

Reducing Unnecessary Postoperative Complete Blood Count Testing in the Pediatric Intensive Care Unit

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ABSTRACT

Context: Complete blood count (CBC) testing commonly occurs to determine the need for blood transfusions after surgical procedures. Many clinicians believe postoperative CBCs are “routine.”

Objective: To decrease unnecessary routine CBC testing in a low-risk cohort of postoperative patients in the pediatric intensive care unit (PICU) at The Children’s Hospital of Philadelphia by 50% in 6 months.

Design: Quality-improvement study. Data from our institution regarding frequency of ordering laboratory studies and transfusion requirements were collected for prior quality-improvement work demonstrating the safety and feasibility of avoiding routine postoperative CBCs in this cohort. Baseline survey data were gathered from key stakeholders on attitudes about and utilization of routine postoperative laboratory testing. Patient and clinician data were shared with all PICU clinicians. Simple Plan-Do-Study-Act cycles involving education, audit, and feedback were put into place.

Main Outcome Measures: Percentage of postoperative patients receiving CBCs within 48 hours of PICU admission. Balancing measures were hemoglobin level below 8 g/dL in patients for whom CBCs were sent and blood transfusions up to 7 days postoperatively for any patients in this cohort.

Results: Sustained decreases below our 50% goal were seen after our interventions. There were no hemoglobin results below 8 g/dL or surgery-related blood transfusions in this cohort within 7 days of surgery. Estimated hospital charges related to routine postoperative CBCs decreased by 87% during 6 postintervention months.

Conclusion: A simple approach to a systemic problem in the PICU of unnecessary laboratory testing is feasible and effective. By using local historical data, we were able to identify a cohort of patients for whom routine postoperative CBC testing is unnecessary.

INTRODUCTION

Prior studies at large academic centers have demonstrated the high cost and high variability of common laboratory testing in the intensive care unit (ICU).¹⁻³ These costs are reflected not just in dollar amounts but also in resultant anemia. In the pediatric intensive care unit (PICU), blood draws have been shown to account for 73% of daily blood loss and can lead to the need for blood transfusions.⁴ These transfusions are associated with greater number of days

of mechanical ventilation, longer length of stay in the PICU, increased mortality, and cardiorespiratory dysfunction.⁴ Other institutions have demonstrated that a focused educational effort on current utilization of common laboratory testing can result in decreased utilization in a safe manner.⁵⁻⁷ In postoperative pediatric cardiac patients, interventions removing standing laboratory order panels have resulted in decreased utilization of laboratory testing with no resultant differences in mortality

or extubation failure.⁸ We sought to develop a unique evidence-based approach to reducing laboratory testing in low-risk postoperative patients in the PICU.

Complete blood count (CBC) testing commonly occurs in postoperative patients to identify or to follow-up large-volume blood loss and need for blood transfusions. Data from our own institution of 30,545 patients (Figure 1), which had been collected for a prior quality-improvement (QI) project, allowed us to retrospectively identify patients with very low risk of transfusion and who therefore should not require routine CBC testing postoperatively. This cohort included postoperative patients who had undergone the following procedures: tonsillectomy and adenoidectomy, ventriculoperitoneal shunt placement, endoscopic third ventriculostomy, laryngotracheal reconstruction, and laminectomy. The largest groups of procedures reviewed were patients undergoing tonsillectomy and adenoidectomy (22,291 patients) and those patients undergoing ventriculoperitoneal shunt placement (3501 patients).

Our aim was to decrease unnecessary routine CBC testing in this cohort of postoperative patients in the PICU at The Children’s Hospital of Philadelphia by 50% within 6 months.

METHODS

Setting

This QI intervention took place in a large tertiary care medical-surgical PICU with 55 beds that has averaged more than 3500 admissions per year during the past

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5 years. Ordering clinicians include ICU attendings, fellows, residents, and nurse practitioners. The cardiac surgical ICU and neonatal ICU were excluded. We received institutional support in the form of a clinical QI advisor and data analyst who facilitated the QI project. The background information that informed this project was part of a study approved by the institutional review board at The Children's Hospital of Philadelphia.

Measures

Initial baseline survey data were gathered from key ordering clinicians regarding the utilization and necessity of routine postoperative laboratory testing. This data informed the metric selection. Our primary outcome measure was the percentage of patients with in the low-risk postoperative cohort receiving routine CBC with or without differential. Secondary outcomes included estimated total hospital charges and costs for CBCs. Balancing measures included hemoglobin level below 8 g/dL in patients for whom CBCs were sent and blood transfusions up to 7 days postoperatively for any patients in this cohort. A conservative threshold of hemoglobin level below 8 g/dL was chosen as a balancing measure despite evidence that in critically ill children, a transfusion threshold of 7 g/dL limits risks without decreasing the benefit to these patients.⁹ Cost and charge data were estimated on the basis of known average hospital charges and costs for CBC testing (differences included for CBC with and without differential) for these patients. Because the bundling of PICU payments for certain ages and procedures varies by both insurance and region, charges and costs were estimated on the basis of the overall decrease in the number of CBCs both with and without differential.

Planning Key Interventions

Initially we collected baseline survey data to gather key stakeholders' thoughts on the utilization of routine postoperative laboratory testing for this cohort. We collected survey data from 95% of attending physicians (21 of 22), from 69% of fellow physicians (11 of 16), and from 60% of frontline clinicians (12 of 20). From this data, we derived a key driver diagram (Figure 2). Attending physicians were either unlikely or very unlikely to order laboratory

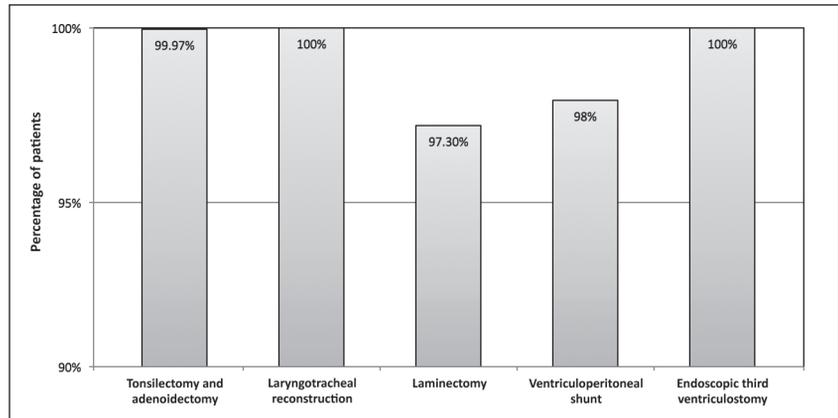


Figure 1. Percentage of patients not requiring intraoperative and postoperative transfusions from 2000 to 2010.

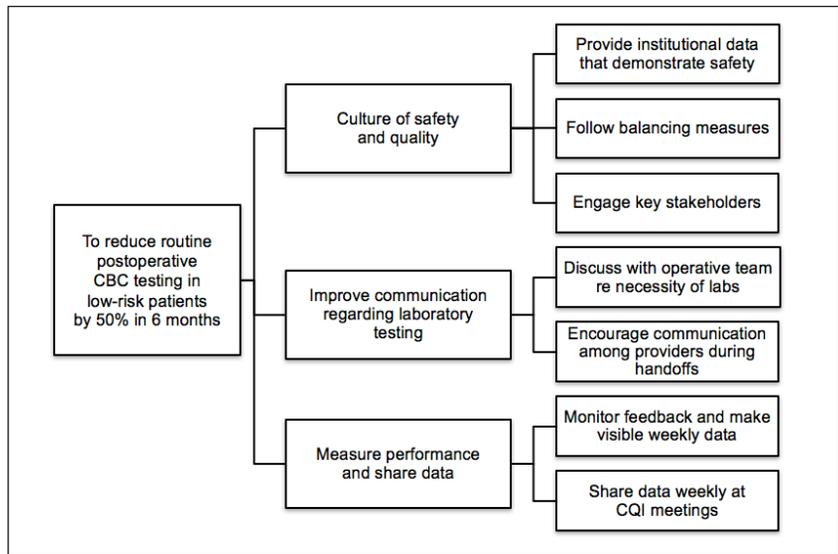


Figure 2. Key driver diagram derived from key stakeholder survey results and improvement team development. CBC = complete blood count; CQI = continuous quality improvement; labs = laboratory studies; re = regarding.

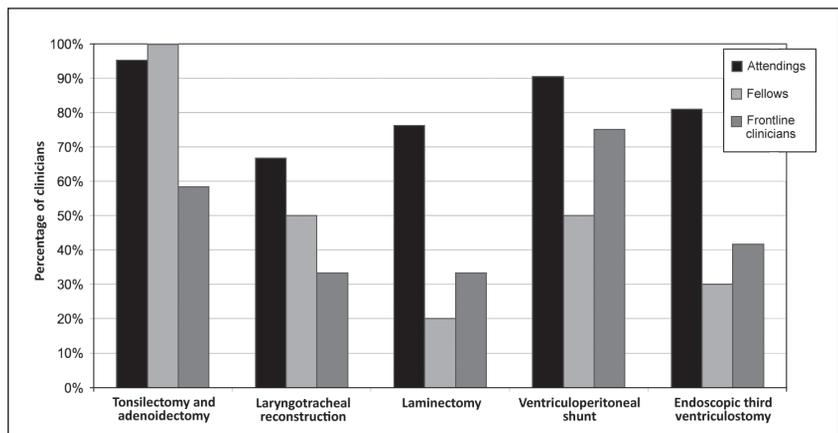


Figure 3. Survey from key stakeholders regarding initial opinions on necessity of any postoperative laboratory studies for this cohort.

testing for this cohort, with the largest agreement for no testing (95%) in the ventriculoperitoneal shunt group and the lowest agreement (67%) for patients who underwent laryngotracheal reconstruction. Fellows and frontline clinicians were more likely to order routine postoperative testing than were attending physicians for 4 of the 5 procedures (Figure 3).

After engaging key stakeholders and presentation of the baseline data regarding lack of postoperative or intraoperative transfusions in this cohort, as well as the high utilization of laboratory testing, we initiated our first Plan-Do-Study-Act (PDSA) cycle with education regarding our institutional data in this low-risk cohort. Initial education was done at weekly clinical QI meetings with video clips as well as reviews of attending survey data and current utilization demonstrating the variations in beliefs among different clinicians. Workplace reminders were posted in all stationary clinical ordering areas. Discussion of routine postoperative testing was added to our postoperative handoff tool to encourage discussion of the necessity by the attending physician with the team at the time of arrival to the PICU from the operating room.

The second PDSA cycle focused on audit and feedback. Postoperative laboratory ordering was tracked, and feedback was given monthly. Realizing that many orders are placed on workstations on wheels during rounds, laminated reminder cards were placed on these workstations as part of this

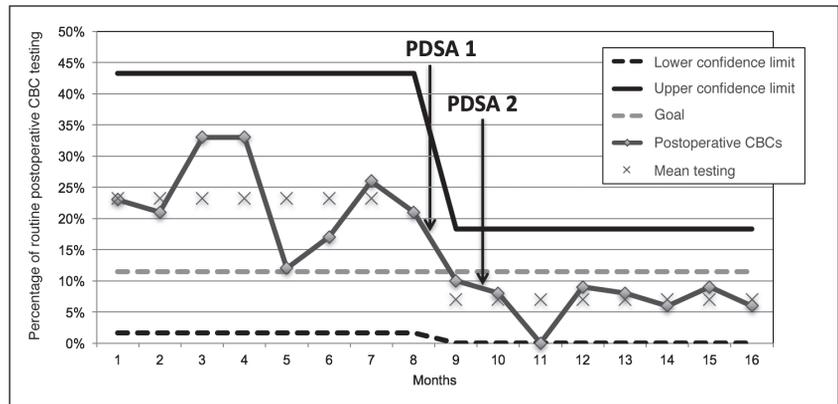


Figure 4. Statistical control chart of retrospective and prospective local data used for decision support shows overall decrease to below 10% after 2 Plan-Do-Study-Act (PDSA) cycles.

CBC = complete blood count.

second PDSA cycle. Further draft PDSA cycles were developed but never implemented because of decreases below the goal line with these simple interventions alone.

Analysis

We used run charts generated with QI Macros SPC software (KnowWare International Inc, Denver, CO) for Excel (Microsoft, Redmond, WA). A run chart was used to depict the percentage of the low-risk postoperative cohort receiving CBCs. Data analyst support provided weekly tracking of metrics through the utilization of a data visualization application, QlikView (Qlik-Tech, Radnor, PA), available for viewing. Information regarding hemoglobin results

was also tracked and displayed in a scatterplot as a balancing metric. Cost and charge data were estimated on the basis of known hospital charges and costs for CBC testing (differences were included for CBC with and without differential) for these patients.

RESULTS

Baseline measurements for the 6 months before the intervention demonstrated that 12% to 33% of cohort patients received routine postoperative CBCs within 48 hours of the procedure (Figure 4). Approximately 30 to 40 patients per month fit this cohort. The median time to first CBC was 17.4 hours, and all postoperative hemoglobin levels checked during this 6-month period

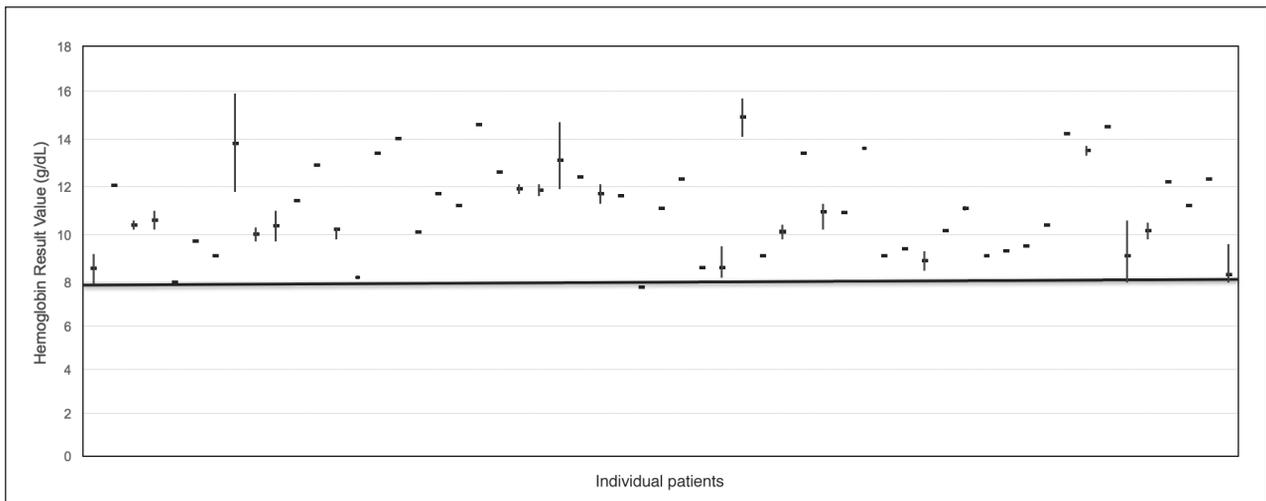


Figure 5. Balancing metrics included hemoglobin results from patients who did have complete blood counts (CBCs) to demonstrate safety. The vertical lines indicate the minimum and maximum values of CBCs drawn per patient.

were above 8 g/dL and therefore above transfusion thresholds (Figure 5). No patients in the cohort received blood transfusions related to their surgical procedure in the 7 days after surgery. After initiation of our first PDSA cycle, we saw a decrease in utilization of routine postoperative CBCs to less than 10%, achieving the 50% reduction aim. This number has stayed consistent more than 6 months postintervention.

Hospital charges also were estimated for routine postoperative CBCs in this cohort. Estimated preintervention hospital charges because of postoperative CBCs totaled \$27,643.84 during a 6-month period. Estimated postintervention hospital charges because of postoperative CBCs was \$3702.30 during 6 months, demonstrating decreased hospital charges of 87%.

DISCUSSION

The high cost and high variability of laboratory testing in the ICU has been well described,^{1,3} and prior studies have shown that up to 67.9% of inpatient laboratory tests ordered do not result in improved patient care.¹⁰ Prior studies to reduce laboratory testing have mainly focused on restriction through the use of limitations in the clinician computer order entry system.⁵⁻⁸ By limiting the use of standing or repeating laboratory orders, we were able to demonstrate sustained decreases in laboratory testing. Other interventions have focused on displays of cost data to encourage decreased utilization of testing, and although successful, the decreases have been small (less than 10%).¹¹ We sought to use the power of our own historical experience to convince clinicians of the safety of decreasing routine postoperative CBCs in this cohort. Partnering with our anesthesia colleagues who were working to reduce unnecessary preoperative type and screen testing,¹² we were able to use the same large historical data set to display the safety of eliminating routine postoperative CBCs in this cohort.

Because education alone often does not lead to sustained change in quality improvement, we linked our successes to the robustness of the data presented and the willingness of the clinicians to change their ordering habits. Through the review of our own historical data, we were able to identify five postoperative patient populations for which routine CBC testing was

unnecessary. Utilizing the information gathered from our key stakeholders regarding the necessity of routine postoperative testing, we highlighted our current data and added simple low-cost interventions to change perceptions and utilization.

This study had multiple limitations. First, it was a focused effort on a small cohort of patients in a single center. Although the approach was unique, the ability to access a local institution's historical data may not be available to all clinicians as an approach to change culture. In addition, the historical data used were at least five years old at the time of this project. Although we do not expect that the bleeding risk for these patients would change over this time, it remains a limitation of this study. Furthermore, the ability to spread from this small cohort to a larger patient population is difficult in a PICU whose patients are at a perceived higher risk of complications. Spread from this project would likely involve limitations of further postoperative testing to protocol-based testing rather than removal overall. We hope that this initial QI initiative encourages our clinicians to think more proactively about the necessity of all laboratory testing.

There were also multiple lessons learned. The opinions of our key stakeholders allowed us to form a concise and focused driver diagram. This diagram enabled us to choose very simple and targeted PDSA cycles to lead to sustained change. Furthermore, the robustness of local historical data encouraged all clinicians, including our late adopters, to be supportive of this project. Long-term sustainability will be based on continued updating of the clinician group with the results and continued education of frontline care clinicians, who have a high turnover.

CONCLUSION

A simple approach to a systemic problem in the PICU of unnecessary laboratory testing is feasible and effective. By using local historical data, we were able to identify a cohort of patients for whom routine postoperative CBC testing is unnecessary and therefore make strong recommendations regarding the avoidance of postoperative CBCs in this cohort. ♦

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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