

Impact of smoking on trauma patients

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ABSTRACT

BACKGROUND: The harmful effects of smoking have been well-documented in the medical literature for decades. To further the support of smoking cessation, we investigate the effect of smoking on a less studied population, the trauma patient.

METHODS: All trauma patients admitted to the surgical intensive care unit at the LAC + University of Southern California medical center between January 2007 and December 2011 were included. Patients were stratified into two groups - current smokers and non-smokers. Demographics, admission vitals, comorbidities, operative interventions, injury severity indices, and acute physiology and chronic health evaluation (APACHE) II scores were documented. Uni- and multi-variate modeling was performed. Outcomes studied were mortality, duration of mechanical ventilation, and length of hospitalization.

RESULTS: A total of 1754 patients were available for analysis, 118 (6.7%) patients were current smokers. The mean age was 41.4 ± 20.4 , 81.0% male and 73.5% suffered blunt trauma. Smokers had a higher incidence of congestive heart failure (4.2% vs. 0.9%, $p=0.007$) and alcoholism (20.3% vs. 5.9%, $p<0.001$), but had a significantly lower APACHE II score. After multivariate regression analysis, there was no significant mortality difference. Patients who smoked spent more days mechanically ventilated (beta coefficient: 4.96 [1.37, 8.55, $p=0.007$]).

CONCLUSION: Smoking is associated with worse outcome in the critically ill trauma patient. On an average, smokers spent 5 days longer requiring mechanical ventilation than non-smokers.

Key words: Critical care; mechanical ventilation; smoking; trauma.

INTRODUCTION

Tobacco use is the number one cause of preventable death in the United States (US).^[1] Over 440,000 deaths are attributed to smoking annually. In addition, billions of dollars are spent every year directly on medical expenses to treat smoking related diseases.^[2,3]

The chronic health effects of smoking are well-documented in the medical literature. In addition to being linked to long-term diseases including, cancer, chronic bronchitis, and emphysema, studies in the surgical literature show patients

who smoke have worse outcomes than prior or non-smokers.^[4-9] A recent study, using the large National Surgical Quality Improvement Program (NSQIP) database found smokers had a 30% increased risk of developing major perioperative morbidity or mortality.^[4]

There are multiple mechanisms by which smoking contributes to worse surgical outcomes. Smoking is recognized as a risk factor for poor wound healing, cardiovascular and thromboembolic events, respiratory compromise and need for prolonged mechanical ventilation, after surgery.^[5,6] In addition, the host inflammatory response is altered leading to an inability to control bacterial contamination resulting in increased post-operative infections.^[7]

Given the breadth of literature regarding the pathophysiology of smoking on the respiratory system, the increase in pulmonary complications is not surprising. The basic protective mechanisms of the airway are lost.^[8,9] Small airways are narrowed, mucus secretion is increased, and the cilia lining the respiratory tract become dysfunctional reducing the host's ability to clear inhaled toxins leading to epithelial damage, oxidative injury, and chronic inflammation. Damage to the cil-

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ia and alveolar macrophages worsen the respiratory defense contributing to the increased number of smokers with post-operative pneumonias.^[6]

Despite the overwhelming evidence to abstain, 20% of the population smokes.^[2,3] When stratified by age and gender the prevalence is highest in males and the 18-24 years old population.^[3] Probably not coincidentally, this is the demographic also most commonly associated with traumatic injury.^[10] Therefore, we thought it pertinent to investigate the impact of smoking on the acutely injured patient. We hypothesized that patients who smoked at the time of injury will have an increased incidence of complications, specifically respiratory.

MATERIALS AND METHODS

Approval for this study was obtained from the University of Southern California Institutional Review Board. This retrospective study was conducted in the verified, level one trauma center, admitting an average of 5000 trauma patients, annually. Each year, our 30 bed surgical intensive care unit (SICU) admits over 1200 patients, including all critically injured patients.

All trauma patients admitted to the SICU, between January 2007 and December 2011, were identified. Patients were stratified into two groups – current smokers and non-smokers. Smoking status was determined from the admitting physician's history and physical, physician consultation notes and/or nursing documentation in the chart. Patients were excluded from analysis if smoking status was unknown. Demographics, admission vital signs, Glasgow coma scale (GCS), comorbidities, operative interventions, injury severity indices, acute physiology and chronic health evaluation (APACHE) II scores, and complications were abstracted. Outcomes variables collected included mortality, duration of mechanical ventilation, SICU length of stay (LOS) and overall length of hospitalization.

Descriptive statistics are reported using means \pm standard deviations for continuous variables and percentages for categorical variables. Certain continuous variables were dichotomized using clinically relevant cut-points to include age ≥ 55 years, admission GCS ≤ 8 , injury severity score (ISS) ≥ 25 , abbreviated injury scale ≥ 3 , and hypotension, defined as a systolic blood pressure ≤ 90 mmHg. Normality testing for continuous variables was done using the Shapiro–Wilk test, and compared using Student's t-test or Mann–Whitney U-test as appropriate, while dichotomous variables were compared using Chi-square or Fisher's exact test.

Outcomes were analyzed using multivariate analyses adjusting for variables differing significantly at $p < 0.05$ from the univariate analysis. Results of the multivariate analysis are reported as adjusted odds ratio (OR) and beta coefficients for the dichotomous and continuous outcome variables, respectively.

All statistical analysis was performed using Statistical Package for Social Sciences (SPSS Windows[®]), version 17.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

A total of 1754 trauma patients were eligible for analysis. Of these patients, 118 (6.7%) were identified as current smokers. In comparison of the two groups, the current smoker and non-smoker cohorts were equally matched in most categories. The majority, in both groups, was male and sustained blunt trauma. Overall, patients were young, with only a quarter of the patients in each group over 55 years of age. Comparing comorbidities, the current smokers had a higher incidence of congestive heart failure (4.2% vs. 0.9%, $p = 0.007$) and alcoholism (20.3% vs. 5.9%, $p < 0.001$).

In regards to injury severity at the time of admission, current smokers had higher GCS (14.4 ± 1.8 vs. 12.7 ± 3.9) and less patients had a head abbreviated injury score (AIS) > 3 (22% vs. 35%). Groups were similar in chest, abdominal and extremity AIS and ISS. The current smokers had a significantly lower APACHE II score (12.5 ± 7.2 vs. 16.5 ± 9.6) when compared to the non-smoker group. Difference in heart rate was statistically significant ($p = 0.015$) between the two groups, however, not considered clinically significant (92.5 vs. 98.7 bpm). There was no significant difference between the current smokers and non-smokers in regards to open chest or abdominal explorations. Comparison of the two groups is shown in Table 1.

Outcomes

Hospital and ICU LOS was equivalent between the current smokers and non-smokers. On uni- and multi-variate analysis there was no significant difference between the two groups. Mortality rate was significantly higher in the non-smokers (7.6%) than the current smokers (2.5%, $p = 0.042$). However, on multivariate analysis the difference in mortality between the two groups did not reach statistical significance ($p = 0.963$). Comparison of the total days spent requiring mechanical ventilation differed significantly on multivariate analysis. The current smoker group spent, on average, 5 more days on the ventilator than the non-smokers. Outcome comparisons are shown in Table 2.

DISCUSSION

Our study demonstrates that patients who smoke and suffer major trauma have a significantly higher risk of requiring prolonged mechanical ventilation. Despite being less critically ill, as indicated by the lower APACHE II and head AIS and higher GCS, smoking was associated with worse outcomes. The smokers in our study spent an average of 5 days longer requiring mechanical ventilation than the non-smokers.

About 50% of injuries occur in patients under the age of

Table 1. Cohort comparison

| | Current smokers (n=118) | Non-smokers (n=1636) | p |
|-------------------------------------|-------------------------|----------------------|--------|
| Age 41.2±18.7 | 39.9±22.8 | 0.778 | |
| Age ≥55 | 24.6% (29/118) | 25.3% (414/1636) | 0.860 |
| Gender (Male) | 87.3% (103/118) | 80.6% (1318/1636) | 0.088 |
| Comorbidities | | | |
| Alcoholism | 20.3% (24/118) | 5.9% (97/1636) | <0.001 |
| Hypertension | 22.9% (27/118) | 16.0% (261/1636) | 0.050 |
| Diabetes | 14.4% (17/118) | 9.4% (154/1636) | 0.077 |
| Congestive heart failure | 4.2% (5/118) | 0.9% (14/1636) | 0.007 |
| Respiratory disease | 4.2% (5/118) | 2.1% (35/1636) | 0.186 |
| End stage renal disease on dialysis | 2.5% (3/118) | 1.4% (23/1636) | 0.253 |
| Obesity | 0.8% (1/118) | 1.9% (31/1636) | 0.720 |
| Blunt trauma | 72.9% (86/118) | 73.6% (1205/1636) | 0.865 |
| Systolic blood pressure | 132.6±25.6 | 131.8±29.3 | 0.864 |
| Hypotension | 5.2% (6/115) | 6.7% (107/1609) | 0.549 |
| Heart rate | 92.5±19.6 | 98.7±26.0 | 0.015 |
| Admission Glasgow coma scale | 14.4±1.8 | 12.7±3.9 | <0.001 |
| Glasgow coma scale ≤8 | 2.7% (3/112) | 17.1% (274/1599) | <0.001 |
| Head Abbreviated injury score >3 | 22.0% (26/118) | 35.5% (580/1636) | 0.003 |
| Chest Abbreviated injury score | 39.0% (46/118) | 35.1% (574/1636) | 0.392 |
| Abdominal Abbreviated injury score | 23.7% (28/118) | 18.9% (310/1636) | 0.204 |
| Extremity Abbreviated injury score | 20.3% (24/118) | 21.6% (354/1636) | 0.740 |
| Injury severity score | 15.3±10.8 | 16.6±10.9 | 0.102 |
| Injury severity score >25 | 22.0% (26/118) | 22.9% (374/1635) | 0.834 |
| APACHE II score | 12.5±7.2 | 16.5±9.6 | <0.001 |
| Thoracotomy/sternotomy | 1.7% (2/118) | 3.7% (61/1636) | 0.436 |
| Laparotomy | 18.6% (22/118) | 21.3% (348/1636) | 0.499 |

APACHE: Acute physiology and chronic health evaluation.

Table 2. Outcomes

| | Smokers (n=118) | Non-smokers (n=1636) | AOR (95% CI)/beta (95% CI) | p |
|-------------------|-----------------|----------------------|----------------------------|-------|
| Mortality | 2.5% (3/118) | 7.6% (125/1636) | 1.03 (0.28, 3.81) | 0.963 |
| HLOS* | 14.4±17.5 | 14.8±24.9 | 0.69 (-4.05, 5.43) | 0.766 |
| ICU LOS* | 9.1±15.1 | 8.6±11.3 | 2.10 (-0.02, 4.22) | 0.052 |
| Total ventilator* | 11.9±21.2 | 7.9±11.3 | 4.96 (1.37, 8.55) | 0.007 |

*Measured in days. AOR: Adjusted odds ratio; CI: Confidence interval; HLOS: Hospital length of stay; ICU: Intensive care unit; LOS: Length of stay.

45.^[10] Accordingly, the mean age for both our smoker and non-smoker cohort was 40, considerably younger than the average patient age in the rest of the literature on surgery and smoking. One of the largest studies, on the effects of smoking in the surgical patient was based on the Veteran Affairs database, an older male population.^[5] In the large NSQIP study by Sharma et al.,^[4] the median age was 60. Our study

looked not at the elderly, comorbid smoking patient, but at the critically injured smoker. Despite being young and less critically ill the smokers still had worse outcomes than non-smokers.

The study findings mimic those published in the elective surgical literature. Ngaage et al.,^[8] analyzed 2163 elective cardiac

surgery patients. 10% of the patients, despite preoperative counseling, were active smokers at the time of surgery. These patients required a longer duration of mechanical ventilation and were twice as likely to experience post-operative pulmonary complications.

Regardless of the surgical specialty the risk of smoking preoperatively has been demonstrated. Hawn et al.,^[5] looked at over 100,000 smokers who underwent elective surgery across multiple surgical disciplines. Smokers were across the board more likely to suffer surgical complications, including wound infections, deep vein thrombosis, myocardial infarctions, and mortality. Respiratory complications, including pneumonias, prolonged mechanical ventilation and reintubation, were also markedly increased in patients with a smoking history. Even after accounting for complexity of procedure, the increased complication rates applied across all surgical procedures.

The effect of smoking on patients undergoing elective surgery is well-documented; however, the impact on outcomes after acute injury has been minimally investigated. To the best of our knowledge, only two other studies have looked specifically at the trauma population when assessing the risks of smoking. Calfee et al.^[11] followed severe blunt trauma patients for the development of acute lung injury (ALI). To accurately identify, the smoking cohort, plasma cotinine levels were measured upon patient's arrival to the emergency department. Cotinine, a metabolite of nicotine can quantify cigarette smoke exposure. Patients with the highest levels of cotinine, the identified active smokers, were over 3 times more likely to develop ALI than patients with the lowest levels, the identified non-smokers. Interestingly, with this method, patients who were exposed to heavy secondhand smoke were also able to be studied. Patients exposed to moderate to high levels of secondhand smoke had a nearly equivalent risk for developing ALI as the active smokers (OR, 3.03; 95% confidence interval, 1.15-8.04).

The findings reported by Nguyen-Ferro et al.^[12] failed to show any statistically significant differences between a smoker and non-smoker outcomes in the 327 severely injured patients they studied. However, both the need for intubation and the occurrence of respiratory failure were increased in the identified smoker cohort. This study faced the same limitations as ours, being retrospective and having unreliable smoking documentation. In addition, their sample size was smaller, which may account for the lack of statistical significance.

As previously mentioned, our study was limited by the inherent biases of a retrospective study. The smoking prevalence of our trauma population is almost certainly underestimated. One-fifth of the US population currently smoke, and this percentage is higher in the trauma patient population.^[2,3] The smoker cohort in our study accounted for only 6.7% of our overall patient population. It is difficult to retrospectively ob-

tain accurate documentation of smoking status, especially in the critically ill, intubated and sedated patients. Patients who were not identified at the time of admission as current smokers were not included in this study. Smokers are more likely to be classified as non-smokers than the other way around.^[11] Calfee et al., found 41% of patients demonstrated to be active smokers based on cotinine levels were not documented as such in the chart.

These inaccuracies likely only underestimate the harmful effect of smoking on the trauma patient. Future studies should be focused on accurate documentation of patient's smoking histories, including the amount and duration. Inclusion of patients with second hand smoke exposure and previous smokers would also be of interest to analyze and compare to current smokers.

Conclusion

Smoking is associated with a worse pulmonary outcome in the critically injured patient. Smokers were mechanically ventilated for longer periods of time, on average, 5 days more. The impact of smoking in the trauma patient warrants future, prospective study. Programs promoting smoking cessation, especially in the younger, trauma prone population, are strongly encouraged.

Conflict of interest: None declared.

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KLİNİK ÇALIŞMA - ÖZET

Travma hastalarında sigaranın etkisi

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AMAÇ: Onyıllardan beri tıp literatüründe sigara içmenin zararlı etkileri iyice belgelenmiştir. Sigara bırakmaya ilave destek sağlamak için sigara içiminin daha az incelenmiş bir popülasyonda, travma hastalarındaki etkisini inceliyoruz.

GEREÇ VE YÖNTEM: Ocak 2007 ile Aralık 2011 arasında LAC + Güney Kaliforniya Üniversitesi (University of Southern California) tıp merkezi cerrahi yoğun bakım ünitesine kabul edilen travma hastalarının hepsi çalışmaya dahil edildi. Hastalar halihazırda sigara içenlerle içmeyenler olarak iki gruba ayrıldı. Demografik özellikler, kabuldeki yaşamsal bulgular, komorbiditeler, cerrahi girişimler, travma şiddet derecesi indeksleri, akut fizyoloji ve kronik sağlık değerlendirme (APACHE) II skorları kaydedildi. Tek ve çok değişkenli analizler uygulandı. İncelenen son noktalar mortalite, mekanik ventilasyon tedavisinde kalma ve hastanede yatış süresiydi.

BULGULAR: Analize 118'i (%6.7) sigara kullananlar olmak üzere toplam 1754 hasta alındı. Yaş ortalaması 41.4 ± 20.4 , yıl olup, hastaların %81.0'i erkek idi. Hastaların %73.5'i kafa travması geçirmişti. Sigara içenlerde konjestif kalp yetersizliği (%4.2'ye karşın %0.9; $p=0.007$) ve alkolizm (%20.3'e karşın %5.9, $p<0.001$) insidansı daha yüksek olmasına karşın APACHE II skoru anlamlı derecede daha düşüktü. Çok değişkenli regresyon analizinde mortalitede anlamlı bir farklılık saptanmadı. Sigara içicisi hastalar mekanik ventilasyon tedavisinde daha uzun süre kaldı (beta katsayısı: 4.96 [1.37; 8.55, $p=0.007$]).

TARTIŞMA: Sigara kullanımı kritik travma hastasında daha kötü sonuçlarla ilişkilidir. Sigara kullanmayanlara göre sigara içiciler mekanik ventilasyonda beş gün daha uzun süre kalmıştır.

Anahtar sözcükler: Kritik hasta bakımı; mekanik ventilasyon; sigara kullanımı; travma.

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