



Overnight observation in former premature infants undergoing inguinal hernia repair

Carrie A. Laituri^a, Carissa L. Garey^a, Benjamin J. Pieters^b, Peter Mestad^b, Eric E. Weissend^b, Shawn D. St. Peter^{a,*}

^aDepartment of Surgery, Children's Mercy Hospital, Kansas City, MO 64108, USA

^bDepartment of Anesthesia, Children's Mercy Hospital, Kansas City, MO 64108, USA

Received 1 October 2011; accepted 8 October 2011

Key words:

Prematurity;
Apnea;
Bradycardia;
Desaturation;
Postoperative

Abstract

Background: Overnight observation for apneic events is standard practice in former preterm infants. However, the literature supporting current protocols is dated. Therefore, we retrospectively evaluated the post-anesthetic risks in these patients.

Methods: A retrospective review was conducted on former preterm infants admitted after an inguinal herniorrhaphy between 1/00 and 10/09. The protocol for overnight admission was for patients born before 37 weeks gestation who are less than 60 weeks post-conceptual age (PCA).

Results: There were 363 patients, of which 23 were <40 weeks PCA (group 1), 244 were 40 to 49.9 weeks PCA (group 2), and 96 were 50 to 60 weeks PCA (group 3). Events registered by alarms occurred in 4 patients (1.1%), 2 from group 1 and 2 from group 2. In Group 1, one occurred during nasogastric tube placement and resolved spontaneously. In group 2, one was apnea-induced bradycardia that resolved spontaneously, and one was in a patient on home monitors with an event similar to home reports. There were no events in group 3.

Conclusion: Conservative guidelines for overnight observation after inguinal hernia repair could be set for patients born before 37 weeks gestation who are under 50 weeks PCA.

© 2012 Elsevier Inc. All rights reserved.

Postoperative events related to apnea are more common in former preterm infants. Hospital admission for overnight observation after elective operations under general anesthetic is standard practice in former preterm infants. The post-conceptual age that triggers admission for observation is debated, and the literature supporting current protocols is dated. Therefore, we reviewed our experience with overnight

observation to assess the current post-anesthetic risks in former premature patients.

1. Methods

After obtaining institutional review board approval, a retrospective review was conducted on all former preterm patients who were admitted for observation after an inguinal herniorrhaphy from January 2000 to October 2009. Our protocol for overnight admission includes patients born before 37 weeks gestation who are less than 60 weeks post-

* Corresponding author. Department of Pediatric Surgery, Children's Mercy Hospital and Clinics, Kansas City, MO 64108, USA. Tel.: +1 816 983 6465; fax: +1 816 983 6885.

E-mail address: sspeter@cmh.edu (S.D. St. Peter).

conceptional age (PCA). All patients had continuous cardiorespiratory monitoring postoperatively throughout their hospital stay with a combination of continuous recording devices, impedance pneumography with alarms, and nursing observation. As a retrospective study, the anesthetic technique was not fixed and practitioner dependent including variables such the use of narcotics, use of muscle relaxants, and the timing of extubation. Data recorded included demographics, surgery details, factors associated with apnea, bradycardia, and desaturation, and their outcomes. An apneic event was counted by either documentation of apnea by anesthesia or nursing notes through visual observation or documented pauses ≥ 15 seconds. Severe apnea was defined as a desaturation of $\leq 85\%$ or requiring mask assistance for apnea.

Patients were divided into 3 groups for analysis. Group 1 was composed of patients less than 40 weeks PCA, group 2 was between 40 and 49.9 weeks PCA, and group 3 was between 50 and 60 weeks PCA. Comparison among groups was performed using analysis of variance for continuous variables and χ^2 for categorical variables. Significance was defined as $P < .05$.

2. Results

There were 363 patients included in the study who were former premature infants at the time of surgery. Mean PCA was 47 weeks (33.3-59.9 weeks) and mean weight at operation was 4.6 kg (2.1-8.9 kg) for the study population. There were 23 patients in group 1, 244 in group 2, and 96 in group 3. Demographics and operative details for each group are listed in Table 1.

The immediate postoperative course was eventful. In the whole population, 41.9% (151 patients) had an isolated episode of apnea, bradycardia, or desaturation postoperatively while in the recovery room. The breakdown of recovery room courses by group is outlined in Table 2.

After the patients were discharged from the recovery room and admitted to the general surgery service, there were events registered by cardiorespiratory alarms in 4 patients, resulting in an overall incidence of 1.1%. The events occurred with 2 patients in group 1 and 2 patients in group

Table 2 Recovery room course

| | Group 1 | Group 2 | Group 3 | <i>P</i> |
|----------------------|-----------------|-----------------|-----------------|----------|
| Extubated in RR | 65.2 % | 59.0% | 58.2% | .8 |
| Desaturation | 56.5% | 43.4% | 29.6% | .02 |
| Apnea | 43.5% | 20.9% | 16.3% | .0004 |
| Severe apnea (<85%) | 26.1% | 19.2% | 9.2% | .03 |
| Bag mask ventilation | 17.4% | 10.7% | 10.2% | .28 |
| CPAP | 17.4% | 4.9% | 3.1% | .01 |
| Bradycardia | 0 | 4.9% | 2% | .07 |
| Mean RR time (min) | 71.9 \pm 44.2 | 63.0 \pm 26.8 | 57.6 \pm 20.7 | .16 |

RR indicates recovery room; CPAP, continuous positive airway pressure.

2, the details of these events are outlined in Table 3. The oldest gestational age for any of the 4 infants was 33 weeks.

3. Discussion

There is a long-standing practice to admit former preterm infants after an anesthetic. The initial documentation of postoperative apnea in former premature infants recovering from general anesthesia appeared in 1982 [1]. In the years to follow, a debate developed centered entirely around the post-conceptional age at which infants remain at risk. Some have suggested that the likelihood of apnea was nearly absent by 44 weeks PCA [2], whereas others reported that the risk of apnea persisted until as late as 60 weeks PCA [3-5]. The 1995 meta-analysis of 8 small series used the widely variable incidences reported in these series to establish a predictive curve, which pointed to a significant reduction in the incidence of apnea at 52 to 54 weeks PCA, with an incidence of apnea to less than 1% at 54 weeks PCA [4]. The curve created by this model possessed an upper confidence interval that drags out to 60 weeks PCA, which represents the most conservative interpretation for a safety margin from these data. Although some debated the validity of this conservative estimate at the time suggesting it would be safe to set more liberal criteria [6], many centers including ours established protocols to admit former preterm infants under 60 weeks PCA. An additional variable posed at the time was anemia [4]; however, patients now rarely have blood draws now before an elective hernia repair.

The debate is clouded by the quality and amount of data available. The data are flawed by variable means of monitoring, definitions of events, and the lack of current evidence. Variability in the technology used to detect events also creates bias, and expectedly, the lowest incidence of reported events have been in studies that used the least sophisticated technology including nursing observation [2,4,7]. Higher rates of events are reported with the utilization of continuous recording devices [3,4].

Table 1 Patient characteristics

| | Group 1 | Group 2 | Group 3 | <i>P</i> |
|--------------------|-----------------|-------------------|-----------------|----------|
| | <40 wk PCA | 40-49.9 wk PCA | 50-60 wk PCA | |
| No. of patients | 23 | 244 | 98 | |
| Mean PCA (wk) | 38.4 | 45 | 54.0 | |
| Mean weight (kg) | 3.5 | 4.2 | 5.9 | <.0001 |
| Mean OP time (min) | 34.3 \pm 12.9 | 35.5 \pm 17.2 | 41.6 \pm 24.3 | .05 |

Table 3 Overnight events registered by cardiorespiratory alarms

| | Group 1 | Group 2 | Group 3 |
|--------------------|--|---|---------|
| No. of events | 2 | 2 | 0 |
| Details by patient | <p>Patient A: former 29 week EGA at 39.3 wk PCA—event occurred during nasogastric tube for abdominal distention, required intubation</p> <p>Patient B: former 28 week EGA at 38.1 wk PCA—event was apnea with feeds at 4 h postoperatively</p> | <p>Patient C: former 33 week EGA at 47.3 weeks PCA—1 event was apneic spell for 30 s while sleeping with desaturation to 80% at 1 h postoperatively, another event was bradycardia to 60-70s at 8 h postoperatively that self-resolved</p> <p>Patient D: former 30 week EGA at 41.3 PCA—2 events were apnea and bradycardia at 8 h postoperatively and bradycardia at 10 h postoperatively—this patient on home monitors with history of bradycardia events to 30 at home</p> | |

EGA indicates estimated gestation age.

A lack of consensus on the definitions of apnea and bradycardia creates a concerning source of bias in previous studies. There are at least 6 separate definitions for apnea and 3 definitions for bradycardia [1-4,7-10]. Apnea has been declared on the time between breaths ranging from 10 to 20 seconds, with or without association with bradycardia or oxygen desaturation, whereas others use a definition of visual observation of absence of respirations. Severe apnea has been defined as apnea resulting in desaturation with $SpO_2 < 85\%$, which we used [4]. Standard definitions are clearly necessary in further delineating postoperative care guidelines.

The fact that most guidelines are based on studies completed over a decade ago poses a concern about the applicability of these data considering the ongoing evolution of anesthesia practice. In particular, the use of the newer less soluble volatile anesthetic agents leads to faster awakening in the recovery room [11,12]. Certainly the lingering effects of exposure to general anesthesia have a profound influence on the incidence of apnea. It is reasonable to assume that the incidence of apnea may have changed over the past decade as new agents, which are more quickly eliminated, have come into widespread clinical use. The most recent investigation, which retrospectively reviewed the hospital course for 126 infants admitted after hernia repair, concluded that the risk of apnea is much lower in contemporary practice than previously reported in the series that make up the current policies [13]. Our series makes the same conclusion, and we feel it is time to readdress these policies with more contemporary data.

Regardless of the history of prematurity or current age, when infants demonstrate apneic events, this often prompts admissions for overnight observation [4]. However, our data call this practice into question as Table 2 shows that a high percentage of the premature population experiences a rocky course in the recovery room, which does not translate into overnight events. Therefore, although it is justifiable to keep a patient in the recovery room until they demonstrate stability after apneic events, it may not be necessary to admit patients that would have not otherwise been admitted due to PCA as

none of the overnight events occurred in patients over 45 weeks PCA.

Evidence-based medicine requires data to justify patient management protocols. The available data to establish observation protocols in preterm infants are with substantial flaws and are now dated. As cost-efficiency and quality assurance are becoming guiding principles within hospital systems, it becomes more important to have quality data that are continually reviewed to avoid low yield uses of medical resources. This large data set offers a good starting point for the establishment of more progressive guidelines while still remaining conservative; however, further progression with more aggressive protocols should be established in a stepwise fashion with prospective data. Although it would appear safe to avoid admission in patients born before 37 weeks EGA who undergo an anesthetic beyond 50 weeks PCA, we acknowledge that the inherent flaws of a retrospective series do not offer the strength to make this a universal recommendation. We have established a prospective protocol to further evaluate the risk of prematurity and to validate the proposed guidelines.

References

- [1] Steward DJ. Preterm infants are more prone to complications following minor surgery than are term infants. *Anesthesiology* 1982; 56:304-6.
- [2] Malviya S, Swartz J, Lerman J. Are all preterm infants younger than 60 weeks postconceptual age at risk for postanesthetic apnea? *Anesthesiology* 1993;78:1076-81.
- [3] Kurth CD, LeBard SE. Association of postoperative apnea, airway obstruction, and hypoxemia in former premature infants. *Anesthesiology* 1991;75:22-6.
- [4] Coté CJ, Zaslavsky A, Downes JJ, et al. Postoperative apnea in former preterm infants after inguinal herniorrhaphy. A combined analysis. *Anesthesiology* 1995;82:809-22.
- [5] Fisher D. When is the ex-premature infant no longer at risk for apnea? *Anesthesiology* 1995;82:807-8.
- [6] Wiener E, Touloukian R, Rodgers B, et al. Hernia survey of the section on surgery of the American Academy of Pediatrics. *J Pediatr Surg* 1996;31:1166-9.

- [7] Warner LO, Teitelbaum DH, Caniano DA, et al. Inguinal herniorrhaphy in young infants: perianesthetic complications and associated preanesthetic risk factors. *J Clin Anesth* 1992;4:455-61.
- [8] Liu LMP, Cote CJ, Goudsouzian NG, et al. Life-threatening apnea in infants recovering from anesthesia. *Anesthesiology* 1983;59:506-10.
- [9] Finer NN, Higgins R, Kattwinkel J, et al. Summary proceedings from the apnea-of-prematurity group. *Pediatrics* 2006;117:S47-51.
- [10] American Academy of Pediatrics, Committee on Fetus and Newborn. Apnea, sudden infant death syndrome, and home monitoring. *Pediatrics* 2003;111:914-7.
- [11] Samer JB, Levine M, Davis PJ, et al. Clinical characteristics of sevoflurane in children. A comparison with halothane. *Anesthesiology* 1995;82:38-46.
- [12] Lerman J, Davis PJ, Welborn LG, et al. Induction, recovery, and safety characteristics of sevoflurane in children undergoing ambulatory surgery. A comparison with halothane. *Anesthesiology* 1996;84:1332-40.
- [13] Murphy JJ, Swanson T, Ansermino M, et al. The frequency of apneas in premature infants after inguinal hernia repair: do they need overnight monitoring in the intensive care unit? *J Pediatr Surg* 2008;43:865-8.

Discussion

Discussant: Kurt Heiss, MD, (Atlanta, GA):

DR. HEISS: This is well done. I wondered, you are very thoughtful about the way you approached your research questions. How does the structure of your study differ from the anesthesia papers that are kind of the foundation for the way we behave in these premature patients?

Secondly, how have you in concert with your anesthesia colleagues adjusted your clinical practice to take advantage of your understanding that this post-40 week group does not need to stay until they are 60 weeks corrected age?

Response: DR. LAITURI: Fortunately, we worked with the anesthesia department closely during this evaluation and the reason that we had prompted this is because those data, the studies that had been reported were over a decade ago and additionally anesthetics has also changed during that time. In further looking at that, what would differentiate that was 36 weeks 6 days compared to 36 weeks 7 days? In further evaluation, a majority of our anesthesia colleagues also felt as though the recovery room events may dictate and correlate into events overnight and noting that our event rate was only 1.1% that further

validated prompting a prospective protocol as well and changing the estimated post-conceptual age requirement.

Discussant: Donald Meier, MD, (El Paso, TX):

DR. MEIER: How do you manage postoperative pain in these children and was there any correlation with your pain management with those that had apnea?

Response: DR. LAITURI: That is a very good question. As this was a retrospective review, it was not necessarily standardized for a protocol but in further validation we did look at the narcotic utilization and the timing of narcotic administration to see if they did have events. Looking at those, it did vary as to when those patients were extubated as the majority of patients were extubated if they received intraoperative narcotics only; however, the apnea, bradycardia, and desaturation events did not change if they received intraoperative narcotic utilization versus PACU narcotics only. As you can see on the top table, in looking at when the narcotics were given, if they received no narcotics at all versus intraoperative narcotics versus PACU administration only, there are more patients extubated in the operating room if they received intraoperative narcotic utilization only but respiratory events were similar.

DR. MEIER: On the floor during your observation period, did you use narcotics or acetaminophen?

DR. LAITURI: They received narcotics if necessary.

Discussant: Unknown Speaker: Have you looked at the correlation between the operative time, the length of operation, and the postoperative events?

Response: DR. LAITURI: The operative time was essentially similar amongst the three groups. There was a trend towards having a longer operative time in group three. What we propose is that these patients were larger babies that still had difficult hernias; however, possibly required a longer procedure due to more tissue, but there were no events in group three. Although they did have a longer operative time, there were no overnight events that would correlate to assuming that was a correlation.