The Role of Bronchoscopy in Acute Burns

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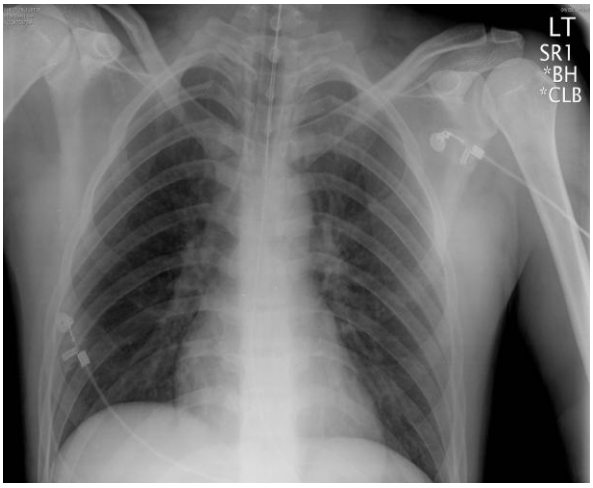
A 20 year old man presented to the emergency department with an acute burn. After acute alcoholic intoxication, he fell into a large outdoor fire. He suffered burns to his face, hands, and upper chest, and was intubated by paramedics on the scene.

He has no significant past medical history and takes no medications. He smokes cigarettes and occasionally uses marijuana and alcohol. His vital signs were stable after intubation. Chest X-ray is shown:



The primary survey estimated his burns to be 40-45% of his Total Body Surface Area (TBSA). Bronchoscopy with bronchoalveolar lavage was requested.

What is the role of bronchoscopy in acute burns?

Inhalational injury has become the most common cause of death in burn victims. The mortality from shock has been reduced with improved fluid resuscitation, and sepsis-related mortality has been reduced with improved surgical techniques[1]. The mortality of acute inhalational injury, however, hasn't changed over the last 10 years. The presence of inhalational injury increases the relative mortality and risk of pneumonia regardless of the severity of cutaneous burn[1].

Is bronchoscopy superior to history and physical for diagnosing inhalational injury?

Studies from the 1970s evaluated the utility of bronchoscopy in the diagnosis of inhalational airway injury. Studies using clinical findings such as the presence of facial burns, "closed space" burns (burns in an enclosed area where inhalation of smoke was likely present), carbonaceous sputum, abnormal chest examination, and hypoxemia as compared to bronchoscopy revealed conflicting results[2,3]. More recent studies demonstrated that using routine bronchoscopy to evaluate the airways for soot, charring, mucosal necrosis, airway edema, and inflammation led to a two-fold increase in the diagnosis of inhalational airway injury[4]. The addition of endobronchial biopsies may further increase the sensitivity of bronchoscopy for diagnosing inhalational injury. In one study from a burn unit in France, 130 consecutive burn victims underwent bronchoscopy and bronchial biopsies of the proximal and distal right lung[5]. 44 were diagnosed with inhalational injury, including 19 patients whose inhalational injury was not suspected by clinical criteria alone, and 9 patients who were diagnosed by histology alone. 52% of the patients with inhalational injury developed ARDS, versus 7% of the patients without inhalational injury.

Does the severity of inhalational injury at initial bronchoscopy have prognostic value?

Bingham et al evaluated 27 patients with clinically suspected inhalational injury and graded the bronchoscopic findings from grade 0 (no laryngeal edema) to grade 5 (severe tracheal edema and erythema)[7]. Non-survivors had an index of 3.2 ± 1.6; survivors 3.4 ± 1.2, demonstrating that bronchoscopic grading did not predict mortality. The severity of injury did not correlate with oxygen requirements or with duration of intubation[6]. Another study from Japan evaluated patients within 24 hours of injury using endobronchial biopsies of the main and lobar bronchi. The biopsy specimens were graded by a pathologist as follows; G0 (negative), G1 (mild edema and hyperemia with or without carbon soot), G2 (severe edema and hyperemia with or without carbon soot) and G3 (ulcerations, necrosis). Increasing depth of mucosal injury was associated with increased risk of developing ARDS (4% for G1, 33% for G2, 77% for G3), but was not associated with mortality rates.

Does the presence of inhalational injury have an effect on fluid resuscitation?

A landmark study by Navar et al in 1985 demonstrated that patients with inhalational injury required significantly more intravenous fluid to achieve adequate resuscitation from the initial shock than those without it (5.8 vs. 4.0 ml/kg/%TBSA burn) [8]. This observation was later confirmed in a retrospective study[9].

A recent retrospective study examined 80 patients with clinically suspected inhalational injury[10]. The degree of inhalational injury was graded using bronchoscopy from grade 0 (no visible injury) to grade 4 (massive injury, necrosis, mucosal sloughing). There was no significant difference in fluid resuscitation requirements for patients with Grade 0 and 1 injuries as compared to patients with Grade 2, 3 or 4 injuries. Patients with less severe inhalational injury did not have significantly fewer ventilator days (8.6 vs. 12.8, p = 0.11), but had a better survival rate (84% v. 57%, p = 0.03).

Is there any benefit to performing bronchoalveolar lavage during the initial airway examination?

Patients with suspected inhalational injury are usually emergently intubated. The authors of a recent study considered that airway contamination during initial intubation could contribute to ventilator-associated pneumonia and pulmonary complications during the hospital course[11]. In this study, Mosier et al conducted a retrospective review of 74 patients with inhalational injury who required emergent intubation and underwent bronchoscopy with BAL within 24 hours of the injury. These patients were grouped depending on the results of the BAL cultures – no growth, normal flora, $<10^5$cfu pathologic organism growth, and $>10^5$cfu pathologic organism growth. 16% of patients had $>10^5$cfu growth (most commonly gram-positive cocci), those patients had a trend toward longer ventilator requirement and length of hospital stay. 13 of the 74 patients developed ventilator-associated pneumonia within the first 6 days after injury, but only 8 of those 13 patients had pathologic organisms on the initial BAL.

Patient Course

Our patient underwent bronchoscopy with BAL of the left upper lobe on the day of admission. He had mild diffuse erythema and scant carbon deposits consistent with a grade 1 inhalational injury. His BAL cultures grew *Hemophilus influenzae* as well as *methicillin-resistant Staphylococcus aureus*. Unfortunately,

quantitative cultures were not obtained. He was treated for 10 days with vancomycin and piperacillin/tazobactam. His hospital course was complicated by a wound infection and *E. Coli* bacteremia. He had difficulty weaning from the ventilator and underwent tracheostomy on hospital day 15. He was discharged to long-term acute care on hospital day 17. He was discharged to home and returned for an uneventful skin graft revision 1 month later.

Conclusions:

- Bronchoscopy is superior to clinical exam for the diagnosis of inhalational injury, and should be performed within 24 hours of injury.
- Bronchial biopsies may increase the sensitivity of bronchoscopy, and the histologic depth of injury may help predict risk of developing ARDS.
- It's not clear if the visual severity of injury predicts survival.
- Fluid resuscitation requirements are increased in the presence of inhalational injury, but these requirements do not correlate with the severity of the injury.
- More studies need to be performed to evaluate the clinical utility of routine bronchoalveolar lavage on initial bronchoscopic inspection.
- A standard grading system for bronchoscopic findings in inhalational injury needs to be established for future studies.

References

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	Endorf et al	Bingham et al
Grade 0 (no injury)	Absence of carbonaceous deposits, erythema, edema, bronchorrhea, or obstruction.	N/A
Grade 1 (mild injury)	Minor or patchy areas of erythema, carbonaceous deposits in proximal or distal bronchi (any or combination).	No laryngeal edema.
Grade 2 (moderate injury)	Moderate degree of erythema, carbonaceous deposits, bronchorrhea, with or without compromise of the bronchi (any or combination).	Minimal laryngeal edema and erythema.
Grade 3 (severe injury)	Severe inflammation with friability, copious carbonaceous deposits, bronchorrhea, bronchial obstruction (any or combination).	Slight tracheal mucosal edema and erythema.
Grade 4 (massive injury)	Evidence of mucosal sloughing, necrosis, endoluminal obliteration (any or combination).	Moderate tracheal mucosal edema and erythema.
Grade 5	N/A	Severe tracheal edema and erythema.

Table 1. Bronchoscopic criteria used to grade inhalational injury [7,10]