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A comparison of surgical outcomes between in-hours and after-hours tracheoesophageal fistula repairs

Anthony Yeung [a], Sonia A. Butterworth [b,c,*]

[a] Faculty of Medicine, University of British Columbia, Vancouver, BC, Canada
[b] Division of Pediatric Surgery, Department of Surgery, University of British Columbia, Vancouver, BC, Canada
[c] Division of Pediatric Surgery, Department of Surgery, British Columbia Children's Hospital, Vancouver, BC, Canada

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ABSTRACT

Background: Emerging literature has found increased complications for some patients undergoing nonemergent surgeries performed after-hours. For infants born with esophageal atresia and tracheoesophageal fistula (EA/TEF), no literature exists addressing the impact of the timing of surgery on outcomes.
Methods: With IRB approval, EA/TEF repairs (2005–2010) performed at a tertiary children's hospital were reviewed retrospectively. All patients had an esophageal anastomosis. After-hours surgeries were defined as 1530–0800 Monday to Friday, weekends/holidays. Demographics, EA/TEF type, operative details, anastomotic tension, and complications were compared. Outcomes measured included intraoperative desaturations, esophageal complications (leak, stricture, recurrence), pneumothorax, and mortality.
Results: There were 28 patients, of which 21 underwent the procedure in-hours and 7 after-hours. Patient age, gestational age, weight, EA/TEF type, cardiac anomalies, and preoperative, intraoperative, and postoperative variables were not different between the groups. Operative time, intraoperative desaturations, anastomotic tension, blood loss, total ventilation days, or length of hospitalization were not significantly different. There was a significant increase in esophageal leaks in the after-hours group ($n = 3$) vs. the in-hours ($n = 0$) group ($p = 0.014$).
Conclusions: In this study, infants with an EA/TEF repaired after-hours had a significant increase in anastomotic leaks. The observed increase in leaks requires further evaluation to ensure more optimal outcomes for this fragile group of patients.

Esophageal atresia with tracheoesophageal fistula (EA/TEF) is the most common form of esophageal atresia and occurs at a rate of 1 in 3500 births, with approximately half of the cases presenting with VACTERL associations (vertebral, anorectal, cardiac, tracheoesophageal, renal, and limb defects) [1]. Advances in neonatal care, surgery and anesthetic care have significantly improved outcomes for EA/TEF patients [2–5]. Amidst these advances however, improving the postoperative outcomes of patients after EA/TEF repairs has become an important issue [6,7].

In the past decade, literature has emerged which examines the effect of fatigue and human factors on surgical outcomes [8]. Its application in healthcare, particularly in anesthesia and surgery, is recent, but gaining wider recognition as a critical factor that influences patient outcomes [9–12]. Analysis of performance outcomes involving a wide range of complex tasks in healthcare has uniformly demonstrated less effective communication, decreased task performance and increased critical errors occur with fatigue [8,13,14]. Studies evaluating effects of fatigue and night shift work on physicians have shown that performance generally decreases with increased fatigue [13,15].

In the field of pediatric surgery, it is estimated that 25%–30% of surgical procedures are nonelective (immediate, urgent or expedited) [16]. At our institution, during standard hours, patient cases needing immediate surgery typically break into the first available operating room, bumping into the elective slate. However, patients with urgent surgical conditions (i.e., requiring operation within hours to days) pose a challenge to the system. Given that these surgeries only have a medical need to be performed within hours of diagnosis and not immediately, they typically do not bump into elective slates. As a result, these operations achieve access to the operating room through one of three ways: cancellation of elective cases, access to "open" operating room time [bookings close 21 hours prior, are available to all specialties and are prioritized based on medical urgency (only available 3 days a week)] or surgery after-hours.

The information about outcomes of pediatric surgery patients with urgent surgical conditions operated on during standard working hours compared to after-hours is extremely limited [17]. Given some of the current literature regarding the potential for worse outcomes in patients operated on after-hours for nonemergent conditions, we hypothesized that the intraoperative outcomes would be less favorable for patients having EA/TEF repair after-hours compared to standard hours. A secondary aim was to compare the postoperative outcomes in the patient groups.

* Corresponding author at: British Columbia Children's Hospital, K0-113 ACB, 4480 Oak Street, Vancouver, BC, V6H 3V4, Canada. Tel.: +1 604 875 2667; fax: +1 604 875 2721.
E-mail address: sbutterworth@cw.bc.ca (S.A. Butterworth).

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1. Methods

With research ethics board approval (#H11-02746), a retrospective review of all patients operated on for esophageal atresia with tracheoesophageal fistula at British Columbia Children's Hospital between 2005 and 2010 was performed. Infants with isolated esophageal atresia, isolated TEF or who underwent ligation of fistula only were excluded from the study. Hospital and clinic charts as well as all electronic medical records for the patients were reviewed. Patient demographics (gestational age, birth weight, gender, incidence of cardiac anomalies, presence of associated anomalies), operative characteristics (skin-to-skin time, anastomotic tension) and postoperative characteristics (total ventilation days, length of hospital stay) were examined. The time from diagnosis to operation was also documented. Operative data were gained by utilizing the ORSOS (Operating Room Scheduling Office System) database (a prospective database of all surgeries performed at the institution) to collect dates and times related to the surgery (in room time, skin-to skin operative time, total operative time). Intraoperative complications measured were intraoperative desaturations, blood loss and any other complication listed in the dictated operative report. The postoperative complications that were examined included anastomotic leakage, esophageal strictures, fistula recurrence, pneumothorax and mortality. Operation times beginning between 0800 and 1530 Monday to Friday were considered to be an in-hours operation consistent with the hospital's designation of standard of operating hours. Holidays during weekdays were considered after-hours. Any operative times starting outside these hours were considered to be after-hours.

Postoperatively, all infants were monitored in the neonatal intensive care unit until discharge. Patients routinely had a contrast esophagogram typically 5 days (range 4–7 days) postoperatively. All patients had follow-up with the surgical team to monitor for postoperative complications, including anastomotic leaks, stricture and fistula recurrence.

The inclusion criteria for congenital heart anomalies included preterm patent ductus arteriosus that spontaneously closed or required medical or surgical intervention. Total ventilation time was defined as the total preoperative and postoperative intubation, time under continuous positive airway pressure (CPAP), synchronized intermittent mechanical ventilation (SIMV) or bilevel positive airway pressure (BiPAP). An intraoperative desaturation event was defined as oxygen saturation below 90% at any time during the operation. Anastomotic leaks were defined as leaks detected during postoperative esophagograms or when there was clinical evidence of a leakage documented in the patient chart. Esophageal strictures were defined as any anastomotic narrowing documented on esophagogram or requiring at least one dilation.

Patient demographics, operative outcomes and the incidence of postoperative complications between the in-hours and after-hours groups were compared with the Pearson χ^2 test with Yates' correction using a 95% confidence interval for statistical significance. Student's t test was used to compare the difference in mean values between the in-hours and after-hours groups. p Values less than 0.05 were considered statistically significant.

2. Results

A total of 28 EA/TEF patient charts between 2005 and 2010 were reviewed, 12 were female (42%) and 16 were male (58%). The average birth weight was 2522 g (range 1000 to 3790 g). All 28 patients had Type C (proximal esophageal atresia and distal tracheoesophageal fistula) EA/TEFs. Cardiac anomalies were present in 19 patients (68%), including patent foramen ovale, patent ductus arteriosus, teratology of Fallot, atrial septal defect and ventricular septal defect.

A comparison of patient demographics and intraoperative variables was made between the in-hours and after-hours groups (Table 1). There were no differences in the gestational age, birth weight or incidence of cardiac anomalies between the in-hours and after-hours groups. Operative variables including skin-to-skin operative time and anastomotic tension were similar between groups. The in-hours group averaged a higher, though insignificant, delay time of 31 hours between diagnosis and EA/TEF repair, while the after-hours group waited an average of 6.85 hours for an EA/TEF repair.

Table 1
Patient demographics and clinical characteristics (preoperative).

		In-hours ($n = 21$)		After-hours ($n = 7$)		p Value[a]
Gender	Male	52.4% ($n = 10$)		85.7% ($n = 6$)		0.211
	Female	47.6% ($n = 11$)		14.3% ($n = 1$)		
Cardiac anomalies	Present	66.7% ($n = 14$)		71.4% ($n = 5$)		1.00
	Absent	33.3% ($n = 7$)		28.6% ($n = 2$)		
Anastomotic tension	None	52.4% ($n = 11$)		42.9% ($n = 3$)		0.823
	Minimal	9.5% ($n = 2$)		14.3% ($n = 1$)		
	Moderate	33.3% ($n = 7$)		28.6% ($n = 2$)		
	Significant	4.8% ($n = 1$)		14.3% ($n = 1$)		
		Mean	SD	Mean	SD	p Value
Preoperative characteristics						
Age at operation (days)		6.95	16.436	0.43	0.535	0.095
Birth weight (kg)		2.559	0.727	2.41	0.72	0.936
Gestational age		36.8	3.20	37	3.30	0.193
Delay between diagnosis and operation (hours)		31.9	44.4	6.86	11.71	0.410
Preoperative ventilation time (days)		3.24	13.30	0.04	0.09	0.222

[a] Yates' correction.

Analysis of the intraoperative complications measured did not demonstrate any difference between the groups (Table 2). Specifically, there was no observed correlation of desaturations with the day or time of day the surgery was performed. Intraoperative blood loss similarly was not found to be different between the two groups.

In regard to the postoperative course, there was no significant difference in the length of total ventilation time: the in-hours group averaged 9.3 days and the after-hours group averaged 16.1 days (Table 3). However, the postoperative ventilation time alone was significantly higher in the after-hours group (mean 16.1 days) compared to the in-hours group [mean 6.1 days ($p < 0.05$)]. There were no significant differences in the length of postoperative hospital stay between the in-hours and after-hours groups, which were 30.7 days and 37.7 days, respectively (Table 3).

The incidence of postoperative complications between the in-hours and after-hours groups was found to be significantly different in some categories (Table 3). There was no significant difference in the incidence of strictures, recurrence, postoperative pneumothorax or mortality between the two groups. There was however, a significant difference in the incidence of anastomotic leaks: 3 of the 7 after-hours patients developed a leak, while none of the 21 in-hours patients developed a leak ($p = 0.014$). All procedures complicated by leaks had incision times at or after 2130. Five different surgeons performed the EA/TEF repairs, and there were no significant differences in the incidence of postoperative complications (leaks, strictures, or recurrence) between the surgeons. There was one postoperative death in the in-hours group caused by CHARGE syndrome and parental desire to take only comfort care measures after the EA/TEF repair.

3. Discussion

Human factors research has found many areas of decreased performance with increased fatigue [8–15]. It has been demonstrated that surgeons with disturbed sleep or no sleep for one day immediately before a day of surgery demonstrated decreased operative dexterity in virtual laparoscopic surgery studies [13]. Similarly, Gawande et al. [18] identified fatigue (either because of the length or lateness of duty), excessive workload, and inadequate staffing as one of the fifteen major factors resulting in surgical errors. The delicate process of suturing two esophageal pouches together in EA/TEF requires a considerable amount of dexterity and psychomotor demands. These processes could both be