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Weekday vs. weekend repair of esophageal atresia and tracheoesophageal fistula

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ABSTRACT

Purpose: We hypothesize that weekend esophageal atresia and tracheoesophageal fistula (EA/TEF) repair has worse outcomes compared to procedures performed on weekdays.
Methods: Kids' Inpatient Database (1997–2009) was searched for EA/TEF in infants admitted at <8 days of life. Cases were limited to patients who underwent repair during their hospitalization. Risk-adjusted multivariate analysis (MVA) compared complications, mortality, and resource utilization (length of stay [LOS] total charges [TC]) between weekday and weekend procedures.
Results: Overall, 861 EA/TEF cases with known day of repair were identified. Cohort survival was 96%. On risk-adjusted MVA, complication rates were higher with EA/TEF repair on a weekend (OR: 2.2) compared to a weekday. Additionally, complications (OR: 6.5) and LOS (OR: 9.3) were found to be higher among African American children compared to Caucasians. LOS was higher in patients with Medicaid (OR: 2.4) and repairs performed at non-teaching hospitals (OR: 3.2). Weekend vs. weekday procedure had no significant effect on mortality or resource utilization.
Conclusion: By risk-adjusted MVA, increased complication rates for EA/TEF are seen in patients undergoing repair on weekends compared to weekdays. Additionally, African American children experienced higher complication rates compared to Caucasians. LOS after repair varies according to race, payer status, and hospital characteristics.

The "weekend effect" is the presumption that decreased and unfamiliar ancillary staffing, and wide cross-coverage results in worse outcomes when surgery is performed on weekends compared with weekdays [1]. Furthermore, worse outcomes have been related to delays in diagnosis and treatment [2]. Insufficient trainee experience and limited resource availability have also been proposed hypotheses [3]. However, the "weekend effect" has been studied in cardiovascular disease, pediatrics, stroke, and gastroenterology, revealing inconsistent results [1,2,4–9]. The "weekend effect" had been previously measured in terms of mortality; more recently, qualitative metrics such as length of stay (LOS) have also been analyzed [4,10].

Specifically, Yeung and Butterworth reported worse outcomes in 7 newborns after esophageal atresia (EA)/tracheoesophageal fistula (TEF) repair during "off-hours," including weekends [9]. EA is found in combination with a TEF in at least 88% of cases, often at the level of the carina [11,12]. In addition, nearly half of patients with EA/TEF are found to have other anomalies, with concurrent cardiac anomalies reported to be as common as 34% [11,13–15]. EA/TEF is a highly morbid condition that necessitates surgical repair, making this condition an appropriate subject for assessing the "weekend effect."

To the best of our knowledge, the present study is the largest study examining outcomes following EA/TEF repair on weekdays versus weekends. We hypothesize that weekend esophageal atresia and tracheoesophageal fistula (EA/TEF) repair has worse outcomes compared to procedures performed on weekdays.

1. Methods

This retrospective review was exempt from institutional review board review. We used the Kids' Inpatient Database (KID) to search for cases of EA/TEF in infants admitted at <8 days of life. KID is a sample of national pediatric admissions, which provides data for up to 7.6 million weighted cases per year. Data releases are available triennially, and for this analysis, cases were drawn from KID releases in 1997, 2000, 2003, 2006, and 2009. Cases were weighted to project national estimates, and all analyses were limited to available data.

Cases were limited to type C EA/TEF, repaired with or without feeding access. Since the ICD-9-CM diagnosis code does not differentiate between types of EA/TEF, procedure codes were used to identify cases of type C EA/TEF as performed in a previous analysis [16]. Esophageal reconstruction procedures were defined as esophageal repairs (ICD-9-CM procedure code 42.8x) or intrathoracic (42.5x) esophageal anastomosis.

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Tracheal fistula repair procedures were defined as closure (31.73) or other repair (31.79) procedure performed on the trachea. Feeding tube procedures were defined as a gastrostomy (43.1x), gastrojejunostomy (44.32) or jejunostomy (46.32). EA/TEF cases were defined with the presence of an esophageal reconstruction or tracheal fistula repair procedure with or without a feeding tube placement.

Risk-adjusted multivariate analysis (MVA) compared in-hospital mortality, complications, and resource utilization (length of stay [LOS], total charges [TC]) between weekday and weekend procedures. Demographic, clinical, and hospital characteristic variables were used to construct logistic regression models. The binary, backward step-wise method was used to identify determinants of mortality and complications, whereas ordinal regression models were constructed for determinants of resource utilization endpoints. Additional adjustment for comorbid risk factors was performed for common diagnoses in prematurity (necrotizing enterocolitis, cardiac anomalies, bronchopulmonary dysplasia, intraventricular hemorrhage, sepsis, and multiple gestation) and also using the Elixhauser method, which has been validated in prior surgical outcomes analyses [17,18]. Cases with disposition coded as 'transfer to short term hospital' or 'other transfers, including skilled nursing facility, intermediate care, and another type of facility' were excluded from survival analyses. Complications were limited to those associated with surgical procedures, defined as reoperation, postprocedure hemorrhage, perforation/laceration, septicemia, pneumonia, other infections, pulmonary embolism, acute gastrointestinal ulcer, nausea/vomiting/diarrhea, or accidental cut, puncture, perforation or hemorrhage, as previously defined by Van Tuinen et al. [19]. TC values were standardized to 2009 US dollars (USD), according to inflation rates provided by the US Bureau of Labor Statistics [20]. We set the significance level at $\alpha = 0.05$, and SPSS Statistics, version 21.0 (IBM; Armonk, NY) was used to analyze data.

2. Results

Overall, 2913 EA/TEF cases were identified, with an overall survival rate of 96%. Cases with known day of repair (weekend versus weekday) amounted to 861 EA/TEF patients. Median (interquartile range) LOS was 17 (23) days and TC was 93,160 (144,165) US dollars. Survival for these cases was 96%. Patients were most commonly male (52%), Caucasian (63%), and underwent repair on weekdays (80%). Most common comorbidities included sepsis (6.5%), cardiac anomalies (4.3%), and intraventricular hemorrhage (1.0%). For additional demographic and clinical characteristics of the overall cohort, see Table 1. On bivariate comparative analysis of TEF repair by day of repair, most demographic and clinical variables were not significantly different. Caucasian patients were repaired at a higher rate on weekdays, whereas a greater percentage of Hispanic patients had surgery on weekends, $p < 0.04$. Urban nonteaching hospitals had a higher case incidence on weekends vs. weekdays, $p = 0.004$. Total charges were higher for weekday repairs, $p = 0.002$. For additional details from the comparison by day of repair, see Table 2.

On risk-adjusted MVA, complication rates were higher among patients undergoing EA/TEF repair on a weekend (odds ratio [95% confidence interval]: 2.20 [1.01, 4.80]) compared to a weekday, $p = 0.048$. Additionally, complications (OR: 6.53 [1.80, 23.7]) and LOS (OR: 9.31 [2.87, 30.2]) were found to be higher among African American children compared to Caucasians, $p < 0.005$. LOS was also higher in patients with Medicaid (OR: 2.44 [1.22, 4.88]) and repairs performed at nonteaching hospitals (OR: 3.21 [1.05, 9.77]), $p < 0.05$. Weekend vs. weekday procedure had no significant effect on mortality or resource utilization, $p \geq 0.05$. For a tabular representation of determinants of complication and resource utilization endpoints, see Table 3.

3. Discussion

EA/TEF can prove to be fatal if not appropriately managed, and the necessity for urgent surgical management makes this pathological condition a great subject for evaluating the "weekend effect." In our study, the overall survival rate was 96%, which is consistent with recent studies [16,21,22]. Wang et al. [16] utilized the KID in their study and reported a survival rate of 91% after EA/TEF repair, likely lower because the current study limited cases to those admitted within 8 days of life. Our baseline demographics, which revealed that Caucasian males more commonly underwent EA/TEF repair, confirms previous reports [9,13,16,23–25].

Our results showed that there is no increase in mortality in weekend versus weekday repair of EA/TEF. This may be because the mortality is already generally low, and a relatively small sample size is unable to detect statistical significance. Goldstein et al. [26] used KID and the Nationwide Inpatient Sample (NIS) to evaluate outcomes after urgent surgery in 439,457 pediatric patients, and reported a modest (0.03%), yet significant, increase in mortality in pediatric patients undergoing urgent surgery during the weekend. The same study also reported significantly higher complication rates after weekend surgery, including procedural complications and likelihood of receiving a blood transfusion. Yeung and Butterworth [9] reported a significantly higher rate of anastomotic leaks in 7 children who underwent EA/TEF repair during after hours, which included weekends. We also found higher complication rates in our risk-adjusted MVA, which revealed that neonates were 2.2 times more likely to suffer a complication when undergoing EA/TEF repair on a weekend compared with a weekday. It is accepted that hospitals

Table 1
Descriptive characteristics of study cohort. Esophageal atresia/tracheoesophageal fistula (EA/TEF) cases were identified using the Kids' Inpatient Database, 1997–2009.

	Overall (n = 861)	
Category	Median (IQR)	
Length of stay, days	17 (23)	
Total charges, US dollars	93,160 (144,165)	
	n	**%**
Gender		
Male	450	52
Female	411	48
Race		
Caucasian	446	63
African American	54	7.6
Hispanic	139	20
Asian/Pacific Islander	12	1.7
Native American	*	<1
Other	53	7
Payer		
Medicaid	304	35
Private insurance	516	60
Self-pay	14	2
Other	24	2.8
Repair type		
Without feeding access	565	66
With feeding access	296	34
Hospital bed size		
Small	160	19
Medium	225	27
Large	464	55
Hospital type		
Children's unit in a general hospital	308	36
Children's general hospital	280	33
Nonchildren's hospital	261	31
Hospital location/teaching		
Urban nonteaching	101	12
Urban teaching	744	88
Complications		
Yes	244	28
No	617	72

Complications were limited to those associated with surgical procedures, defined as reoperation, postprocedure hemorrhage, perforation/laceration, septicemia, pneumonia, other infections, pulmonary embolism, acute gastrointestinal ulcer, nausea/vomiting/diarrhea, or accidental cut, puncture, perforation or hemorrhage. Asterisks (*) indicate censored values in accordance to the Healthcare Cost and Utilization Project Data Use Agreement requirement regarding small value cells; corresponding percentages are also censored. IQR – interquartile range.