Impact of Timing of Urgent Coronary Artery Bypass Grafting Following Coronary Angiography on Acute Kidney Injury

Presented by SaeRam Oh, MD

B. Peine, Y. Fu, S. Oh, S. Quinn, J. Bethea, J. Mendes, L. Kindell, W. Irish, S. Akhter

ECU

Background

- Patients who develop AKI following CABG have worse outcomes, including higher rates of operative mortality
- First two studies to look at a possible association with coronary angiography-cardiac surgery interval with AKI were published in 2007
  - One found an increased risk of AKI in patients who had cardiac surgery within 24 hours of angiography
  - The other found no increased risk
- Despite several subsequent studies on the question, no definitive recommendation on the subject has been established

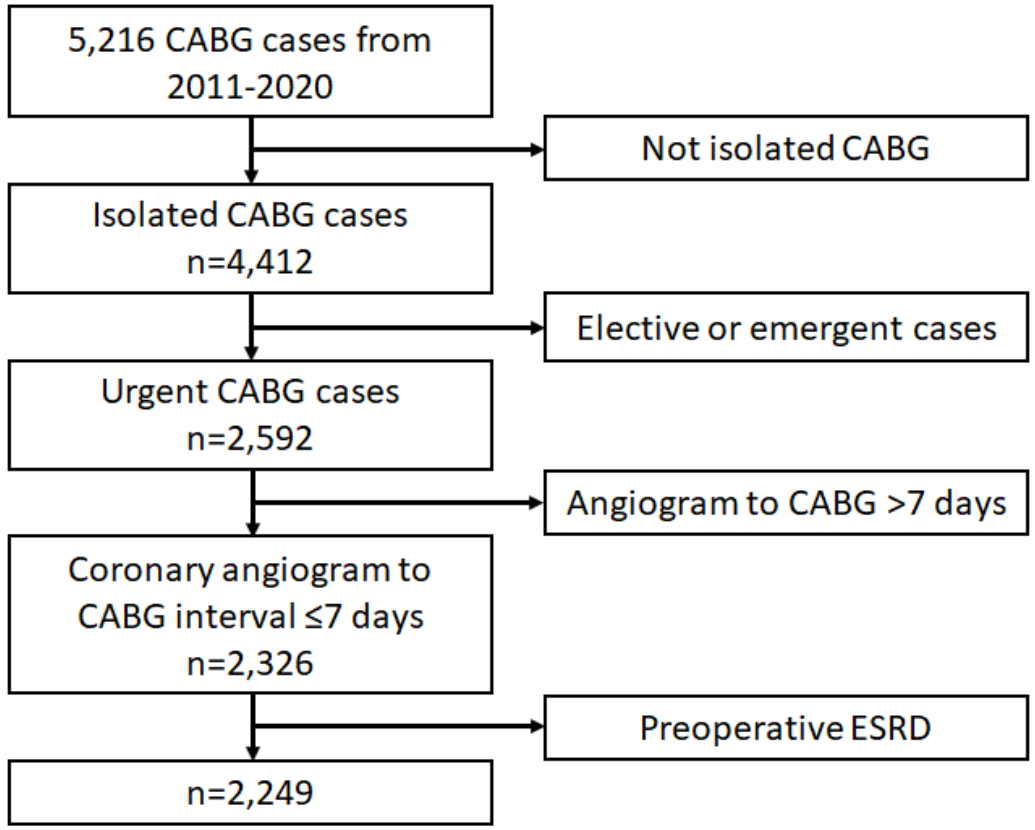
Study Purpose

- No prior studies have examined this clinical question in patients undergoing urgent CABG or focused on those with CKD
- Study questions:
  - Is the interval between coronary angiography and urgent, isolated CABG associated with an increased risk of AKI?
  - Is this effect different in patients with preexisting kidney disease?

Methods

Patient Selection

- Retrospective, single-center study of CABG patients from 2011-2020
- Utilizes the STS Adult Cardiac Surgery Database for patients from our institution
- Criteria for study inclusion: isolated, urgent CABG with angiogram within 7 days of surgery and not on dialysis



Preoperative Management

- Heart catheterization performed following institutional renal-sparing protocols, including adjustments for patients with CKD
- Surgeons independently determined timing for CABG relative to CA

Definitions

- Chronic kidney disease stage determined by eGFR, as defined by the KDIGO guidelines (2021)
  - Proteinuria not available for our patients, cannot differentiate between patients with no CKD and those with CKD stage 1
- Acute kidney injury defined by the KDIGO guidelines (2012)
  - An increase in serum creatinine by ≥0.3 mg/dl (≥26.5 µmol/l) within 48 hours of suspected insult
  - An increase in serum creatinine to ≥1.5 times baseline within 7 days of suspected insult

Patient Groupings

- Patients grouped by time interval between coronary angiography and surgery
  - 0-1 day
  - 2 days
  - 3 days
  - 4-7 days
- Subgrouped by CKD stage
  - No CKD/CKD stage 1
  - CKD stage 2
  - CKD stage 3a
  - CKD stage 3b/4/5

Analysis Methods

- Test-of-trend analysis
- Locally estimated scatterplot smoothing (LOESS) curves were used to visualize the data
- Adjusted odds ratios of the risk of AKI, controlling for multiple covariates, were compared between time interval groups
- All analyses were repeated for CKD subgroups

Results

Patient Characteristics

Characteristic	Overall
N	2249
Age	65 (57, 72)
Female	629 (28.0%)
White*	1680 (74.7%)
Body mass index	29.1 (25.7, 33.1)
Diabetes mellitis	1138 (50.6%)
Hypertension	1961 (87.2%)
Heart failure within last two weeks	452 (20.1%)
Ejection fraction ≤35%	269 (12.0%)
Myocardial infarction within 7 days*	1247 (55.4%)
Last creatinine level prior to surgery*	0.9 (0.8, 1.1)
STS predicted risk of renal failure*	1.6% (0.8%, 3.3%)
Preoperative PCI during encounter	105 (4.7%)
On-pump case*	2066 (91.9%)
Cardiopulmonary bypass time (min)	108 (85, 133)
Intraoperative blood use	697 (31.0%)

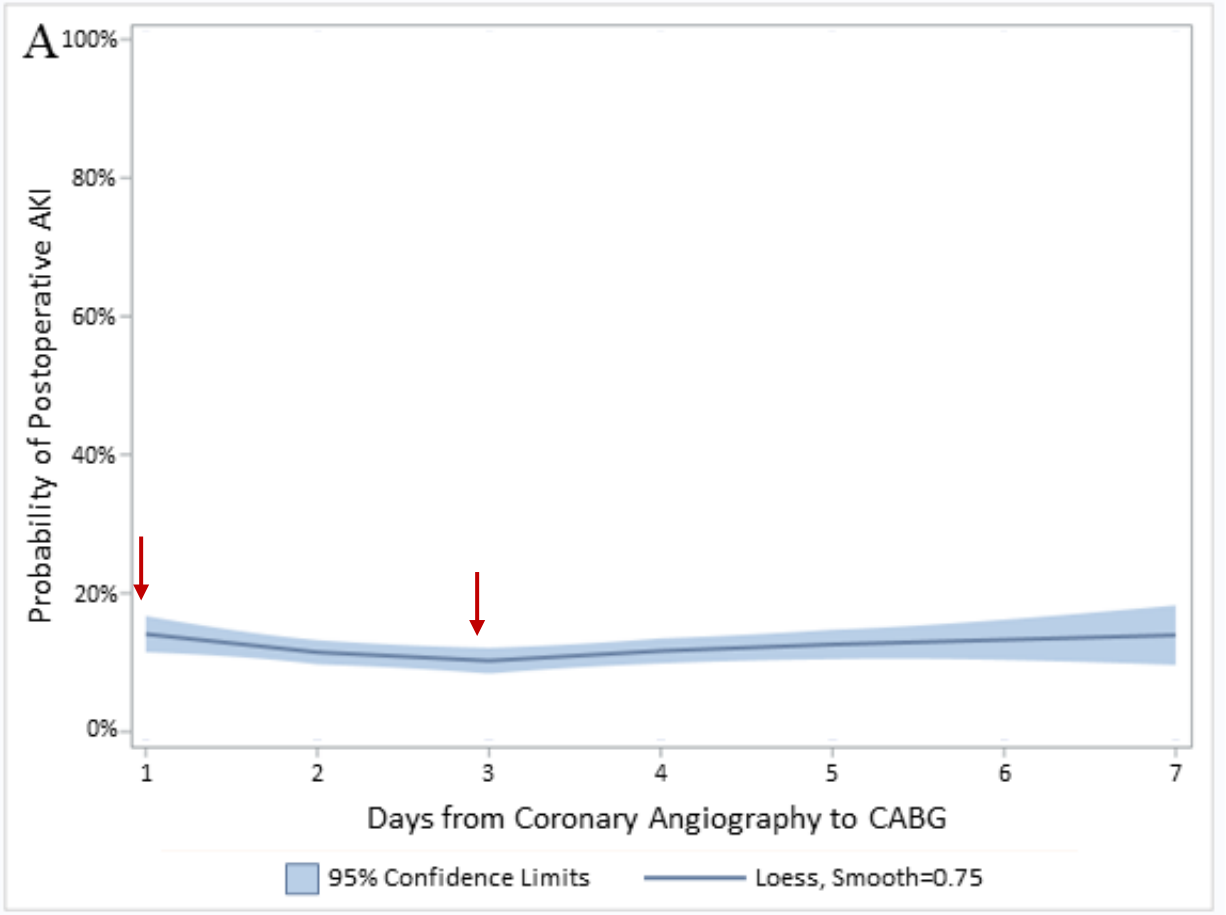
STS, Society of Thoracic Surgeons. PCI, percutaenous coronary intervention.
*Significant difference between time interval groups.

ECU

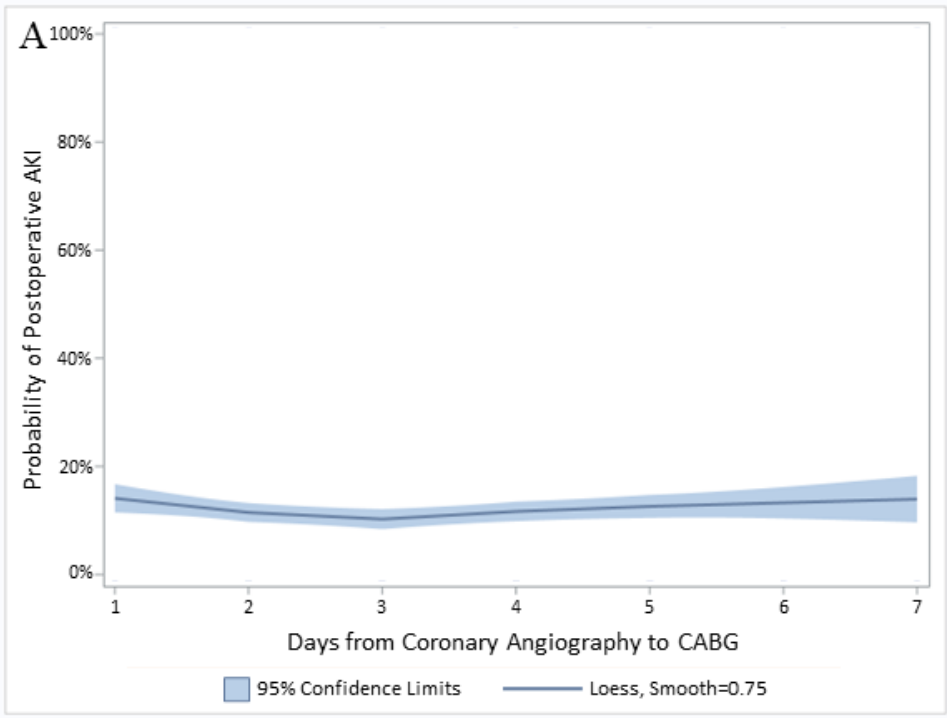
Results - All patients

Group	N	AKI
Overall	2,249	271 (12.0%)
Day 0-1	512	72 (14.1%)
Day 2	477	55 (11.5%)
Day 3	399	35 (8.8%)
Days 4-7	861	109 (12.7%)

Cochrane-Armitage test-of-trend for AKI by time interval group: p=0.96



Results - All patients



Adjusted* Odds Ratios and 95% Confidence Intervals for Post-CABG AKI by Angiography-to-Surgery Interval (reference "Day 0-1")

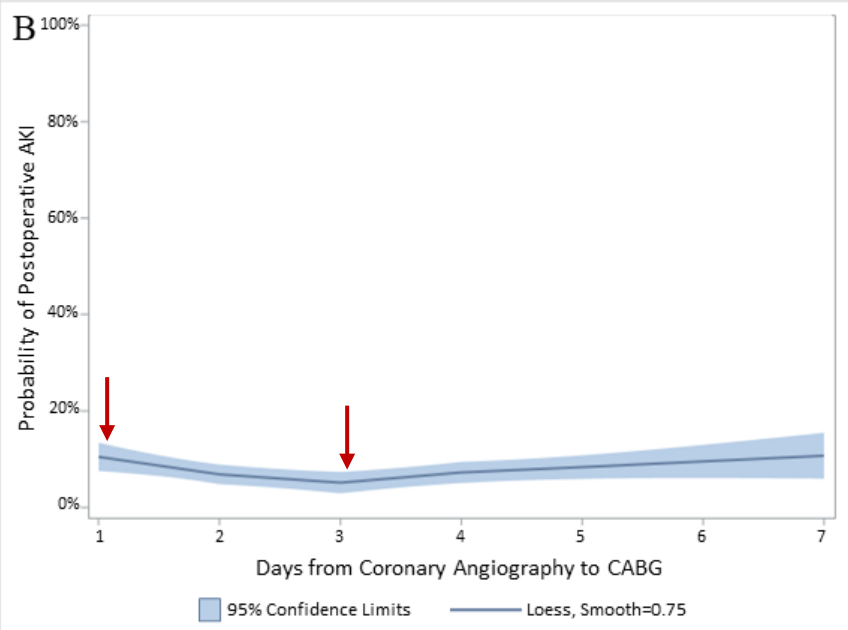
Group	Day 0-1	Day 2	Day 3	Days 4-7
Overall	1	0.696 (0.460, 1.052)	**0.503 (0.317, 0.797)**	0.721 (0.507, 1.024)

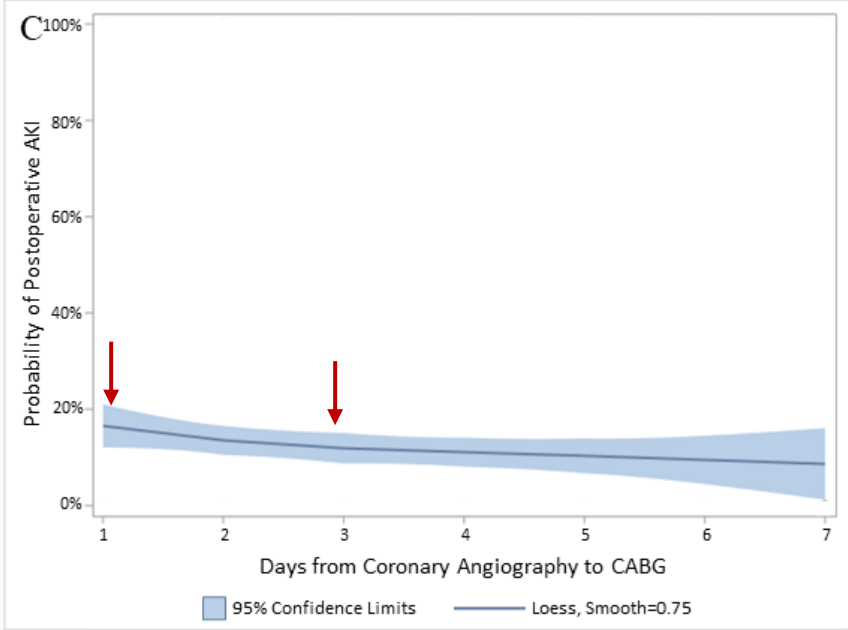
Bold typefont indicates statistically significant result

*** Adjusted with Age, Sex, Race, Body Mass Index, Recent Heart Failure, Diabetes, Hypertension, Cardiopulmonary Bypass Time, Myocardial Infarction within 7 Days, Intraoperative Blood Product Use, and STS Predicted Risk of Renal Failure.**

ECU

Results – CKD Subgroups





No CKD/CKD Stage 1

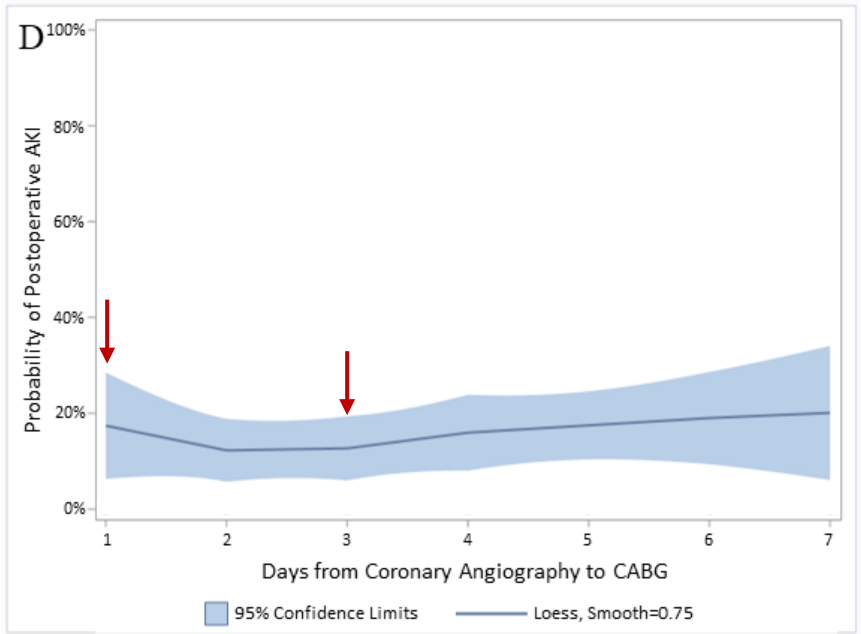
Group	N	AKI
Day 0-1	281	30 (10.7%)
Day 2	254	16 (6.3%)
Day 3	175	7 (4.0%)
Days 4-7	394	33 (8.4%)

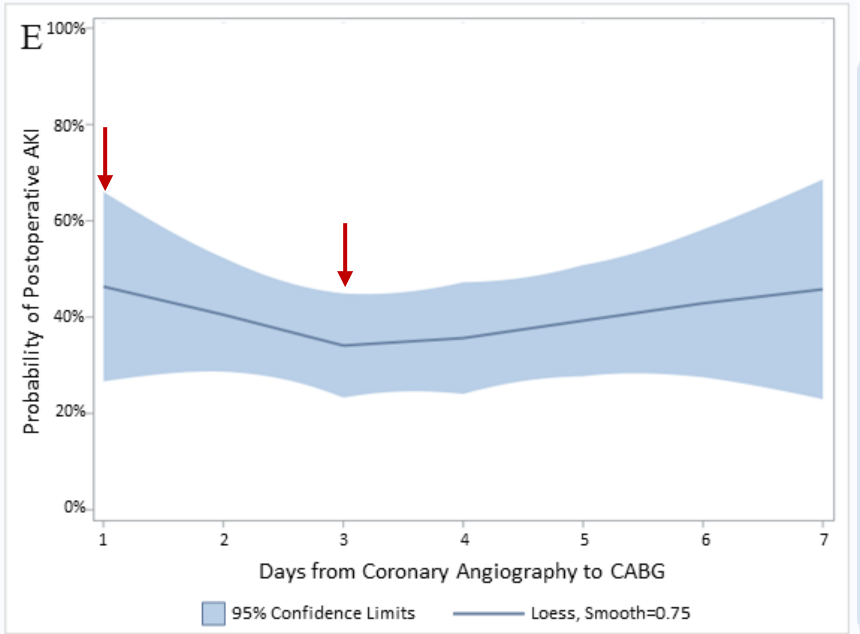
CKD Stage 2

Group	N	AKI
Day 0-1	185	30 (16.2%)
Day 2	144	21 (14.6%)
Day 3	157	15 (9.6%)
Days 4-7	319	35 (11.0%)

ECU

Results – CKD Subgroups





CKD Stage 3a

Group	N	AKI
Day 0-1	32	6 (18.8%)
Day 2	49	5 (10.2%)
Day 3	40	4 (10.0%)
Days 4-7	80	15 (18.8%)

CKD Stage 3b/4/5

Group	N	AKI
Day 0-1	14	6 (42.9%)
Day 2	30	13 (43.3%)
Day 3	27	9 (33.3%)
Days 4-7	68	26 (38.2%)

ECU

Results – CKD Subgroups

Adjusted* Odds Ratios and 95% Confidence Intervals for Post-CABG AKI by Angiography-to-Surgery Interval (reference "Day 0-1")

Group	Day 0-1	Day 2	Day 3	Days 4-7
No CKD/CKD Stage 1	1	0.539 (0.273, 1.065)	**0.295 (0.118, 0.741)**	0.765 (0.436, 1.341)
CKD Stage 2	1	0.903 (0.468, 1.742)	0.502 (0.247, 1.019)	**0.521 (0.292, 0.929)**
CKD Stage 3a	1	**0.164 (0.033, 0.820)**	0.339 (0.074, 1.556)	0.778 (0.233, 2.597)
CKD Stage 3b/4/5	1	2.092 (0.446, 9.813)	0.974 (0.208, 4.558)	1.684 (0.412, 6.888)

Bold typefont indicates statistically significant result

*** Adjusted with Age, Sex, Race, Body Mass Index, Recent Heart Failure, Diabetes, Hypertension, Cardiopulmonary Bypass Time, Myocardial Infarction within 7 Days, Intraoperative Blood Product Use, and STS Predicted Risk of Renal Failure.**

ECU

Results

- Operative mortality was 7.5 times higher for patients who developed AKI (RR 7.5, 95% CI 3.7-15.0)
- Risk of AKI, dialysis, and death increased with advancing CKD stage

Group	N	AKI	Dialysis	Operative Mortality
Overall	2,249	271 (12.0%)	19 (0.8%)	35 (1.6%)
No CKD/CKD Stage 1	1104	86 (7.8%)	1 (0.1%)	7 (0.6%)
CKD Stage 2	805	101 (12.5%)	3 (0.4%)	18 (2.2%)
CKD Stage 3a	201	30 (14.9%)	2 (1.0%)	5 (2.5%)
CKD Stage 3b/4/5	139	54 (38.8%)	13 (9.4%)	5 (3.6%)

ECU

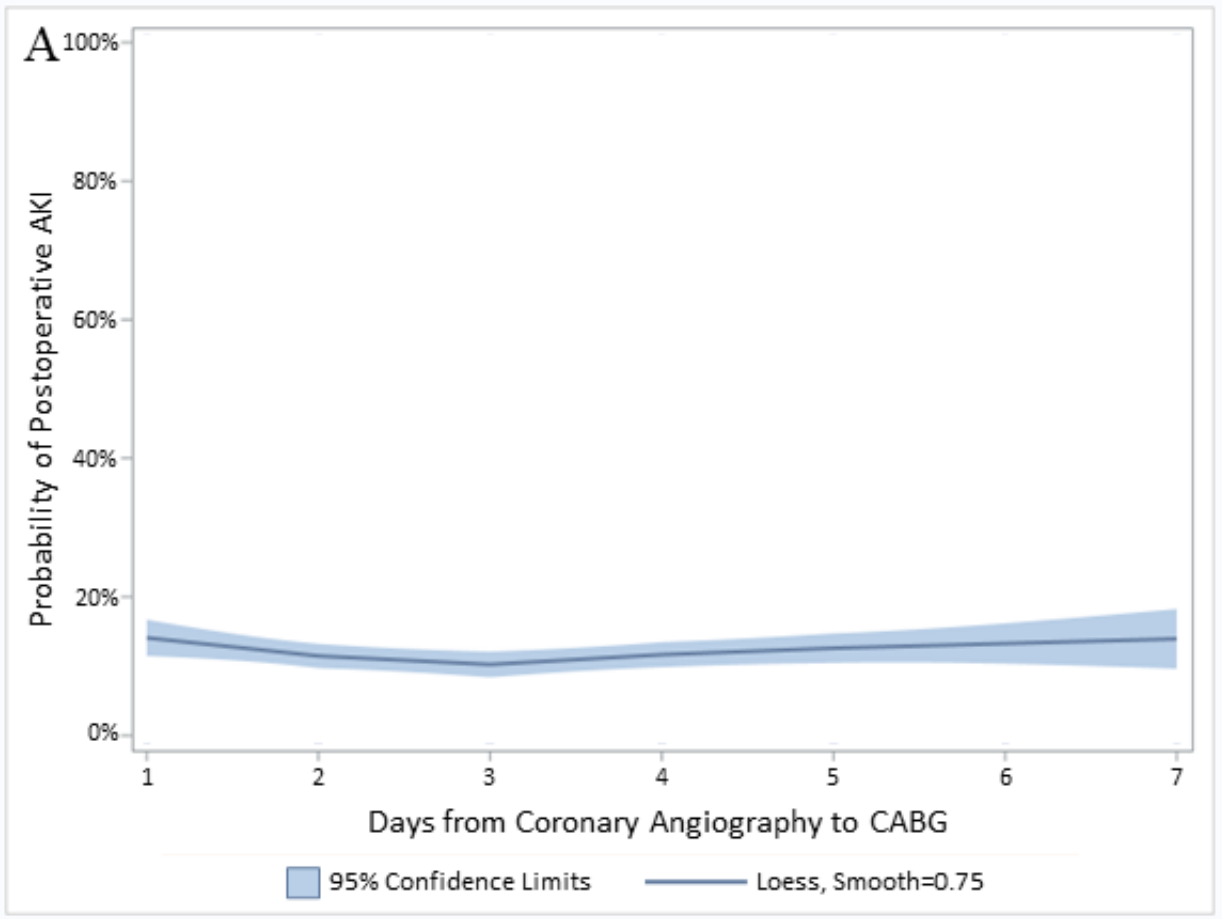
Discussion and Conclusions

Study Findings

- Patients who underwent surgery 3 days after coronary angiography had a lower incidence of AKI compared with those operated on within 1 day
  - Statistically significant difference for overall population and the No CKD/CKD Stage 1 subgroup
  - Trend towards significance in other CKD subgroups (analysis in smaller subgroups limited by inadequate power)

Study Findings

- After day 3 there was no further decline in risk of AKI relative to day 0-1 cohort
- This finding may be due in part to surgeons independently determined timing of surgery
- Patients who are less healthy in ways we cannot adequately measure may be more likely to have surgery delayed



Conclusions

- Based on our data, it appears that delaying CABG until the 3rd day after coronary angiography decreases the risk of AKI, regardless of preexisting kidney disease
- The decision for timing of surgery must be made within the context of all relevant clinical factors
- Our study findings support the need for a large, multi-center randomized prospective trial that could inform guidelines on this issue with a high level of evidence

ECU

Thank you


526 Moye Blvd
EAST CAROLINA
HEART INSTITUTE
AT VIDANT MEDICAL CENTER

References

1. Zanardo G, Michielon P, Paccagnella A, Rosi P, Caló M, Salandin V, et al. Acute renal failure in the patient undergoing cardiac operation. Prevalence, mortality rate, and main risk factors. J Thorac Cardiovasc Surg. 1994;107:1489-95.
2. Mangano CM, Diamondstone LS, Ramsay JG, Aggarwal A, Herskowitz A, Mangano DT. Renal dysfunction after myocardial revascularization: risk factors, adverse outcomes, and hospital resource utilization. The Multicenter Study of Perioperative Ischemia Research Group. Ann Intern Med. 1998;128:194-203.
3. Conlon PJ, Stafford-Smith M, White WD, Newman MF, King S, Winn MP, et al. Acute renal failure following cardiac surgery. Nephrol Dial Transplant. 1999;14:1158-62.
4. Olsson D, Sartipy U, Braunschweig F, Holzmann MJ. Acute kidney injury following coronary artery bypass surgery and long-term risk of heart failure. Circ Heart Fail. 2013;6:83-90.
5. Han SS, Shin N, Baek SH, Ahn SY, Kim DK, Kim S, et al. Effects of acute kidney injury and chronic kidney disease on long-term mortality after coronary artery bypass grafting. Am Heart J. 2015;169:419-25.
6. Warren J, Mehran R, Baber U, Xu K, Giacoppo D, Gersh BJ, et al. Incidence and impact of acute kidney injury in patients with acute coronary syndromes treated with coronary artery bypass grafting: Insights from the Harmonizing Outcomes With Revascularization and Stents in Acute Myocardial Infarction (HORIZONS-AMI) and Acute Catheterization and Urgent Intervention Triage Strategy (ACUITY) trials. Am Heart J. 2016;171:40-7.
7. Chertow GM, Lazarus JM, Christiansen CL, Cook EF, Hammermeister KE, Grover F, et al. Preoperative renal risk stratification. Circulation. 1997;95:878-84.
8. Mehta RH, Grab JD, O'Brien SM, Bridges CR, Gammie JS, Haan CK, et al. Bedside tool for predicting the risk of postoperative dialysis in patients undergoing cardiac surgery. Circulation. 2006;114:2208-16.
9. Han SS, Kim DK, Kim S, Chin HJ, Chae DW, Na KY. C-Reactive Protein Predicts Acute Kidney Injury and Death After Coronary Artery Bypass Grafting. Ann Thorac Surg. 2017;104:804-810.
10. Del Duca D, Iqbal S, Rahme E, Goldberg P, de Varennes B. Renal failure after cardiac surgery: timing of cardiac catheterization and other perioperative risk factors. Ann Thorac Surg. 2007;84:1264-1271.
11. Ranucci M, Ballotta A, Kunkl A, De Benedetti D, Kandil H, Conti D, et al. Influence of the timing of cardiac catheterization and the amount of contrast media on acute renal failure after cardiac surgery. Am J Cardiol. 2008;101:1112-8.
12. Kramer RS, Quinn RD, Groom RC, Braxton JH, Malenka DJ, Kellett MA, et al. Same admission cardiac catheterization and cardiac surgery: is there an increased incidence of acute kidney injury? Ann Thorac Surg. 2010 Nov;90(5):1418-23.
13. Ranucci M, Ballotta A, Agnelli B, Frigiola A, Menicanti L, Castelvecchio S; Surgical and Clinical Outcome Research (SCORE) Group. Acute kidney injury in patients undergoing cardiac surgery and coronary angiography on the same day. Ann Thorac Surg. 2013;95:513-9.
14. Andersen ND, Williams JB, Fosbol EL, Shah AA, Bhattacharya SD, Mehta RH, et al. Cardiac catheterization within 1 to 3 days of proximal aortic surgery is not associated with increased postoperative acute kidney injury. J Thorac Cardiovasc Surg. 2012;143:1404-10.
15. Medalion B, Cohen H, Assali A, Vaknin Assa H, Farkash A, Snir E, et al. The effect of cardiac angiography timing, contrast media dose, and preoperative renal function on acute renal failure after coronary artery bypass grafting. J Thorac Cardiovasc Surg. 2010;139:1539-44.
16. Mehta RH, Honeycutt E, Patel UD, Lopes RD, Williams JB, Shaw LK, et al. Relationship of the time interval between cardiac catheterization and elective coronary artery bypass surgery with postprocedural acute kidney injury. Circulation. 2011;124:149-55.
17. Hu Y, Li Z, Chen J, Shen C, Song Y, Zhong Q. The effect of the time interval between coronary angiography and on-pump cardiac surgery on risk of postoperative acute kidney injury: a meta-analysis. J Cardiothorac Surg. 2013;8:178.
18. Tecson KM, Brown D, Choi JW, Feghali G, Gonzalez-Stawinski GV, Hamman BL, et al. Major Adverse Renal and Cardiac Events After Coronary Angiography and Cardiac Surgery. Ann Thorac Surg. 2018;105:1724-1730.
19. Brown ML, Holmes DR, Tajik AJ, Sarano ME, Schaff HV. Safety of same-day coronary angiography in patients undergoing elective valvular heart surgery. Mayo Clin Proc. 2007;82:572-574.
20. Mariscalco G, Cottini M, Dominici C, Banach M, Piffaretti G, Borsani P, et al. The effect of timing of cardiac catheterization on acute kidney injury after cardiac surgery is influenced by the type of operation. Int J Cardiol. 2014;173:46-54.
21. Liu K, Li M, Li L, Wu B, Xu X, Ge Y, et al. The Effect of Coronary Angiography Timing on Cardiac Surgery Associated Acute Kidney Injury Incidence and Prognosis. Front Med (Lausanne). 2021;8:619210.
22. Khwaja A. KDIGO clinical practice guidelines for acute kidney injury. Nephron Clin Pract. 2012;120:c179-84.
23. Delgado C, Baweja M, Crews DC, Eneanya ND, Gadegbeku CA, Inker LA, et al. A Unifying Approach for GFR Estimation: Recommendations of the NKF-ASN Task Force on Reassessing the Inclusion of Race in Diagnosing Kidney Disease. Am J Kidney Dis. 2022;79:268-288.
24. Stevens PE, Levin A, KDIGO Chronic Kidney Disease Guideline Development Work Group Members. Evaluation and management of chronic kidney disease: synopsis of the kidney disease: improving global outcomes 2012 clinical practice guideline. Ann Intern Med. 2013;158:825-30.
25. Sedhai YR, Golamari R, Timalsina S, Basnyat S, Koirala A, Asija A, et al. Contrast-Induced Nephropathy After Cardiac Catheterization: Culprits, Consequences and Predictors. Am J Med Sci. 2017;354:462-466.
26. Wang Y, Zhu S, DU R, Zhou J, Chen Y, Zhang Q. Statin initiation and renal outcomes following isolated coronary artery bypass grafting: a meta-analysis. J Cardiovasc Surg (Torino). 2018;59:282-290.
27. Subramaniam RM, Suarez-Cuervo C, Wilson RF, Turban S, Zhang A, Sherrod C, et al. Effectiveness of Prevention Strategies for Contrast-Induced Nephropathy: A Systematic Review and Meta-analysis. Ann Intern Med. 2016;164:406-16.
28. Brown JR, Baker RA, Shore-Lesserson L, Fox AA, Mongero LB, Lobdell KW, et al. The Society of Thoracic Surgeons/Society of Cardiovascular Anesthesiologists/American Society for Extracorporeal Technology Clinical Practice Guidelines for the Prevention of Adult Cardiac Surgery-Associated Acute Kidney Injury. Anesth Analg. 2023;136:176-184.

ECU