Targeting Operating Room Inefficiencies in the Complex Management of Vision-Threatening Diseases in Children

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**Objective:** To review the effect of interventions designed to decrease turnover time in infants and children (median age, 2.6 years; range, 1 month to 10 years) who required examinations under anesthesia.

**Methods:** Five efficiency interventions (3 anesthesia providers for 2 rooms, digital remote communication, change in patient scheduling, standardization of case order, and streamlining administration of preoperative medications) were implemented during a 4 1/2-year period from January 2003 to July 2007. Using data from our in-house operating room information system, we analyzed turnover times (time it took 1 patient to leave the operating room and the next to enter).

**Results:** The mean turnover times decreased from 12.1 minutes to 3.8 minutes. The 90th percentile of longest turnover times decreased from 14.5 minutes in 2003 to 5.8 minutes in 2007, despite a progressive increase in the number of cases per day.

**Conclusion:** Caring for children who require extensive examinations under anesthesia can be efficiently achieved in nonpediatric environments.

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**CHILDRREN WITH RETINOBLASTOMA require frequent examinations under anesthesia to closely monitor the disease and to recognize disease progression and complications in a timely fashion. Highly specialized personnel—such as medical photographers, ophthalmic ultrasonography technicians, and oculists—as well as advanced equipment (eg, laser and cryotherapy devices) are needed for the evaluation and treatment of these patients. From a scheduling perspective, grouping a large number of children into a single block of operating room (OR) time is the most efficient use of this space and its resources. However, the inevitable delays that occur when performing a large number of operative procedures in 1 day often conflict with the current financial reality of the need for OR efficiency as well as the desire of patients, families, and clinicians to maximize throughput. In this article, we describe 5 efficiency interventions—3 anesthesia providers for 2 rooms, digital remote communication, change in patient scheduling, standardization of case order, and streamlining administration of preoperative medications—that were intended to decrease the time between cases (turnover time) and to maximize OR block time use despite an increasing volume of patients.**

**METHODS**

We retrospectively reviewed OR data for all infants and children (median age, 2.6 years; range, 1 month to 10 years) who underwent examinations under anesthesia for retinoblastoma or other vision-threatening conditions (that require a thorough indirect ophthalmoscopic examination) at the Bascom Palmer Eye Institute from January 2003 and July 2007. All examinations were performed by a single ophthalmologist. Using Structured Query Language reports, we extracted data from our in-house OR management system. Data collected included date of procedure, date of birth, time patient was in room, time patient left OR, time patient entered OR, OR room number, and Current Procedural Terminology codes. Cases were sorted by date, OR number, and the time patient was in the room. Turnover times were calculated as the difference between the time a patient left the OR and the time the next patient entered. For each calendar year of the study, we calculated the following: number of cases per day and per year, number of turnover events between cases, duration of each turnover, and time of day the last case was completed.

Deidentified data from our OR information management system were analyzed. Our
institution has determined that institutional review board approval is not required when no direct identifying patient information is obtained. This study was evaluated under the auspices of our patient care and quality assurance review to assess trend analysis in our OR facilities. During the 4 1/2-year period, a number of interventions were implemented to improve the case flow.

Following the recruitment of an additional pediatric anesthesiologist (in the fall of 2003), 1 of 2 pediatric anesthesiologists supervised all examinations under anesthesia for children at risk of retinoblastoma. In 2004, we optimized anesthesia staffing in each of the 2 dedicated ORs. The pediatric anesthesiologist supervised 3 residents or certified registered nursing assistants who were collectively assigned to 2 ORs (first intervention). Previously, the pediatric anesthesiologist supervised 2 providers (1 in each room). This modification enabled each room to have anesthesia coverage while the third anesthesiologist completed the documentation and prepared for the next patient (eg, reviewed the preanesthesia history and physical examination results and prior OR anesthesia records, confirmed/reiterated informed consent with responsible adults, established rapport with the child and parents, provided anxiolytic medications as indicated, and consulted with the attending anesthesiologist).

Patients next in line were seated with their parents in a holding area less than 15 feet from both ORs. Such closeness makes it possible for the attending anesthesiologist to re-evaluate the patient once the previous case has begun. Depending on whether or not the children received oral anxiolytics, they were either carried or walked into the OR. We standardized our turnover process. We typically wiped the OR table down with an antiseptic cleaning agent, placed fresh sheets, and changed the anesthesia circuit.

In late 2004, we instituted the use of a digital remote communication device (Vocera Communications Inc, Cupertino, California) to be carried by each member of the anesthesia team (second intervention). These devices enabled continuous communication among the anesthesiologist, OR control desk, and transporters, thus facilitating the steady flow of patients to the holding area. Operating on our institution’s existing wireless network, this communication process requires a site license and a number of communication “badges,” which cost approximately $200 to $300, depending on the number purchased.

In early 2005, we changed our method of scheduling requirements (third intervention). In prior years, families were instructed to arrive at various designated times throughout the morning. Starting in 2005, all families were asked to be at the hospital in time for a 7:30 AM start. This intervention eliminated unnecessary delays in the schedule owing to patient transportation problems. We realized that delays of even 15 minutes in a patient’s arrival could have significant effects, with the OR being free but no child ready.

Requiring all families to arrive in time for a 7:30 AM start was not met with parental discord. Parents understood that the sooner they arrived to the hospital, the sooner their child would go into the OR. The most common exception was that younger children were generally allowed to cut ahead in line. Because all of these children have needed frequent examinations under anesthesia, parents of older children were able to reciprocate the favor once extended to them—allowing younger children to go first.

In late 2005, we standardized case order (fourth intervention). In general, the younger the child, the earlier the examination was scheduled. All examinations under anesthesia were performed before more involved procedures, such as vitrectomies, removal of cataracts, and enucleations. This strategy improved efficiency by minimizing the need to move large equipment (eg, laser, photography, and ultrasonography equipment).

The fifth and final intervention, implemented in 2006, involved streamlining the administration of preoperative medications. Instead of administering the first set of dilating eye drops in the OR, the ward nurses began administering these medications in the ward before the patient’s arrival to the holding area outside the OR. Most patients received midazolam orally (0.5 mg/kg, up to a maximum dose of 12 mg) before arriving to the holding area, unless the parents declined the medication. These interventions targeted delays resulting from a lack of pupillary dilation or exaggerated patient anxiety in the holding area.

Basic OR case efficiency data are presented in the Table. The total number of examinations under anesthesia was 1955. The number of examinations performed daily and yearly increased steadily during the study period (Figure 1). During most operative days, procedures were carried out simultaneously in 2 adjacent ORs to maximize efficiency by minimizing the need to move large equipment. The mean time per turnover decreased during the study period. There was also a steady improvement in the cumulative frequency distribution of turnover times (Figure 2). For example, the 90th percentile for turnover times decreased each year (2003, 14.5 minutes; 2004, 13 minutes; 2005, 10 minutes; 2006, 8.5 minutes; and 2007, 5.8 minutes).

This study examined the efficacy of 5 efficiency-related interventions that were implemented in our ORs during a 4 1/2-year period. During the study, the number of ex-

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Table. Operating Room Efficiency Data for Examinations Under Anesthesia in Children With Vision-Threatening Diseases

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of cases</th>
<th>No. of turnovers</th>
<th>Turnover time, mean (SD), median, min</th>
<th>Latest time last child left operating room</th>
<th>Mean time last case finished</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>338</td>
<td>283</td>
<td>12.1 (18.2), 8</td>
<td>6:15 PM</td>
<td>12:40 PM</td>
</tr>
<tr>
<td>2004</td>
<td>387</td>
<td>331</td>
<td>11.7 (21.9), 8</td>
<td>4:31 PM</td>
<td>12:34 PM</td>
</tr>
<tr>
<td>2005</td>
<td>359</td>
<td>312</td>
<td>7.2 (10.3), 5</td>
<td>7:19 PM</td>
<td>12:17 PM</td>
</tr>
<tr>
<td>2006</td>
<td>535</td>
<td>465</td>
<td>5.7 (7.0), 5</td>
<td>3:10 PM</td>
<td>11:58 AM</td>
</tr>
<tr>
<td>2007</td>
<td>336</td>
<td>300</td>
<td>3.8 (3.2), 3</td>
<td>2:32 PM</td>
<td></td>
</tr>
</tbody>
</table>

*Projected estimate of 576 cases for 2007 based on the rate at the time of manuscript preparation.*
aminations under anesthesia increased per day and year, while the mean turnover time and number of cases with lengthy turnover times decreased.

Changes in health care structure have imposed increasing pressure on health care facilities to improve their efficiency in inpatient and outpatient, and clinical and operative settings. Many highly specialized freestanding outpatient surgical centers have become facile in the completion of a large number of rapid surgical cases in a short time with minimal turnover times. This level of efficiency is typically more difficult to achieve when administering anesthesia to children in nonpediatric settings. We sought to define specific interventions that could improve efficiency in such a hospital setting without compromising patient care or safety.

Our data indicate that these interventions were effective. In addition to the economic benefits of improved OR efficiency, our anecdotal experience indicates that the children’s families were more satisfied with the care, as the amount of time their children spent on a nothing-by-mouth protocol was minimized and discharge from the hospital was hastened. We recommend these interventions to all large eye or general inpatient hospitals attempting to accommodate a full day of examinations under anesthesia for children with retinoblastoma or other vision-threatening ocular diseases.

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Figure 1. Examinations under anesthesia for vision-threatening diseases in children. *Estimated based on the rate at the time of manuscript preparation.

Figure 2. Cumulative frequency distribution of turnover time of examinations under anesthesia for vision-threatening diseases in children. Indicates the percentage of turnover times that were less than or equal to the corresponding times (on the x-axis).