Improving Operative Flow During Pediatric Airway Evaluation
A Quality-Improvement Initiative

Jeremy D. Prager, MD; Amanda G. Ruiz, BA; Kristin Mooney, BSN, RN; Dexiang Gao, PhD; Judit Szolnoki, MD; Rahul K. Shah, MD, MBA

IMPORTANCE Microlaryngoscopy and bronchoscopy procedures (MLBs) are short-duration, high-acuity procedures that carry risk. Poor case flow and communication exacerbate such potential risk. Efficient operative flow is critical for patient safety and resource expenditure.

OBJECTIVES To identify areas for improvement and evaluate the effectiveness of a multidisciplinary quality-improvement (QI) initiative.

DESIGN, SETTING, AND PARTICIPANTS A QI project using the “Plan-Do-Study-Act” (PDSA) cycle was implemented to assess MLBs performed on pediatric patients in a tertiary academic children’s hospital. Forty MLBs were audited using a QI evaluation tool containing 144 fields. Each MLB was evaluated for flow, communication, and timing. Opportunities for improvement were identified. Subsequently, QI interventions were implemented in an iterative cycle, and 66 MLBs were audited after the intervention.

INTERVENTIONS Specific QI interventions addressed issues of personnel frequently exiting the operating room (OR) and poor preoperative preparation, identified during QI audit as areas for improvement. Interventions included (1) conducting “huddles” between surgeon and OR staff to discuss needed equipment; (2) implementing improvements to surgeon case ordering and preference cards review; (3) posting an OR door sign to limit traffic during airway procedures; and (4) discouraging personnel breaks during airway procedures.

MAIN OUTCOMES AND MEASURES Operating room exiting behavior of OR personnel, preoperative preparation, and case timing were assessed and compared before and after the QI intervention.

RESULTS Personnel exiting the OR during the MLB was identified as a preintervention issue, with the surgical technologist, circulator, or surgeon exiting the room in 55% of cases (n = 22). The surgical technologist and circulator left the room to retrieve equipment in 40% of cases (n = 16), which indicated the need for increased preoperative preparation to improve case timing and operative flow. The QI interventions implemented to address these concerns included education regarding break timing, improvements in communication, and improvements in ordering and preparation of equipment. After the QI intervention, the surgical technologist exiting rate decreased from 20% (n = 8) to 8% (n = 5), and the circulator exiting rate decreased from 38% (n = 15) to 27% (n = 17). In addition, the rate of surgeon exiting decreased significantly (from 25% [n = 10 of 40] to 9% [n = 6 of 66]) (P = .03). The surgical technologist and circulating nurse remaining in the room were significantly associated with decreased operating time (1.84-minute decrease for surgical technologist [P = .04] and 1.95-minute decrease for circulating nurse [P = .001]).

CONCLUSIONS AND RELEVANCE Gains were made in personnel exiting behavior and case timing after implementation of the QI interventions, potentially leading to decreased risk. This process is easily reproduced and is widely accepted by stakeholders.

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S ystematic error analysis is a well-established methodology in many high-risk fields where human error can have serious implications. Aviation, for instance, uses a systems science approach to error evaluation and management. There is a standardized method used to investigate and document errors and to disseminate the results of error analysis. Physicians, like pilots, work collectively with teams and technology to carry out their duties in high-risk environments. Human error in the operating room (OR), just as in the cockpit, can contribute to significant adverse events and substantial financial cost.

The Joint Commission on Accreditation of Healthcare Organizations identified “human factors” and “communication” as the top 2 causes of sentinel events in health care in 2013. Emerging evidence of the prevalence of opportunity for error in the OR related to these factors has sparked research into decreasing chances for preventable harm, increasing patient safety, and improving surgical outcomes. Halverson et al classified communication breakdowns in the OR by type, subject, and effect. They identified 66 communication failures over a 150-hour period and observed that most communication errors were related to surgical equipment.

In a 2012 observational study, Shah et al identified pediatric direct microlaryngoscopy and bronchoscopy (MLB) as a surgical procedure in the field of otolaryngology that lends itself to the study of operative flow and patient safety. In that study, an impartial monitor used a 144-field audit tool and visual observation to evaluate MLB procedures for case timing, preoperative preparation, and operative flow and to assess the movements of operating room personnel. The authors found that perioperative preparation went smoothly in 39% of the cases, and operative flow proceeded without disruption in 46% of cases. They also reported that the surgical technologist left the room in 5% of cases, the circulating nurse in 37%, and the anesthesiologist in 22% of cases. The authors concluded that there were multiple opportunities for improvement before and during these procedures and proposed several potential interventions.

The present study is intended to build on the foundation of the previous one. The MLB, as a procedure that is performed frequently and that poses risk for severe adverse events, is a perfect vehicle for error analysis within otolaryngology. This prospective quality-improvement (QI) initiative sought to assess opportunities for improved patient safety during MLB at a tertiary children’s hospital, implement QI interventions to address these opportunities, and measure improvements after the intervention.

Methods

Neither written informed consent nor institutional review board approval was required for this internal QI initiative. A multidisciplinary team was created, composed of an attending pediatric otolaryngologist, attending pediatric anesthesiologist, and otolaryngology operating room nurse and service leader. The team reviewed current literature regarding errors and safety within the operating room and proposed a project building on the work of Shah et al, using QI methodology and the Plan-Do-Study-Act (PDSA) cycle, a QI tool commonly used in health care and developed by Walter Shewart and Edward Deming.

The 144-field audit tool used by Shah et al in their study of pediatric MLB was adopted. The audit tool was edited for ease and accuracy of data collection. The 2-page audit tool consisted of case timing data, preoperative preparation and operative flow data, and an assessment of OR personnel (Figure). An impartial observer was selected by the QI team. The otolaryngology research assistant was the observer in all cases.

Case timing was evaluated using intervals and definitions described by Varughese et al. Since some cases involved a combination of MLB and other procedures, in the current study, the time from procedure start to procedure end (T2) was calculated both for the entire operative time and for just the MLB portion of each operation. The QI team elected to include combination cases because MLB-only procedures are less frequently scheduled than MLB combination procedures. In an attempt to limit variability, MLB combination procedures were limited to commonly performed, short-duration procedures such as tonsillectomy, adenoidectomy, supraglottoplasty, and ear tube placement.

The time intervals were defined as follows:

- Time 1 (T1), time from when patient enters OR to procedure start;
- Time 2A (T2A), time from procedure start to procedure end;
- Time 2B (T2B), time from MLB start to MLB end;
- Time 3 (T3), time from procedure end to when patient exits OR; and
- Time 4 (T4), time from when patient exits OR to when next patient enters OR (turnover).

The multidisciplinary team chose to audit 40 cases prior to QI intervention. Forty MLB cases were observed and evaluated using the adopted audit tool over a 7 1/2-week period. Following baseline data collection, the plan phase of the PDSA cycle was carried out. The data collected were analyzed by the QI team. Areas for improvement were identified and classified according to who was responsible for this portion of the case. Potential interventions were proposed by the team. The QI team then transitioned to the do phase of the PDSA cycle in which interventions were implemented over a 1-month period by the members of the QI team. Following the 1-month implementation period, the team returned to the OR for reassessment. From the data collected at baseline, a power analysis was carried out addressing the variables of essential
Figure. Audit Tool

Operative Flow for Bronchoscopy and Laryngoscopy
Observations/Data collection sheet

Timing
OR Ready: ________ Pt. in room: ________ Scheduled Start: ________ True start: ________ End: ________
Pt. out: ________ PACU Arrival: ________ PACU Hand-Off: ________
Total prior case turnover time: ________ Total procedure time: ________ Total time Pt. in room: ________
Procedure Delay Codes: Surgeon □ Anesthesia □ Patient □ Nursing PreOp □ Nursing OR □
Prior Procedure Delay □ Other Comments: ________

Pre-Op Preparation
Time H&P complete? ________ Consent Ready? ________ MLB Equipment ready on time? ________
MLB Equipment working? ________ Communication between surgeon & Circulating Nurse? ________
Anesthesia equip. ready on time? (IV masks ETts) ________ Anesthesia tech came in? ________ All meds present? ________
Anesthesia equip. checked? ________
Overall preparation comments: ________

Operative Flow
#ENT Providers: ________ #Rooms ENT Provider: ________ #Anes. Providers: ________ #Rooms Anes. Provider: ________
Surgical Time-out? ________ Anesthesia Time-Out? ________ Everyone participate (Scrub N., Circulating N., Attending, Anes. Provider?) ________
Silence during time-out? ________ All present paid attention? ________
Comments: ________
IV access obtained? ________ # of IV attempts: ________ IV Issues: ________ Contact precautions taken? ________
Pt. position/draping issues: ________
Room equipment properly aligned (video/instruments, etc.?) ________ Did room organization need to be changed? ________
All MLB equipment function properly? ________ Backup equipment available in room? ________
Emergence without problem? ________ Anesthesia meds tolerated? ________
Overall operative flow comments: ________

Operating Room Personnel Assessment

<table>
<thead>
<tr>
<th>Team Member</th>
<th># if &gt;1</th>
<th>Left Room?</th>
<th>Reason for Leaving</th>
<th>Appropriate Time to Leave?</th>
<th>Intermittences?</th>
<th>Describe Interruptions</th>
<th>Total Time Over</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgeon</td>
<td></td>
<td></td>
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<tr>
<td>Otol INS Resident</td>
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<tr>
<td>Anesthesiologist</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Nurse anesthetist (CRNA)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Anest. Resident</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical Student</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Scrub Nurse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Otol INS trained Scrub Nurse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circulating Nurse</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Laser Nurse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scrub Student</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Other Trainer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Communication issues: ________

General Observation: ________

Adapted from Shah et al.6
Table 1. MLB Procedure Timing

<table>
<thead>
<tr>
<th>Time Code</th>
<th>Description</th>
<th>Duration of Procedure, Mean (Range), min</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Preintervention (n = 40)</td>
</tr>
<tr>
<td>T1</td>
<td>Patient enters OR to procedure start</td>
<td>12 (2-32)</td>
</tr>
<tr>
<td>T2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2A</td>
<td>Total operating time, procedure start to end</td>
<td>24 (3-147)</td>
</tr>
<tr>
<td>T2B</td>
<td>Operating time for MLB portion only</td>
<td>8 (2-45)</td>
</tr>
<tr>
<td>T3</td>
<td>Procedure end to when patient is transported out of OR</td>
<td>7 (0-20)</td>
</tr>
<tr>
<td>T4</td>
<td>Turnover time, time the patient exits OR to when the next patient enters OR</td>
<td>37 (15-98)</td>
</tr>
<tr>
<td>T1 + T2 + T3</td>
<td>Total time patient in OR</td>
<td>45 (17-164)</td>
</tr>
</tbody>
</table>

Abbreviations: MLB, microsurgical laryngoscopy and bronchoscopy; OR, operating room.

Results

Before the CI intervention, the average total operating time (T2A) was 24 minutes, and the average MLB portion of all cases (T2B) was 8.3 minutes, representing 53% and 18% of the total time the patient was in the OR, respectively (Table 1). The number of personnel in a single OR ranged from 4 to 9 (mean [SD], 6.2 ± 1.1). The MLB equipment malfunctioned in 20% of all cases (n = 8). In the vast majority of incidences (n = 5), this was operator error rather than equipment failure. Ten percent of all cases started on time (n = 4), while 63% started late (n = 25), and 28% started early (n = 11). For those cases that started late, the average delay time was 28 minutes. Case delay causes are listed in Table 2.

Before the CI intervention, personnel left the operating room while the otolaryngology surgeon, fellow, or resident was performing the MLB and instrumenting the airway in 70% of cases (n = 28) (this included essential and nonessential [eg, anesthesia residents, medical students] personnel). Essential personnel exits were categorized by personnel type and classified by reason for the exit (Table 3). The surgical technologist left the room in 20% of cases (n = 8), on 4 occasions to retrieve equipment, 3 for a break, and on 2 other occasions for unidentified reasons. The surgical technologist left the room more than once during 1 procedure. The circulating nurse exited in 38% of cases (n = 15), 12 times to retrieve equipment, 2 for a break, and once for an unidentified reason. The observer noted 1 case during which inappropriate noise levels were observed during the MLB portion of the case.

Following analysis of data from the preintervention MLB cohort, CI interventions were planned and carried out by the responsible parties (Table 4). After the CI intervention, the average total operating time (T2A) was 21 minutes, and the average MLB portion of all cases (T2B) was 5.6 minutes, representing 47% and 13% of the total time the patient was in the OR, respectively (Table 1). There was no change in the average number of personnel in the OR after the CI intervention. After the intervention, the MLB equipment malfunction rate decreased from 20% (n = 6) to 9% (n = 6); 5% of cases started on time (n = 3); 68% started late (n = 45); and 27% started early (n = 18). In regard to case timing, very little changed from before the CI intervention (eg, turnover time, total time patient in OR), and that small change was not statistically significant.

After the CI intervention, the OR exiting rate of the surgical technologist decreased from 20% (n = 8) to 8% (n = 5), and the exiting rate of the circulating nurse decreased from 38% (n = 15) to 27% (n = 18), both owing to (1) improved communication among surgeon, circulator, and surgical technologist; (2) improved equipment ordering and preparation; (3) improved timing of breaks; and (4) education regarding risks of personnel change during airway procedures. However, the changes were not statistically significant.

The OR exiting rate of the surgeon decreased significantly (from 25% [n = 10 of 40] to 9% [n = 6 of 66]) (P = .03) (Table 3). A linear regression of surgical technologist and circulating nurse exit rates was carried out on the outcome variable total operating time (T2A). The surgical technologist and circulating nurse remaining in the room after the CI intervention were each associated with a significant decrease in total operating time (1.84-minute decrease for surgical technologist [P = .04] and 1.95-minute decrease for circulating nurse [P = .001]).

Discussion

Communication during the delivery of care in the OR setting is critical for patient safety and resource expenditure. Several studies have found that communication breakdown among teams of providers is prevalent in health care and commonly contributes to avoidable errors.3-7,14-15 A surgical procedure that lends itself to the systematic evaluation of

personnel exiting and turnover time. The QI team desired to see a 50% reduction (50% desired effect size) or more in the rate of essential personnel exiting and turnover time, a statistical power level of 80%, and a probability level set at .05. To achieve this, a minimum sample size of 64 cases was required. Sixty-six cases were audited following the intervention period.

The team then transitioned to the study and act stages to assess the success of the interventions and to formalize recommendations and communicate with other stakeholders within the perioperative community. A total 73 MLB combination cases and 33 MLB only cases were assessed.
operative flow is one that is performed frequently and if interrupted may pose a high risk to patient safety. The MLB is a commonly performed short procedure with potential for adverse airway events. The present study aimed to investigate opportunities for improved patient safety and OR efficiency during pediatric MLB and to evaluate the effectiveness of a QI initiative.

During the preintervention QI audit of 40 MLB procedures, the team identified communication issues as the chief causes of operative flow disruption. Essential personnel were frequently exiting the operating room during airway instrumentation to retrieve needed equipment that could have been electronically ordered and/or verbally requested well in advance by the surgeon. Surgeons and OR staff were failing to communicate equipment needs preoperatively. In addition, OR staff were exiting for breaks, which signaled a lack of training about ideal timing of patient handoffs and the risks of exiting during airway procedures. The surgeons were also exiting often. In addition, equipment malfunction and misuse seemed prevalent during MLBs.

The plan portion of the PDSA cycle entailed QI team meetings to propose solutions for these identified issues. It was concluded that surgeons and OR staff should urgently overhaul the method in which procedures were ordered, equipment requested, and cases discussed among the team. Surgeon education was performed at 2 faculty meetings by the first author (J.D.P.). Surgeon preference cards, which exist in electronic format within our medical record system, were reviewed and audited by the individual surgeons. Fifteen additional options for ordering MLBs were built into the electronic medical record as well (eg, “MLB with suspension and steroid injection”), and surgeons were encouraged to write additional needs into the order (eg, “difficult IV”). Surgeons were also urged to reinforce by example the message that pediatric MLB cases are high-acuity procedures by remaining in the OR while the airway was being instrumented.

In addition, essential OR personnel were tasked with conducting huddles to discuss the day’s upcoming procedures. In-service educational efforts were recommended for OR staff on the checking of equipment function prior to the procedure and the potential risks of handing off patient care to take breaks intraoperatively. In fact, all breaks and unnecessary OR entries or exits during procedures that averaged less than 10 minutes were discouraged. Each stakeholder group within the team (physicians, OR staff, and OR administration) were given a month to implement these interventions prior to resuming case auditing (the do stage).

Studying the results of the postintervention audit, the QI team noted improvements in total operating time as well as in the MLB portion only (T2A and T2B). Equipment malfunction was reduced by half. Reductions were also found in the percentage of cases in which the surgical technologist and/or circulator left the room (Table 3). Surgical technologist exits to retrieve equipment per the surgeon’s request decreased from 10% (n = 4 of 40) to 6% (n = 4 of 66), and surgical technologist breaks and transitions during the MLB decreased from 8%

### Table 3. OR Exiting Rates During MLB for OR Personnel and Reasons for Exiting

<table>
<thead>
<tr>
<th>Exiting OR Team Member</th>
<th>Preintervention (n = 66 Procedures)</th>
<th>Postintervention (n = 66 Procedures)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Otolaryngology physician</td>
<td>10 (25)</td>
<td>6 (9)</td>
<td>.03</td>
</tr>
<tr>
<td>To check on second room</td>
<td>7 (18)</td>
<td>5 (8)</td>
<td></td>
</tr>
<tr>
<td>Other reason</td>
<td>3 (8)</td>
<td>1 (2)</td>
<td></td>
</tr>
<tr>
<td>Anesthesiologist</td>
<td>11 (28)</td>
<td>17 (26)</td>
<td>.90</td>
</tr>
<tr>
<td>To check on second room</td>
<td>4 (10)</td>
<td>10 (15)</td>
<td></td>
</tr>
<tr>
<td>Left after induction while resident and/or fellow and/or AA still present</td>
<td>4 (10)</td>
<td>4 (6)</td>
<td>NR</td>
</tr>
<tr>
<td>Other reason</td>
<td>3 (8)</td>
<td>3 (5)</td>
<td></td>
</tr>
<tr>
<td>Surgical technologist</td>
<td>8 (20)</td>
<td>5 (8)</td>
<td>.07</td>
</tr>
<tr>
<td>To retrieve equipment per surgeon request</td>
<td>4 (10)</td>
<td>4 (6)</td>
<td></td>
</tr>
<tr>
<td>Lunch break and/or transition</td>
<td>3 (8)</td>
<td>1 (2)</td>
<td></td>
</tr>
<tr>
<td>Other reason</td>
<td>2 (5)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Circulator</td>
<td>15 (38)</td>
<td>18 (27)</td>
<td>.27</td>
</tr>
<tr>
<td>To retrieve equipment per surgeon request</td>
<td>12 (30)</td>
<td>13 (20)</td>
<td></td>
</tr>
<tr>
<td>Lunch break and/or transition</td>
<td>2 (5)</td>
<td>4 (6)</td>
<td></td>
</tr>
<tr>
<td>Other reason</td>
<td>1 (3)</td>
<td>1 (2)</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: AA, anesthesiologist assistant; MLB, microlaryngoscopy and bronchoscopy; NR, not reported; OR, operating room.

* Total number of exits will not add up to total number of cases because multiple personnel may have exited the OR during the same case.
(n = 3) to 2% (n = 1). Total exits by the circulating nurse were reduced by 10% (from n = 14 of 40 to n = 18 of 66). Circulator exits for equipment decreased from 30% (n = 12 of 40) to 20% (n = 13 of 66). There was no decrease in exiting for breaks. While these reductions were not statistically significant, higher surgical technologist and circulating nurse OR exiting rates were significantly associated with increased operating time (1.84-minute decrease for surgical technologist [P = .04] and 1.95-minute decrease for circulating nurse [P = .001]), demonstrating the importance of limiting these exits. A significant reduction in surgeon exits was seen as well (from 10 of 40 [25%] to 6 of 66 [9%] [P = .03]). The QI team believed that these findings demonstrated the benefits of the surgeon ordering the proper equipment ahead of time, the huddle, and OR personnel verifying equipment function: shorter procedures, less anesthetic exposure, and key personnel remaining in the room at all times.

We believe that the lack of improvement in turnover time and case delays reflects a limitation inherent in our interventions which were intended to address events inside the OR as opposed to processes occurring outside the OR (e.g., room cleaning, preoperative history, physical examination).

Examining other results revealed additional barriers to our interventions. For example, OR personnel continued to take breaks during MLB procedures. In addition, while equipment preparedness was improved by improved ordering processes, as measured by the decrease in OR exiting rates, and equipment malfunction (misuse) decreased, these occurrences remained all too frequent. These problems reflect the difficulty of changing perioperative culture and patterns of behavior across disciplines (from surgeon to OR personnel). As a small, surgeon-led group, we may have lacked sufficient influence among our colleagues during the plan and do stages of our project to eliminate these problems completely. However, the act portion of the PDSA cycle was composed of efforts to present our results and conclusions to the larger body of stakeholders within the perioperative environment, demonstrating the positive outcomes of their efforts, reinforcing the gains made and pointing out our continued barriers to better care. In addition, we have continued to advocate for a dedicated airway team among OR personnel rather than our current system in which personnel of varying experience levels and ability are assigned to rooms the morning of surgery. By presenting evidence that these and our other interventions lead to safer care through improved communication, shorter procedures, and less frequent personnel exits, we hope to make permanent our interventions and improvements and to bring about continued improvements in the future.

In their 2012 article on operative flow during MLB, Shah et al conclude that pediatric MLB operative procedures suffer from poor efficiency and poor operative flow owing primarily to communication issues (personnel turnover, absent or nonfunctional equipment, inadequate preoperative case planning with OR staff). They conclude that flow, efficiency, and potentially safety will improve with the design and implementation of an intraoperative protocol for pediatric MLB, as has been established in other surgical fields. They propose the following building blocks of this protocol:

1. Essential OR team members (anesthesiologist and scrub technician and nurse) must remain in the OR for the duration of the procedure;
2. Equipment must be checked preoperatively;
3. Surgeon preferences for each individual case must be clearly communicated;
4. Intravenous difficulties must be identified preoperatively; and
5. Dedicated airway teams should be created for MLB procedures.

The present study verified that communication issues during pediatric MLBs are similar and common across locations and used QI methodology to investigate and demonstrate the efficacy of certain QI interventions. Though gains were modest, our initiative reduced surgical time, equipment malfunction, and the percentage of cases in which essential personnel exited the room. In addition, our results indicate the link between improved equipment ordering and huddles (communication improvements) and subsequent reduction in essential personnel leaving the room and surgical time. These interventions increase patient safety by improving communication and decrease the opportunity for error and the time the patient spends under anesthetic. Time spent under anesthesia is a growing concern within pediatrics, with increasing focus on its potential negative long-term effects. In addition, our results were achieved with relative ease, using simple QI methodology, a small team of stakeholders, and our electronic medical record system to facilitate improved ordering and equipment needs.

Limitations of the current study include the lack of improvement in case turnover and delay issues. Our interventions were not directed at the multitude of variables involved in our case turnover and delay issues. In addition, decreases in certain personnel OR exit rates and in surgical time were not statistically significant. A small sample size may have affected these results. Despite good intentions, cases exist in which plans change, equipment malfunctions, or additional equipment is needed and personnel must exit the OR. The task at hand is to reduce these instances, conserve medical resources, and limit the potential for patient harm. We add our findings to the weight of

Table 4. Implemented Interventions

<table>
<thead>
<tr>
<th>Target</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgeon</td>
<td>Otolaryngology attending physicians reviewed their equipment preference cards to ensure that they reflected current requirements and updated as needed. Additional MLB orders were created in electronic medical record.</td>
</tr>
<tr>
<td>Attending physician</td>
<td>were educated to place specific needs of the case and/or patient in the comments section when scheduling a case.</td>
</tr>
<tr>
<td>OR Staff</td>
<td>OR personnel were instructed to “huddle” with their surgeon and anesthesiologist prior to case to discuss the necessary and anticipated equipment requirements and case plan and record them on the OR board for all personnel to review.</td>
</tr>
<tr>
<td>OR Policy</td>
<td>A sign designed by the QI team cautioning against OR entry or exit during airway procedures was placed on all OR doors.</td>
</tr>
</tbody>
</table>

Abbreviations: OR, operating room; QI, quality improvement.
Operative Flow During Pediatric Airway Evaluation

Evidence that an intraoperative protocol that mandates (1) preoperative equipment specification, (2) team communication, and (3) continuous OR presence by essential personnel during pediatric airway evaluation will increase operative efficiency, resource conservation, and patient safety. Instruction in this or a similar protocol at stakeholder national conferences (eg, American Society of Pediatric Otolaryngology, Society of Head and Neck Nurses) should be considered.

Conclusions

Preventing harm and reducing the chance for errors in the OR requires that QI procedures be continuously implemented by invested stakeholders. Our QI team identified multiple potential areas of opportunity for increasing efficiency and safety during pediatric airway evaluation. Interventions created through an interdisciplinary QI process to improve communication and operative flow were shown to reduce personnel OR exiting rates and surgical time and improve surgical equipment preparation. This QI process and its findings and conclusions have been met with enthusiasm by stakeholders at our institution and have had lasting effect on team communication, operative flow, and safety within our ORs. Minimal investment of time and resources were required to effect these reproducible changes. Formal instruction in improving operative flow and safety should be considered.

ARTICLE INFORMATION

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Author Contributions: Dr Prager had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Prager, Mooney, Szolnoki, Shah.

Acquisition, analysis, or interpretation of data: Prager, Ruiz.

Drafting of the manuscript: Prager, Ruiz, Mooney.

Critical revision of the manuscript for important intellectual content: Ruiz, Mooney, Gao, Szolnoki, Shah.

Statistical analysis: Ruiz, Mooney, Gao.

Administrative, technical, or material support: Ruiz, Shah.

Study supervision: Prager, Mooney, Shah.

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REFERENCES


