Chloride is the most abundant anion in extracellular fluid and there has been an increase in the use of chloride-rich solutions such as 0.9% Sodium Chloride leading to increased adverse events. Medication diluents account for a significant portion of unintended chloride and total volume administered to intensive care unit (ICU) patients. Increasing chloride burden can lead to hyperchloremia, electrolyte disturbances, acute kidney injury (AKI), metabolic acidosis, and the need for renal replacement therapy (RRT). A single center, prospective study was conducted in intensive care patients comparing the use of 0.9% Sodium Chloride with Dextrose 5%, which found an increase in the incidence of hyperchloremia and acute kidney injury in the 0.9% Sodium Chloride group. Despite the known risks associated with increased 0.9% Sodium Chloride use and elevated chloride loads, there is a lack of robust clinical literature demonstrating the fluid burden and adverse events related to medication diluents.

The purpose of this study is to quantify the total diurnal and non-diluant chloride loads for septic patients in the intensive care unit.

This is a single center, retrospective chart review of adult patients with a primary diagnosis of sepsis admitted to the ICU from May 1, 2019 to June 30, 2019. This study was approved by the Institutional Review Board (IRB).

### Methods

**Inclusion Criteria:** Patients ≥ 18 years old with a primary diagnosis of sepsis admitted to the ICU were evaluated

**Exclusion Criteria:** Pregnant, breastfeeding, and/or did not receive intravenous fluids or medications in the ICU

Patient demographics, electrolytes, serum creatinine, fluid type and quantity were obtained from the electronic medical record

Evaluated quantity of chloride loads, incidence of hyperchloremia, AKI, and RRT

Statistical Analysis: Descriptive statistics, Mann-Whitney U, and Spearman’s Rho Correlation were performed

### Definitions

- **Diluent chloride**
  - Chloride from continuous and intermittent medications

- **Non-diluent chloride**
  - Chloride from maintenance and resuscitation fluids

- **AKI**
  - Increase in serum creatinine (Scr) of ≥ 0.3 mg/dL within 48 hours
  - Scr ≥ 1.5 times baseline within the prior 7 days
  - Unif volume ≥ 0.5 mL/kg/h for 6 hours

- **Hyperchloremia**
  - Chloride ≥ 110 mEq/L

- **RRT**
  - Identified through dialysis orders or review of physician notes

### Results

**Table 1: Baseline Characteristics**

<table>
<thead>
<tr>
<th>Baseline Characteristic</th>
<th>Result (N = 41)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years, mean ± STD</td>
<td>66.5 ± 14.7</td>
</tr>
<tr>
<td>Female, no. (%)</td>
<td>22 (53.7%)</td>
</tr>
<tr>
<td>ICU LOS in days, mean ± STD</td>
<td>4.6 ± 3.4</td>
</tr>
<tr>
<td>Hospital LOS in days, mean ± STD</td>
<td>10.8 ± 9.9</td>
</tr>
<tr>
<td>Medical Intensive Care, patients (%)</td>
<td>27 (65.9%)</td>
</tr>
<tr>
<td>Surgical Intensive Care, patients (%)</td>
<td>13 (31.7%)</td>
</tr>
<tr>
<td>Cardiac Intensive Care, patients (%)</td>
<td>1 (2.4%)</td>
</tr>
<tr>
<td>Hyperchloremia, patients (%)</td>
<td>22 (53.7%)</td>
</tr>
<tr>
<td>Acute Kidney Injury (AKI), patients (%)</td>
<td>24 (58.5%)</td>
</tr>
<tr>
<td>Need for Renal Replacement Therapy (RRT), patients (%)</td>
<td>7 (17.1%)</td>
</tr>
</tbody>
</table>

**Table 2: Spearman’s Rho Correlation for hyperchloremia, AKI, and RRT**

- **Hyperchloremia**
  - Diluent Chloride Load Correlation Coefficient: \( \rho = 0.238 \)
  - Non-Diluent Chloride Load Correlation Coefficient: \( \rho = 0.488 \)

- **AKI**
  - Diluent Chloride Load Correlation Coefficient: \( \rho = 0.25 \)
  - Non-Diluent Chloride Load Correlation Coefficient: \( \rho = 0.218 \)

- **Need for RRT**
  - Diluent Chloride Load Correlation Coefficient: \( \rho = 0.167 \)
  - Non-Diluent Chloride Load Correlation Coefficient: \( \rho = 0.230 \)

**Table 3: Chloride load and development of hyperchloremia**

<table>
<thead>
<tr>
<th>Chloride Load (mEq/L), median (IQR)</th>
<th>Hyperchloremia (N = 22)</th>
<th>No Hyperchloremia (N = 19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diluent Chloride Load</td>
<td>218.4 (110.3-693.3)</td>
<td>135.9 (38.0-266.4)</td>
</tr>
<tr>
<td>Non-Diluent Chloride Load</td>
<td>1265.3 (939.4-2000.3)</td>
<td>462.0 (314.3-1151.8)</td>
</tr>
<tr>
<td>Total Chloride Load</td>
<td>1483.7 (1272.1-2485.9)</td>
<td>597.9 (484.9-1439.9)</td>
</tr>
</tbody>
</table>

### Conclusion

Diluent chloride load accounted for a smaller proportion of total chloride and volume compared to other studies. Non-diluent chloride was moderately correlated with the development of hyperchloremia. Diluent chloride load was similar among patients who developed hyperchloremia, acute kidney injury and/or the need for renal replacement therapy compared to those who did not. Larger, prospective studies investigating the impact of medication diluents and alternatives on chloride load are required. Limitations of this study include sample size, retrospective review, and that total chloride loads were dependent on appropriate nurse documentation. Future direction includes the development and implementation of a fluid guideline or protocol to limit or reduce the total chloride load in critically ill patients.

### References


The authors have no conflicts of interest to disclose.