the main instructor for conducting the competency and plans to have all nurses passed in eight weeks. The nurse educator will train three to five nurses per shift to be instructors over two weeks and then they will train the rest of the staff over the next six weeks. After all 150 nurses are deemed competent, audits must occur to determine whether nurses are continuing to adhere to the new policy. If nurses are maintaining compliance, then the effect of the competency on CLABSI can be determined. As outcomes manager, another CNL student could be responsible for comparing the CLABSI rate before and after the competency.

Conclusion

CLABSI is extremely relevant to nurses because they can introduce germs into the bloodstream of their patients if they break sterility when changing central line IV tubing. Despite some initial resistance to standardizing practice when changing IV tubing, a culture of safety was established as nurses embraced the notion of a competency. The goal to have all nurses deemed competent by the end of the CNL project was delayed largely because nurses requested to be involved in revision of the new policy and to be thoroughly educated on all the changes. Encouraging bedside nurses to be active participants in the CNL project has enhanced their ownership over the problem of CLABSI and the solution of IV tubing competency.

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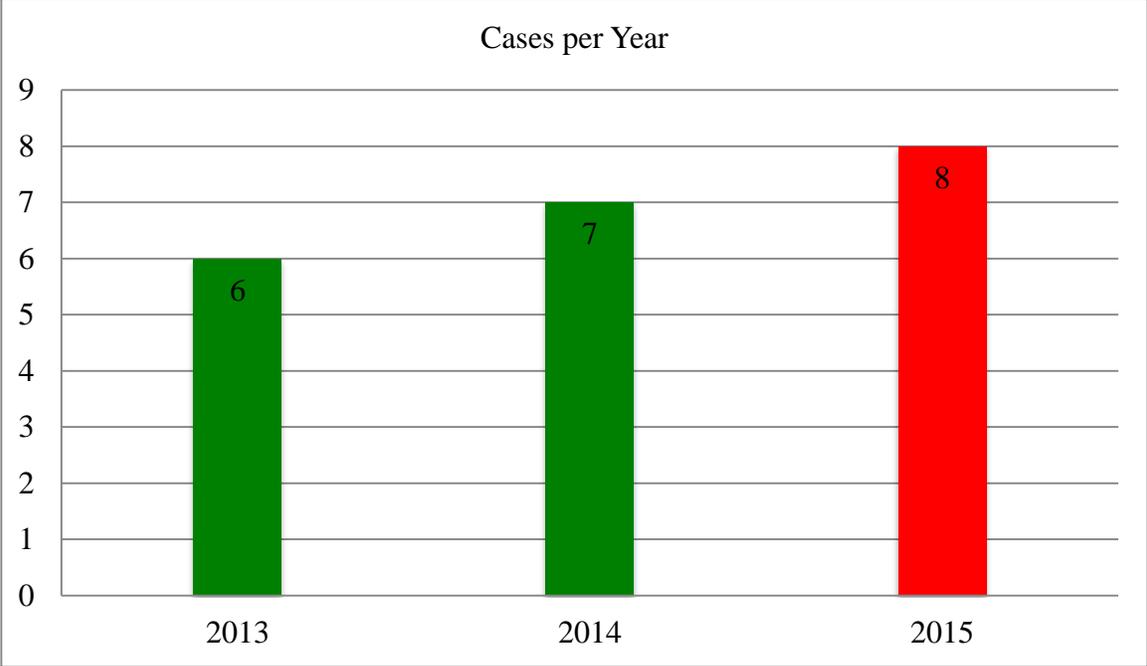
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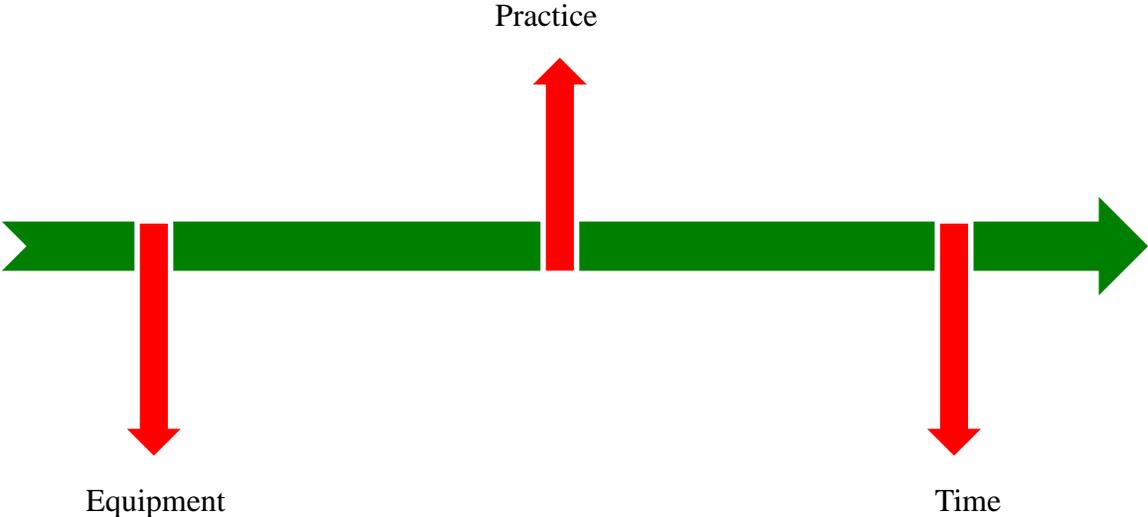
**Appendix A
CLABSI Rate**



Appendix B
Nurse Interview Questions

1. What time do you change lines?
2. Do all nurses change lines at the same time or does it occur in a trickle?
3. Do you change lines by yourself or do you change in pairs with the assistance of another nurse?
4. Do you feel like the line carts are well stocked or do you ever have to break sterility or ask someone else to help you get supplies?
5. Do you feel like all nurses change lines in the same way or is there noticeable variation in practice?
6. How often do you see another nurse break sterility: never, rarely, sometimes, usually?
7. If you see another nurse break sterility, how often does she/he start over: never, rarely, sometimes, usually?
8. Do you have sufficient time to perform line changes or do you feel rushed?
9. Do you get interrupted during line change? If so, what are common interruptions?
10. Do you have any questions or concerns about line change?

Appendix C
Root Cause Analysis Fishbone



Appendix D
Variations in Practice: Raw Data from 15 Observations

1. Assembling the Line

7/15 (47%) attached TPN/lipid/med lines to trifuse and then primed (according to policy)

8/15 (53%) primed TPN/lipid/med lines separately then attached to trifuse (adaptation to policy)

2. Connecting the Line

6/15 (40%) spiked TPN bag using 4x4 with sterile gloves on (according to policy)

9/15 (60%) spiked TPN bag using other methods and materials (adaptation to policy)

3. Priming the Line

4/15 (27%) primed in order: TPN, lipid, med (according to policy)

11/15 (73%) primed in order: TPN, med, lipid (adaptation to policy)

4. Creating a Clean Field

9/15 (60%) used sterile drape as clean field under site of connection (according to policy)

6/15 (40%) used other materials under site of reconnection (adaptation to policy)

5. Programming the IV Pump

2/15 (13%) programmed pump before connecting to patient (according to policy)

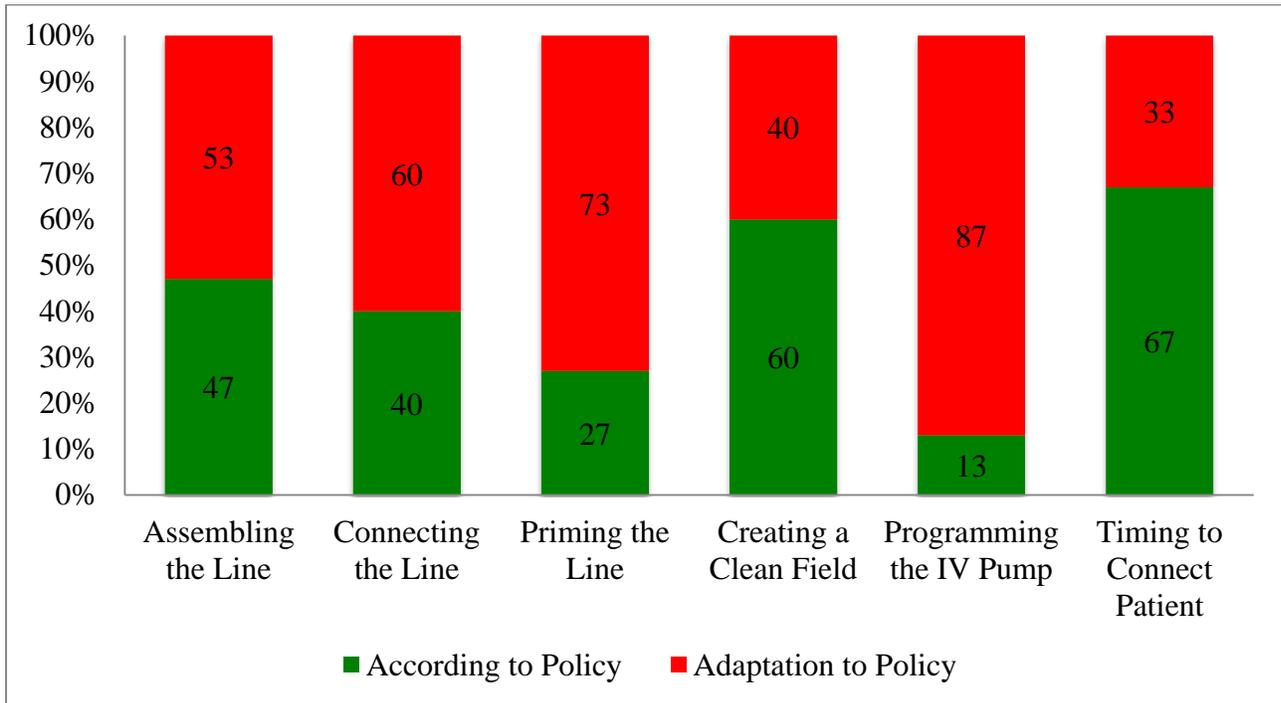
13/15 (87%) programmed pump after procedure completed (adaptation to policy)

6. Timing to Connect Patient

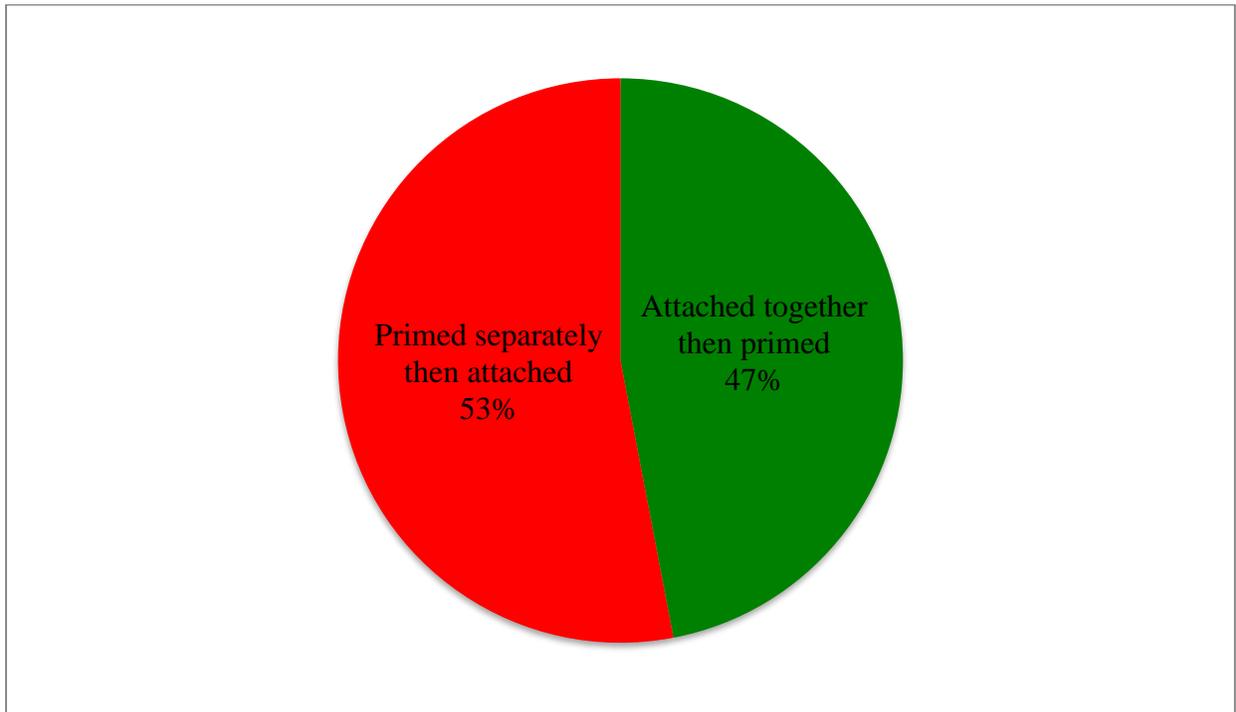
10/15 (67%) connected directly to patient (according to policy)

5/15 (33%) placed set-up to side and connected to patient later (adaptation to policy)

Appendix E
Variations in Practice: Graphic Data from 15 Observations

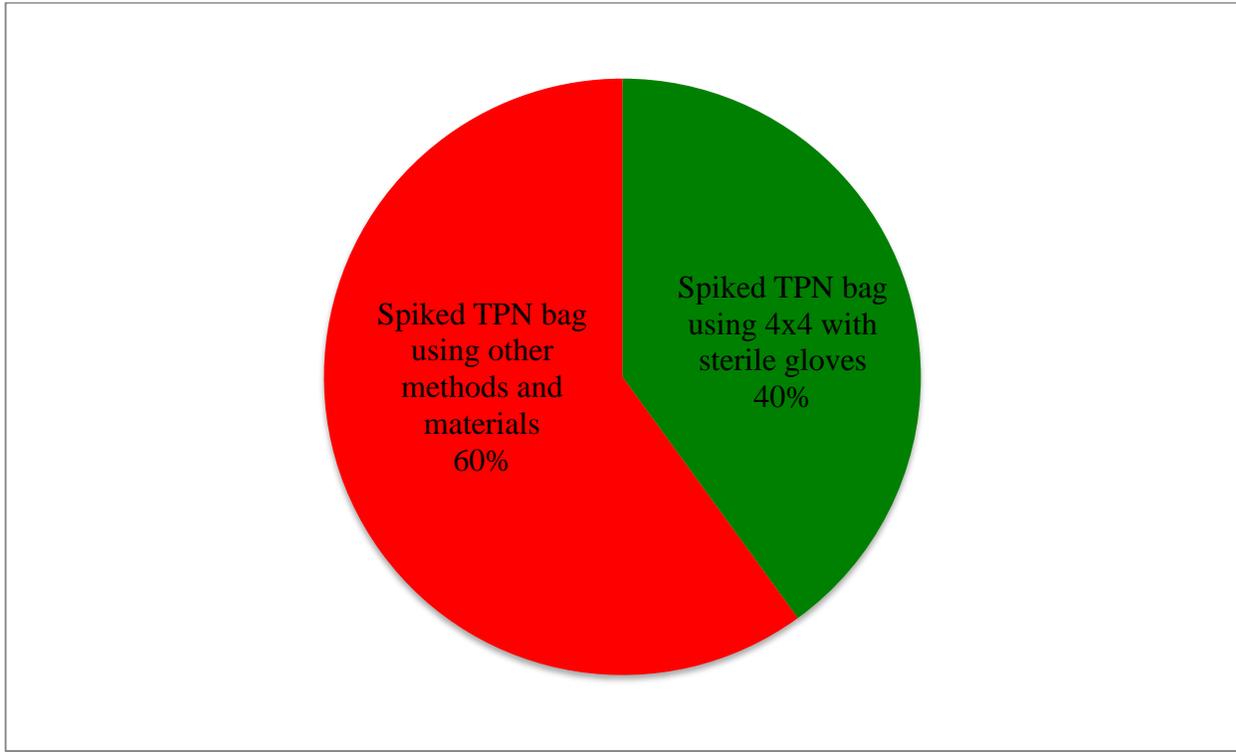


**Appendix F
Assembling the Line**



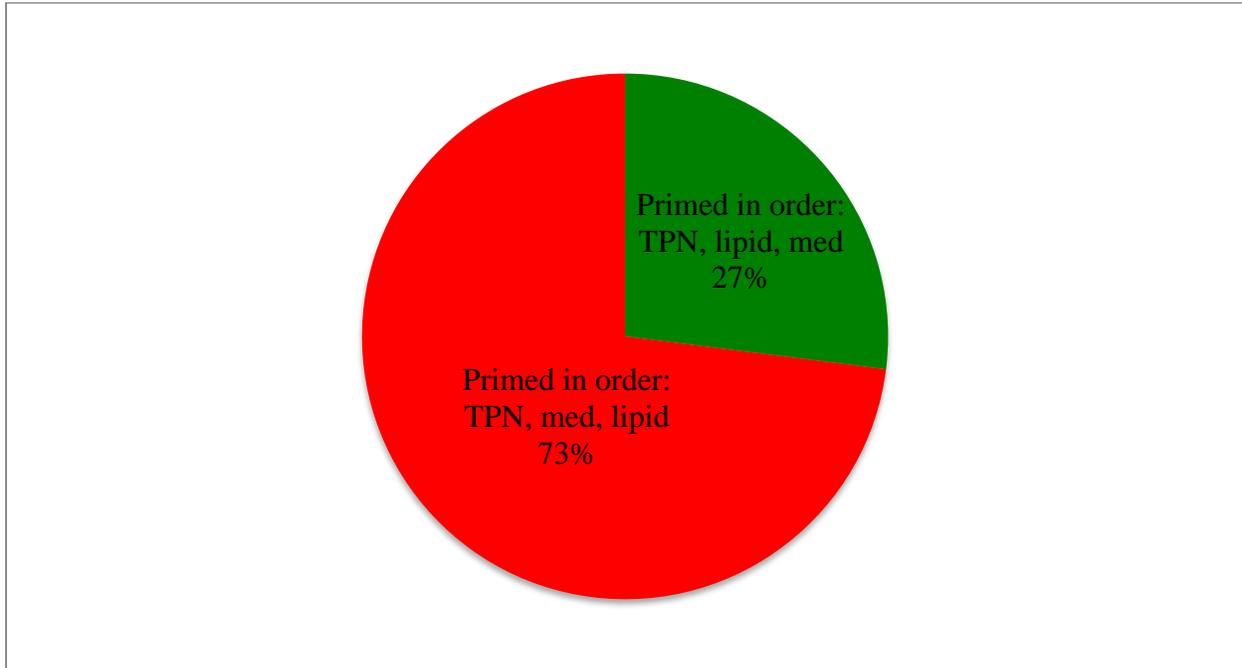
Green: According to Policy
Red: Adaptation to Policy

**Appendix G
Connecting the Line**



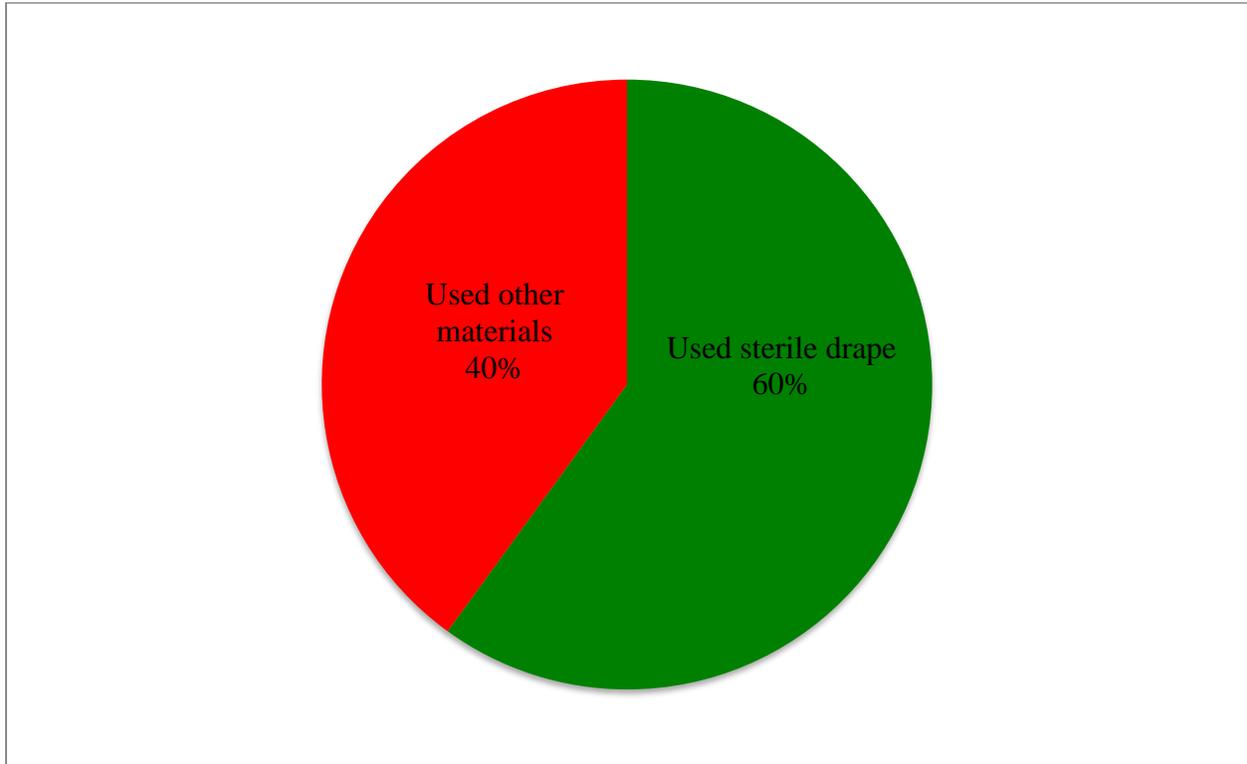
Green: According to Policy
Red: Adaptation to Policy

Appendix H
Priming the Line



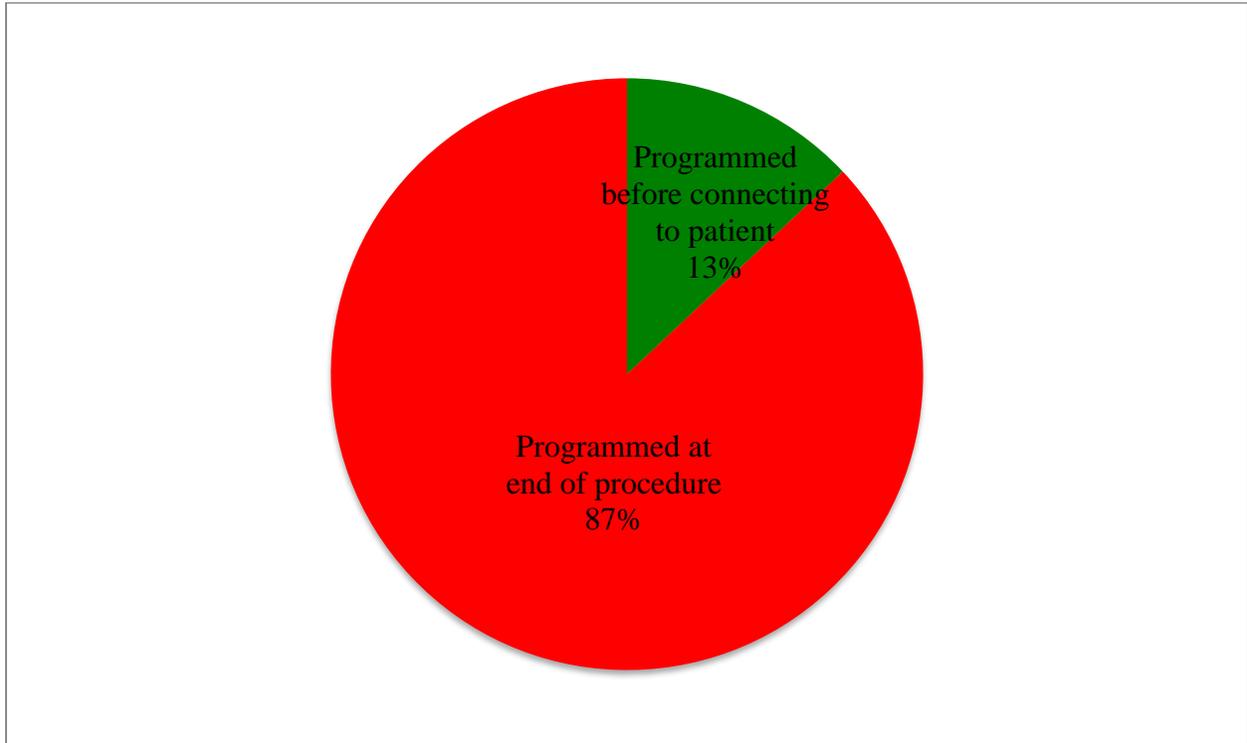
Green: According to Policy
Red: Adaptation to Policy

Appendix I
Creating a Clean Field



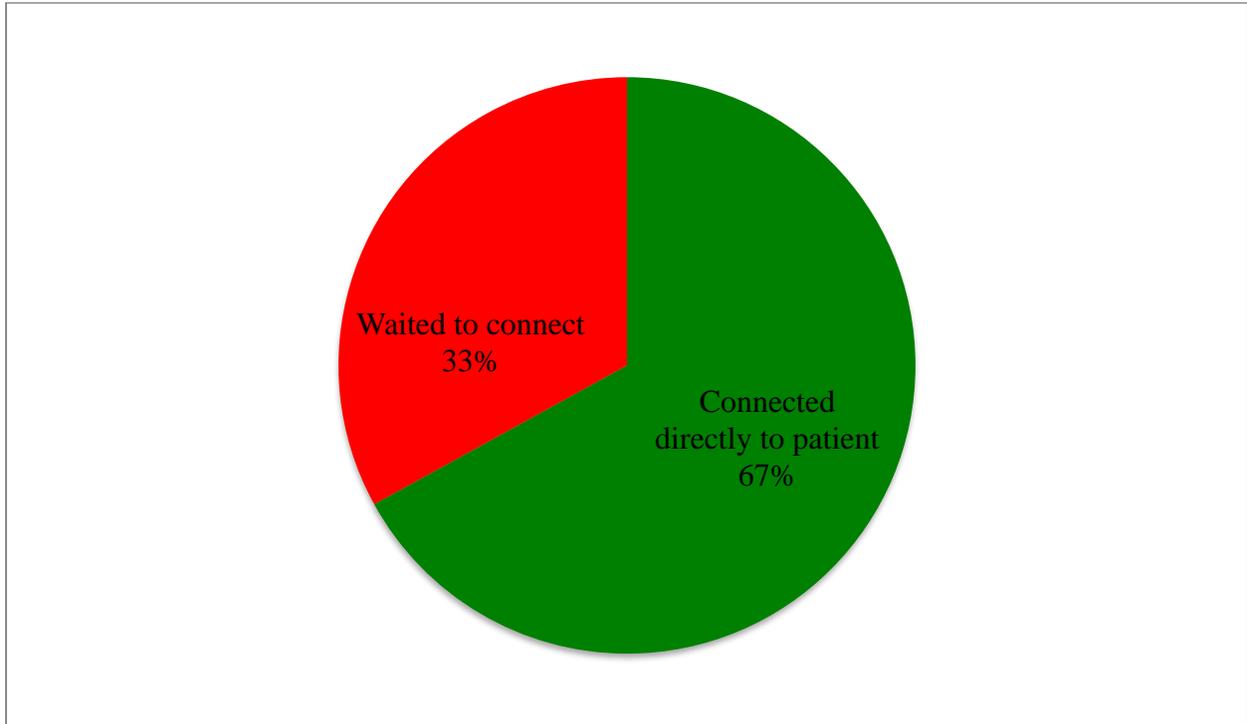
Green: According to Policy
Red: Adaptation to Policy

Appendix J
Programming the IV Pump



Green: According to Policy
Red: Adaptation to Policy

Appendix K
Timing to Connect Patient



Green: According to Policy
Red: Adaptation to Policy

**Appendix L
Gantt Chart**

Start of Project				
	September 2015	October 2015	November 2015	December 2015
Assessment				
Data Collection				
Revision of P&P				
Education				
Competency				
End of Project				
	September 2015	October 2015	November 2015	December 2015
Assessment				
Data Collection				
Revision of P&P				
Education				
Competency				