Furosemide for Treatment of Oliguria during Congenital Cardiac Surgery

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Abstract

Introduction: Surgical repair of congenital heart disease (CHD) gives a number of organ systems at risk. Acute kidney injury (AKI) occurs with an increased frequency (31-66%). Kidney failure requiring renal replacement therapy (RRT) is a rare event, occurring after pediatric cardiac surgery (16), with a reported 1% in this surgical mortality. Nevertheless and only as recently as 2006 was the incidence of acute kidney injury in children during cardiac surgery (AKI-C) documented. As an initial step to enhance the quality of care for this population, we analyzed outcomes and evaluated the incidence of acute kidney injury (AKI) in our institution and evaluated the two different treatment protocols for the treatment of oliguria during cardiac surgery for congenital heart disease.

Methods: This was a retrospective chart review of two sequential treatments for the management of oliguria in children undergoing surgical repair of congenital heart disease. Oliguria was defined in our cohort as cardiac output failing to ensure the delivery of adequate cardiac output. All patients on medical management of oliguria were not included in this analysis. This study took place over 60 months and 80 cases were reviewed. After enrollment oliguria criteria patients in period 1 were treated with furosemide (Lasix; MSD) and those in period 2 with aminephylline (Theophylline; MSD). The control group (N=100) was defined as those children undergoing CHD surgery during the 2 time periods that did not develop oliguria.

Results: There were no significant differences in the demographics and surgery types and complexities between subjects in period 1 or 2. The incidence of AKI was 39%. Patients in the aminephylline group (N=50; 51% of AKI group) predominate significantly more over the control group (N=25; 51% of AKI group) in the early postoperative period (P<.01). This finding is increased since only 9 patients in the control group met AKI criteria for renal replacement therapy. No significant difference in mortality was observed between the aminephylline group versus furosemide group (P<.01).

Discussion: This retrospective study was able to demonstrate that in those patients that developed oliguria or anuria during CHD surgery, the administration of aminephylline was used to treat this condition compared with furosemide. As all of these patients had hemodynamic variables maintained in the normal range, we hypothesized the reduction of this effect to adenosine receptor antagonism in the renal system. We speculated that the oliguria produced during the cardiovascular surgery is a result of decreased renal perfusion and increased intramyocardial pressure. The limited evidence is available in literature regarding the role of adenosine in the pathophysiology of AKI. This study was able to demonstrate that aminephylline has a potential therapeutic role in the treatment of AKI requiring renal replacement therapy (RRT) is a relatively rare occurrence after pediatric cardiac surgery. This study was able to demonstrate that in those patients that developed oliguria or anuria during CHD surgery, the administration of aminephylline was used to treat this condition compared with furosemide. As all of these patients had hemodynamic variables maintained in the normal range, we hypothesized the reduction of this effect to adenosine receptor antagonism in the renal system. We speculated that the oliguria produced during the cardiovascular surgery is a result of decreased renal perfusion and increased intramyocardial pressure. The limited evidence is available in literature regarding the role of adenosine in the pathophysiology of AKI. This study was able to demonstrate that aminephylline has a potential therapeutic role in the treatment of AKI requiring renal replacement therapy.

Results Continued

Aminephylline vs Furosemide Era

<table>
<thead>
<tr>
<th>Period</th>
<th>Furosemide group N=100</th>
<th>Aminophylline group N=100</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PICU (days) (SE)</td>
<td>10 (0.9)</td>
<td>8 (1.0)</td>
<td>NS</td>
</tr>
<tr>
<td>Mean time to discharge from PICU (days)</td>
<td>12 (2.6)</td>
<td>10 (3.2)</td>
<td>NS</td>
</tr>
<tr>
<td>AKI Stage I (mmol/L)</td>
<td>2 (1.0)</td>
<td>3 (1.5)</td>
<td>NS</td>
</tr>
<tr>
<td>AKI Stage II (mmol/L)</td>
<td>6 (1.3)</td>
<td>4 (1.4)</td>
<td>NS</td>
</tr>
<tr>
<td>AKI Stage III (mmol/L)</td>
<td>8 (2.9)</td>
<td>6 (2.3)</td>
<td>NS</td>
</tr>
<tr>
<td>AKI Stage IV (mmol/L)</td>
<td>12 (3.2)</td>
<td>10 (3.7)</td>
<td>NS</td>
</tr>
</tbody>
</table>

Conclusions

What is known about AKI in children undergoing pediatric cardiac surgery? AKI occurs in about 30-50% of patients. AKI significantly increases morbidity and mortality. Anemia increases the incidence of AKI.

What this study offers compared to other Aminophylline studies. Aminophylline is used to treat a specific cause of oliguria/anuria. Timing of the administration of the aminophylline early in the process of renal changes.

Decreased need for renal replacement therapy.

Discussion

Since AKI significantly increases morbidity and mortality, we need a biomarker to help us identify who is at risk. Plasma and urine N-Gal and Cystatin-C are biomarkers of renal injury but do not predict who will develop AKI.

Neither Aminophylline or furosemide can eliminate AKI. Can the combination decrease AKI?

Patients that do not demonstrate anuria/oliguria on bypass can still develop AKI. Should everyone be treated?

The specific Adenosine 1 receptor blocker did not decrease AKI in adult cardiac patients but would it be effective in pediatric cardiac surgical patients?

References


