



Original Contribution

The association of hemodialysis and survival in intubated salicylate-poisoned patients

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ABSTRACT

Introduction: Salicylate poisonings are common due to their multiple uses and wide availability. The variation of presenting symptoms contributes to inconsistent treatments in the emergency department. Patients with severe salicylate overdose require a high minute ventilation. Early in the course of an overdose, a patient will require hyperventilation. If they become too fatigued to compensate, mechanical ventilation may be needed. It can be impossible to recreate such a high minute ventilation with mechanical ventilation. This places patients at a high risk for decompensation and death. Hemodialysis is an effective elimination technique for salicylate overdose and should be considered early.

Methods: All salicylate cases reported to the Illinois Poison Center were reviewed from 2003–2014. All intubated patients with a salicylate level >50 mg/dl were included for analysis. Survival was compared to measured serum salicylate level and the administration of hemodialysis.

Results: 56 Cases were identified with an overall survival rate of 73.2% in patients with a serum salicylate level >50 mg/dl. When patients did not receive hemodialysis, a peak salicylate level >50 mg/dl had a 56% survival rate and 0% survival when the level was >80 mg/dl. In the patients who received hemodialysis, a peak salicylate level >50 mg/dl had a 83.9% survival rate and 83.3% survival when the level was >80 mg/dl.

Conclusion: Survival was decreased in these patients if hemodialysis was not performed. Mortality increases with the measured serum salicylate level. Timely hemodialysis for intubated salicylate overdose patients decreases mortality.

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1. Introduction

Salicylates have long been used for multiple medical conditions due to their antipyretic, antithrombotic, and analgesic properties. They are accessible to the public, come in various formulations, and considered safe when taken in the proper dosage. The most commonly used salicylate is aspirin. Over 24,700 aspirin and salicylate exposures were reported to poison centers in the United States in 2014 with over 200 major exposures [1]. The ubiquitous nature of salicylates makes them an easily available method of overdose whether intentionally or unintentionally. Salicylate poisoning cases can become very complex due to the erratic absorption, distribution, metabolism, and elimination of the drug. Due to these drug characteristics, any medical provider who cares for a salicylate-toxic patient should appreciate how quickly their clinical status can deteriorate.

The pathophysiology associated with salicylate toxicity has been well-documented: early respiratory alkalosis from hyperventilation due to direct sensitization of the medullary respiratory center and metabolic acidosis due to uncoupling of oxidative phosphorylation which shifts cellular

metabolism from aerobic to anaerobic which increases lactate production and accumulation which creates a loss of bicarbonate. The body's natural response to salicylates includes hyperventilating which decreases PCO₂ and increases serum pH. It also increases the renal excretion of bicarbonate, which decreases serum pH. In an acidemic patient, salicylates easily enter the central nervous system. Expelling carbon dioxide is an essential mechanism to alkalinize the blood and becomes even more apparent when sodium bicarbonate is required for urine alkalization [2–10].

The patient with salicylate poisoning should be considered unstable until the clinical manifestations of hyperventilation and any mental status changes have returned to baseline along with a decreasing serum salicylate level to minimal levels. If a patient has any clinical manifestations of toxicity in the setting of an elevated or increasing serum salicylate level, there is a high risk of clinical deterioration. The provider should be vigilant to foresee this decline by attempting gastrointestinal decontamination with activated charcoal as well as urinary alkalization with sodium bicarbonate and aggressive potassium replacement [3,4,11–13].

A patient's mental and respiratory status should be closely monitored for fatigue, which could signal a decompensation created by a metabolic acidosis. If a patient becomes too fatigued to compensate, they may need endotracheal intubation (ETI) and mechanical ventilation. In severe salicylate toxicity, the exact roles of hypoventilation,

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hypercapnea, and worsening acidosis are unclear and optimal ventilator management may be extremely difficult to attain. In ETI patients with severe salicylate intoxication, it may be difficult to provide the high minute ventilation necessary to maintain adequate hyperventilation and acid-base equilibrium [5,6,14].

The dependence upon such a high minute ventilation is difficult to recreate on an artificially ventilated patient and an increase in pulmonary permeability combined with the high amount of fluid needed to alkalinize the urine with sodium bicarbonate puts these patients at high risk of worsening respiratory status [3,5].

When someone is unable to expel carbon dioxide due to intubation without appropriate hyperventilation there is going to be an expected decrease in serum pH. The kidneys continue to excrete bicarbonate, which contributes further to the acidemia. This relatively acidic environment changes aspirin to its nonionized form which can easily cross membranes including the blood brain barrier contributing to neurologic deterioration. The shift of salicylates into the central nervous system due to worsening acidosis has been attributed to peri-intubation cardiac arrest in these patients [2,6,15–17]. All of these complicated and integral factors place a patient at an extremely high risk for further decompensation and death [4–10].

Hemodialysis (HD) is an effective mechanism for eliminating salicylates (ASA) as well as correcting the associated acid-base disturbances in salicylate-toxic patients but must be considered in a timely fashion [4–6,11,12,18]. Many patients do not receive HD despite having generally accepted indications for hemodialysis including severe metabolic acidosis, end-organ injury (seizures, renal failure, pulmonary edema, altered mental status), and ETI [19]. Timely hemodialysis may be a life-saving therapy in these cases.

The purpose of this study was to describe the impact of hemodialysis on survival rates in salicylate-poisoned intubated patients as well as to contribute to the surprisingly limited data related to this group of critical patients.

2. Methods

This is a retrospective observational study. Illinois Poison Center cases from 1/1/2003–12/31/2014 with National Poison Data System (NPDS) generic substance code 041000 (ASPIRIN UNKNOWN IF

ADULT OR PEDIATRIC FORMULATION) or 041703 (ASPIRIN PEDIATRIC FORMULATION) or 041701 (ASPIRIN ADULT FORMULATION) or 201064 (ASPIRIN WITH CARISOPRODOL) or 041700 (ASPIRIN WITH CODEINE) or 041706 (ASPIRIN WITH OXYCODONE) or 041718 (ASPIRIN WITH PROPOXYPHENE) or 041707 (ASPIRIN WITH OTHER OPIOID) or 041708 (ASPIRIN WITH OTHER DRUG: ADULT COMBINATION FORMULATION) or 041717 (ASPIRIN WITH OTHER DRUG: PEDIATRIC COMBINATION) and NPDS treatment code of INTUBATION were included. Intubated patients with a serum salicylate level >50 mg/dl were included for analysis. This level could be reached at any time before or after initiation of mechanical ventilation. Subjects of all ages and with polysubstance ingestions were included but were only eligible if the units of measure were recorded. Fig. 1 illustrates the cases studied.

The serum salicylate level was compared to survival. If sequential salicylate levels were recorded, a peak measured salicylate level was compared to survival. Particular attention was paid to implementation of hemodialysis and if it occurred before or after intubation.

2.1. Exclusions

Eight patients were excluded from analysis due to clear lack of association with salicylate intoxication (Fig. 1).

3. Results

56 Cases were identified with an overall survival rate of 73.2% (41/56).

In 73.3% (11/15) of the fatal cases, patients did not receive HD. Of all the patients who did receive HD, all thirty-one had ETI prior to HD implementation.

ASA level was compared to survival.

3.1. Salicylate serum concentration compared to survival without HD

In patients that did not receive HD, an ASA level >50 mg/dl had a 56% survival rate (14/25) compared to 0% survival (0/9) when the level was >80 mg/dl.

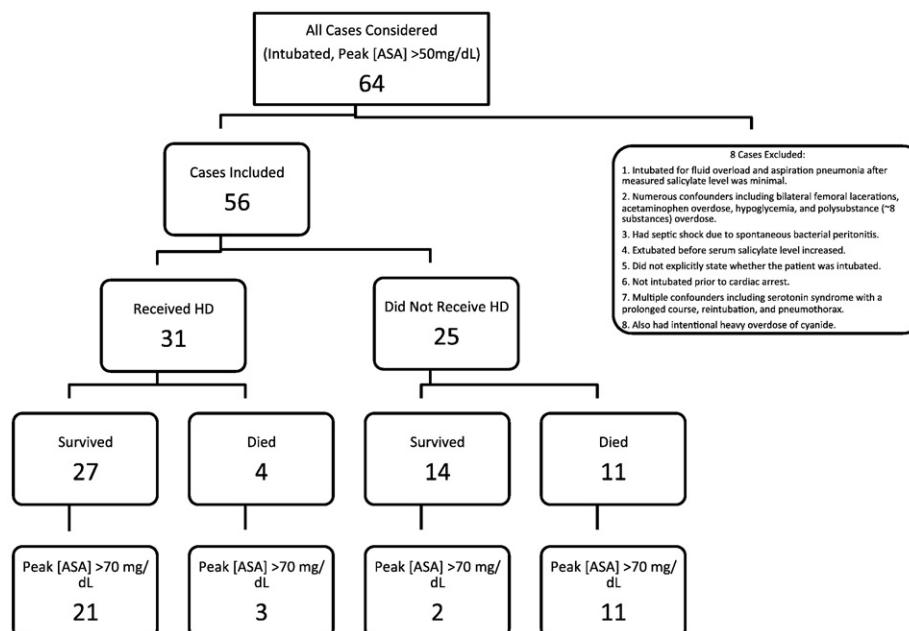


Fig. 1. All cases considered eligible for analysis.

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