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VIEWPOINT
Breast

Lean and Six Sigma Methodology Can Improve Efficiency in Microsurgical Breast Reconstruction

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INTRODUCTION

Operating rooms (ORs) remain one of the most expensive aspects of healthcare in the United States, with costs estimated at over $100 a minute.[1,2] Hospital administrators are therefore increasingly pressured to find ways to maintain the standard of care while minimizing hospital-perspective costs. A quality improvement framework adopted from the manufacturing industry called Lean Six Sigma (LSS)[3–5] emerged in the healthcare sector in the 1990s, with the promise of simplifying operating rooms such that efficiency was maximized and cost minimized. Lean, which evolved from the Toyota production line in 1990[6], described repeated cycles of "value stream mapping" to identify and eliminate wasteful steps that absorbed resources, personnel, and time. Six Sigma, introduced by Motorola in 1986, aimed to correct defects in processes such that errors were less likely to occur. The regimented nature of ORs seemed to lend itself perfectly to the LSS framework, leading to its gradual adoption in the surgical community.

To date, LSS principles have been used successfully to reduce OR times and increase operative capacity.[3, 7–9] Surprisingly, few studies have applied these principles to plastic surgery. The objective of the present study was to apply LSS concepts to operative workflow in microsurgical breast reconstruction.

METHODS

A priori value stream mapping for traditional microsurgical breast reconstruction was created and distributed to multidisciplinary stakeholders (surgeons, nurses, OR technicians). The flow diagram divided the operation into four stages, each of which was examined for non-value-added steps. Meetings were held to address stakeholder safety and efficiency concerns and a complementary solution was proposed for each. Surgeon concerns involved a non-standardized surgical set-up, intraoperative delays due to opening instruments not already on the set-up, and operative interruption by passing instruments through surgical fields. Nursing concerns included unique surgical set-ups from each surgeon and poor communication about the stage of surgery, which prevented anticipation and preparation of following steps. Instrumentation concerns involved the sterilization and organization of multiple surgical instruments never used during the case contributing to unnecessary surgical counts and operative waste. Operator safety concerns involved operating room clutter, leading to workplace hazard and poor operator ergonomics.

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RESULTS

A modified value stream map for deep inferior epigastric perforator flap (DIEP) breast reconstruction was designed that incorporated all stakeholder input (Fig. 1). Standardized cognitive aid references for each of the four steps were laminated and placed in the operating room for each new perioperative team to reference before the case. Preoperative surgical pauses were modified to incorporate confirmation that each surgical set-up was complete based on the cognitive aid diagram. Traditional case counts involved 174 instruments, with a conversion rate of 47%. In other words, only 81 of the 174 instruments organized on the nursing set-up were being used, leading to unnecessary sterilization, packaging and organizational costs. The modified surgical set-up included 91 instruments and was associated with a conversion rate of 90% (82/91 instruments).

DISCUSSION

Like the manufacturing industry, the regimented nature of microsurgical breast reconstruction lent itself well to the LSS framework. The technical execution of breast flap reconstruction has been outlined in anywhere from eight[10] to 100 steps,[11] yet the incorporation of LSS principles can help simplify the process for all involved stakeholders. We used the Six Sigma framework to critically evaluate operative workflow and evaluate defects from a multidisciplinary perspective.

Our conclusions are best appreciated considering the seven key lean principles:

1. *Minimize Inventory*: Crowded OR set-ups tie up capital while increasing storage and processing costs. Just-in-time (JIT) supply management aims at producing only what is needed, when it is needed. JIT processing in the operating room can respond to demand while reducing inventories. Measuring rates of use, simplifying OR set-up and adopting JIT supply management significantly impacts value.

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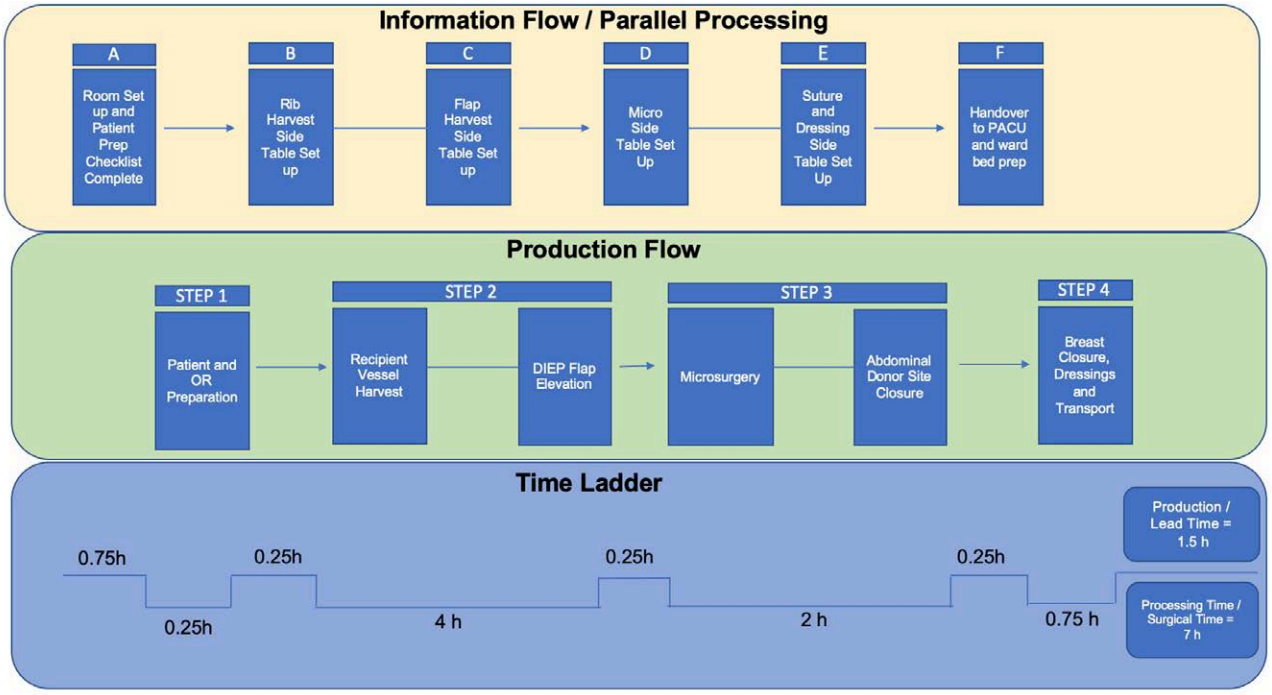

Fig. 1. Value stream mapping for deep inferior epigastric perforator flap breast reconstruction.

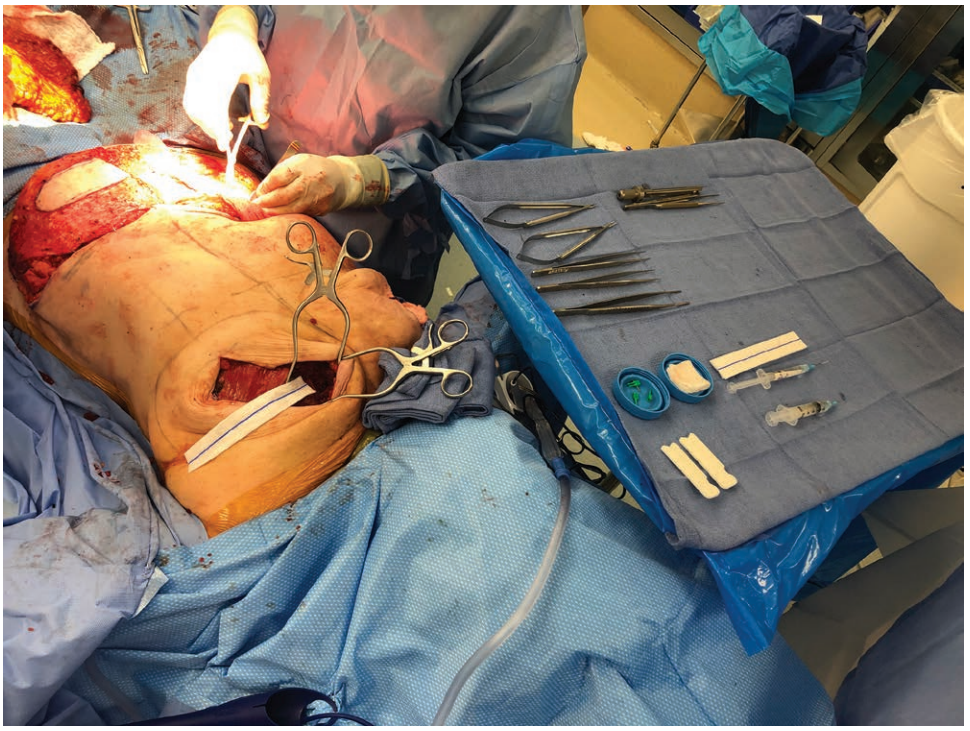

Fig. 2. Self-serve trays in microsurgery.

2. *Minimize Wasted Motion*: Standardized self-serve Mayo stands (Fig. 2) significantly reduce unnecessary motion and improve ergonomics in the OR. This can also potentially reduce workplace injuries, breaks in sterility, and needle stick injuries in the OR.
3. *Limit Overprocessing:* Sterilization/preparation of instruments not used during a case increases environmental waste and hospital-perspective costs. Repeated nursing counts of unnecessary instruments also leads to unnecessary intraoperative distractions and increases operative time.

4. *Reduce Transportation of Equipment:* When the exact number of sutures used is known, there is no reason to open suture packets one by one, waiting for circulator retrieval. Draping and wheeling in a surgical microscope increases time and operational cost without improving patient safety or surgical outcome. Loupe microsurgery has a similar safety and outcome profile as the microscope[12] while reducing OR clutter and the need for moving/draping/positioning.
5. *Eradicate Defects Leading to Waste:* Incorrect table assembly, surgical trays with missing instruments, and passing instruments across sterile fields while obstructing lines of vision for other surgeons are critical forms of waste. Standardized self-serving trays eliminate these defects while improving efficiency and ergonomics.
6. *Reduce Idle-time:* Parallel processing has been instrumental in reducing operating time. Cognitive aids help standardize surgical set-ups such that the nurse can organize the Mayo stand for the next surgical stage while the previous stage is in process.
7. *Maximize Human Potential*: Empowering all OR team members to contribute to a modified value stream surgical pathway improves communication and team dynamics.

CONCLUSIONS

Using multidisciplinary feedback to create a modified value stream map for autologous breast reconstruction eliminates waste, improves efficiency, and strengthens team dynamics. Cognitive aids and Lean Six Sigma principles are valuable instruments that plastic surgeons can use to improve efficiency in the operating room.

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