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ORIGINAL RESEARCH

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Comparison of tracheal resection outcomes at a university hospital vs county hospital setting

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Abstract

Objectives: To evaluate the role of hospital setting on outcomes in open airway surgery by comparing patients who underwent surgery (cricotracheal resection [CTR] or tracheal resection [TR]) at a publicly funded county hospital vs a private university hospital.

Methods: Retrospective chart review of patients undergoing CTR or TR at two institutions; a private university hospital and a publicly funded county hospital from September 2014 to September 2019. Length of intensive care unit (ICU) stay, total time to discharge, minor and major complications were the primary endpoints. Significance was defined as a *P*-value less than .05.

Results: There were a total of 43 patients (17 county, 26 university) who had CTR or TR during the study period. Length of stay outcomes was reported as mean length of stay ± SD. There was a significant difference in ICU stay at the county hospital (7.17 (±5.36 days) compared to the university hospital (2.52 ± 1.85 days, $P < .003$) and a nearly significant total length of stay difference at the county hospital (12.4 ± 9.06 days) compared to the university hospital (7.84 ± 4 days, $P < .072$) There was overall a low incidence of complications but slightly more in the county compared to the university population.

Conclusion: Patients who underwent open airway surgery at the county hospital were more likely to have a longer ICU stay and slight increase in complications despite having a lower ASA (American Society of Anesthesiologists) classification and younger age. These outcomes are multifactorial and may be related to poorer access to primary care preoperatively leading to delay in diagnosis and treatment, poorly

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controlled or undiagnosed medical comorbidities, and differences in hospital resources.

Level of Evidence: IV.

KEYWORDS
socioeconomic status, subglottic stenosis, tracheal resection

1 | INTRODUCTION

Tracheal resection (TR) has been a key treatment modality for patients with post-intubation and post-tracheostomy tracheal stenosis refractory to endoscopic management. It is well-established procedure with significant evidence for both its safety and its efficacy.[1,2] However, complications in TR and reconstruction can be devastating. Anastomotic dehiscence, tracheoinnominate fistulization, and hematomas can be life threatening and carry potential for significant morbidity.[3] Thus, the successful identification of prognostic factors for successful surgery and complications are crucial to tailored patient care and informed decision-making.

Comorbid medical risk factors and operative metrics are most frequently studied for prognostic implications for success of surgery and rate of complications. In TR notable risk factors for complications are reoperation, diabetes, lengthy resections, laryngotracheal resections, young age (pediatric patients), and the need for tracheostomy before operation.[4] Although critically important, many factors outside of a patient's medical comorbidities can drastically alter patient outcomes. Evidence suggests that socioeconomic status affects patient health outcomes and the care they receive. Those with lower socioeconomic status have been found to have a shorter life expectancy, more chronic conditions, and worse self-reported health status.[5] This effect has also been observed in the otolaryngology literature with lower socioeconomic status and poorer access to care correlating with increased risk of complications and decreased patient satisfaction.[6,7] In an analysis of county level socioeconomic status in oropharyngeal cancer patients, a lower level of socioeconomic status correlated with decreased rate of survival.[8]

Investigating what aspects of socioeconomic disparities contribute to altering patient outcomes is a daunting task. Differences in socioeconomic status can lead to care from entirely different health care systems making it difficult to isolate and assess the contribution of key differences in care between socioeconomic groups.

The University of Southern California is uniquely positioned to further clarify some key factors in these disparities in that it encompasses care for many socioeconomic groups through its private and publicly funded hospitals. Los Angeles County + University of Southern California (LAC + USC) Medical Center is the largest public medical hospital in Los Angeles County. It is near its privately funded counterpart, Keck Medical Center of the University of Southern California. Of note, 72.6% of inpatient discharges at LAC + USC Medical Center are Medi-Cal Fee for Service or Medi-Cal Managed Care insured, in contrast to Keck Medical Center of University of Southern California where 19.3% of inpatient discharges are Medi-Cal insured.[9,10] For the Otolaryngology—Head and Neck Surgery service, both hospitals are staffed by the same attending physicians and residents, which allows for comparison of outcomes between the patient populations controlled for providers. Using the experiences of these two hospitals, this study aims to delineate differences in length of ICU care and hospital stay, as well as the frequency of major and minor complications between patients undergoing laryngotracheal and TR.

2 | METHODS

2.1 | Patient selection and data collection

After obtaining institutional review board study approval, medical records were retrospectively reviewed for all patients at the Keck Medical Center of the University of Southern California and LAC +USC Medical Center who had tracheal or cricotracheal resection (CTR) performed by the Otolaryngology service from September 2014 to September 2019. The same four surgeons performed the TRs at both hospitals. Procedures were only included if they had a complete resection and anastomosis.

Demographic data including sex, age at the time of surgery, ethnicity, smoking history, alcohol history, median household income by zip code, and insurance status was recorded. Additionally, American Society of Anesthesiologists (ASA) grade, medical comorbidities including diabetes, cardiovascular disease, obesity, and chronic obstructive pulmonary disease were collected. Surgical data including date of the surgery, surgical time, number of previous procedures for stenosis, etiology of stenosis, length of resection, number of days in the intensive care unit (ICU), and the time to discharge. Patients were deemed ready for discharge when medically stable with return of baseline ambulatory condition and swallowing capacity.

The primary outcome measure was length of ICU stay. Secondary outcomes included total length of stay and post-operative complications. Major complications were defined as reintubation, hematoma with return to the operating room (OR), dehiscence, failure of treatment with repeat tracheostomy, and death. Minor complications included subcutaneous emphysema, non-operative hematoma, and wound site infection.

Preoperative evaluation, procedural technique, and postoperative care were consistent between hospitals. The area of stenosis was evaluated in the preoperative period with in-office flexible laryngoscopy, bronchoscopy, and computed tomography . All patients received perioperative antibiotics and direct laryngoscopy was performed at the beginning of every surgery. Tracheal and CTR were performed as

described in Clayman and Cohen Atlas of Head and Neck Surgery.[11] All patients were extubated in the operating room and were admitted to the ICU for post-operative monitoring. Cervical forced flexion was maintained with a Minerva brace; no Grillo stitches were used. All patients received nebulized Ciprodex twice a day while admitted.

2.2 | Statistical analysis

Chi-squared with Yates's continuity correction and Fisher exact test were used for bivariate statistical analysis. The Yates's continuity correction was required to prevent overestimation of statistical significance from small data. *T* tests were used for analysis of ratio data between groups. All statistical analyses were conducted using R. Statistical significance was attributed to a confidence interval of 95% for all analyses.

3 | RESULTS

The total study population consisted of 17 public patients and 26 private patients who received TR from 2014 to 2019 (Table 1).

3.1 | Patient demographics and insurance status

There was an even distribution of male to female patients at the private hospital. At the public institution, there were 71% male to 29% female. The median age at the public hospital was significantly younger (37) compared to the private one (55; $P < .001$). The majority of patients at the private hospital identified themselves as Caucasian (38%) and Hispanic (35%). In contrast, most patients at the public hospital identified themselves as Hispanic (71%). Consistent with whole hospital data, 59% of public patients had Medi-Cal (California Medicaid program) insurance. Twenty-four percentage were uninsured, 18% had a private HMO, and no patients were covered by Medicare. In contrast, the private hospital had 38% of patients covered by Medicare, 35% by a private HMO, 15% with a private PPO, and only 12% covered by Medi-Cal. Median household income of public patients was $49 621 compared to $68 372 in private patients ($P = .002$).

3.2 | Patient characteristics

Patients at the private hospital had a higher incidence of diabetes (15.4% vs 6.9%, $P = .39$), cardiovascular disease (42.3% vs 25%,

TABLE 1 Patient demographics

	Public hospital n = 17	Private hospital n = 26	*P*-value
Gender	# (%)	# (%)	
Male	12 (70.5)	13 (50)	
Female	5 (29.5)	13(50)	.21
Age at surgery	Years	Years	
	36.8	54.8	<.001
Race	# (%)	# (%)	
Caucasian, n (%)	1 (5)	10(38.5)	
Hispanic, n (%)	9 (52.9)	8 (30.7)	
Black, n (%)	2 (11.7)	3 (11.5)	
Asian, n (%)	0 (0)	3 (11.5)	
Other, n (%)	2 (11.7)	1 (3.8)	<.001
Insurance status	# (%)	# (%)	
Medi-Cal	10 (58.8)	3 (11.5)	
Medicare	3 (17.6)	10(38.5)	
Private HMO/PPO	0(0)	13 (50)	
No Insurance	4 (23.5)	0 (0)	<.001
Median household income			
	$49 621	$68 372	.002
Medical comorbidities	# (%)	# (%)	
Diabetes	8(30.8)	3 (17.6)	.39
Cardiovascular disease	11 (42.3)	4 (23.5)	.26
Obesity	6 (23.1)	3 (17.6)	.74
Pulmonary disease	3 (11.5)	1 (5.9)	.57
ASA score			
Mean	2.92	2.38	.04

P = .26), obesity (23% vs 19%,*P* = .74), and pulmonary disease (11.5% vs 5.8%, *P* = .74). None of these differences in medical comorbidity was statistically significant. However, private patients had higher ASA scores when compared to public patients (2.92 vs 2.38, *P* = .04).

Patients at both hospitals had similar etiologies of stenosis with previous intubation with tracheostomy being the most common (76% private, 65% public). Other etiologies included prolonged intubation without tracheostomy, idiopathic, and papillary thyroid carcinoma with significant tracheal invasion. Both patient populations had failed prior endoscopic management (41% private, 50% public). Public patients had a longer average stenosis length of 3.5 cm compared to 2.7 cm at the private hospital, however this was not statistically significant (*P* = .06).

3.3 | Surgical complications

No intraoperative complications were noted in either patient population. Following surgery, 2/17 (11.7%) of patients at the public hospital experienced minor post-operative complications compared to private patients 2/26 (7.6%; *P* = 1). Patients at the private hospital had suffered no major complications, including no hematomas requiring operative intervention, no repeat intubations, failures of treatment with repeat tracheotomy, or deaths. By comparison, 4/17 patients experienced major complications at the public hospital (*P* = .02). Public patients had four recorded reintubation events (*P* = .10), one operative anastomotic dehiscence, three operative neck hematomas (*P* = .10), two failures of treatment requiring repeat tracheostomy (*P* = .15), and one death from anastomotic dehiscence and tracheainnominate fistulization (*P* = .16). The private hospital had two instances of self-resolving subcutaneous emphysema. The public hospital had one non-operative anastomotic dehiscence that resolved with wound packing, and one self-resolving instance of subcutaneous emphysema.

3.4 | Length of stay

Length of ICU stay was 2.5 days at the private hospital and 7.2 days in the public setting (*P* = .003). The mean time to discharge at the public hospital was 12.4 days compared to 7.8 days at the private one (*P* = .07). At follow-up, 15% of private patients required an additional endoscopic management compared to 12% of county patients (*P* = 1; Table 2).

4 | DISCUSSION

TR has been established as a safe and effective procedure in the management of tracheal stenosis.[3] Given the relative rarity of the procedure, evaluation of socioeconomic status and hospital setting on patient outcomes has been largely unexplored. Our goal was to evaluate patient outcomes between private and county funded hospitals while controlling for operating surgeons. By doing so, we hope to better understand key factors that modify outcomes of open airway surgery between hospital settings and different socioeconomic groups.

Patients served at the public hospital predominantly had county funded insurance or were uninsured in comparison to the private hospital whose patients were more likely to be covered by Medicare or private HMO/PPO plans. Private patients had an average median household income of $68 372 compared to $49 621 in the county population. County patients were younger and with no statistically significant difference in specific medical comorbidities. Notably, the older private university population had a higher ASA grade than their public counterparts. In both populations, the most attributed cause of stenosis was previous tracheostomy. On further review, 47% of county patients had a tracheostomy performed in the setting of trauma (motor vehicle accidents, assault, etc.) compared to 12% of private patients, likely contributing to the notable difference in age.

Our data suggests that patients undergoing TR at a county hospital have longer ICU stays as well as higher major complication rates

TABLE 2 Outcomes

	Public hospital n = 17	Private hospital n = 26	*P*-value
Total length of stay	Days	Days	
Mean (SD)	12.41 (±9.06)	7.84 (±4)	.07
ICU length of stay			
Mean (SD)	7.17 (±5.36)	2.52 (±1.85)	.003
Major complications			
Reintubation	4	0	
Operative hematoma	3	0	
Re-Trach	2	0	
Death	1	0	.02
Minor complications			
Subcutaneous emphysema	2	2	
Non-operative dehiscence	1	0	.37

despite being younger and having a lower ASA grade. A secondary analysis of ICU and total hospital length of stay excluding patients with major complications revealed a much smaller difference in length of hospital stay (7.84 vs 9.38, P = .22). However, ICU length of stay remained significantly different (2.52 vs 5.2, P = .009). After controlling for providers, it begs a closer look into the patient pathways within each hospital system. In a study of trauma, admissions material and social deprivation was associated with an average 2.6 day (24%) longer hospital stay.[12] Another study associated low socioeconomic status with an increased likelihood of ICU stays greater than 5 days. The authors suggested differences in access to long-term care facilities and community aid, availability of natural caregivers, and ability to acquire necessary supplies for post-operative care as possible driving factors.[13]

The two hospitals have comparable ICU capacity, with 2:1 nurse to patient ratios. Without obvious functional variance in the level of care, perceived differences between the two settings could alter the likelihood of a provider transferring a patient to a step-down unit, extending ICU time. Moreover, patients in the county system have more barriers to resources like home health care and have less access to primary care, which may increase their total length of stay. In a study evaluating access to primary care, patients perceived as having a high socioeconomic status was associated with an odds ratio of 1.78 for the offer of an appointment.[14] With preferential access for patients with higher socioeconomic status, providers may hold a lower functional status requirement prior to discharge. This can be contrasted to the county hospital setting where lack of confidence in follow up and health care resources could lead to a lower tolerance for recovery at home, ultimately increasing hospital length of stay.

Patients at the public hospital were also more likely to have major and minor complications than patients treated at the private hospital. No private patient suffered a major complication compared to four patients at the public hospital. Although major complications were overall low, the difference in complication rates between these populations is significant. Major complications required either a return to the operating room or a reintubation event, highlighting the gravity of complications associated with open airway surgery.

In the case of the single mortality, the procedure was performed in a patient with invasive thyroid carcinoma and poorly controlled diabetes. Given the extensive burden of disease at presentation including extensive tracheal invasion and airway obstruction, the patient was unable to be medically optimized prior to surgery. The patient developed anastomotic dehiscence requiring a tracheotomy. In the post-operative period, she developed and ultimately died from a tracheoinnominate fistula. Less access to primary care could have contributed to her uncontrolled medical comorbidities as well as her delayed presentation for invasive papillary carcinoma.

The main limitation of the study is the small sample size. A post hoc power analysis of ICU length of stay was 92%. Although this analysis suggests significance, there were much larger fluctuations in total hospital stay and complication rates more likely indicative of an underpowered study. Given open airway surgery is less frequently performed, it is difficult to amass a large sample in a single institution study. A larger patient population or a prospectively designed study could strengthen our findings. Patient records were reviewed for the presence of medical comorbidities but were not graded based on severity. ASA grade was also recorded to better assess patient's perioperative risk. However, ASA grade is a subjective assessment made by anesthesiology and does not necessarily represent a patient's true perioperative risk or overall health status. Another notable difference between the two populations was the average length of resection, 2.7 cm at the private hospital and 3.5 at the public one (P = .06). This approached statistical significance with the average length being nearly a centimeter in difference. This baseline difference in case characteristic could be a contributing factor to the difference seen in patient outcomes.

5 | CONCLUSION

Patients who underwent TR at a publicly funded hospital had longer ICU and higher complication rates despite being younger and having a lower ASA grade when compared to patients treated at a university hospital staffed by the same physicians. The total length of stay also approached significance with data suggesting a longer stay in the public setting. These outcomes are almost certainly multifactorial and may be related to poorer access to primary care preoperatively leading to delay in diagnosis and treatment, poorly controlled or undiagnosed medical comorbidities, and differences in hospital resources.

CONFLICT OF INTEREST

The authors declare no conflict of interest. No funding was received for this work.

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