Snoring, Trouble Breathing, Un-Refreshed (STBUR) Screening Questionnaire to Reduce Perioperative Respiratory Adverse Events in Pediatric Surgical Patients: A Quality Improvement Project

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Children who present for surgery with undiagnosed sleep-disordered breathing are particularly vulnerable to perioperative respiratory adverse events (PRAEs). Preoperative screening can identify children at increased risk who would benefit from evidence-based perioperative management, reducing serious preventable harm or death. The purpose of this quality improvement study was 2-fold: (1) increase identification of pediatric surgical patients who may be at increased risk of PRAE through the introduction of a validated pediatric screening questionnaire (Snoring, Trouble Breathing, Un-Refreshed [STBUR]), and (2) reduce preventable harm by introducing evidence-based perioperative management guidelines. A pre-post intervention design was conducted in 6,216 patients aged 1 to 18 years. The STBUR questionnaire embedded in the electronic medical record was the primary intervention.

Data for the primary outcome measure and 3 secondary process measures were analyzed using Yates $\chi^2$ and Fisher exact test to compare proportional change. After STBUR implementation, PRAE risk identification increased from 10.5% to 15% ($\chi^2 (1, N = 12,975) = 57.19, z = −7.59, P < .001, odds ratio = 1.49$). Results of the secondary process measures were mixed. The STBUR screening questions embedded in the medical record significantly improved identification of patients at risk, allowing modification of perioperative management toward safer practices.

**Keywords:** Obstructive sleep apnea, pediatric, perioperative respiratory adverse events, sleep-disordered breathing, STBUR (Snoring, Trouble Breathing, Un-Refreshed) questionnaire.
yet exposure to chronic intermittent hypoxemia renders patients with OSA more susceptible to the respiratory depressant effects of opioids and more sensitive to the analgesic effects of opioids compared with patients without OSA. Brown et al hypothesized that the analgesic sensitivity in patients with OSA could be due to the proliferation of μ-opioid receptors in several brainstem regions in response to recurrent hypoxemia while asleep. In animal studies, intermittent hypoxia, such as occurs with OSA, has been shown to increase the number of μ-opioid receptors centrally and may explain the reduced dose of exogenous opioid required to achieve adequate pain relief in the child with OSA. A follow-up study by Brown et al demonstrated the total analgesic opioid dose in children with OSA and recurrent hypoxemia was one-half of the dose required in children without such a history. Thus, the standard weight-based dose of an opioid medication may actually lead to significant respiratory depression with resultant hypoxia and hypercarbia in a child with OSA.

The current gold standard for diagnosis of OSA is polysomnography, also known as a sleep study. Polysomnography is used to measure biophysiological changes that occur during sleep and is performed in an overnight sleep laboratory. Polysomnography is also used to determine the severity of SDB through an assessment of obstructive breathing during sleep and scoring of the apnea-hypopnea index (AHI). Apnea is defined as the cessation of airflow for 10 seconds or longer. Hypopnea is a 30% decrease in airflow lasting more than 10 seconds and resulting in at least a 4% oxygen desaturation. The AHI score is defined as the number of apnea and hypopnea episodes that occur per hour of sleep. According to Dayyat et al, an AHI exceeding 1 event per hour of sleep in children is abnormal, but with OSA, the AHI may range from 1 to more than 100 events per hour. An AHI value of more than 10 events per hour is classified as severe OSA in the pediatric population. Polysomnography is an expensive test with limited availability in many hospitals, thus reducing its clinical utility and practicality for routine preoperative use.

Screening questionnaires can assist in identifying relevant questions about sleep. Several questionnaires for OSA have been validated for use in adult surgical patients, including the Berlin questionnaire, the ASA checklist, and the STOP or STOP-BANG questionnaire. The Sleep-Related Breathing Disorder scale of the Pediatric Sleep Questionnaire developed by Chervin et al is a 22-item SDB screening questionnaire validated in children aged 2 to 18 years. Tait et al validated a pediatric screening questionnaire called the Snoring, Trouble Breathing, Un-Refreshed (STBUR) questionnaire. The STBUR questionnaire is composed of the 5 symptoms from the Sleep-Related Breathing Disorder questionnaire that were strongly predictive of PRAE. Tait et al found that the likelihood of developing PRAE was increased by 3-fold (positive likelihood ratio = 3.06; 95% confidence interval [CI] = 1.64-5.96) in the presence of any 3 STBUR symptoms and by 10-fold when all 5 symptoms were present (positive likelihood ratio = 9.74; CI = 1.35-201.8). The STBUR questionnaire was more predictive than any of the other validated screening tools for identifying children at risk of PRAE.

Given the pathogenesis of SDB and OSA, anesthesia providers are in a unique position to identify patients who present with undiagnosed SDB in the perioperative period. Tait et al found that children with symptoms consistent with SDB are at an increased risk of perioperative complications, and the importance of identifying those at risk of SDB is paramount. Before this quality improvement project, the preanesthesia documentation at Children’s Hospital Colorado (CHC) did not include SDB screening questions. The quality improvement project’s main intervention included the introduction of a validated SDB screening questionnaire into the electronic medical record (EMR) with outcome goals of increasing identification of patients with clinical symptoms consistent with SDB who may be at risk of PRAE.

This quality improvement project’s primary and secondary outcome goals aligned with CHC’s organizational mission and goal statements of reducing preventable harm by 10% in 2013. Benchmarking data were collected from December 2012 through March 2013 for both primary and secondary outcome measures. Preintervention PRAE risk identification was 10.5% (n = 655) with a postintervention goal of increasing identification of patients at risk of PRAE to 15.8% (50% improvement goal). Secondary outcome measures included (1) reducing the incidence of opioid-induced desaturation events in the postanesthesia care unit (PACU) from a preintervention identification of 11.6% (n = 120) with a postintervention goal of reducing to 7.3% (10% improvement goal); (2) reduce the incidence of respiratory depression events (RRT) or Code Blue activation in postoperative patients outside the intensive care unit (ICU) in the first 24 hours from a preintervention identification of 9% (n = 22), to a postintervention goal of 5.5% (10% improvement goal); and (3) reduce the incidence of unanticipated ICU transfers.
from inpatient surgical floors because of PRAE occurring within 24 hours of PACU transfer from a preintervention identification of 5% (n = 13) to a postintervention goal of 4.5% (10% improvement goal).

This QI project introduced screening questions preoperatively to raise provider awareness of pediatric surgical patients who may be at increased risk of PRAE based on clinical symptoms consistent with SDB (Figure 1). The project also introduced an electronic practice advisory based on practice guidelines published by the ASA17,18 to assist all perioperative providers with decision support surrounding management of patients at risk of PRAE or with diagnosed OSA (Figure 2).

**Materials and Methods**

Based on the findings of the benchmarking data collected in December 2012 through March 2013, a QI project was developed and implemented. Its purpose was to improve SDB screening and to implement practice guidelines to reduce variation in anesthetic care and preventable harm resulting from PRAE. The Organizational Research Risk and Quality Improvement Panel at CHC and the College of Nursing Doctorate of Nursing Practice Capstone Bridge Committee at the University of Colorado Denver approved the project.

The Department of Surgery at CHC performs more than 16,000 surgical procedures for infants, children, and adolescents each year. Inclusion data for the QI project were surgical patients aged 1 to 18 years presenting for surgery December 1, 2012, through March 31, 2014. Audit data were collected to determine if the anesthesia provider asked about SDB and completed the electronic STBUR questionnaire. Personal information collected was limited to surname, initials, and medical record number. Collected chart review data were recorded on Excel spreadsheets and de-identified before data analysis. Subjects’ data were kept on password-protected secure servers with a nightly data backup function. Whenever investigators accessed the campus network remotely, a virtual private network software was used with an appropriately configured firewall in place.

Deming’s model of Plan, Do, Study, and Act provided the foundation for the development of this QI project. The Plan, Do, Study, Act series, conducted to support the implementation of the electronic STBUR questionnaire and practice advisory, consisted of 8 cycles.

• **Cycle 1.** The first cycle included introducing 8 nonvalidated screening questions, which were derived from the literature and expert opinion to be suggestive of SDB, through creation of a hard-copy form to a small sample population of operative patients (n = 10). The small test for cycle 1 yielded 7 (70%) of 10 randomly screened patients who were “positive” for primary snoring and 2 (20%) of 10 patients who had greater than 3 clinical symptoms consistent with SDB.

• **Cycle 2.** The second cycle included introducing the recently published 5 STBUR screening questions through creation of a hard-copy form to a small sample population of operative patients (n = 10). The validated STBUR questionnaire was published in *Pediatric Anesthesia* in April 2013.1 The goal of this cycle was to improve both parental comprehension of the questionnaire and clinical utility of the questionnaire for the end user. The small test for cycle 2 yielded 6 (60%) of 10 randomly screened patients who were positive for primary snoring and 3 (30%) of 10 patients who had greater or equal to 3 clinical symptoms consistent with SDB.

• **Cycle 3.** The anesthesia faculty received a 15-minute educational session introducing the STBUR questionnaire. A posttest was administered via email to the anesthesia department with the intent to test the level of comprehension and competence of administration and scoring of the STBUR questionnaire among anesthesia faculty. Analysis of survey data showed 94.4% of respondents found the STBUR questionnaire easy to administer and score. During the question-and-answer period, a few anesthesia providers recommended that the admitting nurses administer the STBUR during their preoperative patient assessment.

• **Cycle 4.** Education was provided to perioperative nursing staff through 15-minute educational sessions introducing the STBUR questionnaire and its predictive ability to identify patients who may be at risk of PRAE. Additionally, hard-copy STBUR questionnaires were disseminated among small groups at the conclusion of educational sessions to test competence of administration and scoring. Feedback data related to pros and cons of which providers should administer the screening questions were collected and used for the creation of an opinion survey that was disseminated to anesthesia faculty and perioperative nursing staff. Opinion survey results found that 57.8% of respondents indicated anesthesia providers should administer the screening
questions, 26.32% indicated the preoperative admitting nurses should administer the questions, and 15.79% indicated the nurse practitioner should administer the questions while conducting the history and physical examination. The QI project committee members concluded that the STBUR questionnaire should be embedded in the preanesthesia documents section to be administered by anesthesia providers.

• **Cycle 5.** The first chart audit occurred after initial implementation of the electronic STBUR questionnaire on September 30, 2013. The chart audit (23 providers) provided data to determine how frequently anesthesia providers were completing the STBUR questionnaire. Data collected identified that only 1 (4%) of 23 providers completed the screening questionnaire. These results determined that a more reliable method to ensure completion of the STBUR questionnaire was needed. A 3-question, open-ended survey was created and sent to audited anesthesia faculty in October 2013. Survey feedback data were analyzed, prompting several changes in the EMR to improve recognition of the location of the STBUR questionnaire and to increase end-user clinical utility.

• **Cycle 6.** Chart audit 2 occurred after implemented changes in November 2013. The chart audit (23 providers) provided data to determine if the frequency of STBUR questionnaire completion had improved compared with chart audit 1. Data collected from the chart audit identified that 17 (74%) of 23 anesthesia providers completed the screening questionnaire. Although use of the screening questionnaire was much improved, several additional measures were implemented to increase SDB risk awareness among all perioperative team members. These measures included STBUR score inclusion in “anesthesia sign-in” as part of the surgical procedural safety checklist and in 3 perioperative handoff report checklists (operating room [OR] to PACU, PACU to inpatient surgical floor, and OR to pediatric intensive care unit). Additionally, an automatic stop was implemented in the EMR, preventing closure of the anesthetic record until completion of the STBUR questionnaire.

• **Cycle 7.** A practice advisory was created based on practice guidelines published by the ASA to assist anesthesia providers with decision support surrounding perioperative management of patients at increased risk of PRAE or with diagnosed OSA in September 2013. Chart audit 1 occurred 6 weeks after implementation of the practice advisory on November 11, 2013. The chart audit (10 records) provided data to determine how frequently anesthesia providers were using evidence-based practice guidelines. Data collected from the chart audit identified that 9 of 10 anesthesia providers (90%) reduced long-acting opioid dosages in patients with an increased risk of PRAE or with OSA. These results determined that the electronic practice advisory provided anesthesia providers with patient-specific clinical decision support, thus allowing modification of the management plan toward safer practices.

• **Cycle 8.** The practice advisory went into production for perioperative nursing staff in January 2014. Data were collected from an opinion survey disseminated to all perioperative nursing staff after 3 days. The opinion survey received 13 of 33 respondents (39%), with 10 of 13 (77%) indicating a concern with physicians writing standard-dose opioid orders for admission or discharge in patients identified as at risk of PRAE or with OSA. Additionally, several members of the pediatric surgery team filed complaints with perioperative leadership about being contacted by nursing staff regarding their prescribed opioid dosages in the order set. Because of the complaints and expressed concerns, the perioperative quality committee suspended the practice advisory temporarily, in favor of an “action plan.” The action plan

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**Figure 2.** Components of Electronic Practice Advisory With Patient’s Individual STBUR Score Embedded Within Advisory and Evidence-based Perioperative Management Guidelines

Abbreviations: CR, cardiorespiratory; HOB, head of bed; OSA, obstructive sleep apnea; STBUR, Snoring, Trouble Breathing, Un-Refreshed.
Outlined additional educational efforts for perioperative providers, which introduced the STBUR questionnaire and published recommendations included in the practice advisory. All action plan items were completed January 2014 through February 2014. The Perioperative Quality Committee approved the practice advisory for reintroduction in April 2014.

Results

Data collection from chart review occurred from December 1, 2012, through March 31, 2014, to determine the incidence of SDB identification at CHC and the current incidence of opioid-induced oxygen desaturation events in the PACU. Additional data were gathered from CHC Code Blue Committee spreadsheets (December 1, 2012, through March 31, 2014) to determine the incidence of unanticipated ICU transfers and activation of RRT or Code Blue events within 24 hours postoperatively. A power analysis was conducted for a Yates $\chi^2$ test using the G*Power online power calculator to calculate sample size needed to achieve statistical significance for the second outcome measure (opioid-induced oxygen desaturation events in the PACU). The power calculator determined that both pre- and postintervention groups needed 7,928 participants. In an effort to obtain a statistically significant sample size, the investigators included 100% of surgical patients who met age criteria in the QI project from December 2012 to March 2014.

Data were collected over a 15-month period. Records of all pediatric surgical patients meeting inclusion criteria were reviewed to see whether the STBUR screening questions were included in the preanesthesia interview. Data were collected regarding the predictive risk of PRAE (STBUR score $\geq 3$ of 5) or a diagnosis of OSA. To determine if there was a significant change in the identification of patients at high risk of PRAE, a Yates $\chi^2$ test was used. The number of patients identified increased from 10.5% to 15% ($\chi^2 (1, N = 12,975) = 57.19, z = -7.59, P < .001, \text{odds ratio [OR]} = 1.49$). This study showed the odds of identifying patients at high risk of PRAE is 1.49 times more likely after implementing the STBUR screening questionnaire. To determine if there was a significant change in the incidence of opioid-induced oxygen desaturation events in the PACU, a Yates $\chi^2$ test was used. The number of opioid-induced oxygen desaturation events in the PACU increased from 11.6% to 12.7% ($\chi^2 (1, N = 2,007) = 0.72, z = -0.92, P = .40, \text{OR} = 1.13$). To determine if there was a significant reduction in the number of RRT/Code Blue activations outside the ICU, a Fisher exact test was used. The number of RRT/Code Blue activations outside the ICU increased from 9% to 10.2% (OR = 1.14, $z = -0.41, P = .75, 95\% \text{ CI} = 0.61-2.14$). The authors theorize that the percentage increases may be attributed to the higher detection rate of patients at risk of PRAE included for analysis after intervention instead of an actual increase in the number of opioid-induced desaturation events in the PACU during the study. To determine if there was a significant reduction in the incidence of unanticipated ICU transfers from the inpatient floor related to respiratory distress, a Fisher exact test was used. The number of unanticipated ICU transfers from inpatient floor because of respiratory complications decreased from 5.2% to 2.4% (OR = 0.44, $z = 1.57, P = .15, 95\% \text{ CI} = 0.15-1.26$).

Discussion

Considering a large proportion of children present for surgery with clinical symptoms consistent with SDB or OSA, a screening questionnaire is critical to the preanesthesia assessment. Tait et al$^3$ and Spruyt and Gozal$^15$ both published validated screening questions that can be used to reliably identify children with probable SDB based on subjective respiratory clinical symptoms. Screening questionnaires are simple, inexpensive, predictive tests that
can be used in a busy preoperative setting, which serve to raise awareness of potential risks, allowing modification of management plans toward safer practices. Results of this QI project showed that the electronic STBUR screening questionnaire significantly increased the identification of children presenting for surgery at CHC who may be at risk of PRAE over a 6-month timeframe (Figure 3).

Côté et al. found that children with symptoms consistent with SDB are at an increased risk of perioperative death and permanent neurologic complications, and the authors stressed the importance of identifying patients with clinical symptoms of SDB preoperatively. These collective studies provide evidentiary support of the implementation of preoperative SDB screening questionnaires.

Because of the temporary suspension of the practice advisory, the STBUR score in the handoff checklist reports served as the sole “risk” reminder for perioperative physicians, providers, and nursing staff. The interventions for the secondary outcome measures were the STBUR education and dissemination of printed materials containing the published recommendations. Education alone has not been shown to be an effective strategy to gain acceptance of practice guidelines among clinicians. The use of multifaceted implementation strategies are more effective at producing effects that are more widely accepted and sustainable. The implementation of electronic decision supports (eg, practice advisory) serve as automatic reminders for providers to perform clinical tasks based on best practice that improve quality and reduce patient morbidity and mortality. These automatic reminders serve to standardize the care being provided during the perioperative period, as clinicians often make substantially different management decisions for similar clinical situations based on their own knowledge base and clinical experiences. This QI project’s interventions affected several specialties in the CHC organization and initiated major institutional change across departmental boundaries. Consequently, the interventions encountered not unexpected resistance to implementation from perioperative physicians. Physicians often fail to comply with best practices and consider individual variation in practice as acceptable or even desirable. Perioperative provider education, project involvement of key influential leaders in the perioperative quality committee, and CHC’s organizational culture of safety contributed in large part to successful implementation of this QI project’s patient safety interventions.

A number of limitations are acknowledged in this quality improvement project. First, the use of education and printed materials instead of the electronic practice advisory was not a valid or reliable measurement tool for the 3 secondary outcome measures. The data collected for these outcome measures were unable to show whether clinician awareness of the STBUR score and published recommendations reduced (1) opioid-induced oxygen desaturation events in the PACU; (2) RRT/Code Blue events in postoperative patients with respiratory distress outside the ICU; or (3) unanticipated ICU transfers in postoperative patients because of respiratory distress. Second, potential confounding variables, such as parallel safety efforts in the perioperative environment, were not controlled for. Third, the QI project took place in a single pediatric level I hospital; therefore the project’s findings are not generalizable. However, the site is typical to a large pediatric academic facility in terms of patient volume, staff, and surgeries performed. Finally, the secondary outcome measures’ small sample sizes may have contributed to the inability to statistically detect the effects of the interventions. These results indicate that additional investigation is warranted.

This QI project served to heighten perioperative providers’ and nursing staff’s awareness of risks associated with SDB and OSA. A practice advisory was implemented in an effort to support the use of best practice surrounding perioperative management of patients with SDB or diagnosed OSA. An environment of shared leadership in the perioperative department facilitated this improved patient safety process. The doctorate-prepared advanced practice nurse is well prepared to work effectively in a large variety of settings and has attained the necessary leadership skills to make evidenced-based recommendations that support the improvement and transformation of healthcare. This QI project created the framework in the perioperative setting in which to model a broader hospitalwide implementation. Future expansion of this practice change will require a multidisciplinary leadership effort to ensure the overall success of the implemented practice changes to provide the best outcomes for patients and to facilitate sharing of this work beyond the CHC organization.

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