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Caroline Siefken

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Applying Lean Methodology to Improve the Response and Management of Postpartum Hemorrhage

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### Abstract

Postpartum Hemorrhage is an obstetric emergency that can lead to substantial maternal morbidity and mortality. Lean methodology is an improvement framework that addresses processes and identifies opportunities to eliminate waste and introduce efficiencies. The North Shore Medical Center uses an improvement framework modeled after the Toyota Production System that uses lean methodology to assess processes. This framework is called the North Shore Production System. This quality improvement project used the lean methodology tools from the North Shore Production System and applied them to interdisciplinary, simulated drills at the North Shore Medical Center Birthplace. After analysis of the tools, a postpartum hemorrhage management checklist was implemented based on the findings. Post intervention simulation drills were conducted to assess improvement. Defect rates were used to demonstrate improvement. Defect rates, steps in the nursing process, and reduction in non-value-added time to the process were all improved with checklist implementation. Utilizing a checklist to organize work assist in decision making during postpartum hemorrhage drills resulted in improved response and efficiency.

Keywords: Obstetrics, Postpartum Hemorrhage, Drills, Simulation, Lean

## Applying Lean Methodology to the Response and Management of Postpartum Hemorrhage

### Introduction

#### Problem Description

Postpartum hemorrhage is an obstetric emergency that can be life threatening. Complications from postpartum hemorrhage remains a leading cause of maternal morbidity and mortality worldwide. From 1993 to 2014 the rates of postpartum hemorrhage in the United States requiring blood transfusion increased from 7.9% to 39.7% (CDC, 2017). The sharpest increase in this rate was over the last ten years where the rate rose by 183% (AWHONN, 2014). If response or management errors are made by clinicians, outcomes can worsen. Teamwork and collaboration is essential to efficient management of postpartum hemorrhage. Postpartum hemorrhage occurs in 2.9% of deliveries in the United States and in 3-5% of deliveries worldwide (AWHONN, 2014). It is one of the top five causes for maternal mortality in both developed and underdeveloped nations (Belfort, Lockwood, and Barss, 2018). Complications of postpartum hemorrhage are detrimental and draining to both the patients and the system. Response and management are key to reduction of transfusions, Intensive Care Unit admissions, maternal transfers, surgical interventions including hysterectomy, and extended hospital stays.

North Shore Medical Center is located in Salem Massachusetts and approximately 1,300 deliveries occur at the hospital each year. The medical center serves a wide range of communities and populations north of Boston, MA. The number of deliveries in this community does not necessarily reflect the level of acuity. In the United States, non-severe postpartum hemorrhage rates have remained steady, while severe postpartum hemorrhage rates have increased drastically. From 2001-2012 the rate of postpartum hemorrhage requiring blood

transfusions more than doubled and the rate of postpartum hemorrhage with procedures other than transfusions increased including hysterectomy, embolization, and uterine tamponade (Ahmadzia, Grotegut, and James, 2016). Obstetric emergencies, postpartum hemorrhage in particular, can be more difficult to manage in a small community hospital setting with resource limitations.

### **Available Knowledge**

In order to isolate the applicable and timely research, only articles published in the past ten years were included when searching for postpartum hemorrhage resources. The initial strategy is to isolate articles related to postpartum hemorrhage and improvement work. The first search terms used were “postpartum hemorrhage” and “lean” in PubMed. This search yielded 4 results, only one of which was applicable to this work. This article is by Beth Faulkner and is included in the literature review. Next, in order to identify additional work that could inform the review of applying lean methodology to postpartum hemorrhage, the University of New Hampshire Discovery Service was searched for the terms “postpartum hemorrhage” and “management” and “improvement”. This search yielded 301 results, of which 5 were identified as appropriate after review. These five articles are by Sheikh et al, Lutgendorf et al, Bingham, Vendittelli et al, and Einerson et al. CINAHL was then searched using the term “postpartum hemorrhage improvement”, which returned two studies by Lutgendorf et al and Hermida et al. The Lutgendorf article remained in the review as it was previously identified in the search and the Hermida article was excluded at this time as it was not clinically relevant once the abstract was reviewed focusing on third stage management to prevent hemorrhage as opposed to optimization of management. Finally, a grey literature hand search was performed and an AHRQ guideline on postpartum hemorrhage was located to be included in the review. In all, the search

returned seven total references that were included in the literature to be reviewed at this time.

Themes in the literature review include the need to establish an organized approach to postpartum hemorrhage management, eliminate variation, and support decision making through protocols and simulated drills. This was demonstrated when Sheikh et al implemented a protocol and were able to more readily and consistently take evidence-based steps to manage postpartum hemorrhage (Sheikh, 6). Practicing said organization through simulation is shown to improve comfort levels in management of obstetric emergencies including postpartum hemorrhage (Lutgendorf, 1765). Bingham looks at the complexity of the process of postpartum hemorrhage and how the number of steps and variation lend themselves to different kinds of human errors. Evaluating the different types of potential errors in postpartum hemorrhage management, implementing standards and protocols, and finally attacking the rule-based errors through repeated simulation were found to be effective error reduction strategies (Bingham, 547). One article assessed the differences between hospitals in France and their medical management of postpartum hemorrhage once a protocol was in place and found that when protocols were present, the medical management was improved and better met the 2004 French Guidelines for postpartum hemorrhage, further lending weight to the need for a protocol (Vendittelli, 25). Finally, the work by Einerson et al described the sustainability of such organization and protocolization of postpartum hemorrhage management. The intervention in this study was a postpartum hemorrhage safety program which was able to better utilization of interventions to minimize negative outcomes in postpartum hemorrhage management. Implementation of a checklist, combined with education for staff and universal active management of the third stage comprised the safety program (Einerson, 140) and like the other studies mentioned, the resonating theme remained that organization of the work and protocolization of the management



can positively impact outcomes and behaviors.

Next, the search aimed to identify those resources that could be used to apply lean management principles in healthcare, specifically in obstetrics. For this purpose, the search terms “lean” and “obstetrics” were entered into both PubMed and CINAHL. PubMed did not return any results with these two terms. CINAHL returned 25 potential articles from these terms. Of these, two grey literature resources were identified, both of which are write ups of poster presentations. These references are by Price et al and Shields and Chandler and they both demonstrate successful application of improvement tools to processes in obstetrics. In addition to the grey literature, the article by Walker is included in the review from the CINAHL search.

Lean methodology has been globally applied as part of a perinatal improvement team at Roper St. Francis Healthcare in South Carolina. Successful initiatives born of this team include improving postpartum hemorrhage response by implementing a cart and a protocol that was able to reduce incidence of postpartum hemorrhage in that health system by .09% (Walker, 54). While this article explores a number of measures in obstetrics that were analyzed using lean methodology, success specifically as it relates to postpartum hemorrhage is beneficial as this work is proposed.

Pierce et al used lean tools such as spaghetti maps and waste walks on the gemba to identify barriers to implementing skin to skin contact in their operating room after cesarean sections. PDSA cycles were implemented to successfully create change. While this was a continued work in progress, the first application of these tools to create change was successful in raising compliance rates with the target behavior of skin to skin in the operating room (Price, 17). This poster presentation lends weight to the impact lean tools can have in the obstetric setting. Another encouraging application of improvement strategies from the literature review is

the application of lean and six sigma tools such as process mapping to organize interdisciplinary simulation drills in obstetrics with positive feedback from staff (Shields and Chandler, 13). The idea that application of structured improvement tools can better organize and structure a process for all disciplines lends credit to the approach proposed in this paper.

An article that was identified in the first round of the search is applicable as it relates to this aspect of the review in that it explores components of lean methodology as they were applied specifically to postpartum hemorrhage management in a busy postpartum unit admitting up to 5,000 patients annually in 2013 (Faulkner, 404). While this improvement project used some of the lean tools to develop a postpartum hemorrhage care bundle and implement it, there are a number of additional standard operations tools that the Toyota Production System, Virginia Mason Production System, and now North Shore Production System apply regularly to processes that were not utilized in the Faulkner work and could potentially add value to the findings. In addition, this project showed improvement on the time for all of the elements of the bundle to be met. This is the most applicable article in the literature review and coupling the success from this work with the aforementioned poster presentations indicates that there is a necessity to apply this framework to the process at North Shore Medical Center to see how the lean tools highlight the need for waste reduction/elimination and potential interventions specific to our environment.

While applying an improvement framework is clearly shown to be impactful as far as streamlining processes in healthcare, knowing the gold standard of recommended steps to take in postpartum hemorrhage will be integral to informing practice and any potential interventions to address issues in the current state process. AHRQ National Guideline Clearinghouse's guideline on postpartum hemorrhage gives these recommendations. One of the most useful aspects of the lean management tools is that when they are applied to the same process in different

environments, they highlight completely different opportunities for improvement. Using lean methodology is the perfect complement to rolling out a new process or set of recommendations, as it takes into consideration the aspects that are specific to the environment and personnel being observed. This, combined with the literature theme that an organized and practiced approach to postpartum hemorrhage decreases maternal morbidity and mortality indicates that implementing a quality improvement project targeting postpartum hemorrhage and utilizing the lean methodology is timely and has the potential to be very impactful at North Shore Medical Center.

### **Rationale**

The National Partnership for Maternal Safety published guidelines around best practice in postpartum hemorrhage assessment, recognition, and management. Challenges exist in implementing the bundle and providing a coordinated approach to this emergency. The Agency for Health Care Research and Quality (AHRQ) gap analysis tool compares best practice to the current state of a process at the institution of interest and works to identify the barriers to achieving the desired state of best practice management (AHRQ, 2016). The California Maternal Quality Care Collaborative (CMQCC) is an organization in that uses research and quality improvement toolkits to improve health outcomes for mothers and newborns (CMQCC, 2015). CMQCC has developed an obstetric hemorrhage bundle that has been proven to reduce mortality and morbidity rates with postpartum hemorrhage by 20.8% (CMQCC, 2015). The postpartum hemorrhage bundle consists of recommendations in the areas of readiness, recognition, response, and reporting (CMQCC, 2015). While North Shore Medical Center has been able to implement portions of these recommendations, the challenges remain in the areas of staged responses and protocols. This gap stems from a lack of organization. Without the protocol and tools to utilize, staff are approaching postpartum hemorrhage emergencies with knowledge of what interventions

exist, but lack the coordination of a stage-based response with clarity around steps and progression.

The Toyota Production System is a management method that focuses on value and waste, ultimately finding better ways to carry out processes by applying tools and creating an iterative process by which improvement is continuous, value is always being assessed, waste is limited or eliminated, and variations from the expected are immediately evident (Spear, 2004). Lean methodology is a way to address the waste at the heart of the Toyota Production System. Lean provides a way to specify value, do more with less, and give customers what they want more consistently and reliably (Womack and Jones, 1996). Application of lean methodology to the process by which postpartum hemorrhage is managed in the inpatient obstetric unit is a way to improve the efficiency and coordination of this emergency. Lean methodology is a commonly used improvement framework that applies several tools to observations of a process and implements plan, do, study, act (PDSA) cycles to create more consistent and efficient operators, or people performing the work, and processes. Lean methodology has been successful in healthcare. An example of this is application of lean methodology to decrease the time from order entry to delivery of medications in both chemotherapeutic and antibiotic drugs (Brunsmann, 2018). Lean management involves implementing interventions that aim to create more value for the customer, often in healthcare this is the patient, through eliminating waste from a process. Opportunities for these interventions are highlighted when tools are used to identify waste and non-value-added steps in a process. Ultimately, the Toyota Production System uses lean methodology to empower workers to be scientists and constantly build and test hypotheses focused on how to improve processes (Spear and Bowen, 1999).

North Shore Medical Center is on an improvement journey and is working to integrate lean methodology into improvement efforts. North Shore Medical Center is working with Virginia Mason Institute to develop staff training and tools that mirror the work done in their healthcare system but are applicable to this setting. This has led to training opportunities for staff, application of tools to process improvement work, and approaches that support and embrace lean methodology. The North Shore Production System is modeled closely after the work done at Virginia Mason, which is modeled after the Toyota Production System. This framework includes using tools referred to as Standard Operations and using the information gleaned from said tools to apply PDCA cycles to the process and optimize flow and value.

Postpartum hemorrhage is a leading cause of maternal mortality and morbidity worldwide. Complications of postpartum hemorrhage lead to medical, personal, and financial burdens on patients, staff, families, and systems. The best way to minimize the damage incurred from this obstetric emergency is to ensure an organized and predictable response. Applying the lean management principles to the process of managing postpartum hemorrhage can optimize accessibility to supplies and medications, create role clarity and definition, and expedite decision making and treatment. An additional barrier identified using the AHRQ gap analysis is the identification of waste. In order to clarify and simplify a process, waste must be identified and targeted. A substantial part of lean methodology is identification of and minimization of waste. North Shore Production System does this by applying the standard operation tools to the process. Barriers may include one or more of the seven types of waste identified by Taiichi Ohno; motion, time, transportation, overproduction, processing, inventory, and defects (McIntyre, 2016). Observing how North Shore Medical Center manages postpartum hemorrhage through the lens of waste will highlight potential opportunities to eliminate said waste and move closer to the

best practice standard identified by the CMQCC bundle.

Lean methodology embraces concepts that aim to assess processes and address opportunities for reduction or elimination of waste within them. The application of lean has been used in many industries, healthcare included. This project used the lean model of the North Shore Production System (NSPS) House. See Appendix A. The NSPS House is a model that visually depicts many of the lean concepts at North Shore Medical Center and highlights the central theme of waste elimination. This framework was used to guide the DNP project which encapsulates the various concepts that are trying to be achieved through application of the lean methodology to postpartum hemorrhage at North Shore Medical Center. The foundation of the NSPS house is elimination of waste and level production. This project aimed to evenly distribute, or level load the work that occurs in the process of postpartum hemorrhage management to best utilize resources and personnel and efficiently organize care delivery. There are two pillars in the visual NSPS house representative of Just In Time and Jidoka, both concepts that were applied during project implementation. Just In time refers to operating in a reliable manner, but with minimal resources. Reliability and access to supplies, medication, and equipment are essential elements of postpartum hemorrhage management. Jidoka refers to automation with a human touch. This is to say that whenever possible, those portions of a process that do not require human thought processes or conceptualization should be automated. Replacing non-personnel work with machines and/or equipment can give time and capacity back to medical professionals to use judgment and critical thinking, which is particularly valuable during emergencies such as postpartum hemorrhages. The NSPS house also highlights a need to focus on people and standard work. These aspects of the process; the operators, the steps they take, and the time that

it takes them to do so, were all assessed when applying lean methodology to postpartum hemorrhage management in this project.

### **Specific Aims**

The aim of this quality improvement project is to identify and implement an intervention through utilization of the lean methodology tools, specifically the North Shore Production System Standard Operations tools, to the process of postpartum hemorrhage response and management at North Shore Medical Center. The specific intervention of a postpartum hemorrhage checklist was determined by information gleaned from the application of the Standard Operations tools.

The goals and objectives of this project were successful application of the Standard Operations Tools and application of interventions to decrease waste within the process. The specific tools that were applied to postpartum hemorrhage are the Standard Work Sheet, Detailed Time Observation Form, Standard Work Combination Sheet, and Value Stream Map. Data collected was analyzed for improvement opportunities and waste identification. An intervention of a postpartum hemorrhage checklist was selected for this quality improvement project. The author collected the standard operations data and reviewed with a multidisciplinary team of clinicians. This group identified the specific intervention of a checklist and the author completed additional post intervention standard operations tools to measure improvement. There were three aims of this work. First, the overall goal of reducing waste was exemplified by specified reduction in number of steps on the standard work sheet by 20%. Next, the project aimed to reduce the non-value add time on the Value Stream Map by 20%. The final aim was to decrease the defect rate for CMQCC recommended steps in postpartum hemorrhage management by 50%.

These outcomes were an initial step in an iterative process by which additional Plan, Do, Study, Act (PDSA) cycles (see Appendix B) can be applied to the response and management of postpartum hemorrhage to continue to improve on this process at North Shore Medical Center after the completion of this DNP project. The aim was to achieve these goals of reduction in the observation metrics specified above after the initial checklist intervention was implemented for the DNP project.

## **Methods**

### **Context**

This process improvement project was designed based upon the assumption that process improvement is achieved by applying lean methodology. The methods that were used to obtain the data for this project were direct observations of simulated postpartum hemorrhage scenarios on a Labor and Delivery inpatient hospital unit. These observations were collected and documented by the author using Standard Work Sheets and Detailed Time Observation Sheets. Once six simulated cases were collected, the author met with an interdisciplinary team of clinicians including nurses, obstetric care providers (physicians and certified nurse midwives), anesthesiologists, and patient care assistants to review the findings and propose and discuss potential interventions. The checklist intervention was selected at this time. After implementing the intervention, the author observed using the Standard Operations tools described above to collect additional data. This data was compared with the initial data to show evidence of improvement. In addition, debriefs were held at the conclusion of each simulated drill. This information will be relayed back to the team to inform future PDSA cycles.

The DNP project took place at North Shore Medical Center in Salem, MA. The observations occurred on the Birthplace, which is the inpatient obstetric unit. North Shore



Medical Center is located less than 15 miles north of Boston, MA. It is a Community Hospital primarily serving the surrounding communities of Salem, Lynn, Peabody, Swampscott, Marblehead, Peabody, Danvers, and other towns on the North Shore. The Birthplace delivers approximately 1,300 patients each year and has a level IIB maternal-newborn designation from the Massachusetts Department of Public Health. The participants in this Quality Improvement project were the staff who participate in simulation drills. These clinicians included all who participate when a live emergency presents itself; nurses, physicians and midwives, and patient care assistants. The observations did not all include the same complement of disciplines or number of personnel from each discipline, as this is not predictable in actual events and the tools should represent the spectrum of resources and personnel available at any given time. In addition, they were not all be conducted in the same room on the unit, conversely the intention will be to utilize different rooms during observations. This is why six baseline simulation drills were observed. It was anticipated that the tools and interventions were universal and would be effective in improving the process regardless of the operators or environment. Finally, the simulation drills were conducted on all three shifts to ensure universal applicability of the baseline and post-intervention characteristics. There are typically between ten and twelve nurses on the day shift, between eight and ten nurses on the evening shift, and between seven and nine nurses on the night shift. From the hours of 8am to 8pm, there are two to three obstetric care providers on call in the Birthplace. The Birthplace has one Physician covering call from 8pm-8am Monday through Thursday. In addition to this coverage, there is always a dedicated backup call provider accessible to be called in if needed. Exclusion criteria were any drills that did not have representation from both OB provider and nursing disciplines and those that did not have at

least two nurses responding. This is to ensure applicability because the vast majority of postpartum hemorrhages are managed by at least two nurses and at least one OB provider.

Implementation of this DNP project was largely reliant on the ability to conduct simulation drills and work with staff offline to determine intervention strategies. This required the support and buy in of the hospital staff and leadership, which was confirmed prior to initiation. Because lean methodology relies on the ideas coming from the people who do the work, this project would have struggled to be successful without the participation, perspective, and ideas generated by frontline staff. Facilitators to the project were both nursing and provider leadership. Deliveries at Northshore Medical Center for the summer and fall months of 2018 were above average. June, July, and September were the three busiest months of the year, with as few as 5, but as many as 44 more deliveries than other months this year. Simulation drills were scheduled with alternate dates in mind to accommodate for shifts during which there were not available participants for the simulation drills because of this surge. Nurse and provider leaders at NSMC are supportive of participation in simulation drills and include this participation in employee reviews. This was helpful in that it encouraged active participation.

### **Intervention**

Simulation drills were scheduled on all three shifts, 7a-3p, 3p-11p, and 11p-7a. These drills were scheduled with backup dates to guarantee completion. One date required utilization of the backup date because of the acuity of the unit and lack of availability in terms of both space and staff. To take unit census into account two drills will be scheduled for each shift and all baseline drills will be completed prior to analysis of the baseline data. Schedule of drills was not available to participating staff and all drills were called without prior announcement to any staff.

An interdisciplinary team with representation from nursing, obstetric providers, and anesthesia then met to review the completed tools and determine an intervention for the first PDSA cycle. Adaptation of a postpartum hemorrhage checklist (See appendix C) used at another Partners facility, Newton Wellesley Hospital, that was shared with us from their physician and nursing leadership was carried out and after implementation, there were three post intervention simulation drills completed, one per shift. After completion of these drills, new tools were created, reviewed and compared to baseline data to observe for improvement and inform the next iteration of PDSA.

### **Study of the Intervention**

The pre and post intervention Standard Operations tools were compared at the conclusion of the project. The value stream maps and Standard Work Sheets were compared to demonstrate changes in the nursing steps and non-value-add time in the process. Using the CMQCC checklist the defect rate was calculated by dividing the number of met criteria by the number of recommended criteria and multiplying the result by 100 to determine how often criteria recommended by CMQCC were met comparatively. The intervention was applied in the same drill scenario and during all three shifts to account for changes in staff resources and time of day.

### **Measures**

The standard operations tools were used to measure this project. The Standard Work Sheet is a tool to depict the operators' movements made and steps taken in the process. Each operator is followed through the process by drawing a line of his or her movements on the map. Safety and Quality Checks are depicted on the map as well. The Detailed Time Observation Sheets were used to collect time data on the steps in the process and once these forms were

completed, the information on them was combined using the modes or if necessary medians to determine the actual times for each step in the process and the process as a whole. This is called the Process Summary Form. The Standard Work Combination Sheet is used to depict the work of the nurse, in categories of waiting, walking, machine work, and human work. The Percent Load Chart depicts the workload and how it is broken up between operators during this process. Finally, the information gleaned was analyzed to build a value stream map giving a visual depiction of the process, concrete numbers for time observations, and opportunities for improvement identified in kaizen bursts on the map. Following implementation of the checklist, the post intervention process was observed and evaluated in the same manner. The two sets of tools were compared to demonstrate improvements.

Applying lean tools, strategies, and principles that have been proven effective in other realms of healthcare to postpartum hemorrhage management is of high importance given the necessity to manage these emergencies to the best of the team's ability and in the most efficient and productive way. If application of lean management principles to the process of postpartum hemorrhage management can be effective in improving outcomes for patients, thereby impacting patient safety, then this work is necessary and significant.

## **Analysis**

Six simulated postpartum hemorrhage drills were observed and data collection tools completed. The process began at the time of recognition of postpartum hemorrhage and ended at the decision to transfer the patient to the Operating Room. The CMQCC toolkit checklist sample was modified for North Shore Medical Center and used to determine the defect rate in the process. The project began on July 1, 2018. The six baseline data collection simulated drills and

their backup times were scheduled for completion during the month of July 2018. Standard Operations tools were completed by August 15, 2018. By September 1, 2018 the team had met to review the baseline findings and identify an intervention. The team determined that a second, unplanned meeting would be necessary to create and validate the proposed checklist. This meeting occurred on October 9, 2018. All team meetings were completed at this time. The checklist was rolled out by October 18, 2018. This was done over two twelve-hour Skills Day sessions to the Birthplace staff. This was a later date than was originally anticipated as a visit from the Massachusetts Department of Public Health to the North Shore Medical Center occupied the time of all participants for a week in early October. The three post-intervention simulated drills were completed inclusive of data collection by October 24, 2018. Using said data, the post intervention Standard Operations tools were completed by November 1, 2018. This concluded this DNP project as well as the first PDSA cycle to address improving postpartum hemorrhage management at North Shore Medical Center. See Appendix D.

### **Results**

The baseline Standard Operations Tools showed substantial room for improvement. The total steps observed in the Standard Work Sheet or spaghetti map for the responding nurses was 14, while the primary nurse had a total of 5 steps. The post intervention drills demonstrated a Standard Work Sheet with 11 steps for the responding nurses and 5 steps for the primary nurse. See Appendix E. This reduction in nursing steps from a total of 19 pre-intervention to 16 post intervention was 16%, which did not meet the goal of 20%. That said, there were unanticipated barriers to reduction of this rate. These included what Toyota Production Systems would refer to as monuments, or unmovable items that require the waste of motion to access and utilize. An example of this in this project is the medication dispensing system. While it would eliminate the

wastes of motion and transportation to have the medications available at the point of care delivery, there is no ability to remove medications from the Omnicell until a hemorrhage is established and they are needed for administration. This is hospital policy. Of note, while the steps in the process have not been reduced for the primary nurse, all of these steps are now confined to the patient room, whereas pre-intervention some were outside of the room, taking the nurse away from the patient. To summarize, while the set goal of 20% reduction was not seen in relation to nurse steps in the process, a reduction was demonstrated, additional benefits occurred, and the stage was set for future interventions to continue to improve this process.

The next goal of this project was to decrease the non-value add time in the Value Stream Map by 20%. The baseline Value Stream Map showed a total non-value add time of 217 seconds. The post intervention value stream map showed a total non-value add time of 139 seconds. See Appendix F. This demonstrates a reduction in total non-value add time for the process of 36% which exceeded the goal of 20% reduction. The pre-intervention lead time, or time for the whole process from recognition of hemorrhage to decision to move to the operating room, was 324 seconds and after implementation of the checklist this time was 269 seconds. This time reduction of 55 seconds is important because even seconds are significant in obstetric emergencies and this demonstrates that organizing the necessary steps by way of a checklist creates a more efficient response. In addition, the pre-intervention value stream map included 9 kaizen bursts, while the post-intervention map had only 2. This is noteworthy because kaizen bursts represent opportunities for improvement and/or highlight inefficiencies and inconsistencies. The elimination of 7 of these kaizen bursts speaks to the standardization of the process by use of the checklist.

Finally, and most significantly, the application of this intervention was analyzed in terms of how it affected defect rates. The defect rate in the baseline drills was 45%. This number represents how defective our process was in the baseline period in relation to meeting the CMQCC recommended steps to take when managing a postpartum hemorrhage. The post-intervention drills showed a defect rate of 7%. The decrease is an 84% reduction in the defect rate. See Appendix G. This far overshoot the goal of 50% and is an impressive improvement in management of postpartum hemorrhage through adherence to the CMQCC recommended steps in response and management.

## **Discussion**

### **Summary**

This project was able to demonstrate some improvements far more substantial than anticipated and others less substantial, nonetheless still demonstrating an improved process. The impact of these improvements cannot be overstated. Coordinating a predictable, standardized response in an obstetric emergency where time is critical is important. This project was able to apply jidoka by removing the reliance on the memory of the clinicians in the room, while not taking away their clinical judgement or decision making. That is to say that for example, there is no way to forget thinking about blood products, as they are on the checklist, but the amount, type, and time to order said products is left in the hands of the managing clinician. This checklist has made patients safer by standardizing which responders are called, which supplies and equipment are brought to the room, and when more interventions should be considered.

### **Interpretation**

Postpartum hemorrhage is a leading cause of maternal mortality and morbidity

worldwide. Complications of postpartum hemorrhage lead to medical, personal, and financial burdens on patients, staff, families, and systems. The best way to minimize the damage incurred from this obstetric emergency is to ensure an organized and predictable response. Applying the lean management principles to the process of managing postpartum hemorrhage can optimize accessibility to supplies and medications, create role clarity and definition, and expedite decision making and treatment.

Checklist utilization has proven effective in healthcare and in high reliability organizations and industries. This coupled with the support from AWHONN and ACOG for adoption of safety bundles including checklists made this an ideal intervention for this project. Future work around postpartum hemorrhage management at NSMC will use additional PDSA cycles to aim to continue decreasing waste and bring the defect rate for CMQCC recommended management steps to 0%. Qualitative data gained from this project included the feedback from the debrief sessions of both the baseline and post-intervention periods. Anecdotal feedback about the disorganization and confusion in the baseline drills supported the data collected. Feedback about how to best utilize the checklist in the post-intervention drills has already spurred the purchase of bright green folders to assist in identification of the checklist reader or event manager and an improved Quantitative Blood Loss worksheet for nursing. See Appendix H. Future PDSA cycles will also include debriefing to collect and apply feedback from participants.

This quality improvement project did not incur a financial cost to the unit or institution. Simulated drills were completed on the Birthplace by personnel during their regularly scheduled shift. Emergency preparedness training is a requirement for clinical providers in an obstetric unit. Benefits of simulation training and emergency preparedness include improving overall staff competence and confidence (Skryabina et al, 2017). Obstetric team training has been found to be



cost-effective when completed on site at hospitals and provides the advantage of the interdisciplinary team working together, in their working environment (van de Vena et al, 2017). Training locally with interdisciplinary teams is inexpensive and it has been shown that obstetric emergency training that is on site, low tech, and associated with quality improvement initiatives are more likely to be effective than those without said qualities. In addition, simulation drills of this type are not only associated with transfer of knowledge, but also foster safer workplace culture, build confidence within the team, and better both communication and clinical practice (Collins and Draycott, 2015). These benefits coupled with the lack of a financial burden, make this work incredibly cost effective.

### **Limitations**

There are limitations to this project. The quality improvement work and intervention were applied to simulated events. This is an obvious limitation because while the improvement in postpartum hemorrhage response and management is well demonstrated in this environment, it cannot be directly translated to real time obstetric emergencies. That said, practicing applying the checklist to hemorrhage in the same environment, with the same team members, and with the same equipment is encouraging in terms of applicability of the results. In addition, the project intervention was a checklist that contains elements recommended by professional organizations but was tailored to meet the needs of the institution, so reproducibility would likely require site specific edits. Finally, the nurses were all presented the baseline defect rates at a Skills Day and were likely very committed to the list as a result of the awareness of our current state gap in adherence to recommendations. This could have encouraged them to be more diligent about using the checklist to guide care. Moving forward, there is no way to force the function of utilizing the checklist, so the effectiveness will be based on clinicians remembering and electing

to use the list when managing postpartum hemorrhage. This limitation will be addressed through repetitive simulations in an effort to build safety checklists in to the culture of obstetric emergency management at NSMC.

## **Conclusion**

Postpartum hemorrhage is an obstetric emergency that can have devastating consequences for patients and their families. Clinical outcomes and resource utilization can be substantially improved with organized interdisciplinary response and management. The application of lean methodology to processes inside and outside of the healthcare setting has demonstrated improvements in standardization and efficiency through eliminating waste and highlighting opportunities for interventions. Observation of postpartum hemorrhage simulation drills and application of Standard Operations tools to document the current process followed by interdisciplinary involvement to determine specific intervention plans and return observations demonstrated significant improvement in compliance with the CMQCC recommended response, which is endorsed by both AWHONN and ACOG. This DNP project initiated an iterative PDSA process to create a culture of continuous improvement around postpartum hemorrhage response and management in the North Shore Medical Center Birthplace.

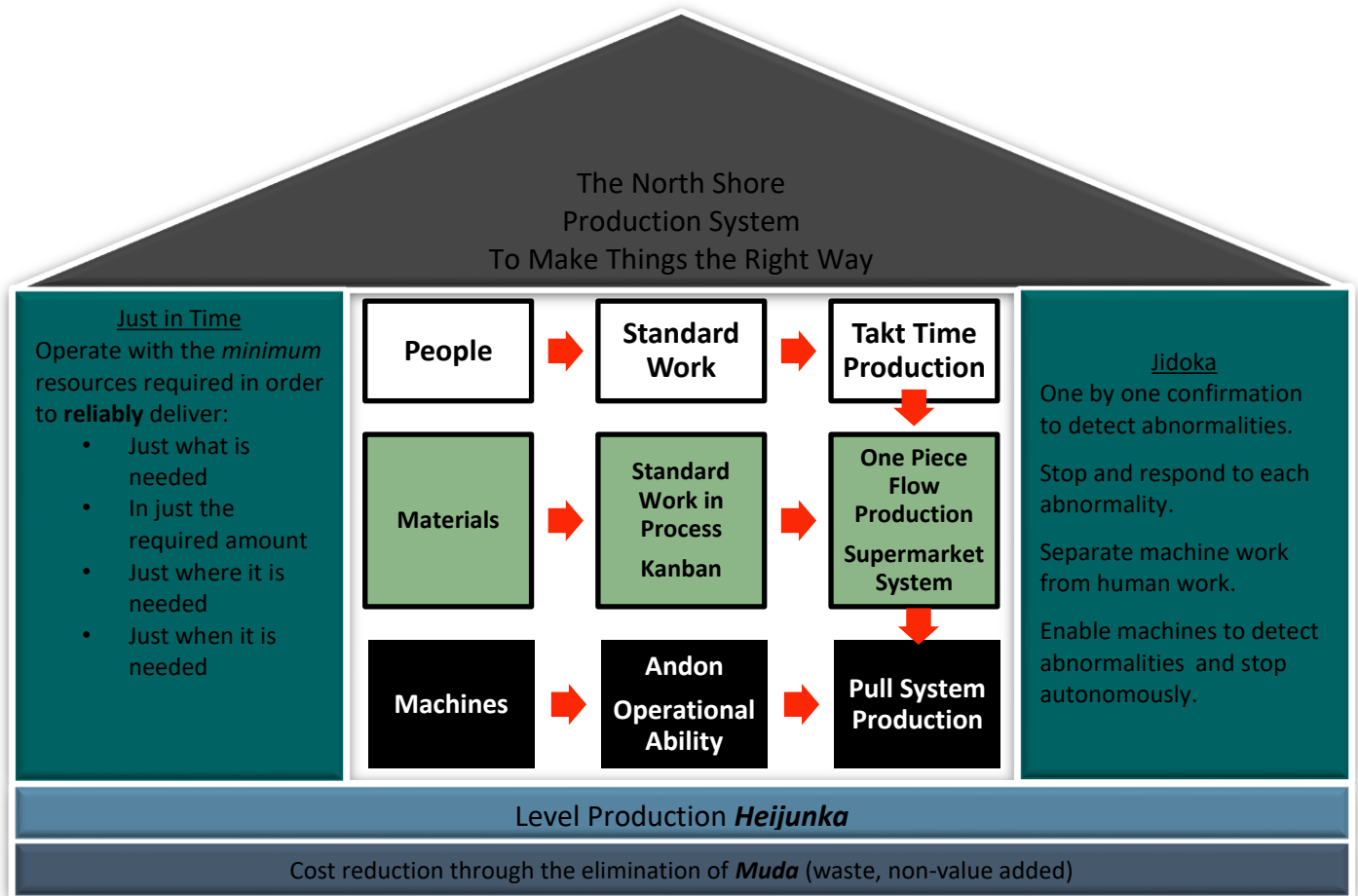
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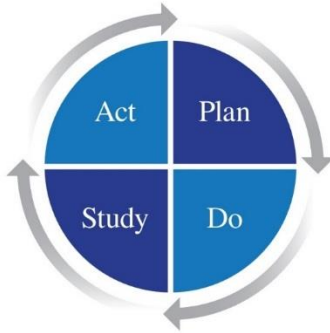
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APPENDIX A – NSPS House: source: North Shore Medical Center 2018.



APPENDIX B:

PDSA Cycle:



Source: The Deming Institute 2018.

APPENDIX C:

8

Obstetrical Hemorrhage

10/9/2018

START

- ① Activate OBCRT
- ② Establish an event manager
- ③ OB hemorrhage cart to room
- ④ Scale to room
- ⑤ IV cart to room & access x 2
- ⑥ Pitocin @ 999mL/hr
- ⑦ Consider Tranexamic Acid
- ⑧ Fundal massage/exam
- ⑨ Monitor & announce vital signs (include O2 sat) q 5 mins
- ⑩ Weigh & announce QBL q10 min
- ⑪ Give uterotonic agents (med kit)
- ⑫ Empty bladder
- ⑬ Contact Blood Bank x 4124 consider "OB Massive Transfusion protocol"
- ⑭ Send STAT labs: CBC, BMP, PT/PTT, Fibrinogen, Ionized Calcium  
Repeat labs q30-60 mins
- ⑮ O2 to maintain sats >95%
- ⑯ Warm patient and fluids
- ⑰ Family support

**TRANSFUSION**

- PRBC:FFP:Platelets @ 4:4:1 ratio
- Cryoprecipitate 10 units for Fibrinogen <80
- After 8-10uRBCs and full coagulation replacement, may consider consult re rFactor VIIa risk/benefit

**CONSIDER**

- >> Transfer to OR – D&C
- >> Intrauterine balloon
- >> Embolization
- Call x4432 or on call Radiologist
- >> Uterine artery ligation
- >> Uterine compression suture
- >> Hysterectomy/Ligasure
- >> ABG (O2 sat <95%)/Art line
- >> Calcium administration

**DRUG DOSES & TREATMENTS**

**Pitocin** 30u/500mL

**Methergine** 0.2 mg IM q 2-4 hrs (no IV administration) (Caution with HTN, prior ephedrine, cardiac disease.)

**Tranexamic Acid** 1gm in 100mL over 10 mins, may repeat x1 in 30 mins if needed

**Hemabate** 250 mcg q 15-90 min x 8 prn  
\*Intramuscular - NOT intravenous  
\*Caution w/asthma/HTN

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\*\*\*Consider only if necessary

**Calcium Chloride:**  
200-500 mg/unit RBCs if massive transfusion

**Misoprostol:**  
600-800mcg PO if no IV access

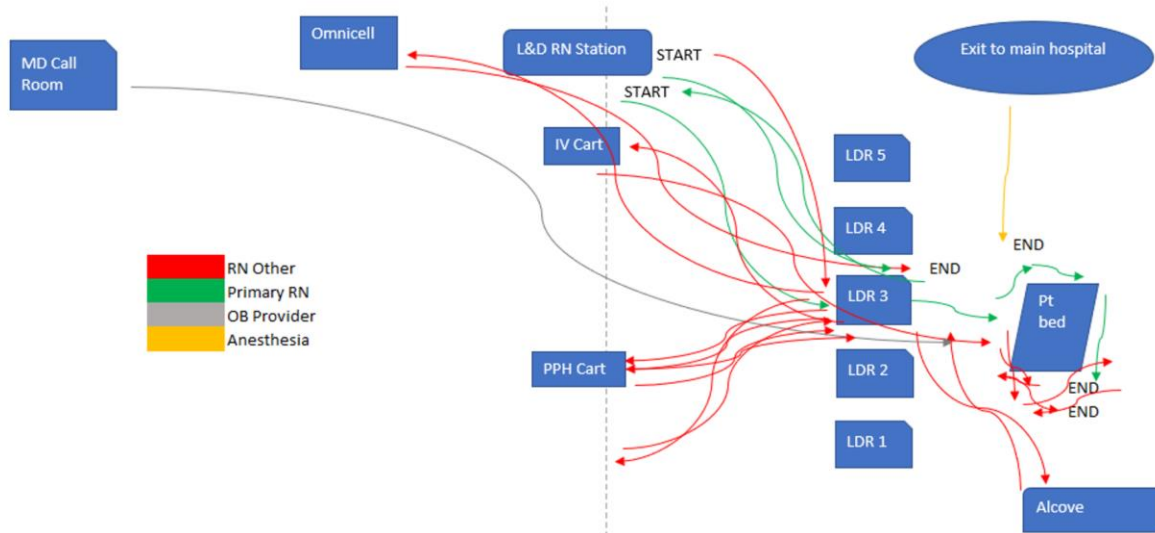
## APPENDIX D: Project Timeline

DATE	PROJECT STATUS
July 1, 2018	Proposal Approval
July 31, 2018	6 Baseline drills completed
August 15, 2018	Baseline Standard Operations tools completed
October 9, 2018	Team meetings completed
October 18, 2018	Interventions implemented
October 24, 2018	Post intervention drills completed
November 1, 2018	Post intervention Standard Operations tools completed



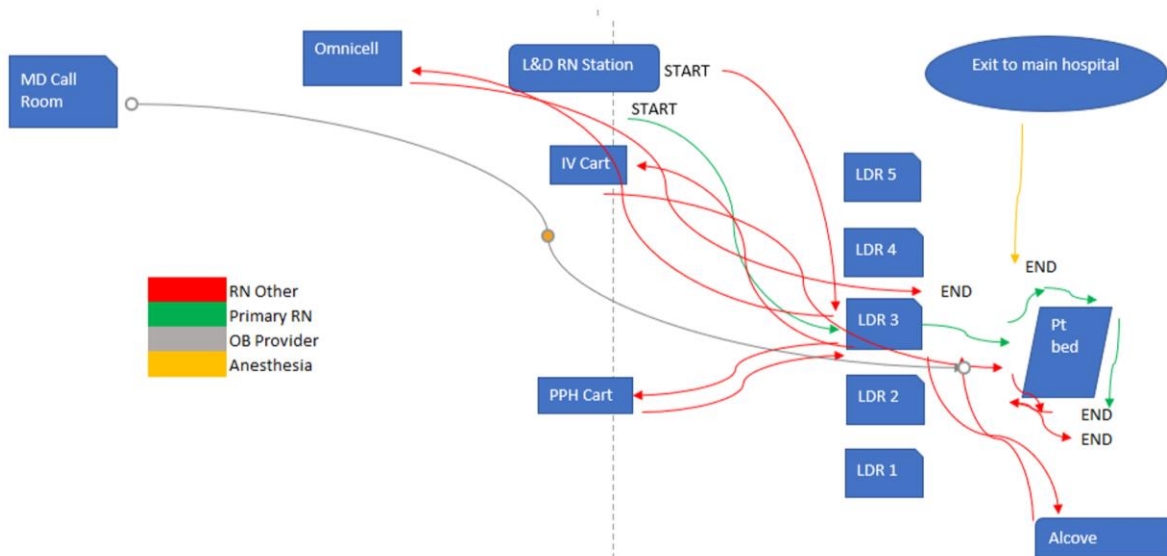
APPENDIX E: Pre-Intervention Standard Worksheet

Results – baseline and post-intervention standard work sheets

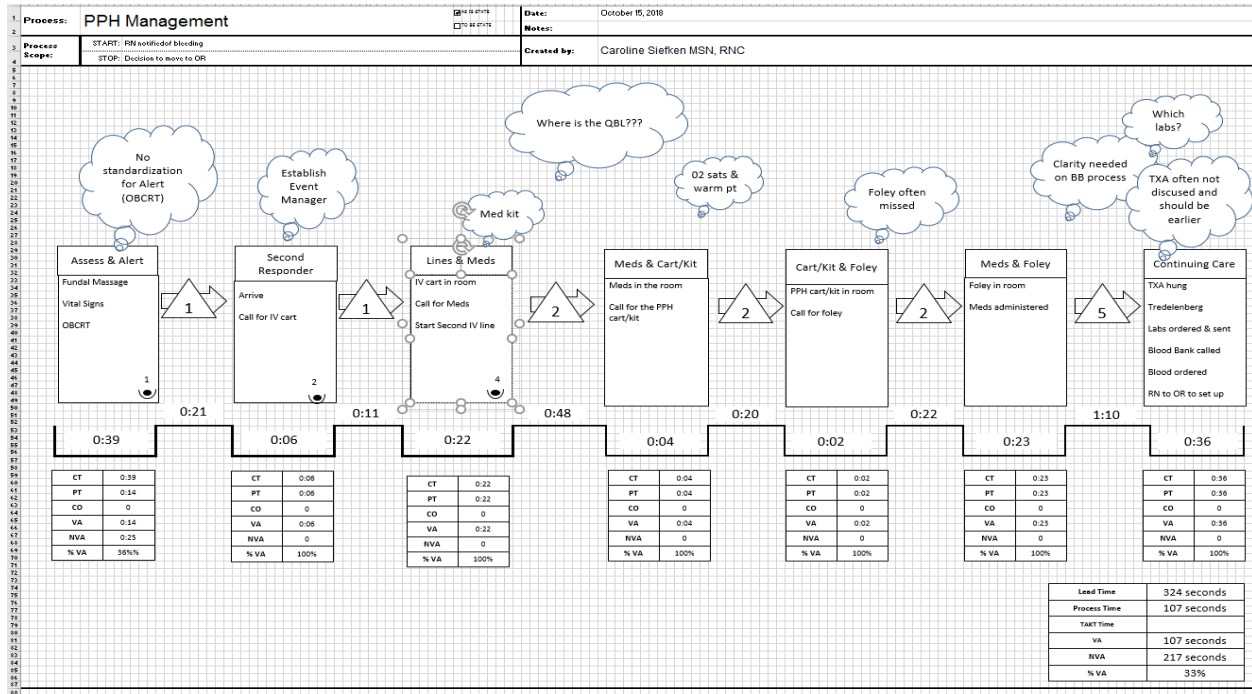


Post-Intervention Standard Worksheet –

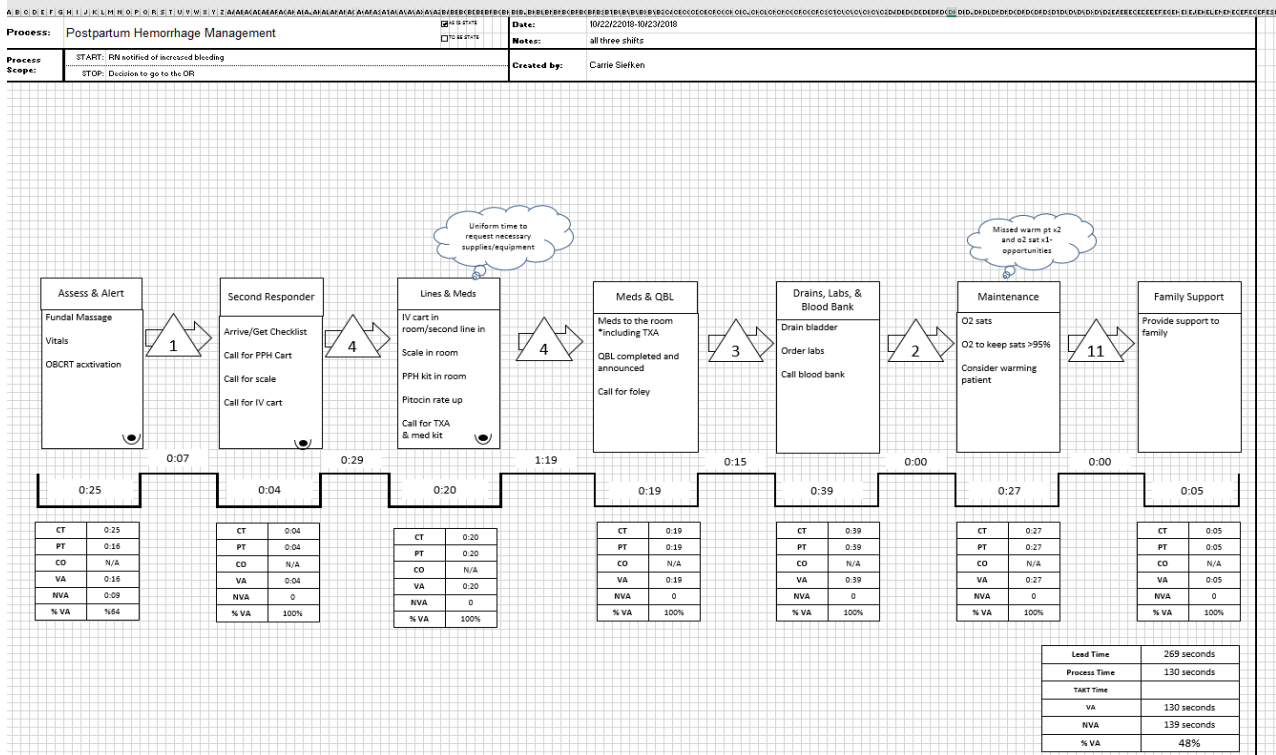
Results – baseline and post-intervention standard work sheets



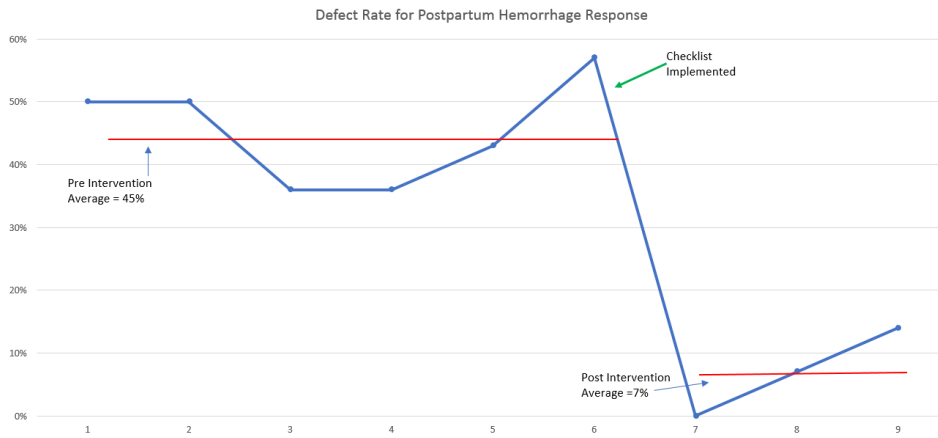
APPENDIX F: Baseline Value Stream Map



Post-intervention Value Stream Map



Appendix G:



Appendix H:

Quantitative Blood Loss Worksheet

ITEM	How many?	Multiply by	Dry weight		Total
Chux		X	20	=	
Single lap sponge (18x18)		X	20	=	
5 lap sponges (18x18 each)		X	100	=	
Single skinny lap		X	6	=	
5 skinny laps		X	30	=	
Peripad		X	10	=	
Peripad with ice		X	140	=	
Big green bed pad		X	425	=	
White bath towel		X	270	=	
White face cloth		X	40	=	
OR plastic sponge count bag		X	20	=	
Fitted white sheet		X	755	=	
Flat white sheet		X	521	=	
Disposable mega-chux pad		X	106	=	
Blue OR towel		X	52	=	
Placenta bucket		X	123	=	
TOTAL ALL ROWS					=
Weight on scale	subtract	Supply Weight	=		Weight QBL

Amount of fluid in drape after repair	Subtract	Amount of fluid in drape pouch/cannister immediately following placenta delivery	Add	Weight of clots from top of drape	Equals	Fluid QBL
	-		+		=	

Weight QBL	+	Fluid QBL	=	Total QBL =