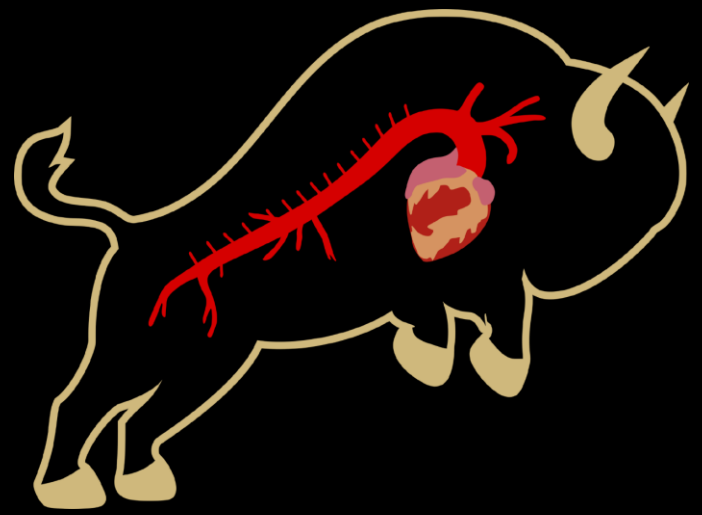
Decreased Long-Term Survival After Severe Acute Kidney Injury in Hemiarch Surgery

Adam Carroll (1), Michal Schafer (1), William Riley Keeler (1), Jintong Liu (1), Nicolas Chanes (1), Muhammad Aftab (1), T. Brett Reece (1)

(1) University of Colorado Anschutz, Denver, CO

No disclosures



Introduction

- Hemiarch surgery offers the benefit of reduced cardiopulmonary bypass times, circulatory arrest times relative to total arch surgery
- Acute kidney injury (AKI) remains a significant risk in hemiarch surgery
- AKI after hemiarch significantly associated with in-hospital morbidity and mortality, but unclear how it affects long term survival
  - Furthermore, unclear how severity of AKI affects long-term survival

Aim

- To investigate acute kidney injury of different severity after hemiarch surgery and impact on in-hospital outcomes
- Determine risk factors for acute kidney injury
- Investigate how acute kidney injury affects long-term survival

Methods

- A retrospective review of a single institution prospective database was used to identify patients who underwent hemiarch surgery
- AKI stratified by Kidney Disease Improving Global Outcomes (KDIGO) criteria
- Assess relationship with pre-operative and operative variables with development of AKI
- Assess how AKI of different KDIGO stage affects in-hospital outcomes
- Perform multivariate logistic regression to determine risk factors associated with AKI development
- Perform Cox proportional hazard regression to determine long-term survival based on AKI stage

Results

- 616 total patients identified
  - AKI occurred in 198 cases (32.1%), with mild AKI most frequent
- Risk factors for developing AKI:
  - Increased age
  - Increased BMI, obesity (BMI>30)
  - History of hypertension or CKD
  - More urgent procedure

	No AKI	Stage 1	Stage 2	Stage 3	p value
N	418	144	27	27	
Preoperative					
Age (years)	59.9 (47.7-68.7)	64.7 (53.9-71.1)	59.5 (51.6-69.1)	66.9 (58.1-71.0)	**0.019**
Male	310 (74.2%)	104 (72.2%)	21 (77.8%)	23 (85.2%)	0.523
BMI (kg/m^2)	27.1 (24.3-31.1)	28.5 (24.9-32.9)	28.5 (24.8-33.4)	32.3 (25.1-36.1)	**0.018**
Obesity (BMI>30)	141 (33.7%)	57 (39.6%)	13 (48.1%)	16 (59.3%)	**0.023**
Dyslipidemia	135 (32.2%)	59 (41.0%)	8 (29.6%)	7 (25.9%)	0.197
HTN	257 (61.5%)	106 (73.6%)	21 (77.8%)	21 (77.8%)	**0.013**
Current Smoker	96 (23.0%)	37 (25.7%)	7 (25.9%)	10 (37.0%)	0.396
Diabetes Mellitus	39 (9.3%)	16 (11.1%)	3 (11.1%)	6 (22.2%)	0.199
Chronic Kidney Disease	30 (7.2%)	20 (13.9%)	2 (7.4%)	6 (22.2%)	**0.011**
Prior Stroke	21 (5.0%)	10 (6.9%)	1 (3.7%)	3 (11.1%)	0.484
Coronary Artery Disease	73 (17.5%)	15 (10.4%)	5 (18.5%)	4 (14.8%)	0.242
Pulmonary Disease	88 (21.1%)	33 (22.9%)	6 (22.2%)	8 (29.6%)	0.751
Urgency					**<0.001**
Elective	326 (78.0%)	85 (59.0%)	12 (44.4%)	5 (18.5%)	
Urgent	42 (10.0%)	18 (12.5%)	1 (3.7%)	8 (29.6%)	
Emergent	50 (12.0%)	41 (28.5%)	14 (51.9%)	14 (51.9%)	

Median with IQR or N(%)

Results

- Longer cardiopulmonary bypass, aortic cross-clamp and circulatory arrest times associated with worsening AKI
  - Nadir bladder temperature also significant, but in range for moderate hypothermia
- Increased rates of intraoperative transfusion of both blood and coagulation products with worsening AKI
- Higher rates of open chest post-operatively for stage 3 AKI

	No AKI	Stage 1	Stage 2	Stage 3	p value
N	418	144	27	27	
Cardiopulmonary Bypass Statistics					
Nadir Bladder Temp	26.8 + 2.1	25.8 + 2.5	25.4 + 3.0	24.9 + 3.0	**<0.001**
Cardiopulmonary Bypass Time	134 (113-180)	158 (127-203)	190 (147-246)	223 (186-318)	**<0.001**
Aortic Cross Clamp Time	98 (76-130)	100 (75-138)	126 (83-168)	142 (92-173)	**0.015**
Circulatory Arrest Time	9 (6-13)	13 (9-20)	18 (9-28)	22 (13-32)	**<0.001**
Intraoperative Product (units)					
No Blood Product	123 (29.4%)	28 (19.4%)	9 (33.3%)	2 (7.4%)	**0.011**
Packed Red Blood Cells	0 (0-4)	1 (0-3)	2 (0-5)	4 (1-12)	**<0.001**
Fresh Frozen Plasma	2 (0-4)	4 (1-6)	4 (0-7)	6 (4-13)	**<0.001**
Platelets	1 (0-2)	2 (1-2)	2 (0-3)	3 (2-4)	**<0.001**
Open Chest	16 (3.8%)	9 (6.3%)	2 (7.4%)	11 (40.7%)	**<0.001**

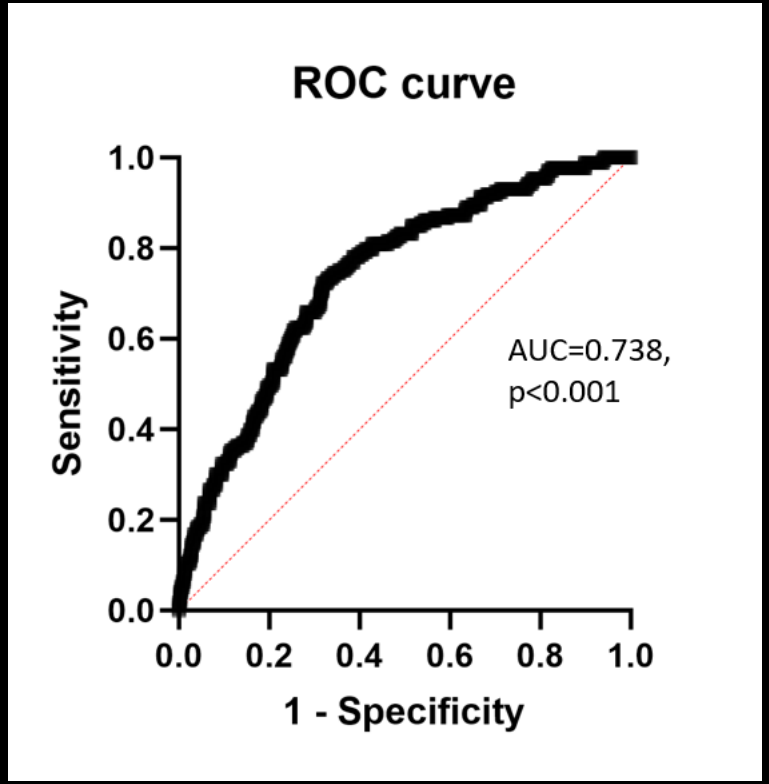
Postoperative Results

- With exception of stroke, increased risk of all morbidity and mortality post-operatively
  - Minimal difference with stage 1 AKI, trend towards increase with stage 2 AKI, significant difference with stage 3

	No AKI	Stage 1	Stage 2	Stage 3	p value
N	418	144	27	27	
Length of Stay	7 (6-10)	8 (7-12)	9 (7-13)	23 (14-31)	**<0.001**
ICU Length of Stay	3 (1-4)	3 (2-6)	4 (3-6)	17 (10-29)	**<0.001**
Coagulopathy	34 (8.1%)	19 (13.2%)	6 (22.2%)	12 (44.4%)	**<0.001**
Stroke	18 (4.3%)	8 (5.6%)	1 (3.7%)	4 (14.8%)	0.109
Delirium	28 (6.7%)	14 (9.7%)	4 (14.8%)	9 (33.3%)	**<0.001**
Prolonged Ventilation (>48 hr)	9 (2.2%)	10 (6.9%)	5 (18.5%)	18 (66.7%)	**<0.001**
Infection	23 (5.5%)	5 (3.5%)	3 (11.1%)	10 (37.0%)	**<0.001**
Mechanical Circulatory Support	11 (2.6%)	8 (5.6%)	3 (11.1%)	10 (37.0%)	**<0.001**
Mortality	13 (3.1%)	6 (4.2%)	3 (11.1%)	8 (29.6%)	**<0.001**

Results Continued

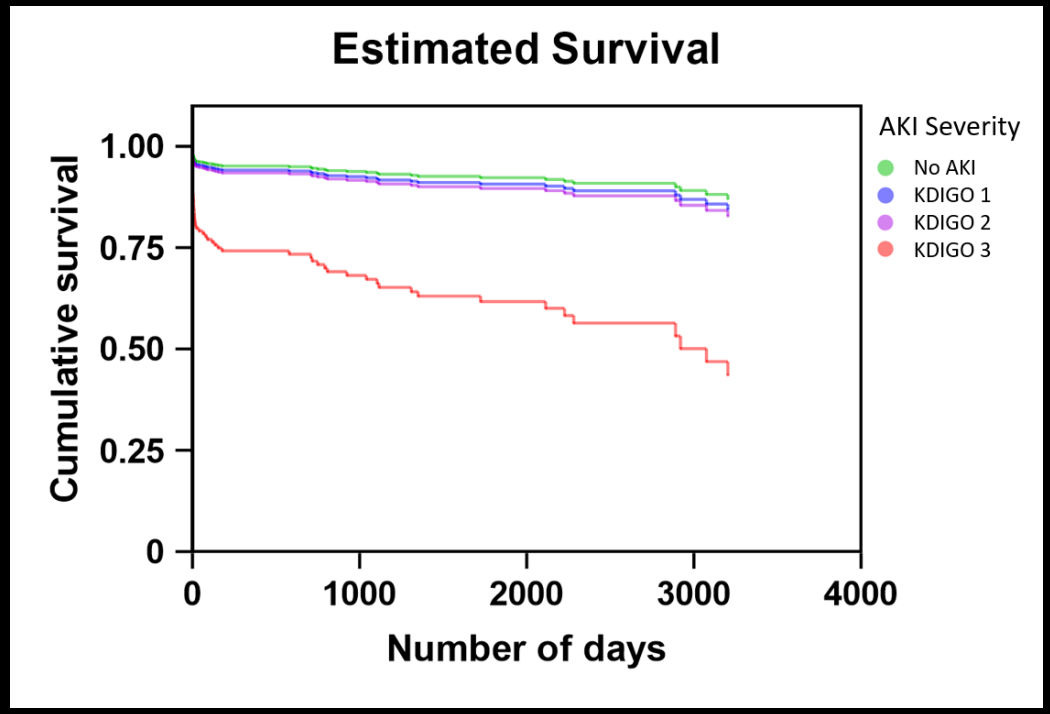
- Multivariate logistic regression for any AKI with significant pre-operative and operative variables demonstrated excellent prediction
  - Significant individual variables included BMI, obesity and procedural urgency



Long Term Survival

- Increased post-discharge mortality in stage 3 AKI patients
- Estimated survival calculated using adjusted Cox proportional hazard, with days determined by either date of last follow-up or date or mortality post discharge
- Significant difference ($p<0.001$) for stage 3 AKI in long-term survival
  - However, half of patients with severe AKI still alive at 10 years

	No AKI	Stage 1	Stage 2	Stage 3	p value
N	418	144	27	27	
Post-Discharge Mortality (excluding in-hospital)	27 (6.7%)	11 (7.9%)	0 (0.0%)	4 (21.1%)	**0.048**
All Mortality	40 (9.6%)	17 (11.8%)	3 (11.1%)	12 (44.4%)	**<0.001**
Living Last Follow-up (Days)	1188 (506-2117)	1418 (743-2784)	1953 (603-3555)	1425(568-2498)	



Conclusions

- AKI of any severity after hemiarch surgery is relatively common, but typically mild
- High BMI, more urgent/emergent patients associated with development of any AKI
- Significant increase in in-hospital morbidity and mortality with more severe AKI
- Stage 3 AKI, the most severe, significantly affects post-discharge long-term survival, however, half of patients are still alive 10 years post-procedure

Questions???