2022 STS Coronary Conference
Accepted Abstracts

Abstract Session 1A – Saturday, June 4, 4:10 pm – 4:50 pm ET (Adam Room)

Presentation 1 – 1A:

Deep Sternal Wound Infection and Mortality in Cardiac Surgery: A Meta-Analysis

Author List:
Roberto Perezgrovas-Olaria MD, Katia Audisio MD, Gianmarco Cancelli MD, Mohamed Rahouma MD, Mudathir Ibrahim MD, Giovanni Jr. Soletti MD, David Chadow MD, Michelle Demetres MLIS, Leonard N. Girardi MD, Mario Gaudino MD, MSCE, PhD

Purpose:
Deep sternal wound infection (DSWI) is a severe complication after cardiac surgery and has been associated with increased early morbidity and mortality. Studies reporting long-term outcomes in patients with DSWI have shown contradictory results. In coronary artery bypass grafting, conduit selection and harvesting technique may impact the incidence of DSWI.

Methods:
We performed a study-level meta-analysis evaluating the impact of DSWI on short- and long-term clinical outcomes. A systematic literature search was conducted to identify studies comparing short- and long-term outcomes of cardiac surgery patients who developed DSWI and patients who did not. The primary outcome was overall mortality. Secondary outcomes were in-hospital mortality, follow-up mortality, major adverse cardiovascular events (MACE), myocardial infarction (MI), and repeat revascularization. Postoperative outcomes investigated were hospitalization time, stroke, MI, respiratory and renal failure.

Results:
Twenty-four studies totaling 407,829 patients were included. Overall, 6,437 (1.6%) patients developed DSWI. Mean follow-up was 3.5 years. DSWI was associated with higher overall mortality (incidence rate ratio [IRR] 1.99, 95% confidence interval [CI] 1.66-2.38, P<0.0001), in-hospital mortality (odds ratio [OR] 3.30, 95%CI 1.88-5.81, P<0.0001), follow-up mortality (IRR 2.02, 95%CI 1.39-2.94, P=0.0002), and MACE (IRR 2.04, 95%CI 1.60-2.59, P<0.0001). No differences in MI and repeat revascularization were found (IRR 1.47, 95%CI 0.48-4.49, P=0.5 and IRR 1.06, 95%CI 0.65-1.72, P=0.81, respectively), but limited studies reported those outcomes. DSWI was associated with longer postoperative hospitalization (standardized mean difference 2.14, 95%CI 1.70-2.58, P<0.001), stroke (OR 2.85, 95%CI 2.25-3.61, P<0.0001), MI (OR 2.42, 95%CI 1.27-4.59, P=0.007), respiratory and renal failure (OR 2.42, 95%CI 1.27-4.59, P=0.007 and OR 3.88, 95%CI 2.81-5.37, P<0.0001, respectively). Sensitivity analyses on isolated coronary artery bypass grafting studies and by adjustment method were consistent with the main analysis.

Conclusion:
Patients who developed DSWI after cardiac surgery have increased overall mortality, in-hospital mortality, follow-up mortality, and higher incidence of MACE at 3.5 years of follow-up compared to patients without DSWI. Studies are needed to delineate the best strategies to reduce the incidence of this complication after cardiac surgery.

Identify the source of the funding for this research project:
No funding.

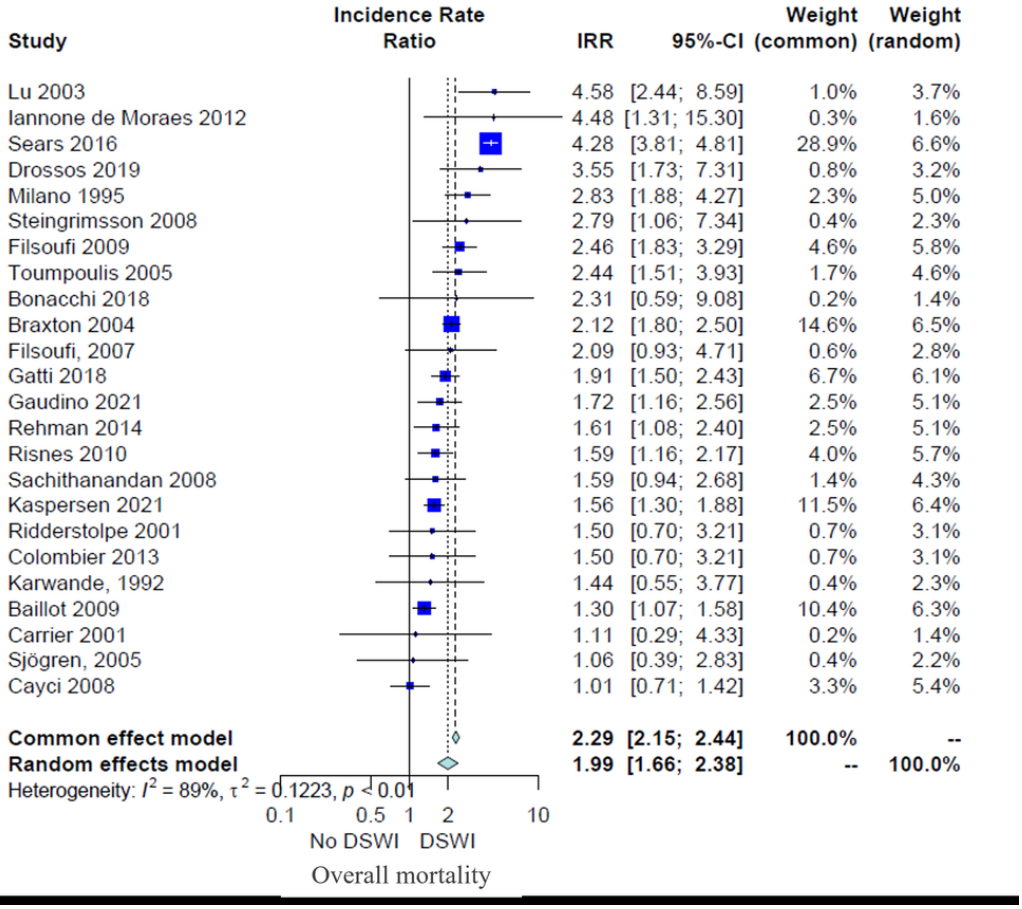
1. Results

Table 1. Summary of outcomes.

Outcome	No. of studies	Effect estimate (95%CI), P value	Heterogeneity (I^2, P)
Overall mortality	24	IRR=1.99 (1.66-2.38), P<0.001	89.2%, P<0.001
In-hospital mortality	16	OR=3.30 (1.88-5.81), P<0.001	78.4%, P<0.001
Follow-up mortality	16	IRR=2.02 (1.39-2.94), P<0.001	95.3%, P<0.001
MACE	4	IRR=2.04 (1.60-2.59), P<0.001	0.0%, P=0.99
MI	2	IRR=1.47 (0.48-4.49), P=0.5	43.0%, P=0.19
Repeat revascularization	3	IRR=1.06 (0.65-1.72), P=0.81	8.9%, P=0.33
Postoperative length of stay	11	SMD=2.14 (1.70-2.58), P<0.001	99.3%, P<0.001
Postoperative stroke	8	OR=2.85 (2.25-3.61), P<0.001	0.0%, P=0.68
Postoperative MI	6	OR=2.42 (1.27-4.59), P=0.007	34.8%, P=0.18
Postoperative respiratory failure	9	OR=5.79 (3.41-9.83), P<0.001	84.5%, P<0.001
Postoperative renal failure	8	OR=3.88 (2.81-5.37), P<0.001	25.3%, P=0.23

CI: confidence interval; IRR: incidence rate ratio; MACE: major adverse cardiovascular events; MI: myocardial infarction; OR: odds ratio; SMD: standardized mean difference.

2. Conclusions:



Conclusions Title:

Forest plot for overall mortality.

Presentation 2 – 1A

Application of microwave surgical instrument for no touch saphenous vein graft harvesting: a preliminary report to take one step further with promising technique

Author List
Kota Itagaki, MD, Kay Maeda, Masayuki Otani, Ryuichi Taketomi, Koki Ito, Yusuke Suzuki, Tomoyuki Suzuki, Shintaro Katahira, Goro Takahashi, Kiichiro Kumagai, Yoshikatsu Saiki
Division of Cardiovascular surgery, Tohoku University Hospital, Sendai, Japan

Purpose
Novel microwave surgical instrument (MSI) has been launched to clinical arena in Japan. 2450 MHz microwave can function to coagulate tissue by vibrating water molecules. We have applied MSI for saphenous vein graft (SVG) harvesting with no touch technique (NT). Preliminary outcomes on NT SVGs harvested with MSI were assessed.

Methods
We enrolled 38 patients (35 men and 3 women) in the single institutional single arm observational study on NT SVG with MSI from June 2020 through March 2022. Median age was 70 years (IQR 63-74). They underwent isolated (23) or concomitant (15) CABG. Since MSI has been upgraded as the second generation since 2021, we attempted to compare the results with NT SVGs derived from the two study periods, i.e., June 2020 to March 2021(G1) and March 2021 through March 2022(G2). Graft patency, wound problems requiring treatments of harvesting sites, re exploration associated with NT SVG harvesting, and in hospital mortality were evaluated.

Results
Nineteen patients were enrolled in each study period. Forty-six SVGs were harvested by no touch technique with MSI, 25 in G1 and 21 in G2. Regarding the location of harvest sites, 19 (76.0%) veins in G1 and 18 (85.7%) in G2 were harvested from the thighs. Postoperative graft patency was 88.0 in G1 and 95.2 in G2. There were no cases in this series who required re exploration for postoperative bleeding from a sealed branch of NT SVGs. Wound problems requiring administration of antibiotics or negative pressure wound therapy were observed in 3 cases in G1 and 2 in G2. They tended to occur more frequently in the early experience s per surgeon. No wound problems were noted with harvest from the lower legs. One in hospital death occurred in G1 due to sepsis apparently unrelated to SVG harvesting.

Conclusion
Although long term patency benefit of NT SVG has been reported, while wound complications and bleeding risk from NT SVG remain as a dilemma, technical modification using a novel microwave surgical scissors especially with multi directional function, for graft harvesting may help mitigate these issues with technical ease.

Presentation 3 – 1A:

Non-reversed saphenous vein is safe and facile in coronary bypass surgery

Author List:

Robert Boova, MD, Christopher McAndrew, DNP, CRNP, David DeFazio MD, Mohammed Kashem MD PhD, G. William Moser MSN CRNP, Yoshia Toyoda MD PhD, Kenji Minakata MD, PhD

Purpose:

Reversed saphenous vein is commonly used in coronary bypass surgery (CABG). Non-reversed saphenous veins (NRSVG), to avoid conduit: target mismatch, is not widely employed. The purpose of this study is to report CABG outcomes, in which the primary non-arterial conduit was NRSVG.

Methods:

After IRB approval, 427 patients undergoing CABG, between March 2013 and October 2019 were reviewed. Operations included both isolated CABG and CABG combined with other procedures. A total of 1154 coronary arteries were bypassed. There were 910 conduits, including 509 arterial and 401 NRSVG's. All saphenous veins (SVG) were harvested endoscopically. All veins were cannulated proximally, valves were lysed with a valvulotome, and antegrade flow was established. NRSVG's were constructed as both straight and sequential grafts. Study endpoints were major adverse cardiac events (MACE) and graft integrity, assessed by transit time flow measurement (TTFM)

Results:

Isolated CABG was performed in 377/427 (88%) patients. Off-pump CABG was performed in 356/377 (94%) patients. At least one NRSVG was utilized in 344 (80.5%) procedures. NRSVG, 401, were utilized to construct 229 straight and 172 sequential grafts, (Table 1). TTFM values were available for 757/910 (83%) conduits and 337/401 (84%) NRSVG. Mean flow by TTFM was 50.4 cc/min for 192 / 229 (83.8%) straight NRSVG's and 79.1cc/min for 145 / 172 (84.3%) sequential NRSVG's. Mean flow by TTFM in 324 LIMA to LAD grafts was 56.9 cc/min. Intraoperative graft revision for perceived insufficient TTFM values was performed in 10 conduits (1.1 %). No NRSVG required intraoperative revision. There were no adverse outcomes attributable to graft failure regardless of conduit configuration or type. There were no adverse cardiac events in the entire study cohort.

Conclusion:

NRSVG is suitable, in varying configurations, for both off-pump and on-pump CABG. The technique mitigates conduit-target mismatch, and facilitates proximal and distal graft construction. Measured TTFM values were satisfactory in all grafts. No adverse outcomes, attributable to this technique, occurred in this observational study. NRSVG can be safely recommended.

1. Results

	Left-sided (LAD, Dx, RI, LCx)	Right-Sided (PDA, p/l, RCA)		Grafts TTFM (n)	Mean (cc/min)
LIMA	386	0		324	56.91
NRSVG					
Straight	123	106		192	50.44
Sequential	273	116		145	79.08

Table 1. Coronary Arteries Bypassed and Graft TTFM

2. Conclusions:

NRSVG Image

Institution:
Wilkes-Barre General Hospital

Presentation 4 – 1A:

Concomitant coronary and carotid artery disease: systematic review and network meta-analysis of available surgical treatments

Author List:
Fabio Ramponi, MD, Michael Seco, Dong Fang Zhao, David Arpon, Suhanya Seimon, Paul Bannon, Leonard Kritharides, John Puskas, Michael Vallely

Purpose:
Patients presenting with concomitant carotid and coronary artery disease represent an exceptional challenge because of the elevated perioperative risk. A network meta-analysis was performed to compare post-operative outcome of multiple strategies with different temporal sequence: on-pump or off-pump coronary artery bypass and carotid endarterectomy/stenting performed simultaneously, staged or reversed-staged.

Methods:
A systematic search of three databases was performed to identify studies comparing at least two treatment arms in which the above-mentioned strategies were adopted. The primary outcome was stroke within 30 postoperative days; secondary outcomes included 30-day transient neurologic injury (TIA), myocardial infarction (MI), and mortality at 30 days. Studies reporting the primary endpoint were included in a Bayesian network meta-analysis.

Results:
There were 50 studies with 103,772 patients included. At baseline there was a trend for patients undergoing staged CEA/ONCAB to have had a previous stroke/TIA (OR 2.26, CI 0.985-5.71). Compared with synchronous CEA/ONCAB, staged CEA-ONCAB was associated with the lowest risk of post-operative stroke (OR 0.609; 95% CI 0.390-0.723; SUCRA 79.48%), followed closely by synchronous CEA/OPCAB (OR 0.639; 95% CI 0.362-0.866; SUCRA 72.84%). Unlike synchronous CEA/OPCAB, staged CEA-ONCAB was associated a three-fold increased risk of 30-day MI (OR 3.34, 95% CI 1.52-8.44). No significant difference in 30-day mortality or TIA rate was demonstrated among treatments.

Conclusion:
This network meta-analysis shows that synchronous CEA/OPCAB provides a neurologic advantage without increased risk of MI.

Abstract Session 1B – Saturday, June 4, 3:40 pm – 4:50 pm ET, MacDonald Room, Mezzanine Level

Presentation 1 – 1B

Feasibility of Pulmonary Vein Isolation and Left Atrial Appendage Ligation at the Time of Off-Pump Coronary Artery Revascularization for the Treatment of Atrial Fibrillation

Author List:
Aaron Tipton, MD, Matthew Janko, MD, Pablo Ruda Vega, MD, Gregory Duncan Rushing, MD
University Hospitals, Cleveland

Purpose:
Atrial Fibrillation (AF) is commonly seen in patients with coronary artery disease (CAD) and is associated with increased all-cause morbidity and mortality. Concomitant surgical ablation (SA) is recommended for those who undergo coronary artery bypass (CABG) surgery. There is limited data on the efficacy of off-pump CABG (OPCAB) with SA.

Methods:
We performed OPCAB with concomitant SA (bilateral pulmonary vein isolation (PVI), left atrial appendage ligation (LAAL)), in patients with CAD and AF. These patients were followed in a rigorous arrhythmia clinic protocol at one, three, six and twelve months. We compared demographics, STS metrics (deep sternal wound infection, reoperation, renal failure, mortality), freedom from atrial fibrillation, and stroke. Primary outcomes were freedom from atrial fibrillation and stroke. Secondary outcome was 30-day mortality.

Results:
Seven patients underwent OPCAB and SA. All patients had paroxysmal atrial fibrillation. The average age was 73 years (SDÂ± 5.9), 5 were men, all were Caucasian. Of those with 90-day follow up, all were in sinus rhythm. One patient developed atrial flutter. There was no incident of stroke. There were no mortalities, and all patients were discharged from the hospital. One patient required re-operation for bleeding.

Conclusion:
This pilot study shows SA with PVI, and LAAL is a feasible and safe treatment of atrial fibrillation in patients undergoing off-pump CABG. Further work is directed toward additional enrollment, and longer follow up.

1. Results

STS Markers	Predicted (Mean %)	Actual (Mean %)
Mortality	1.44	0
Deep Sternal Wound Infection	0.24	0
Permanent Stroke	0.89	0
Discharge Home	N/A	86
Freedom from Atrial Fibrillation (90 days)	N/A	86
Renal Failure	1.13	0

Predicted and Actual Outcomes

Presentation 2 – 1B

Patients with New Onset Atrial Fibrillation after Coronary Artery Bypass with concomitant Left Atrial Appendage Ligation Require No Formal Anticoagulation

Author List:
Usman Aslam, DO, MPH, MS, Jessa Deckwa, BS, Amina Khalpey PhD, Yash Suri MS, Zain Khalpey, MD, PhD
HonorHealth, Scottsdale, AZ

Purpose:
We evaluated the need for anticoagulation in coronary artery bypass graft (CABG) patients with new onset postoperative atrial fibrillation (NOPAF) patients who had a left atrial appendage (LAAL) ligation.

Methods:
A single-center retrospective propensity score analysis of CABG patients performed by a single surgeon (2019-2021), (IRB#20200195) was performed. In all patients the LAA was ligated atraumatically with a 40 mm LAA clip (AtriCure Inc., Mason, OH, USA) and confirmed with intra-operative transesophageal echocardiogram. Subjects with an episode of NOPAF at 30 days were compared with those without. Primary endpoints were mortality, transient ischemic attack (TIA), and ischemic stroke (CVA) evaluated at 1-year followup. The standard 81mg aspirin and 75mg Plavix daily were administered to all patients. Subjects who underwent any other concomitant cardiac procedures were excluded.

Results:
One hundred and thirty patients were included in this study. Median age was 67 years (Â±9.05), and median BMI was 28.83 (Â±5.01). Median CHA2DS2-VASc score was 2.81 (Â± 1.42) and HASBLED score was 1.72 (Â± 1.06). 14.6% (19/130) subjects had a history of stroke or thromboembolism. At 30 days, 28.5% (37/130) developed NOPAF and none of these patients experienced a TIA or ischemic stroke at 1 year follow-up. Of the subjects without NOPAF, only 2.1% (2/93) had an occurrence of TIA or stroke. Overall length of stay was not significantly different for NOPAF subjects (6.70s; Â± 3.70) compared to control (5.90d; Â± 3.29). The ICU stay for NOPAF patients (4.24d; Â± 1.95) compared to control (3.37d; Â± 1.92) was significantly higher (p=0.02). At one year follow-up, readmission rates were not significantly different for NOPAF subjects (8.12%; 3/37) compared with control (10.75%; 10/97).

Conclusion:
Concomitant LAAL confers significant morbidity benefits in patients undergoing CABG. In this study, we demonstrate that with no formal anticoagulation the incidence of thromboembolic events and strokes are significantly lower in patients with NOPAF compared to those without. Further prospective studies are warranted in order to meaningfully influence clinical practice.

1. Results

NOPAF vs Control Subject Characteristics				Subject Characteristics	
Average (SD) or n/N (%)	NOPAF (n= 37)	Control (n= 93)	P Value (T Test)	Average (SD) or n/N (%)	
Age	70 (±7.86)	66 (±9.27)	0.02		
Male	29 (78.38%)	70 (75.27%)	0.71	Age	67 (9.05)
BMI	28.97 (±5.44)	28.77 (±4.85)	0.84	≤64	47/130 (36.15)
CHA_2DS_2-VASc	2.86 (±1.48)	2.78 (±1.41)	0.77	65-74	54/130 (41.54)
CHA_2DS_2-VASc ≥ 2	32 (86.49%)	74 (79.57%)	0.36	≥ 75	29/130 (22.31)
HASBLED	2.46 (±1.24)	2.08 (±1.02)	0.07	Male	99/130 (76.15)
HASBLED ≥ 2	30 (81.08%)	66 (70.97%)	0.24	Female	31/130 (23.85)
STS score	1.25 (±1.03)	1.50 (±3.28)	0.65	BMI	28.83 (5.01)
Congestive Heart Failure	5 (13.51%)	9 (9.68)	0.56	CHA_2DS_2-VASc	2.81 (1.42)
Hypertension	27 (72.97%)	75 (80.65%)	0.34	CHA_2DS_2-VASc≥ 2	106/130 (81.54)
Chronic Lung Disease	2 (5.41%)	19 (20.43%)	0.03	HASBLED	1.72 (1.06)
Prior MI	12 (32.43%)	21 (22.58%)	0.25	HASBLED ≥ 2	96/130 (73.85)
Prior CVA	4 (10.81%)	5 (5.38%)	0.31	STS score	1.43 (2.82)
Prior Pulmonary Embolism	1 (2.70%)	2 (2.15%)	0.85	Congestive Heart Failure	14/130 (10.77)
Prior Peripheral Embolism	2 (5.41%)	5 (5.38%)	0.99	Hypertension	102/130 (78.46)
NOPAF vs. Control Long Term Outcomes				Chronic Lung Disease	21/130 (16.15)
Average (SD) or n/N (%)	NOPAF (n= 37)	Control (n= 93)	P Value (T Test)	Prior MI	33/130 (25.38)
LOS (days)	6.70 (± 3.70)	5.90 (± 3.29)	0.22	Prior CVA	9/130 (6.92)
ICU (days)	4.24 (± 1.95)	3.37 (± 1.92)	0.02	Prior Pulmonary Embolism	3/130 (2.31)
Stroke >30 days	0 (0.0%)	2 (2.1%)	0.37		
Death > 30 days	0 (0.0%)	0 (0.0%)	NA	Prior Peripheral Embolism	7/130 (5.38)
Hospital readmission: 1 year following surgery	3 (8.11%)	10 (10.75%)	0.55		

Comparison of subjects characteristics, short term outcomes, and long-term outcomes between NOPAF and control subjects.

Conclusions Title:

In this study, we demonstrate that with no formal anticoagulation the incidence of thromboembolic events and strokes are significantly lower in patients with NOPAF compared to those without.

Presentation 3 – 1B

Placental Membrane Placement Reduces Postoperative Atrial Fibrillation Following Cardiothoracic Surgery

Author List:
Usman Aslam DO, MPH, MS, Jessa Deckwa BS, Amina Khalpey PhD, Jessie Anderson BS, Zain Khalpey, MD, PhD

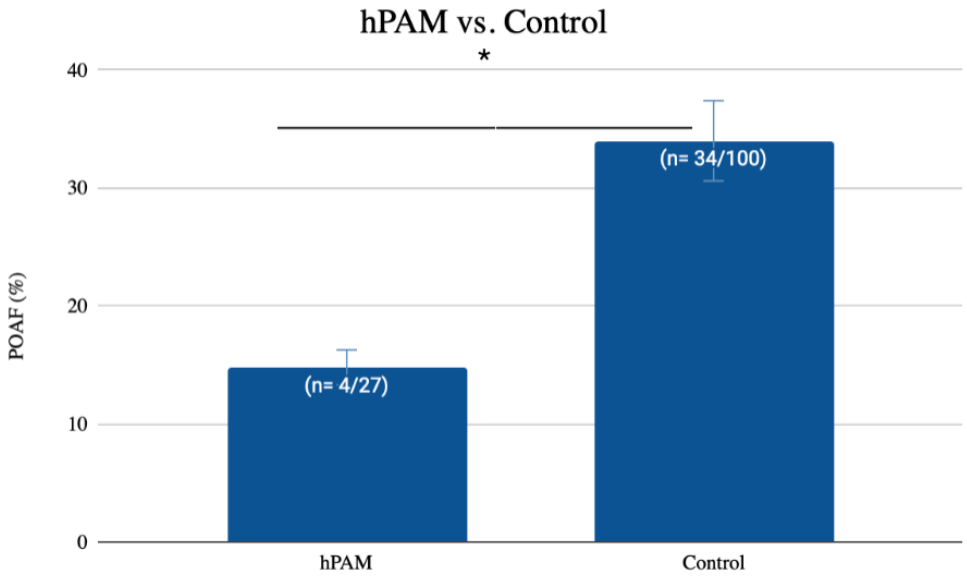
Purpose:
To determine whether the placement of a human placental allograft membrane (hPAM) as a tissue covering epicardium during coronary artery bypass grafting reduces the incidence of postoperative atrial fibrillation (POAF).

Methods:
A single-center retrospective analysis of coronary artery bypass (CABG) patients performed by a single surgeon (2019-2021)(IRB#20200195) was performed. Three dehydrated, aseptically processed amnion/chorion membranes, 5cm x 6cm, were placed over the epicardium (right atrium, right ventricle, and left ventricle) prior to partial pericardial approximation. Subjects treated with hPAM were compared with subjects without this treatment using chi-squared test for association and stepwise regression analysis. Primary endpoint was defined as incidence of POAF at one year.

Results:
One hundred and twenty-seven subjects were included in the present study. Twenty seven subjects were included in the hPAM group and one hundred in the control group. The overall incidence of PAOF after CABG was 29.9% (38/127). Of those treated with hPAM, 15% (4/27) developed POAF compared to 34% (34/100) in the control group. After controlling for age, gender, BMI, comorbidities, and concurrent treatments, the incidence of PAOF in subjects treated with hPAM was found to be significantly lower compared to control subjects (p=0.05).

Conclusion:
POAF is a morbid and costly complication following CABG that may be prevent by covering the cardiac wound with hPAM. In this study we demonstrate that this novel method significantly reduces the incidence of POAF after CABG. Further studies are warranted to understand the far-reaching implications of these findings.

1. Results



Proportion of POAF in cardiac surgery patients treated with hPAM compared to concurrent controls.

Conclusions Title:

In this study we demonstrate that this novel method significantly reduces the incidence of POAF after CABG.

In this study we demonstrate that this novel method significantly reduces the incidence of POAF after CABG.

Presentation 4 – 1B

Sex Differences in Multiple Arterial Coronary Artery Bypass Grafting

Author List:
Justin Ren, PhD, Alistair Royse, MD, Colin Royse
University of Melbourne

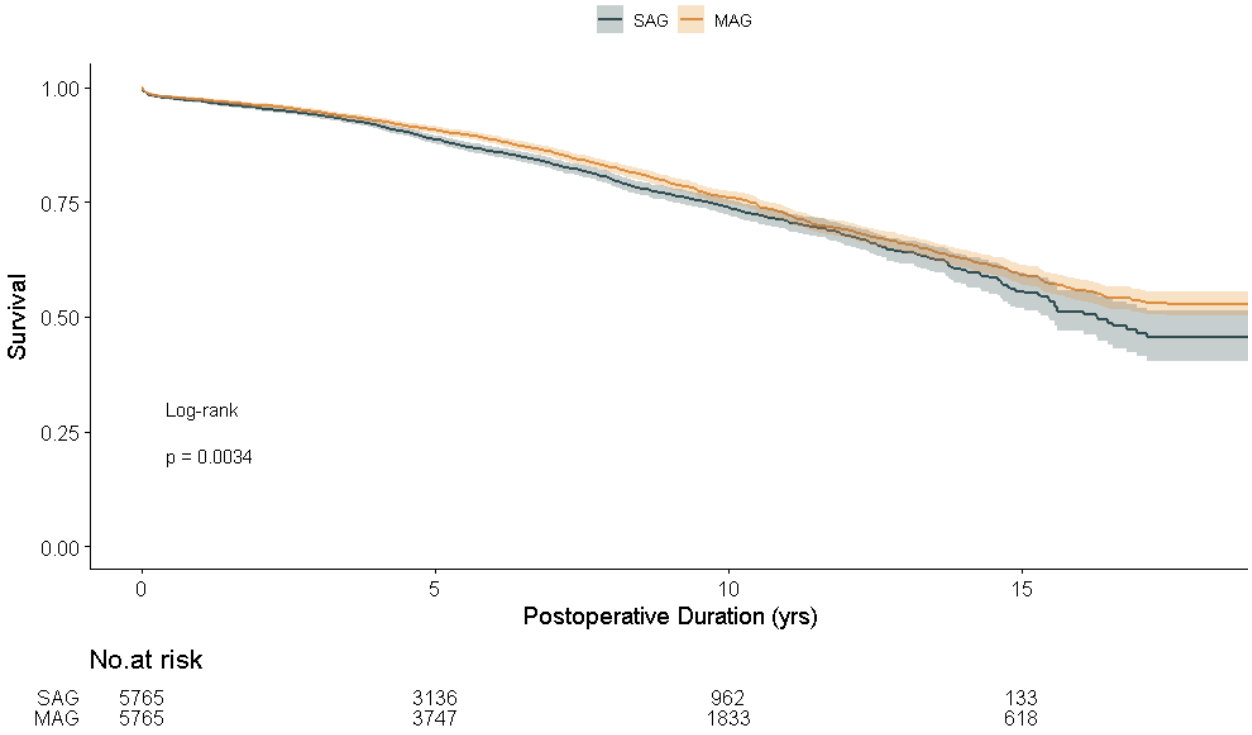
Purpose:
Uncertainty exists over whether multiple arterial revascularization has a sex-related association with survival after coronary artery bypass grafting (CABG). This study aims to investigate the long-term survival outcomes of using multi-arterial versus single-arterial grafting in women and men undergoing bypass surgery.

Methods:
This national retrospective study used the Australian and New Zealand Society of Cardiac-Thoracic Surgical Database (ANZSCTS) to identify 72,444 patients undergoing CABG from June 2001 to January 2020. It has established linkage to the national death index. The endpoint was all-cause mortality at the longest follow-up, which was compared in propensity score matched patients following sex stratification. The matching caliper was 0.2 of the standard deviation (SD) of the logit of the propensity score. We used cox proportional hazard model with an interaction term on sex to calculate hazard ratios (HRs) and confidence intervals (CIs).

Results:
From all patients (58,629 males [80.9%]; mean age Â± SD, 65.8 Â± 10.2) included in the study, propensity score matching generated 23,271 male and 5,765 female pairs. At seven years postoperative, mortality was significantly lower in patients undergoing multiple arterial grafts for both males (HR, 0.89; 95% CI, 0.85-0.93; P<0.001) and females (HR, 0.88; 95% CI, 0.81-0.96; P=0.003) than single arterial graft. The interaction model suggested an insignificant effect of sex (P = 0.87) on the observed survival benefits. The Kaplan-Meier estimated 15-year survival of MAG was higher in both males (MAG, 65.4 %; SAG, 62.2%) and females (MAG, 59.1%; SAG, 56.6%). Female patients have numerically lower survival rates due to poorer baseline characteristics.

Conclusion:
Multiple arterial revascularization is associated with substantially improved long-term survival independent of sex. These data confirm the need for wider adoption of multiple arterial grafting in both male and female populations.

2. Conclusions:



Conclusions:

Kaplan-Meier estimates of 15-year all-cause survival for propensity score matched multi-arterial versus single-arterial grafting in female patients

Previous multiple arterial studies did not show significant survival benefits in females. The current practice is still using venous conduits to supplement a single left internal mammary artery graft.

Presentation 5 – 1B:

The Influence of Coronary Surgical Experience on Selection of Total Arterial Grafting Strategies Based on Hemodynamic Predictors of Optimal Myocardial Perfusion

Author List:
Krish Chaudhuri, PhD, FRACS, Steve Waqanivavalagi, Paget Milsom, Nicolas P. Smith
Green Lane Cardiothoracic Surgical Unit at Auckland City Hospital, New Zealand

Purpose:
The application of total arterial grafting (TAG) utilizing bilateral internal mammary arteries typically requires significant expertise, particularly when performing composite grafts. However, the optimal patient-specific grafting configuration remains unknown. The purpose of this study was to compare configurations selected by expert and novice coronary surgeons for optimizing myocardial perfusion.

Methods:
A subgroup analysis was undertaken by dividing a cohort of 16 surgeons into 8 novices and 8 experts, based on experience. The preferred TAG configuration selections by surgeons, using aorto-coronary ('aortic') and no-touch 'anaortic' techniques, were compared for 5 patients before, and after, they were provided with predictive computer-model derived transit-time flowmetry graft performance data. An optimal grafting configuration was defined using an algorithm maximizing left anterior descending territory and total myocardial perfusion at ideal mean graft flow and pulsatility index in all grafts. Comparisons were made regarding selection of optimal configurations, rejected configurations and influence of myocardial perfusion data.

Results:
There were no significant differences in predicted myocardial perfusion parameters between perfusion-optimising and other ideal grafting configurations (Table 1). With standard decision-making, novices were more likely than experts to select an optimal 'aortic' grafting configuration (82.5% (33/40) vs 47.5% (19/40), P = 0.002) based on a preference for using separate rather than composite grafts, but not for 'anaortic' configurations (2.5% (1/40) vs 10% (4/40), P = 0.359). Following review of the computational models' predictive information, novices selected more perfusion-optimising 'anaortic' configurations (47.5% (19/40) vs 10% (4/40), P < 0.001) but not 'aortic' configurations (70% (28/40) vs 52.5% (21/40), P = 0.168). Compared with experts, novices also chose more grafting configurations that were previously declined (36.54% (19/52) vs 2.63% (1/38), P < 0.001). Furthermore, novices were more likely to change their rankings of preferred TAG configurations following review of additional myocardial perfusion data (45% (36/80) vs 6.25% (5/80), P < 0.001).

Conclusion:
Expert coronary surgeons select ideal anaortic TAG configurations that they are more familiar with in preference to optimising predictive hemodynamic perfusion. When performing aorto-coronary grafts they could consider using separate grafts. Novices are more influenced by predictive hemodynamics despite small differences in perfusion and select configurations less familiar to them.

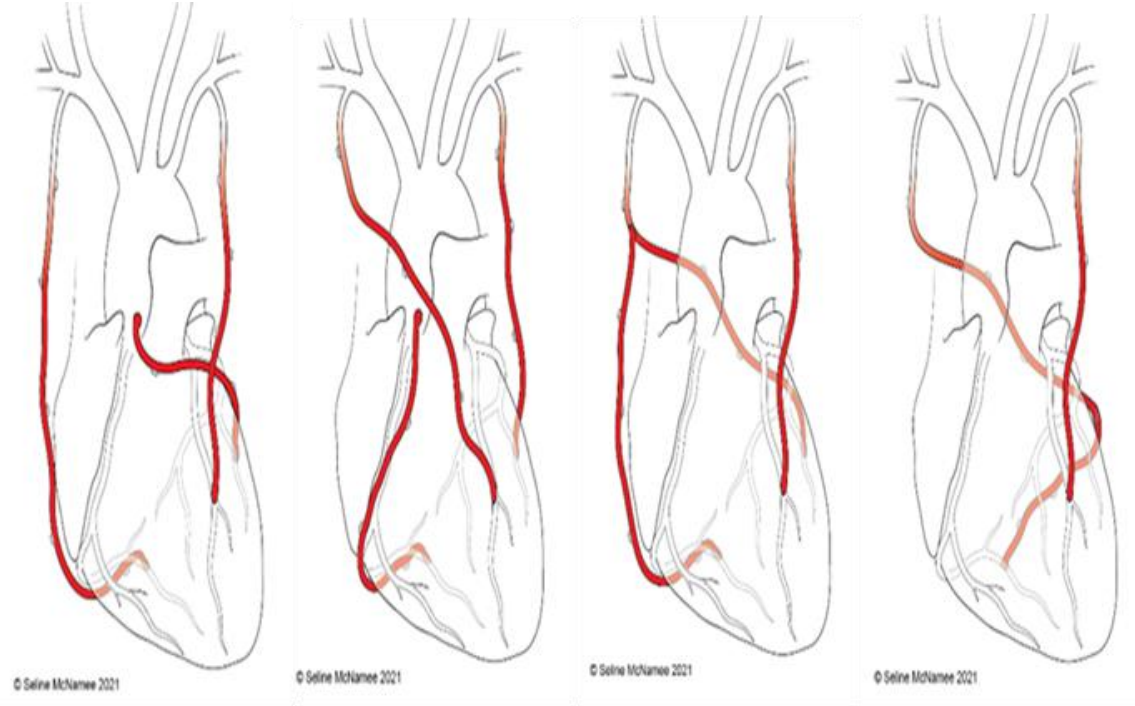
*The study was funded by the Royal Australasian College of Surgeons (RACS) Surgeon Scientist Scholarship

1. Results

Characteristic	Optimal Perfusion Configurations	Other Ideal Configurations	P-value
AORTIC CONFIGURATIONS			
LAD Territory Perfusion (ml/min, mean ± SD)	102.79 ± 9.82	97.75 ± 6.34	0.247
Total Myocardial Perfusion (ml/min, mean ± SD)	253.30 ± 7.51	253.00 ± 5.75	0.932
ANAORTIC CONFIGURATIONS			
LAD Territory Perfusion (ml/min, mean ± SD)	101.73 ± 10.71	97.66 ± 7.50	0.343
Total Myocardial Perfusion (ml/min, mean ± SD)	244.99 ± 9.69	239.53 ± 9.71	0.282

Predictive myocardial perfusion (optimal perfusion vs other ideal configurations)

2. Conclusions:



Set of optimal 'aortic' and 'anaortic' grafting configurations across 5 patients

Presentation 6 – 1B

Machine Learning Models with Intraoperative Features Improve Risk Predictions Following CABG

Author List:
1. **Willa Potosnak**, Carnegie Mellon University, Robotics Institute, Auton Lab; Pittsburgh, PA
2. Keith A. Dufendach, M.D., University of Pittsburgh Medical Center, Division of Cardiac surgery and Carnegie Mellon University, Robotics Institute, Auton Lab; Pittsburgh, PA
3. David Kaczorowski, M.D., University of Pittsburgh Medical Center, Division of Cardiac surgery; Pittsburgh, PA
4. Kyle Miller, Ph.D., Carnegie Mellon University, Robotics Institute, Auton Lab; Pittsburgh, PA
5. Artur Dubrawski, Ph.D., Carnegie Mellon University, Robotics Institute, Auton Lab; Pittsburgh, PA

Purpose:
Intraoperative parameters may offer additional predictive utility in evaluating risk of adverse postoperative events but are absent from current risk models. Machine learning (ML) was used to determine whether inclusion of intraoperative data offers improved model predictions for multiple outcomes following coronary artery bypass grafting (CABG).

Methods:
Preoperative STS database features and risk predictions were combined with retrospectively gathered continuous intraoperative data from 5,295 patients following CABG. Mean and standard deviations of intraoperative data were computed for the pre-incision, pre-bypass, cardiopulmonary bypass, and post-bypass phases and included as features for modeling. Outcomes predicted include postoperative renal failure, 30-day mortality, reoperation, and combined morbidity and mortality (MM). A Random Forest ML classification algorithm was trained on combined preoperative and intraoperative features using 5-fold cross validation. Model performance was measured using area under the receiver operating characteristic curve (AUC-ROC) and sensitivity at a 1% false positive rate (FPR).

Results:
When compared with STS risk scores, Random Forest models trained on both preoperative and intraoperative features had improved mean AUC-ROC, on average, for renal failure (0.816 versus 0.781), mortality (0.804 versus 0.779), MM (0.753 versus 0.700), and reoperation (0.641 versus 0.535). Additionally, the combined feature models exhibited a higher proportion of true positive predictions, defined as sensitivity at a 1% FPR, for 30-day mortality (0.210 versus 0.143), MM (0.151 versus 0.104), and reoperation (0.092 versus 0.028). Notably, important features used by the reoperation prediction model are intraoperative parameters that indicate surgery and bypass durations as well as the use of intraoperative blood products or packed red blood cells are important predictors of need for reoperation. Alternatively, while intraoperative features also improved predictions for renal failure, mortality, and MM, preoperative features contributed to a greater degree for these outcomes.

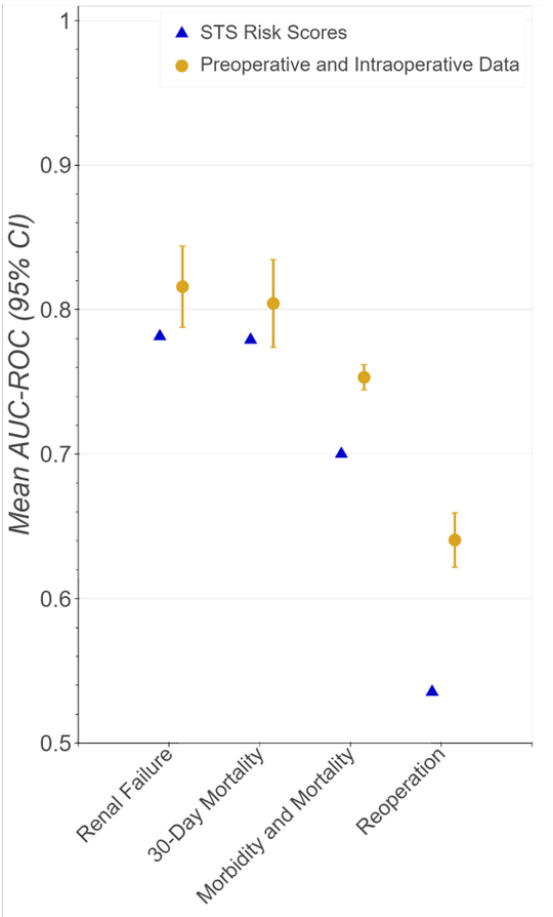
Conclusion:
Incorporating intraoperative data with preoperative patient characteristics improves the ability to predict multiple outcomes, particularly reoperation. These models may improve early postoperative care by identifying patients at highest risk for early adverse events. Additionally, evaluating intraoperative features using ML may identify clinical targets to reduce adverse outcomes.

1. Results

	Renal Failure	30-Day Mortality	Combined Morbidity and Mortality (MM)	Reoperation
AUC-ROC STS Risk Scores	0.781	0.779	0.700	0.535
AUC-ROC (95% CI) Preoperative and Intraoperative Data	0.816 (0.788, 0.844)	0.804 (0.774, 0.835)	0.753 (0.744, 0.762)	0.641 (0.622, 0.659)
Sensitivity at a 1% FPR STS Risk Scores	0.211	0.143	0.104	0.028
Sensitivity at a 1% FPR (95% CI) Preoperative and Intraoperative Data	0.147 (0.120, 0.174)	0.210 (0.198, 0.222)	0.151 (0.123, 0.178)	0.092 (0.067, 0.117)
Top 5 Important Model Features Preoperative and Intraoperative Data	1. STS renal failure risk 2. STS MM risk 3. STS 14-day readmission risk 4. STS mortality risk 5. STS prolonged ventilation risk	1. STS 14-day readmission risk 2. STS 6-day readmission risk 3. STS mortality risk 4. STS stroke risk 5. STS MM risk	1. STS prolonged ventilation risk 2. STS 14-day readmission risk 3. STS MM risk 4. STS 6-day readmission risk 5. STS mortality risk	1. Use of intraoperative blood product transfusions 2. STS MM risk 3. Cardiopulmonary bypass duration 4. Surgery post-incision duration 5. Use of intraoperative packed red blood cell transfusions

Model statistics compared with Society of Thoracic Surgeons Risk Scores for four outcomes hypothesized to be significantly affected by intraoperative events

2. Conclusions: Area under the receiver operating characteristic curve of Random Forest model compared with Society of Thoracic Surgeons Risk Scores for four postoperative outcomes.



Abstract Session 2A – Sunday, June 5, 11:35 am – 12:15 pm ET (Adam Room)

Presentation 1 – 2A

Long Term Outcomes After Minimally Invasive Coronary Artery Bypass Grafting

Author List:
Hugo M. N. Issa, MD; Ming Hao Guo, MD; Thin X Vo, MD, MSc; Kenza Rahmouni, MD; Aun-Yeong Chong, MD; David Glineur, MD, PhD; Marc Ruel, MD, MPH, University of Ottawa Heart Institute

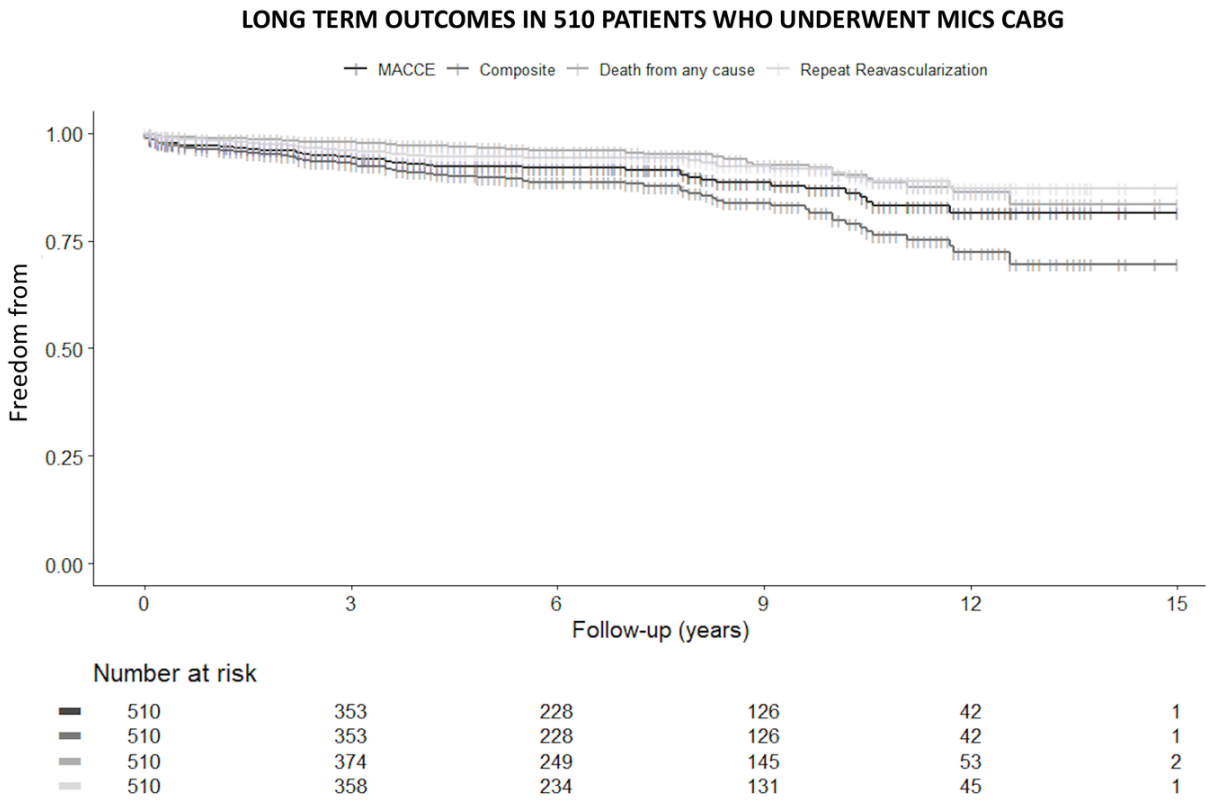
Purpose:
Minimally invasive coronary artery bypass grafting (MICS CABG) allows surgical revascularization of multiple coronary territories through a small thoracotomy. The aim of this study was to report long term outcomes of patients undergoing MICS CABG.

Methods:
From September 2005 to December 2020, 510 consecutive patients who underwent MICS CABG were prospectively followed at a single institution. The outcomes were major adverse cardiac or cerebrovascular events (MACCE), all-cause mortality, composite of all-cause mortality and MACCE, and repeat revascularization. Kaplan-Meier curves were plotted for these outcomes. The cohort was divided into subgroups: number of coronaries revascularized, history of previous revascularization intervention, need of Cardiopulmonary bypass (CPB), presence of acute coronary syndrome (ACS) pre-operatively, first 50 operations compared to the others, and left ventricular ejection fraction (LVEF) <45% vs >45%. Log-rank test was used to compare subgroups.

Results:
The mean follow-up was 6.5 Â± 4.0 years (maximum 15.3 years). The 10-year freedom from the composite outcome of MACCE and all-cause mortality was 82.4 Â± 2.7%. Overall survival for this cohort was 90.8 Â± 2.1%, with 10-year freedom from MACCE of 89.1 Â± 2.1% and freedom from repeat revascularization of 90.8 Â± 2.1% (Figure 1). Subgroup analysis showed that the presence of ACS at the time of MICS CABG had higher rates of repeat revascularization in the follow-up period (p = 0.050). Also, patients with LVEF <45% had higher rates of all-cause mortality (p = 0.002) and composite outcome (p = 0.021). There was no difference in the outcomes regarding the number of coronaries revascularized, the history of previous revascularization intervention, and the need of CPB support during the procedure. Additionally, no outcome difference was found between the first 50 operated patients compared to the other 460.

Conclusion:
MICS CABG provided excellent long-term outcomes in patients with single or multivessel coronary artery disease. The presence of ACS and LV dysfunction at the time of the procedure was associated with compromise of long-term outcomes.

1. Results



Long term outcomes in 510 patients who underwent MICS CABG

Presentation 2 – 2A

Surgical planning for MICS-CABG is facilitate by 3D Printed Anatomic Model

Author List:
Antonio Panza, MD, Prashanth Ravi, PhD, James Bailey, MD, James A. Miller, MD,
Michael B. Burch, MD, Tommaso Hinna Danesi, MD, Louis, MD, Frank Rybicki, MD
University of Cincinnati

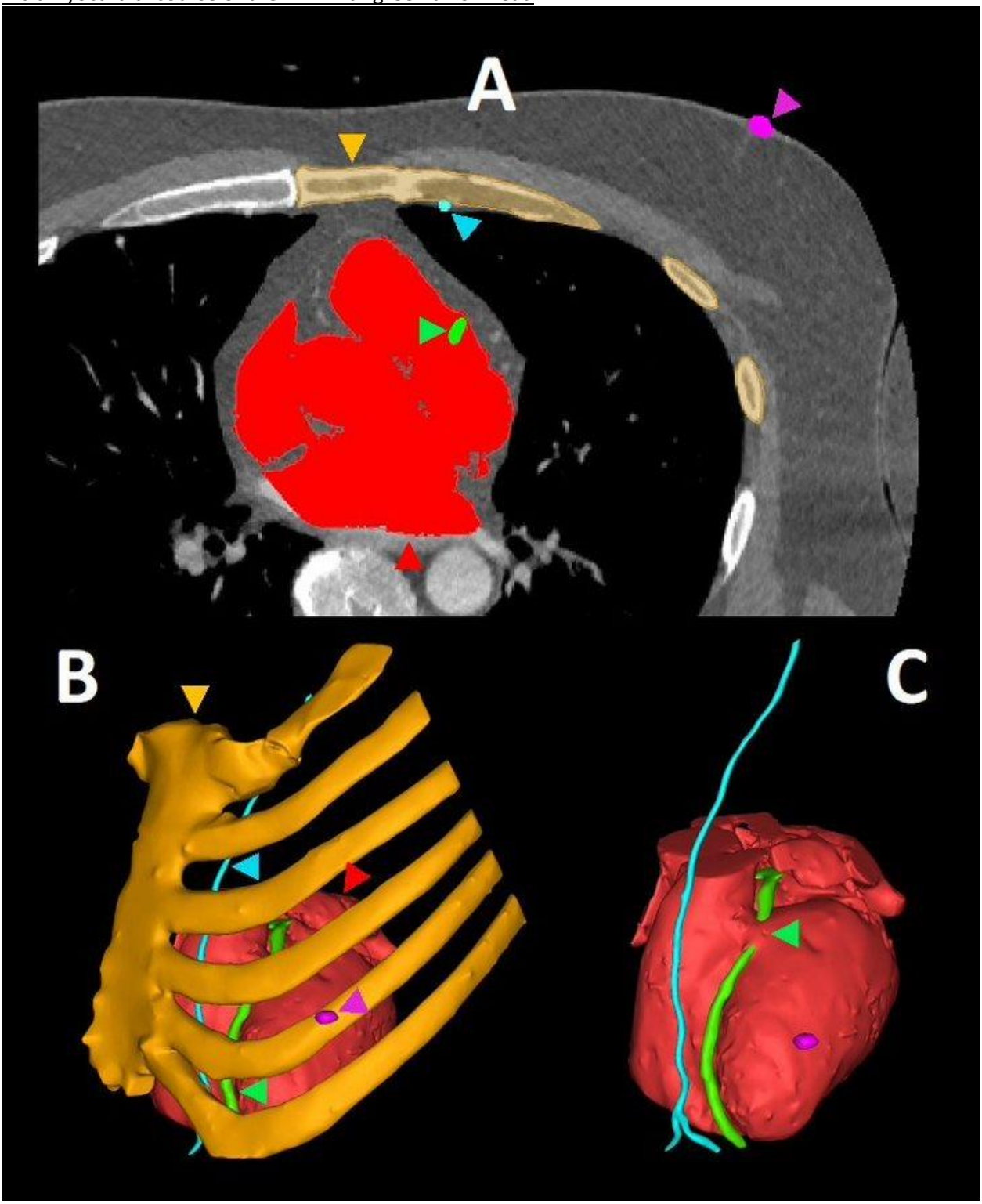
Purpose:
Accurate planning is paramount in mini-invasive surgery. Tridimensional anatomical reconstruction is the latest advance in pre-operative imaging tests. However, to our knowledge, there are no reports in MICS-CABG. The purpose of this study is to introduce and evaluate the role of desktop 3D printed (3DP) anatomical models to facilitate MICS-CABG

Methods:
From March 2020 to May 2021 twenty-one consecutive patients undergoing MICS-CABG received as preoperative planning a 3DP anatomical model. Seventeen of 21 patients (age 65+/-12 years) were male; 3/21 patients received a second graft. Thin section contrast-enhanced CT images were segmented into 5 parts: left 1st-7th ribs with intercostal spaces (ICS), sternum, LIMA, LAD, and nipple locator (for males). Using 3D printed connectors, all 5 anatomic parts were printed monolithically at half-scale (Fig. 1). A single surgeon verified the correspondence between the predicted 3DP and observed intra-operative findings of the mid-sternum/LAD and mid-sternum/LIMA distances, and best ICS entrance.

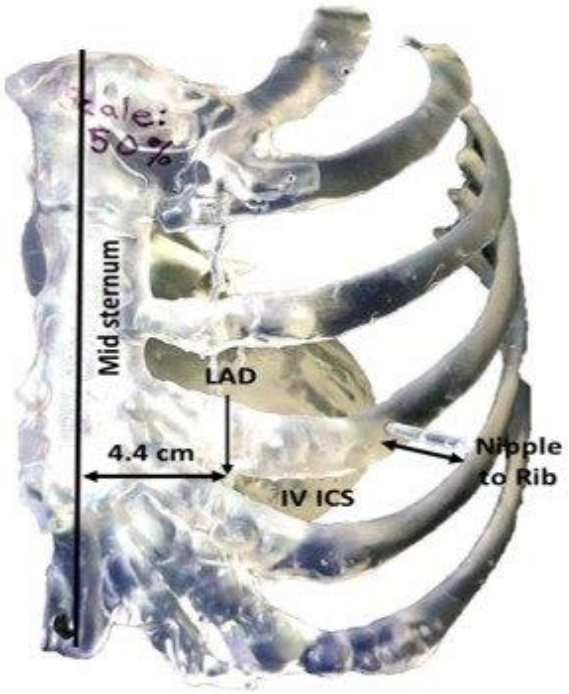
Results:
All patients were successfully grafted. The volumetric reconstruction of the LAD and its relationship with the ICS was 100% effective in guiding us to choose the best ICS between the IV (14 pts) and V (7 pts) and the skin incision location according to the nipple. The maximum absolute difference of midsternum-LAD and rib-nipple distance was only 0.2 cm between intraoperative measurements and 3DPs. The complexity of the procedure was accurately predicted by the well corresponding midsternum-LAD distance (LIMA reachability), rib-nipple distance (surgical depth), and an intramyocardial LAD course. Moreover, the 3DP facilitated its planning among the OR team and the patient comprehension and acceptance of the procedure

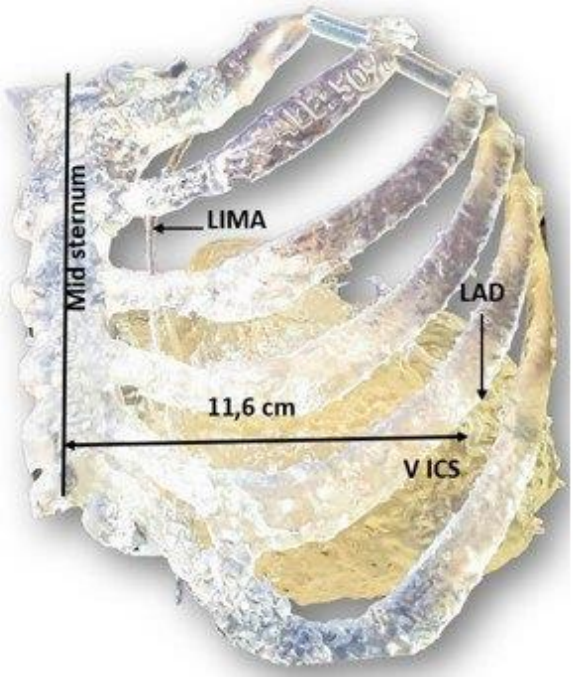
Conclusion:
3DP anatomical models accurately portrayed the volumetric relationships, that, in our hands, have been proved to be helpful in the prediction of the ease of the MICS-CABG. This can facilitate the selection of the right patients. 3DP models might be soon incorporated into the clinical practice of the MICS-CABG procedure

1. Results: (A) Color coded masks of anatomical parts are overlaid on axial CT image. (B) 3D virtual color-coded model: bone in orange, LIMA in cyan, LAD in green, nipple in magenta, and heart in red. (C) Intramyocardial course of the LAD with green arrowhead



2. Conclusions: Two different 3DP models showing great variability in the Mid-Sternum to LAD distance (4.4 cm vs 11.6 cm), and the best ICS entrance (4th vs 5th)


Scale:
50%
Mid sternum
LAD
4.4 cm
IV ICS
Nipple
to Rib


Mid sternum
LIMA
LAD
11,6 cm
V ICS

Presentation 3 – 2A

Comparison of complete surgical revascularization or hybrid coronary revascularization with MICS CABG

Author List:
Hugo M.N. Issa, MD, Ming Hao Guo, MD, Thin X Vo, Kyra Horsthuis, Kenza Rahmouni, Aun-Yeong Chong, MD, David Glineur, MD, PhD, Marc Ruel, MD, MPH, University of Ottawa Heart Institute

Purpose:
Minimally invasive coronary artery bypass (MICS CABG) was developed for complete revascularization of multiple coronaries through a small thoracotomy. The technique could be used for complete surgical revascularization (CSR) or as a component of hybrid revascularization (HCR). This study aims to compare the mid-term outcomes of the two revascularization pathways.

Methods:
Over 15 years at a single institution, 510 patients underwent MICS CABG, of which 250 patients underwent multivessel CSR, and 34 patients underwent complete revascularization via HCR. The primary outcome was the composite of all-cause mortality and major adverse cardiac or cerebrovascular events (MACCE) over the follow-up period. Multivariable stepwise Cox-proportional hazard models identified correlates of the primary outcome.

Results:
Follow-up was complete for 100% of patients with a median follow-up of 5.9 (IQR 2.8, 9.6) years. The HCR group had older patients, and more patients with diabetes, prior MI, NYHA class III or more symptoms, left ventricular dysfunction, and urgency status. There was no significant difference in in-hospital morbidity between CSR and HCR, including mortality (0.4% vs. 0%; p = 0.71) and MACCE (2.0% vs. 2.9%; p = 0.72). The 4-year unadjusted freedom from the composite outcome of MACCE and all-cause mortality was significantly better for CSR than HCR (91.3Â±2.0% vs. 75.0Â±8.4%; p<0.01). At 4-years, CSR group had better survival than HCR (97.7Â±1.0% vs. 89.0Â±6.2%; p<0.01) and freedom from revascularization (94.1Â±1.6% vs. 85.7Â±6.7%; p<0.01), with no difference in MACCE (91.6Â±1.9% vs. 85.7Â±6.7%; p=0.21). On multivariable model, CSR was protective of composite outcome on follow-up (HR 0.3; C.I. 0.1 - 0.7).

Conclusion:
In our study, patients who underwent HCR were more likely to experience composite of death and MACCE on follow-up, and CSR exerted a protective effect on multivariable model. This is a hypothesis-generating analysis that require further exploration from larger randomized studies.

1. Results

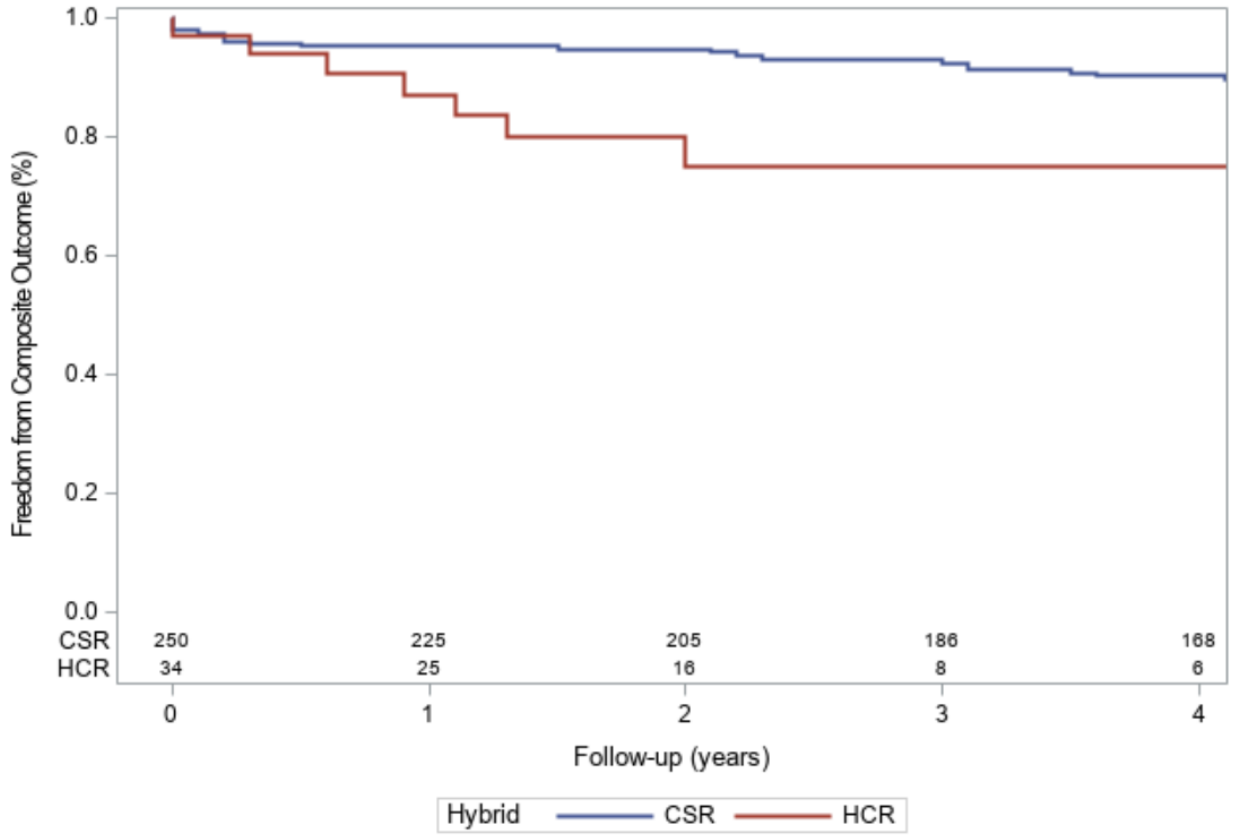


Figure 1. Freedom from mortality and MACCE for both CSR and HCR cohort at 4 years.

Presentation 4 – 2A

Concomitant Anaortic OPCAB and TAVR for High-Risk Patients

Author List:
Ammu Vijayakumar, MD, Michael Vallely, MD, PhD, Bryan Whitson, MD, PhD, Scott Lilly, MD, Dean Boudoulas, MD, The Ohio State University

Purpose:
Severe aortic stenosis and coronary artery disease coexist in up to 50% of cases. Traditionally, patients undergo aortic valve replacement and coronary artery bypass grafting. However, some patients have severe aortic calcification making cardiopulmonary bypass and aortic cross clamping a prohibitive risk. We propose an alternative approach.

Methods:
We performed retrospective chart review for 8 patients between July 2020 and October 2021 who underwent concomitant anaortic OPCAB and transfemoral TAVR during the same anesthetic. All patients had severe aortic stenosis noted on echocardiography and coronary disease that was considered not amenable to PCI. Patients were evaluated by a multidisciplinary structural heart team and the operation was performed. Prior to closure, valve implantation, lack of peri-valvular leak, and resolution of the stenosis were evaluated using echocardiography and calculating transvalvular gradients. Patients received follow up within 30 days of the procedure.

Results:
The mean age at the time of surgery was 78 +/- 4.65 years old. All patients presented with severe aortic stenosis by AHA criteria. Mean aortic valve area was 0.74 Â± 0.08 cm2 with a mean pressure gradient of 44 Â± 11.2 mmHg. All patients presented with coronary artery disease requiring surgical revascularization. 4 (57%) patients presented with 3 vessel disease, 2 (29%) with L MCA stenosis, and 2 (29%) with proximal LAD stenosis. All 7 (100%) patients presented with porcelain aorta. 1 (14%) patient had previous PCI with restenosis requiring repeat intervention. All patients underwent TAVR without any findings of postoperative leak on TEE. An average of 2.29 Â± 0.95 vessels were bypassed. Device success was achieved in 100% of patients. In-hospital and 30-day mortality were 0%. Complications included heart block in 2 (28%) patients, atrial fibrillation in 3 (43%), and 1 (14%) patient requiring pacemaker implantation.

Conclusion:
Combined ONCAB and SAVR is the treatment of choice for patients with coronary artery disease and aortic stenosis. Concomitant OPCAB and TAVR yielded an anaortic surgical flow and showed excellent results, demonstrating feasibility. We propose this technique where aortic manipulation or cardiopulmonary bypass would pose undue risk to the patient.

1. Results

Age	Approach	CABG x	Vessels bypassed	TAVR access	Valve size	Paravalvular leak	Postop gradient
76	Anterolateral thoracotomy	1	LIMA-LAD	RTF	26	No leak	2
82	Sternotomy	3	LIMA-LAD, RIMA/SVG composite to D1, SVG-OM	RTF	29	No leak	5
75	Sternotomy	3	LIMA-LAD, L radial/LIMA-OM, PDA	LTF	29	No leak	12
82	Sternotomy	2	LIMA-LAD, L radial-PLV	LTF	26	No leak	1
71	Sternotomy	3	LIMA-LAD, RIMA/SVG to ramus, PLV	RTF	26	No leak	3
84	Sternotomy	1	LIMA-LAD	RTF	26	No leak	6
79	Sternotomy	3	LIMA-LAD, RIMA/SVG to diag, PDA	LTF	26	No leak	7

Table 1. Intraoperative results from our combined OPCAB and TAVR.

2. Conclusions:

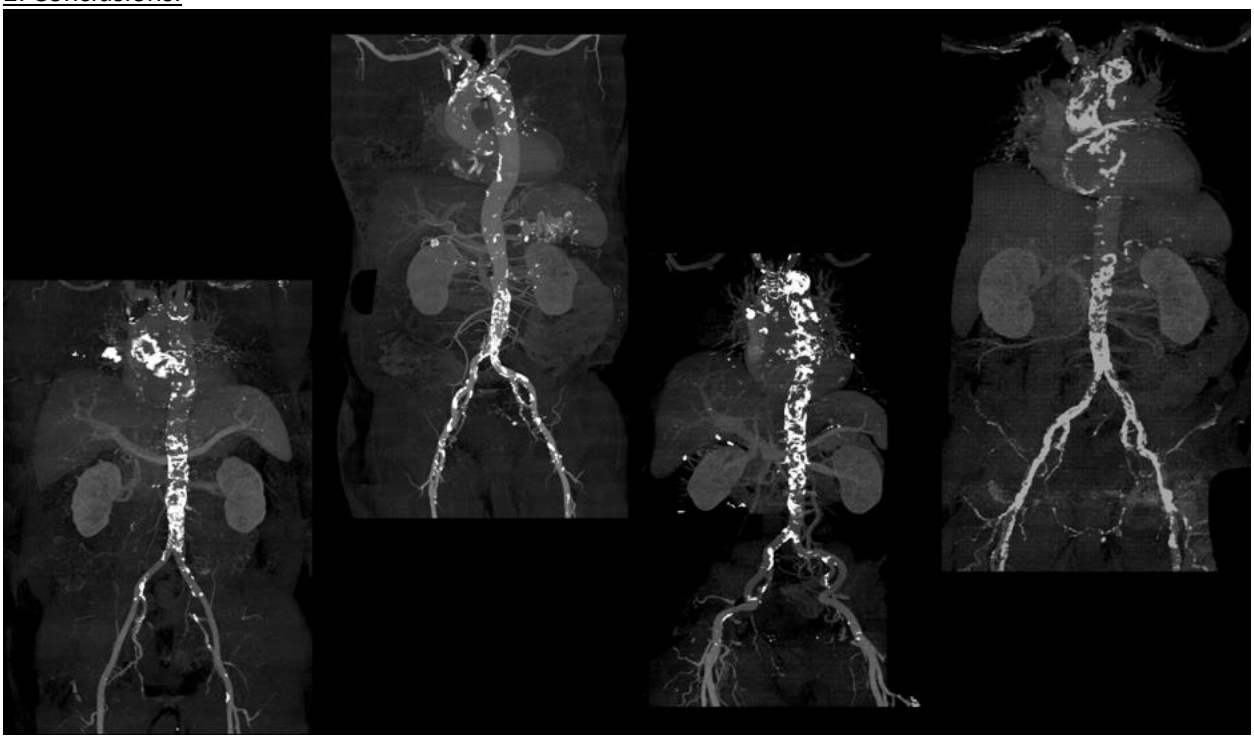


Figure 1. CT images of representative patients in our study populations showing the extensive aortic calcifications, thus diagnosing them with porcelain aortas.

Combining OPCAB and TAVR in one anesthetic is a new field.

Abstract Session 2B – Sunday, June 5, 11:35 am – 12:25 pm ET (MacDonald Room, Mezzanine)

Presentation 1 – 2B:

Novel Machine Learning Technique Defines Patients Who Benefit from Off-Pump CABG

Author List:
1. **Keith A. Dufendach, M.D**., University of Pittsburgh Medical Center, Division of Cardiac surgery and Carnegie Mellon University, Robotics Institute, Auton Lab; Pittsburgh, PA
2. Chirag Nagpal, M.S., Carnegie Mellon University, Robotics Institute, Auton Lab; Pittsburgh, PA
3. Willa Potosnak, Carnegie Mellon University, Robotics Institute, Auton Lab; Pittsburgh, PA
4. Artur Dubrawski, Ph.D., Carnegie Mellon University, Robotics Institute, Auton Lab; Pittsburgh, PA
5. David Kaczorowski, M.D., University of Pittsburgh Medical Center, Division of Cardiac surgery; Pittsburgh, PA

Purpose:
On- versus off-pump coronary artery bypass grafting (CABG) is a controversial topic in coronary revascularization with strong proponents on both sides. Cox Mixtures with Heterogenous Effects (CMHE), a machine learning method of estimating survival benefit, was applied to patients undergoing CABG to discover treatment effects of on- versus off-pump revascularization.

Methods:
8,886 patients who underwent CABG at a single tertiary care center were included in the analysis. 74 preoperative features from the Society of Thoracic Surgeons adult cardiac surgery database were used to train a CMHE model to evaluate the treatment effect of performing off-pump or on-pump CABG. This model discovered two patient subgroups: one more likely to benefit from off-pump surgery and the other more likely to benefit from on-pump CABG. Preoperative feature importance was derived from the learnt coefficients. Baseline characteristics between subgroups were evaluated. Kaplan-Meier survival analysis was performed with bootstrapping to construct 95% confidence intervals.

Results:
Amongst all patients, 812 (9.1%) were more likely to benefit from off-pump CABG with a hazard ratio of 1.64Â±0.83, indicating increased long-term mortality with on-pump surgery. In contrast, 8,074 patients (90.9%) were in subgroup B, with a hazard ratio of 0.75Â±0.16, indicating decreased mortality with on-pump surgery. Subgroup A had a net benefit of 5.51Â±6.05 months from off-pump CABG, while subgroup B had a net benefit of 1.85Â±1.29 months with use of cardiopulmonary bypass. The top five model features favoring off-pump CABG were increased age, presence of severe mitral regurgitation, infective endocarditis, preoperative cardiogenic shock, and second-time redo cardiac surgery. The top five model features favoring on-pump CABG were preoperative steroid use, Hispanic or Latino ethnicity, preoperative syncope, Native Hawaiian or Pacific Islander, and history of intravenous drug abuse.

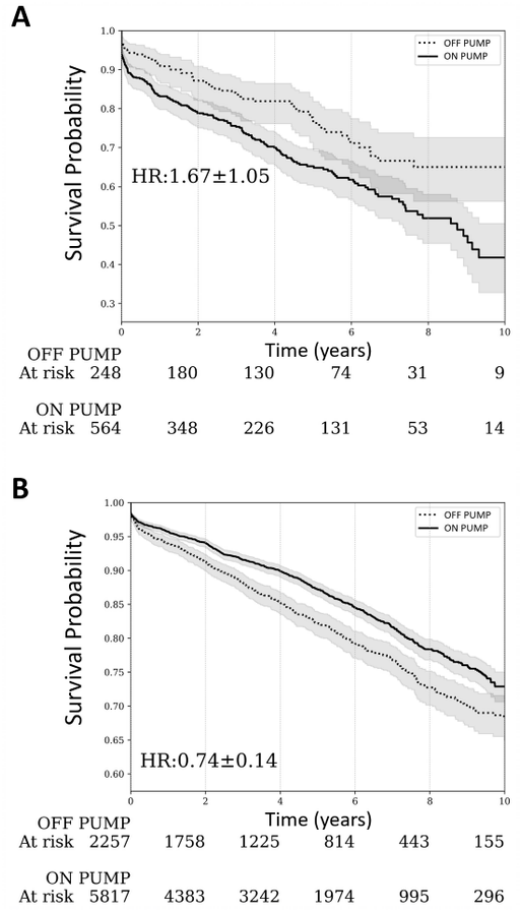
Conclusion:
Novel machine learning techniques, such as CMHE, have the potential to elucidate novel insights into which patients benefit from on- versus off-pump CABG. Rather than apply a single treatment to all patients, these methods may help guide patient management decisions and optimize care for all patients requiring surgical revascularization.

1. Results

Baseline Characteristics/ Model Features	Entire Cohort (N = 8,886)	Group Favoring On-Pump CABG (N =8,074)	Group Favoring Off-Pump CABG (N = 812)	Feature Weights
Top 5 Features for Supporting Off-Pump CABG				
Age (years)	65.9±10.2	64.9±9.9	75.9±7.4	0.289
Severe Mitral Regurgitation	0.8% (72)	0.6% (52)	2.5% (20)	0.249
Infective Endocarditis	0.0% (4)	0.0% (3)	0.1% (1)	0.221
Cardiogenic Shock	2.3% (202)	1.3% (105)	11.9% (97)	0.191
Second-time Redo Cardiac Surgery	0.2% (16)	0.2% (13)	0.4% (3)	0.189
Top 5 Features for Supporting On-Pump CABG				
History of IV Drug Abuse	4.9% (435)	5.4% (434)	0.1% (1)	-0.174
Race - Native Hawaiian or Pacific Islander	0.1% (7)	0.1% (7)	0.0% (0)	-0.186
Preoperative Syncope	3.3% (289)	3.4% (274)	1.8% (15)	-0.206
Hispanic or Latino Ethnicity	0.5% (48)	0.6% (46)	0.2% (2)	-0.264
Preoperative Steroid Use	2.2% (195)	2.3% (188)	0.9% (7)	-0.306

Top five features for distinguishing subgroups favoring treatment with either on- or off-pump coronary artery bypass grafting.

2. Conclusions:



Kaplan-Meier survival curves for subgroup A, which favors off-pump coronary artery bypass grafting, and subgroup B, which favors use of cardiopulmonary bypass.

Presentation 2 – 2B

Enhanced Recovery after Coronary Surgery: Novel Education Software Platform to Improve Patient Outcomes.

Author List:
Gregory Rushing, MD, Aaron Tipton, MD; Craig Jarrett, MD; Alan Markowitz, MD; Kelsey Gray, MD; Omar Hussain, MD; Christian Baeza, MD; Yakov Elgudin, MD, PhD; Yasir Abu-Omar, MD; Pablo Ruda Vega, MD; Joseph Sabik, MD; Mark Pelletier, MD
University Hospitals, Cleveland

Purpose:
Enhanced Recovery After Surgery (ERAS) is a paradigm shift, striving for improved outcomes and cost savings. Initially, "fast-track" surgery described an improved recovery program after coronary revascularization in 1994. We utilized novel patient education software to improve our ERAS program and coronary artery bypass grafting (CABG) outcomes.

Methods:
We partnered with a software platform that provides patient education, tracking, monitoring, and reporting in: 1) pre-operative, 2) in-hospital, and 3) post-operative phases. Patients undergoing CABG in the first six months of our ERAS program were compared with concomitant patients undergoing CABG, not enrolled in ERAS. We evaluated APDRG risk of mortality, length of stay, number of emergency department (ED) visits, re-admissions, office phone calls, discharge to skilled nursing facility (SNF), and total charges. Primary outcomes were ED visits, and re-admissions. Secondary outcomes were discharge to SNF and office phone calls.

Results:
One-hundred patients underwent CABG during the study period; 33 were enrolled in ERAS, 67 were not. Average age was 62.7 years (SDÂ±10.7) in ERAS vs 67.5 years (SDÂ±9.5) in non-ERAS patients (p=0.1). The APRDG risk of mortality was 2.52% in ERAS vs 2.88% in non-ERAS patients (p=0.09). Length of stay was 9.0 days in ERAS vs 13.3 days in non-ERAS patients ($p<0.05$). Number of ED visits were 2 in ERAS vs 19 in non-ERAS patients ($p<0.05$). There was 1 re-admission in ERAS vs 12 in non-ERAS patients ($p<0.05$). Discharge to SNF was 1% in ERAS vs 19.4% in non-ERAS patients ($p<0.05$). There were 9 phone calls to the office in ERAS vs 11 in non-ERAS patients (p=0.160).

Conclusion:
ERAS proposes to decrease length of stay, costs, and improve patient outcomes. Implementation of a novel patient centered software platform reduced ED visits, readmissions, and decreased discharge to SNF, in patients undergoing CABG.

1. Results

Factor	ERAS	Non-ERAS	Difference	P Value
N	33	67		
Age (avg)	62.7	67.5	- 4.8 years	P = 0.1
APRDRG - Risk of mortality	2.52	2.88	- 0.36 units	P = 0.09
LOS (avg)	9.0	13.28	- 4.28 days	P = < 0.05
Pre-op LOS	2.45	4.58	- 2.13 days	P = 0.05
Post-op LOS	6.48	8.68	- 2.2 days	P = < 0.05
# of Readmissions	1	12	- 11 days	P = < 0.05
Readmissions (%)	3.0%	17.9%	↓142%	
# of ED Visits	2	19	- 17 visits	P = < 0.05
ED Visits (%)	6.0%	28.3%	↓130%	
# of phone calls	9	11	- 2 calls	P = 0.160
Phone call (%)	18%	11.9%	40%	
Discharge to SNF (%)	1%	19.4%	↓ 180%	P = < 0.05
Total Charges (avg)	$ 204,838	$ 251,771	↓ $ 46,933	

Outcomes in ERAS vs Non-ERAS CABG Patients

Presentation 3 – 2B

Prospective STS Scoring with "High Risk Pause" Drives Surgeon Collaboration and Decreases Risk Profiles Among CABG Patients

Author List:
Gary Allen, MD, Scott Silvestry, Kevin Accola, George Palmer, Linda Bogar, Lara Crown, Jodie Giambarberee, Elizabeth Purington, AdventHealth, Florida

Purpose:
The STS scoring system, provides quantitative guidance and may improve patient selection when consistently applied to patients' risk/benefit assessment of cardiac surgery. The purpose of this study was to test the effect of prospective STS scoring on case selection in patients referred for isolated CABG (ISO CABG).

Methods:
From January 1, 2018, to October 31, 2020 ISO CABG surgical candidates were selected by the consulting single surgeon alone (Group A). Beginning November 1, 2020, our Institute Value Team coordinated a new decision algorithm which prescribed: (i) global prospective STS scoring and (ii) a trigger for a second surgeon opinion for patients with > 5% mortality risk ("High Risk Pause", Group B). Data was collected prospectively through December 31, 2021, using our STS database. Financial results were sourced from QlikView Â® Healthcare Analytics. There was no "high risk pause" prior to the study period.

Results:
There were 2,376 Group A patients with a mean age of 65.4 + 10.4 years versus 903 Group B patients with a mean age of 65.5 + 10.6 years. Gender distribution was similar between groups (A male 1784 (75.1%) vs B 695 (77.0%)). Study results are shown in Table I.

Conclusion:
Prospective STS scoring with "high risk pause" promotes surgeon collaboration for higher acuity patients. Increased collaboration reduces the fraction of marginal candidates that receive surgery. This may result in improved mortality outcomes.

1. Results

TABLE I

Cohort	Prospective STS Scoring	High Risk Group	High Risk Pause	Mortality 0/E	Ave Cost/Case ($)
Group A n=2,376	31 (1.3%)	262 (10.5%)	0	2.9/2.6	27,315
Group B n=903	659 (73.0%)	56 (6.3%)	43 (76.8%)	1.8/2.6	30,375

Presentation 4 – 2B

Long-term outcomes of childhood surgical intervention for coronary artery lesions related to Kawasaki disease.

Author List:
Yoshikatsu Saiki, MD PhD, Kota Itagaki, MD, Kay Maeda, Koti Ito, Yusuke Suzuki, Shintaro Katahira, Tomoyuki Suzuki, Goro Takahashi, Kiichiro Kumagai
Division of Cardiovascular Surgery, Tohoku University, Sendai, Japan

Purpose:
PCI can be a treatment modality for coronary artery lesion that influences the prognosis of Kawasaki disease; however, CABG is indicated for long segment lesions, coronary ostial lesions, and multivessel lesions. The purpose of this study was to clarify long-term results and issues in patients who underwent CABG in childhood.

Patients & Methods:
Between 2004 and 2013, a clinical chart review identified 5 patients who underwent CABG in childhood for coronary artery lesions after Kawasaki disease in our department. The average age was 8.8 ± 2.4 (6-12) years, 4 males and 1 female, with no emergency / urgency surgery. The average interval from the onset of Kawasaki disease to CABG was 6 years (4 to 8 years). Left coronary artery aneurysm was formed in 4 cases, and right coronary artery aneurysm was observed in 3 cases. Three cases had a history of myocardial infarction, and only two cases had obvious preoperative angina symptoms.

Results:
The average number of bypasses grafting was 1.2 ± 0.44 per patient, and LITA was used in 4 cases. Coronary reconstruction was performed with RITA for one case with only bypass grafting to the right coronary artery. OPCAB was performed in 2 cases (40%), and the others operated under cardioplegic cardiac arrest. No surgical or hospital death was encountered. The average observation period is 7.3 years (4-11 years), and all cases are being followed up at the outpatient clinic. During the course, in one case, the circumflex branch was occluded due to the obstruction of the coronary aneurysm of LMT 4 years after the primary surgery, and re-CABG was performed using free RITA.

Conclusion:
The early- and mid-term results after CABG were favorable. However, there was a case who required re-CABG due to continuing pathological changes taking place long after CABG, close and long-term follow-up is mandatory even after CABG in patients who had developed Kawasaki disease.

Presentation 5 – 2B

Coronary Artery Bypass Grafting For Patients With Unstable Angina Pectoris

Purpose:

to study features of coronary bypass grafting in patients with unstable angina pectoris.
Acute myocardial infarction and unstable angina pectoris - independent risk-factor for early mortality after CABG [1,2].

Author List:

Olena Gogayeva, DSc, Anatolii Rudenko, Vasyl Lazoryshynets
Amosov National Institute of cardiovascular surgery NAMS of Ukraine

Methods:

For 84 random patients with unstable angina pectoris we performed standard laboratory tests, ECG, echocardiography, coronary angiography and CABG.

Results:

Acute myocardial infarction at admittance diagnosed in 12 (14.3%) cases, IV FC of angina - in 52 (61.9 %). Charlson comorbidity index - 5.7Â±1.8. LV EF was in average 49.1Â±8.6%. Average quantity of stenotic lesions of CA - 3.3Â±0.8, left main stenosis > 70% had 24 (28.5%) pts, left anterior descending artery > 70% had 73 (86,9%) pts. Prognostic mortality on EuroSCORE II - 9.6%, STS - 4.01%. All patients were assessed by heart team and operations performed by experienced surgeons (24Â±12.5 years). Emergency operation was performed for 43 (51.1%) pts, off-pump CABG had 82 (97.6%) pts. Average quantity of grafts was 3.3Â±0.8, IMA was used in 67 (79.7%) cases. The duration of operation averaged 255.1Â±61.05 min, mechanical ventilation time - 7.6Â±4.4 h, intraoperative blood loss - 336.6Â±52.8 ml. Postoperative period describe in table 1. All patients were discharged from hospital on 8.7Â±4.04 day.

Conclusion:

Patients with unstable angina have a high prognostic mortality risk. Preoperative discussion of patients by heart team - important moment for individual approach formation. High risk patients with unstable angina have to be operated by experienced surgeons. Beating heart surgery allows to achieve good results even in unstable patients.

1. Results: Postoperative features of patients with unstable angina after CABG

Postoperative features	Patients after CABG (n=84)
Acute heart failure	3 (3.5%)
Postoperative atrial fibrillation	19 (22.6%)
Hemotransfusuion	23 (27.3%)
Ischemic Stroke	1 (1.2%)
Transient ischemic attack	2 (2.4%)
Wound infection	2 (2.4%)
Sternoplasty	1 (1.2%)
Rethoracotomy	2 (2.4%)
Nosocomial pneumonia	2 (2.4%)
Pleural puncture	69 (82.1%)
Average ICU stay, days	3.07±2.2

Abstract Session 3 – Sunday, June 5, 1:40 pm – 2:20 pm ET (Adam Room)

Presentation 1 – Session 3

Characteristics of Postoperative Atrial Fibrillation After Cardiac Surgery and the Effect of Posterior Pericardiotomy. A Post-hoc Analysis of the PALACS Trial

Author List:
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Purpose:
Postoperative atrial fibrillation (POAF) is the most frequent complication of cardiac surgery. However, only few detailed descriptions of the arrhythmia have been reported. With coronary artery bypass grafting being the most commonly performed procedure in adult cardiac surgery, understanding POAF characteristics is paramount to better delineate prophylactic and therapeutic strategies.

Methods:
In this post-hoc analysis, we provide a detailed description of POAF based on data from continuous telemetry during the entire postoperative hospitalization of patients enrolled in the Posterior left pericardiotomy for the prevention of AtriaL fibrillation After Cardiac Surgery (PALACS) trial. Described characteristics include time to onset, duration, hemodynamic instability, rapid ventricular response, need for antiarrhythmic medications or electrical cardioversion, and use of systemic anticoagulation. Additionally, we calculated the POAF burden, defined as the proportion of time that a patient was in POAF relative to the postoperative in-hospital period. The effect of posterior pericardiotomy on POAF was also evaluated.

Results:
Of 420 patients, 103 (24.5%) developed POAF. Median time to onset was 50.3 hours; 70.9% of events occurred on postoperative day 2 or 3. Hemodynamic instability and rapid ventricular response occurred in 8.7% and 51.5% of cases, respectively. Almost all (97.1%) POAF patients required antiarrhythmics, 22.3% electrical cardioversion, and 40.8% systemic anticoagulation. Median POAF duration was 24.0 hours; 70.9% of cases resolved within 36 hours. Median POAF burden was 15.9%. All patients were in sinus rhythm at 30-day follow-up. POAF was associated with longer hospitalization (7 vs 6 days; $P<0.001$), but not increased mortality or morbidity. Posterior pericardiotomy reduced POAF incidence (17.7% vs 31.3%; $P=0.001$), especially after postoperative day two (time to POAF onset 1.7 vs 2.4 days; $P=0.01$). Age and aortic valve replacement were associated with POAF. Female sex, beta blockers, and posterior pericardiotomy were inversely associated.

Conclusion:
POAF is frequent after cardiac surgery. Hemodynamic instability is rare, however rapid ventricular response and need for electrical cardioversion are frequent. The arrhythmias resolve within 30 days. Posterior pericardiotomy reduces POAF incidence particularly after the second postoperative day. Different pathophysiology may underlie POAF according to time of onset.

Table 1. Characteristics of postoperative atrial fibrillation.

Characteristics	POAF (n=103)
Hemodynamic instability	9 (8.7)
Heart rate (BPM)*	96 [83-116]
Rapid ventricular response†	53 (51.5)
• 101 to 110 BPM	12 (22.6)
• 111 to 120 BPM	11 (20.8)
• 121 to 130 BPM	9 (17)
• >130 BPM	8 (15.1)
Other postoperative arrythmias:	10 (9.7)
• Atrial flutter	6 (5.8)
• Other SVT	4 (3.9)
Use of antiarrhythmic drugs	100 (97.1)
• Amiodarone	40 (40)
• Beta blockers	4 (4)
• Both	56 (56)
Need for electrical cardioversion	23 (22.3)
Need for systemic anticoagulation‡	42 (40.8)
Self-resolved POAF	3 (2.9)
Patients discharged in POAF	4 (3.9)
Persistent POAF at 30-day follow-up	0
Postoperative time to onset (hours)	50.3 [36.4-68]
Postoperative day of onset:	
• 1	7 (6.8)
• 2	42 (40.8)
• 3	31 (30.1)
• 4	9 (8.7)
• 5	9 (8.7)
• 6 or after	5 (4.9)
Duration of POAF (hours)	24.0 [12.4-38.9]
Breakdown of POAF duration (hours):	
• ≤ 12	25 (24.3)
• 13 to 24	26 (25.2)
• 25 to 36	22 (21.4)
• 37 to 48	9 (8.7)
• 49 to 72	6 (5.8)
• 73 to 96	5 (4.9)
• 97 to 120	6 (5.8)
• >120	4 (3.9)
Cumulative time in POAF (hours)	3539.4
Overall POAF burden (%)	15.9 [7.3-27.3]
• POAF burden ≤ 20%	61 (59.2)
• POAF burden 21-40%	25 (24.3)
• POAF burden 41-60%	11 (10.7)
• POAF burden 61-80%	5 (4.9)
• POAF burden >80%	1 (1)

Numbers are presented as count (%) or median [IQR].

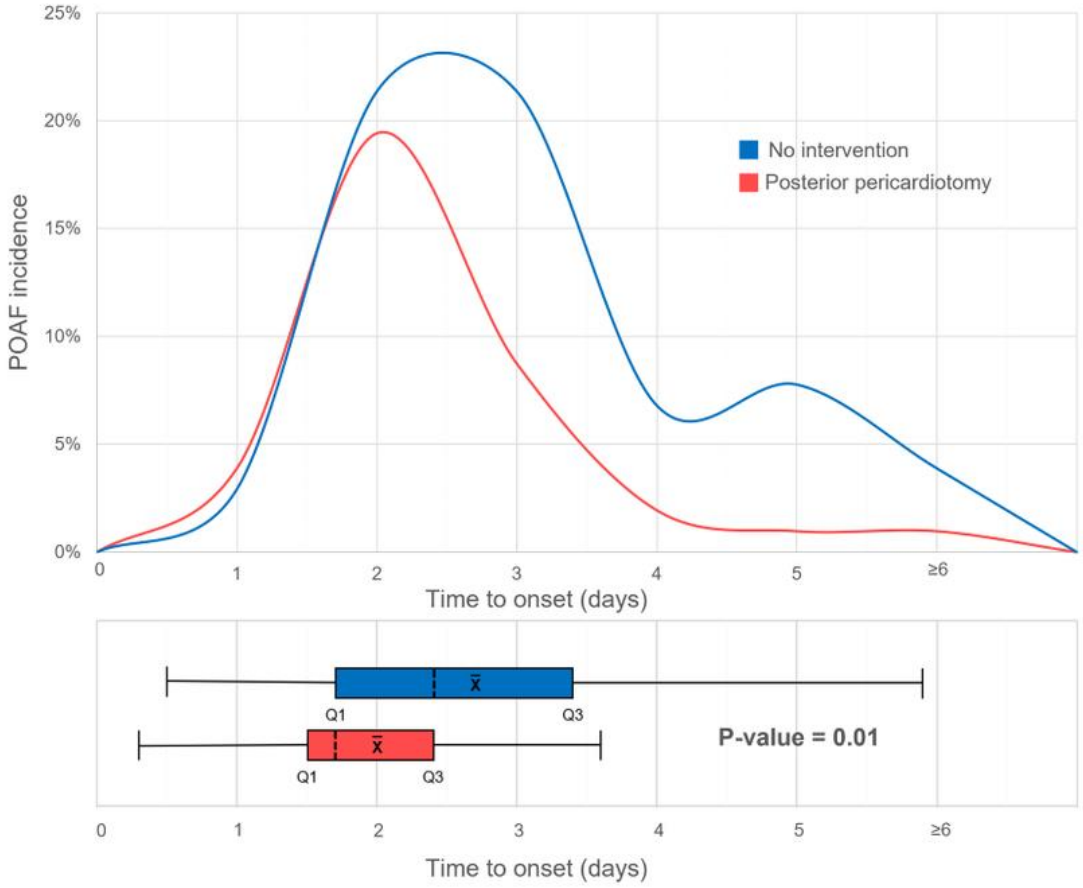
* Based on data from 90 (87.4%) patients.

† Defined as heart rate >100 BPM during episode. Breakdown is based on data from 40 of 53 (75.5%) patients with rapid ventricular response.

‡ Prescribed for episode lasting >24 hours in absence of clinical contraindications.

AF: Atrial fibrillation; BPM: beats per minute; IQR: interquartile range; POAF: postoperative atrial fibrillation; SVT: supraventricular tachycardia.

2. Conclusions:



In the box plot the dashed line represents the median, $\bar{X}$ represents the mean. Q1: lower quartile; Q3: upper quartile.

Median time to onset: posterior pericardiotomy 1.7 days [IQR 1.5-2.4] vs 2.4 days [IQR 1.7-3.4] in the no intervention group; P=0.01.

IQR: interquartile range; POAF: postoperative atrial fibrillation.

*Postoperative time to onset of atrial fibrillation in patients with posterior pericardiotomy versus no intervention.

Presentation 2 – Session 3

Nationwide Analysis of Readmissions After Surgical Coronary Revascularization: Is there a price to pay for early discharge?

Author List:
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Purpose:
Shortening length of stay (LOS) and decreasing readmission rates are competing goals of Enhanced Recovery After Surgery (ERAS) protocols. The impact shorter LOS has on readmissions after surgical coronary revascularization is unknown. We sought to compare readmission rates between patients with short versus average LOS in a contemporary nationwide analysis.

Methods:
This is a retrospective cohort study of all adults who underwent isolated coronary artery bypass grafting (CABG) in the 2015 through 2019 Nationwide Readmissions Database, which is a sample representing half of all U.S. hospital admissions. Patients were stratified by quartiles of LOS, and patients in the first and second quartiles were compared. Descriptive analyses were performed to determine 30-, 60-, and 90-day readmission rates, including timing, cost, and subsequent outcomes. Multivariate logistic regression was used to identify factors associated with readmission. Additional regression models were used to identify differences in mortality, major complications, subsequent readmissions, and costs between quartiles.

Results:
A total of 381,985 patients who underwent isolated CABG were included in the study (mean [SD] age, 65 [12] years; male, 68.1%). For the index hospitalization, median total LOS was 9 days (interquartile range [IQR]: 6-20), and median postoperative LOS was 7 days (IQR: 5-11). The overall 30-day readmission rate was 11.1% (42,271/381,985), and 30-day readmission rates for the first and second quartiles of LOS were 7.0% and 8.9%, respectively (P<.00001). After risk adjustment, the readmission rate remained significantly lower for patients in the first quartile of LOS. The most common causes of readmission among both quartiles were respiratory complications, infections, heart failure, and arrhythmias. Independent predictors of 30-day readmission for the entire cohort included chronic renal failure (OR 1.31), female gender (OR 1.27), >4 Elixhauser comorbidities (OR 1.22), liver disease (OR 1.26), chronic lung disease (OR 1.19), and non-elective surgery (OR 1.12) (all P<.05).

Conclusion:
In this nationwide analysis, early discharge after isolated CABG was not associated with an increased rate of readmission. Clinicians can balance competing goals of shortening LOS and decreasing readmission rates by careful consideration of known risk factors for readmission. Extending LOS with the aim of decreasing readmissions is not advised.

Presentation 3 – Session 3

Coronary Artery Bypass Surgery for Acute Coronary Syndrome: A Network Meta-analysis of On-Pump Cardioplegic Arrest, Off-Pump and On-Pump Beating Heart Strategies

Author List:
Bridget Hwang, Michael L. Williams, David H. Tian, Tristan D. Yan, Martin Misfeld

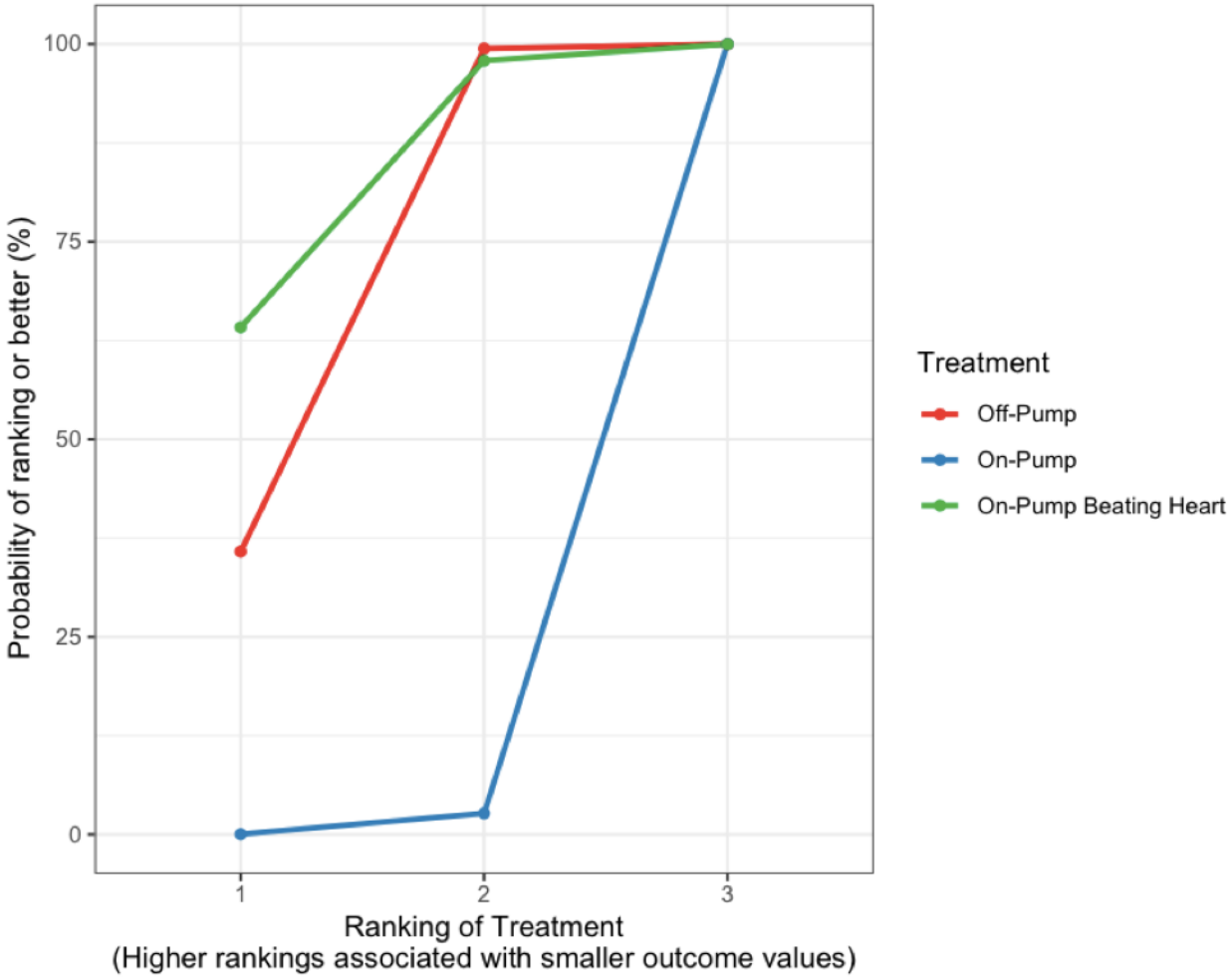
Purpose:
Coronary artery bypass grafting (CABG) in the setting of an acute coronary syndrome (ACS) is a high-risk procedure, and the best strategy for myocardial revascularisation remains debated. This study aims to compare the 30-day mortality benefit of conventional on-pump (ONCAB), off-pump (OPCAB) and on-pump beating heart (OnBHCAB) strategies.

Methods:
A systematic search of three electronic databases (PubMed, Embase and CENTRAL) was conducted for studies comparing ONCAB with OPCAB or OnBHCAB approaches in patients with ACS undergoing emergent or urgent CABG. The 30-day mortality outcome of the three approaches were compared using a Bayesian hierarchical network meta-analysis. A random effects consistency model was applied, and direct and indirect comparisons were made to determine the relative effectiveness of each revascularisation strategy for survival. Secondary outcomes including stroke, renal dysfunction and length of ICU stay were analysed.

Results:
Nineteen studies which fulfilled the inclusion criteria were identified, one of which was a randomised controlled trial and the remaining were retrospective observational studies. A total of 4320 patients underwent ONCAB, 5559 underwent OPCAB and 315 underwent OnBHCAB. Network meta-analysis showed that OnBHCAB (OR, 0.42; 95% CrI, 0.14-1.12) and OPCAB (OR, 0.57; 95% CrI, 0.27-1.02) had lower odds of early mortality compared to ONCAB, with the Surface Under the Cumulative Ranking (SUCRA) plot suggesting OnBHCAB to most likely be the best treatment. However, credible interval crossed unity for all relative effect measures in this analysis. A subgroup network meta-analysis of seven studies assessing only acute myocardial infarction (AMI) patients demonstrated an 89% reduction in likelihood of 30-day mortality after OPCAB compared to ONCAB (OR, 0.11; CrI, 0.01-0.55). With regards to secondary outcomes, there was a 20% lower likelihood (OR, 0.80; 95% CrI, 0.68-0.94) of post-operative renal dysfunction following OPCAB.

Conclusion:
Whilst no single best surgical revascularisation approach in ACS patients has been identified through this network analysis, the significant mortality benefit with OPCAB seen in AMI patients suggests high acuity patients may benefit most from avoiding further myocardial inflammatory and ischemic injury associated with CPB and cardioplegic arrest.

1. Results: Surface Under the Cumulative Ranking (SUCRA) plot of network meta-analysis comparing ONCAP, OPCAB and OnBHCAB strategies



Presentation 4 – Session 3

Minimally Invasive Off-Pump Anaortic Coronary Artery Bypass (MACAB)

Author List:
Ilhan Mavioglu, MD, Michael Vallely, MBBS, PhD, FRACS (The Ohio State University)

Purpose:
Minimally invasive direct coronary artery bypass (MIDCAB) has enabled CABG to compete with the appeal of percutaneous coronary procedures. Successful results of coronary artery bypass surgery performed without the use of cardiopulmonary bypass and without touching the aorta (anOPCAB) have enabled the development and use of minimally invasive methods.

Methods:
The subject is a multi-vessel coronary bypass surgery performed using a minimally invasive method through a small thoracotomy in the left chest with off-pump, anaortic and all-arterial grafts. Between 2016 to 2021, 112 patients underwent a MACAB procedure. The results were collected and retrospectively analyzed. In addition, a total of 8 studies from the literature using the multi-vessel mini-OPCAB and MACAB technique and our consecutive patients were also evaluated.

Results:
From the literature, 2729 patients underwent an average of 2.4 bypasses with an early mortality rate of 0.7% and a stroke rate of 0.16%. In our MACAB case series, 112 patients underwent an average of 2.9 bypasses with a mortality rate of 1.8% and a stroke rate of 0%.

Conclusion:
MACAB can be performed safely and successfully by experienced surgeons, reduces neurological injury and surgical trauma, and may be a good alternative for multi-vessel stenting. However, simulation systems are essential for dissemination, and teams dedicated to coronary surgery - perhaps subspecialty expertise - are necessary to achieve good outcomes.