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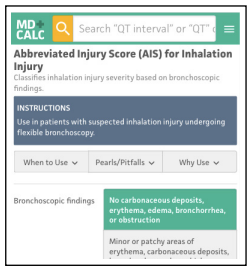

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Abbreviated Injury Score (AIS) for Inhalation Injury

Introduction: The Abbreviated Injury Score (AIS) classifies inhalation injury severity based on bronchoscopic findings.

Points & Pearls

- The AIS may predict the development of acute respiratory distress syndrome (ARDS), the length of time on mechanical ventilation, and prolonged stay in the intensive care unit (ICU).
- Some studies have found a non-statistically significant trend toward worse outcomes with a higher AIS.
- AIS severity has not been consistently associated with mortality (Sheridan 2016).
- The AIS cannot reliably predict the need for high fluid resuscitation requirements.
- A typical flexible bronchoscope is 5 mm in diameter on average; hence, bronchoscopy cannot identify narrower distal airway changes. Thus, bronchoscopic findings cannot be relied upon to accurately reflect the overall severity of airway inhalation injury.

Advice

High AIS severity alone should not dictate management decisions, which should be made in conjunction with a patient's history, physical examination, and laboratory findings.

Critical Actions

Macroscopic manifestations of airway abnormalities may be delayed, falsely reassuring the clinician that inhalation injury has not occurred (Hunt 1975).

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Evidence Appraisal

The AIS criteria were first proposed by Endorf and Gamelli in 2007. The purpose of their study was to identify whether the severity of inhalation injury correlated better with pulmonary parameters (eg, lung compliance, PaO_2:FiO_2 ratio) and acute fluid resuscitation requirement than with bronchoscopically assessed inhalation injury severity. They retrospectively reviewed 80 adult patients with suspected inhalation injury who required intubation, mechanical ventilation, and flexible bronchoscopy within the first 24 hours of admission. AIS criteria were used to separate the patients into 2 groups of bronchoscopic inhalation injury: a group with grades of 0 and 1, and a group with grades of 2, 3, and 4. Characteristics such as fluid resuscitation requirements, initial oxygenation, lung compliance, and duration of mechanical ventilation were compared between the 2 groups; however, only decreased survival correlated with bronchoscopic severity ($P = .03$).

Hassan et al (2010) also found a significant increase ($P < .01$) in mortality with bronchoscopic severity. They did not use the AIS criteria.

Since 2007, several studies have used the AIS to try to tease out a clear relationship between the bronchoscopic grade of injury and a range of clinical outcomes, with varied results. For instance, in contrast to Endorf and Gamelli's 2007 study, studies by Albright et al (2012), Mosier et al (2012), and Spano et al (2016) found that an increasing AIS grade did not have a significant effect on mortality, with P values of 0.21, 0.10, and 0.15, respectively.

Albright et al did show that increasing severity was associated with longer ventilator days ($P = .036$) and ICU stays ($P = .04$). Mosier et al (2012) noted a significant association between AIS grade severity and the development of ARDS at 24 hours ($P < .01$).

Why to Use

- The AIS criteria have not been compared head-to-head with other bronchoscopic criteria; hence, for lack of an alternative well-studied score, the AIS has been widely utilized as the predominant bronchoscopic inhalation injury severity score in the literature.
- There is no universal consensus on diagnostic and grading criteria for inhalation injury. A multicenter prospective cohort study by the American Burn Association is currently underway, with the goal of developing a scoring system for inhalation injury based on clinical, radiographic, bronchoscopic, and biochemical parameters.

When to Use

Use the AIS for adult patients with suspected inhalation injury who are undergoing flexible bronchoscopy.

Next Steps

- Supportive treatment is the primary means of inhalation injury management, as very little is available in the way of pharmacologic treatment once the inhalation injury has occurred.
- Bronchoscopy can play a therapeutic role in airway clearance, as necrotic tissue and eschar can result in formation of pseudomembranes, sloughing of mucosa, and bronchial obstruction.
- Other measures include intensive bronchial hygiene, including:
  - Bronchodilators, such as β_2 agonists
  - Frequent chest physiotherapy
  - Early patient ambulation
- Upper airway edema can progress to respiratory failure necessitating intubation, particularly over the first 24 hours after injury. If mechanical ventilation is required, a high-frequency percussive mode can be considered, as some studies have shown benefit to this patient population. A lung-protective, low tidal volume ventilation strategy (6-8 cc/kg of predicted body weight) is preferred in adults.
- Other supportive measures that have been used with varied success include prone positioning, extracorporeal membrane oxygenation (ECMO), inhaled anticoagulants (eg, heparin, antithrombin), and inhaled *N*-acetylcysteine (NAC).
- Consider referring the patient to a designated burn center.

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Calculator Creators

Frederick W. Endorf, MD and Richard L. Gamelli, MD
Click here to read more about Dr. Endorf and Dr. Gamelli.

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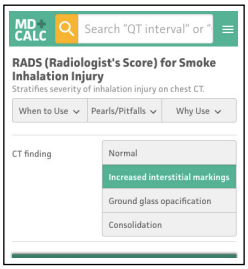

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RADS (Radiologist's Score) for Smoke Inhalation Injury

Introduction: The RADS (Radiologist's Score) for Smoke Inhalation Injury stratifies the severity of inhalation injury detected on a computed tomography (CT) scan of the chest.

Points & Pearls

- The RADS was derived from a sheep model and validated retrospectively in human cohorts, with limited validation in prospective clinical human trials.
- Calculation of the RADS requires assessment of each CT slice, which can be time-consuming.
- A higher RADS 24 hours after smoke inhalation seems to correlate with greater smoke exposure and severity of lung injury.
- Using chest CT scans in the evaluation of inhalation injury has limitations, including the questionable optimal timing of CT and the interpretation of abnormal CT findings in the setting of a negative bronchoscopy.

Advice

The RADS should be used as an adjunct to clinical history, examination, bronchoscopy, and arterial blood gas data to determine the full clinical picture.

Critical Actions

As always, clinical judgment is paramount. Management decisions should not be based solely on the RADS.

Evidence Appraisal

The RADS tool was developed from an ovine study of 20 anesthetized sheep who were intubated, exposed to wood smoke, and then underwent CT scans of the thorax at 6, 12, and 24 hours after exposure (Park 2003). The study raised several questions, including whether smoke inhalation from the combustion of materials other than wood would behave in the same way; whether a normal CT result would be sufficient to rule out significant injury; and how the score would perform in direct comparison to better-established diagnostic tools such as fiber-optic bronchoscopy.

Oh et al conducted a retrospective study of 43 patients (25 with inhalation injury and 19 with-

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Why to Use

Currently, no single tool accurately and reliably risk stratifies and prognosticates outcomes for patients with smoke inhalation injury. The RADS can be a useful adjunct to determine the severity of inhalational injury to the lungs.

A multicenter prospective cohort study sponsored by the American Burn Association is currently underway, with the goal of developing a scoring system for inhalation injury based on clinical, radiographic, bronchoscopic, and biochemical parameters.

When to Use

- Use the RADS for patients with suspected or diagnosed inhalation injury.
- The RADS is best used in conjunction with flexible bronchoscopy.

Next Steps

- Supportive treatment is the primary means of inhalation injury management. This includes intensive bronchial hygiene with the following:
  - Bronchodilators, such as β_2 agonists
  - Frequent chest physiotherapy
  - Early patient ambulation
- Upper airway edema can progress to respiratory failure necessitating intubation, particularly over the first 24 hours after injury. If mechanical ventilation is required, a high-frequency percussive mode of ventilation has shown the most benefit in this patient population (Cioffi 1991). A lung-protective, low tidal volume ventilation strategy (6-8 cc/kg of predicted body weight) is preferred for adults.
- Other supportive measures that have been used with varied success include prone positioning, extracorporeal membrane oxygenation (ECMO), inhaled anticoagulants (eg, heparin, antithrombin), and inhaled *N*-acetylcysteine (NAC).
- Consider referring the patient to a designated burn center if any inhalation injury is present, in accordance with the American Burn Association guidelines.

out); using multiple logistic regression analysis, they found that inhalation injury on bronchoscopy correlated with an 8.3-fold increase in a composite endpoint of pneumonia, acute lung injury/acute respiratory distress syndrome, and death. Positive bronchoscopy in conjunction with a RADS > 8 was correlated with a 12.7-fold increase in the composite endpoints.

We are not aware of any studies looking at inter-rater reliability of the scoring system.

A prospective clinical trial is currently underway to help answer many of the questions that have been raised. Preliminary clinical data from the Inhalation Severity Injury Scoring System trial demonstrated a positive correlation between the RADS and ventilator days.

Use the Calculator Now

Click here to access the calculator.

Calculator Creator

John S. Oh, MD
Click here to read more about Dr. Oh.

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