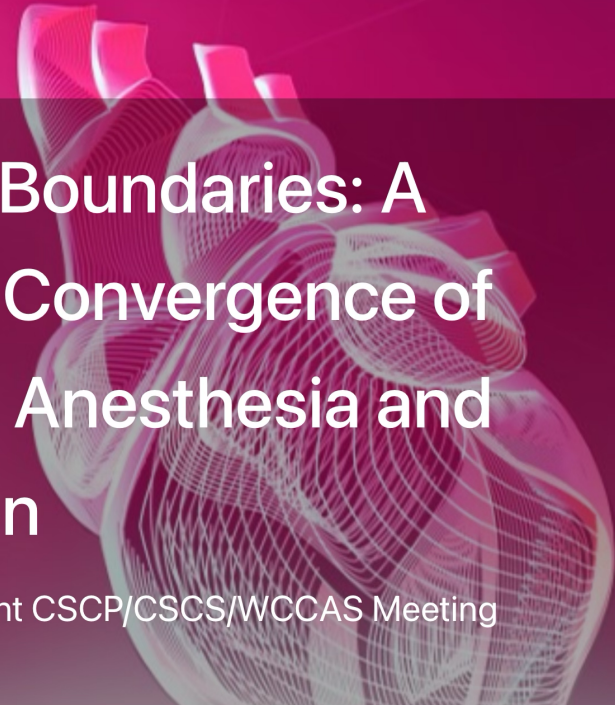


Rapid Recovery for Minimally Invasive Cardiac Surgery

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Beyond Boundaries: A
Cardiac Convergence of
Surgery, Anesthesia and
Perfusion

2024 Spring Joint CSCP/CSCS/WCCAS Meeting

Introduction

- **Goal:**
 - Compare outcomes before and after implementation of a comprehensive rapid-recovery protocol in elective MIMVR for degenerative disease, where adherence to ERAS guidelines is the standard of care.
 - Health Economic outcomes
 - Patient reported outcomes
 - Discussion on how to implement and partner with Industry for a Canadian “Benchmark

Methods

- Rapid-Recovery protocol was developed and executed by a multidisciplinary team starting September 2022- December 2022
- Non-randomized controlled before and after study of minimally invasive mitral valve repair patients.
 - Before: patients pre-protocol
 - Same surgeons and similar surgical techniques
 - After: patients who followed Rapid-Recovery protocol
- Exclusion criteria:
 - 1) previous cardiac surgery, 2) urgent or emergent surgery, 3) additional valvular procedures, 4) sternotomy approach, 5) mitral valve replacement.

(MICS) Fast Track Protocol Care Guidelines

PRE-OPERATIVE



Identify patients with mobility barriers



Discuss length of stay expectations - inform patients/families of potential for discharge post-op day four



Ensure understanding of mobility and post-op physiotherapy expectations



Distribute MICS Patient Education Booklet to all patients before/at the initial surgeon consult



Insertion of peripheral nerve block (PNB) for patients with right lateral mini-thoracotomy incisions



Anesthesia preference for ESP or SAP location for block



Insertion of intercostal Marcaine for patients with right anterior mini-thoracotomy incisions



Tailored anesthesia/analgesia by anesthesia to enhance post-op pain control and early extubation in CVICU

INTRA-OPERATIVE



POST-OPERATIVE



- Wake Up and Breathe Guidelines – discontinuation of Propofol 1 hour from admission to CVICU
- Mobilization expectations for Post-Op Day (POD) 0 – dangle and stand at bedside
- Removal of invasive lines and chest tubes POD 1, prior to rounds as appropriate
- Standard guidelines for early removal of chest tubes by nursing
- Discontinuation of PNB shortly after chest tube removal
- Multimodal pain management approach
- Wean supplemental oxygen POD 1, goal SaO2 90%
- Post-op nausea and vomiting treatment
- Discharge teaching and checklist to begin in CVICU
- Restart home medications POD 1, as appropriate
- Removal of urinary catheter as soon as possible
- Initiation of anti-arrhythmics for patients identified at risk for rhythm disturbances
- Thoracic and Groin Incision Care, POD2
- Epicardial wires removal on POD 3, if appropriate
- Physiotherapy assessment for readiness of discharge – target sign off of care by POD 3
- Conditional discharge orders in place to promote early morning and weekend discharges

(MICS) Protocol

Post-operative Care Guidelines

1. WAKE UP & BREATHE GUIDELINES

- GOAL:** Propofol off within 1hr of admission to CVICU – standard for all post-op patients. Refer to CVICU Wake Up and Breathe Protocol for details.
- ACTION:** Nursing



2. PHYSIOTHERAPY (PT) ASSESS & TREAT - EARLY MOBILIZATION

(Page PT for weekend treatments if needed - to facilitate Monday discharge)

- GOAL:** Dangle &/or Stand POD 0 before midnight, transition to mobilization QID as appropriate (PNB not to interfere with mobilization)
- ACTION:** PT and Nursing

3. REMOVAL OF INVASIVE LINES, CHEST TUBES, AND URINARY CATHETER ON POD 0-1

- GOAL 1:** Remove arterial & central venous catheter prior to AM rounds if appropriate
- GOAL 2:** Standard order – Remove chest tubes if less than 200ml of serosanguineous drainage in the initial 12H from OR with no air leak present, and patient has been mobilized at least once
- ACTION:** Nursing

4. ACUTE PAIN SERVICES (APS) TO DISCONTINUE PERIPHERAL NERVE BLOCK (PNB) FOLLOWING CHEST TUBE REMOVAL

- GOAL:** PNB discontinued when no longer deemed necessary or if chest tubes removed (consider paging APS on call for inadequate pain control)
- ACTION:** Nursing

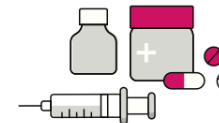


APS Recommendations:

- Intermittent bolus of ropivacaine 2% @ 10-15 mL q 1h x 2 days (will extend past 2 days if chest tubes remain or poor analgesia when turned off)
 - For inadequate analgesia, consider a trial of a one-time bolus of 10-20ml – if successful pain management, consider increasing intermittent bolus dose
 - PNB interventions may take time for effect, use IV Hydromorphone as needed to avoid any pain crisis
- If PNB appears ineffective, try turning off PNB – if no difference in analgesia, consider early removal
 - For additional considerations, consult APS (i.e., redoing block, supplemental blocks, lidocaine/ketamine, PCA)

5. PAIN MANAGEMENT

- GOAL:** To provide adequate pain control post-operatively using a multimodal approach
- ACTION:** Nursing



Recommendations for Multimodal Analgesia:

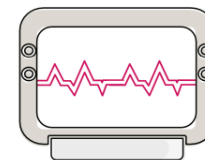
- Acetaminophen 1000 mg PO q6h until discharge (adjust for patients with liver disease)
- Hydromorphone 1-2 mg PO q4h PRN (if age greater than 75yr or weight less than 60kg)

Hydromorphone 2-4 mg PO q4h PRN (if age less than 75yr and weight greater than 60kg)

If pain control inadequate with PO treatment, consider IV dose – start at lowest range and titrate as needed:

Hydromorphone 0.2-0.4 mg IV q4h PRN (if age greater than 75yr or weight less than 60kg)

Hydromorphone 0.2-1.0 mg IV q4h PRN (if age less than 75yr and weight greater than 60kg)



Considerations:

(Especially beneficial for patients with pericardial rub, chest tube irritation, or pericardial ECG changes)

- NSAIDs:
 - Do not give if patients have pre-operative CKD, post-operative eGFR less than 50 or AKI.
 - If NSAIDs indicated preference is to administer as 1st choice PRN, with opioids reserved for 2nd line PRN.
 - FIRST CHOICE:** Ketorolac 10mg IV q8h PRN X maximum 3 doses then reassess
 - SECOND CHOICE:** Naproxen 250-375mg PO q12h PRN

6. POST-OPERATIVE NAUSEA AND VOMITING (PONV) TREATMENT

- GOAL:** To manage post-operative nausea and vomiting effectively
- ACTION:** Nursing

Recommendations:


- Metoclopramide 10 mg IVPB q6h PRN
- Haloperidol 0.5-1.5 mg IV q6-8h PRN
- Ondansetron 4 mg IVPB q8h PRN
- Dexamethasone 4mg PO/IV once PRN

7. WEAN SUPPLEMENTAL OXYGEN STARTING POD 1

- GOAL:** Maintain oxygen saturation greater than 90% and discontinue nasal cannula when appropriate
- ACTION:** Nursing





8. DISCHARGE TEACHING & DISCHARGE CHECKLIST INITIATED POD 1

 **GOAL:** CVICU staff to begin discharge teaching and identify any potential barriers (equipment needs and family support in place) to safe, timely discharge


 **ACTION:** Nursing


9. BEGIN RESTARTING HOME MEDICATIONS POD 1

 **GOAL:** Resume all pre-operative, non-cardiac/blood pressure altering medications prior to leaving CVICU (especially diabetic medications) as appropriate


 **ACTION:** Intensivist, NP, Resident, and Surgeon

10. INITIATION OF ANTI-ARRHYTHMIC MEDICATION FOR PATIENTS IDENTIFIED AS HIGH-RISK FOR RHYTHM DISTURBANCES POD 1-2

 **GOAL:** Consider low dose BB for patients with normal LV/RV function on post CPB; do not initiate BB for patients post CPB requiring inotropes in the preceding 24H; Consider amiodarone/digoxin for patients with LV dysfunction.


 **ACTION:** Intensivist, NP, Resident, and Surgeon

11. THORACIC & GROIN INCISION CARE

 **GOAL:** Gauze dressing to be used for groin incision, remove initial dressing after 48H, and follow Cardiac Surgery Incision Care reference; assess chest incision and groin incision daily and prn. If percutaneous cannulation was used: Femoral cannulation purse string sutures to be removed from groin wound on POD 2 by nursing.


 **ACTION:** Nursing

12. EPICARDIAL WIRE REMOVAL POD 3

 **GOAL:** Standard Order - Remove epicardial wires on POD 3 for patients who remain in NSR for 48 hrs, & INR less than 3.0 & off heparin for greater than 3 hrs, are hemodynamically stable, and EP has not been consulted, or if patient has a conditional discharge order.


 **ACTION:** Nursing


13. PHYSIOTHERAPY & ONGOING INDEPENDENT MOBILITY

 **GOAL:** QID mobilization shared responsibility of physiotherapy & nursing staff. Physiotherapy to complete discharge readiness assessment and sign off on care by POD 3.

 **ACTION:** PT and Nursing

14. CONDITIONAL DISCHARGE ORDERS - ENTERED BY NURSE PRACTITIONER AND/OR SURGEON POD 3

 **GOAL:** Encourage early morning discharges and weekend discharges. If expected weekend discharge, place conditional discharge orders on Friday AM to ensure physiotherapy (consider paging physio for awareness) sees the patient on Friday.

 **ACTION:** NP, Resident, and Surgeon



Methods

- **Primary composite outcome:**
 - Discharge from the ICU by POD#1, and
 - Discharge home by POD#4, and
 - No 30-day all-cause readmission
- **Secondary outcomes:**
 - Cost Analysis
 - Intubation time
 - ICU length of stay
 - Hospital length of stay
 - Post-operative complications at 30-days

Methods

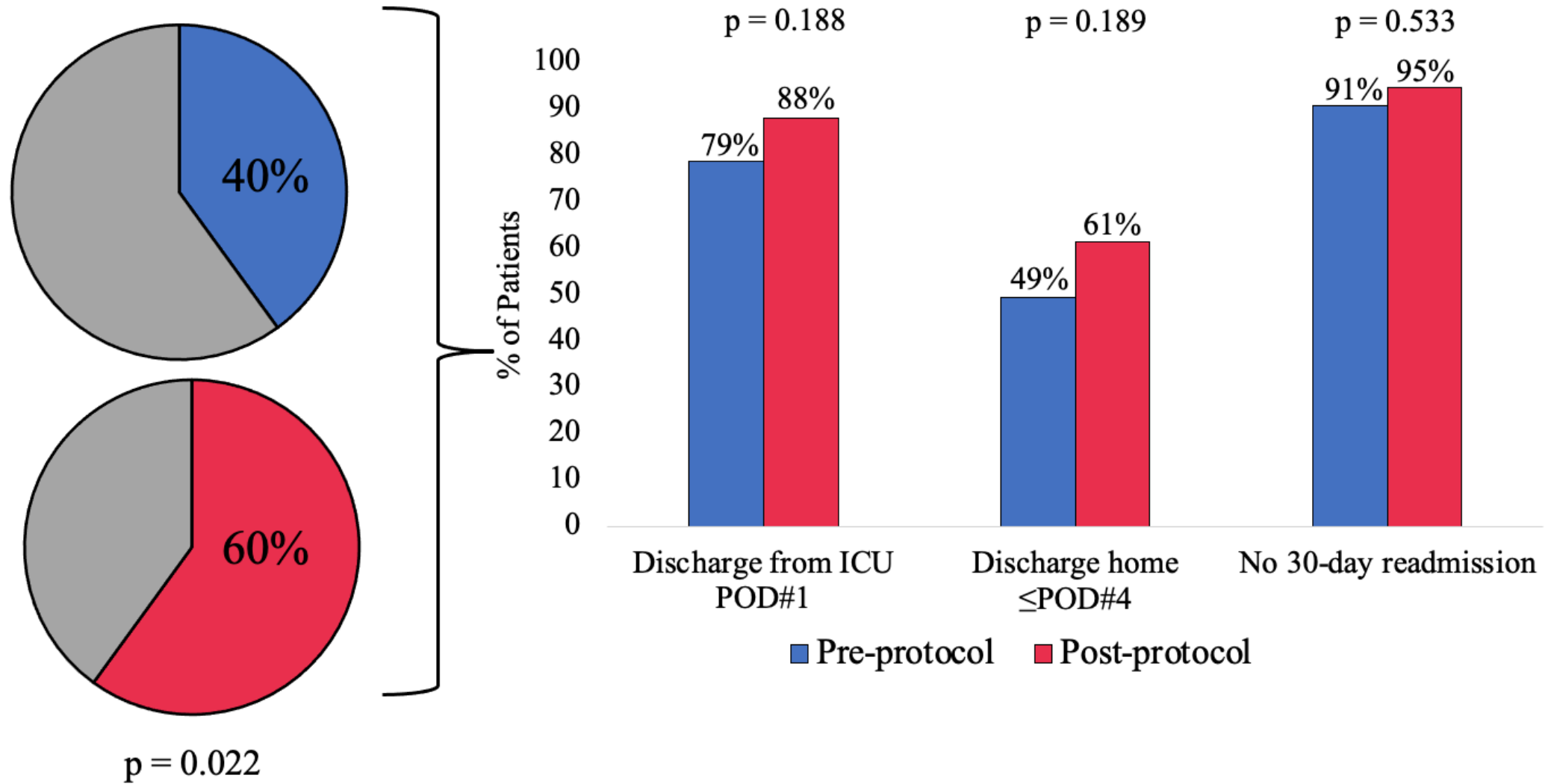
- Continuous variables depicted as mean and standard deviation or median and interquartile range, with significance determined by Kruskal-Wallis test
- Categorical variables shown as frequencies with significance determined by Fisher's Exact test
- Logistic regression performed to identify factors associated with Rapid-Recovery success
 - Effect sizes for regression analysis expressed as odds ratio (OR) with 95% confidence interval (CI)
 - A two-sided alpha level of 0.05 defined statistical significance
-

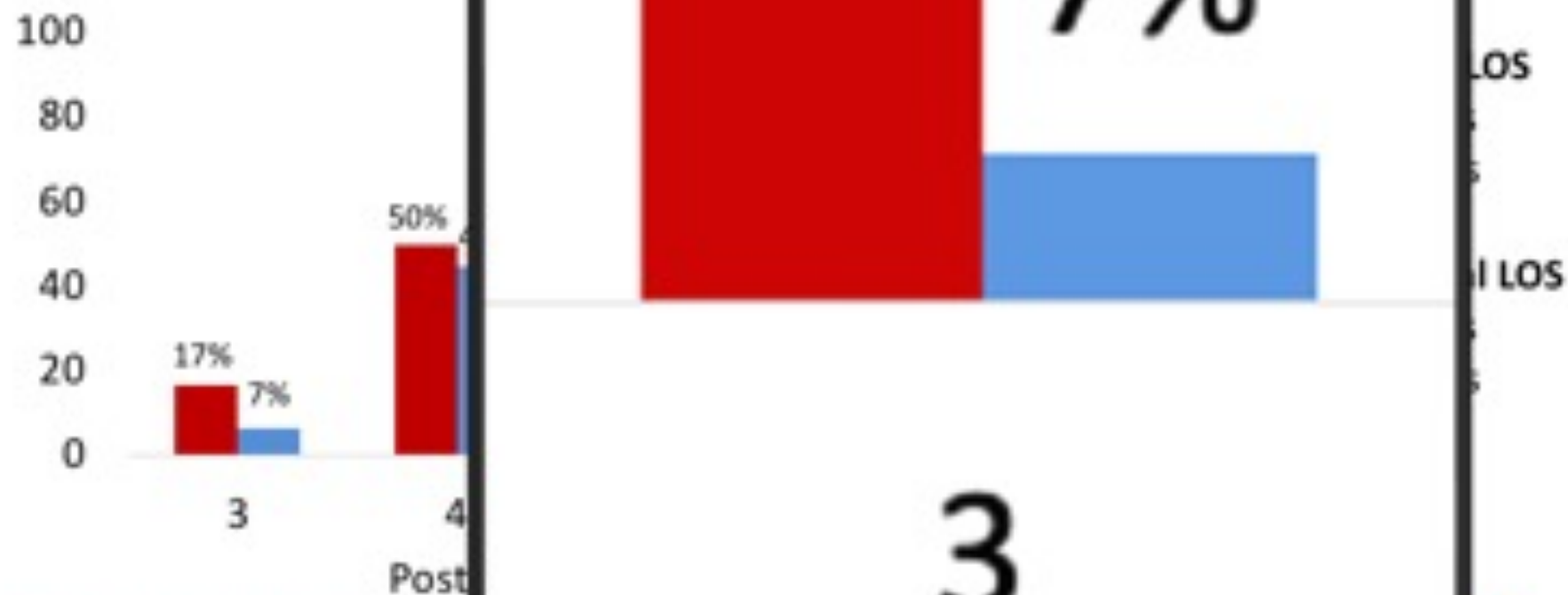
Baseline measurement

Variable	Pre-protocol (n = 75) mean ± SD or n (%)	Post-protocol (n = 75) mean ± SD or n (%)	P value
Age (years)	60.4 ± 12.1	59.9 ± 12.8	.987
Female Sex	30 (40.0)	26 (34.7)	.613
Body Mass Index (kg/m ²)	26.5 ± 4.8	26.4 ± 4.5	.951
NYHA III-IV	13 (17.3)	19 (25.3)	.319
Hypertension	32 (42.7)	27 (36.0)	.504
Dyslipidemia	47 (62.7)	31 (41.3)	.014
Coronary Artery Disease	15 (20.0)	10 (13.3)	.381
Diabetes	10 (13.3)	1 (1.3)	.009
Smoking	8 (10.7)	5 (6.7)	.563
COPD	2 (2.7)	2 (2.7)	1.000
Chronic Kidney Disease	3 (4.0)	5 (6.7)	.719
Previous Stroke or TIA	5 (6.7)	0 (0.0)	.058
Atrial Fibrillation	17 (22.7)	12 (16.0)	.409
LVEF ≥60%	58 (77.3)	61 (81.3)	.687
Tricuspid Regurgitation			
None/trivial	55 (73.3)	57 (76.0)	.851
Mild	17 (22.7)	15 (20.0)	.842
Moderate	3 (4.0)	4 (5.3)	1.000
Severe	0 (0)	0 (0.0)	1.000
Aortic Regurgitation			
None/trivial	68 (90.7)	63 (84.0)	.326
Mild	6 (8.0)	11 (14.7)	.303
Moderate	1 (1.3)	1 (1.3)	1.000
Severe	0 (0.0)	0 (0.0)	1.000

Clinical outcome	Pre-protocol (n = 75) median (IQR) or n (%)	Post-protocol (n = 75) median (IQR) or n (%)	P-value
Postoperative Data			
Intubation Time (hours)	5.4 (4.4-9.6)	6.6 (4.4-11.2)	.265
ICU LOS (days)	1 (1-1)	1 (1-1)	.295
Postoperative Hospital LOS (days)	5 (4-6)	4 (4-5)	.230
ICU Readmission	0	0	-
Reintubation	0	0	-
Pacemaker	1 (1.3)	3 (4.0)	.620
Complications			
Acute Kidney Injury	0	0	-
Atrial Fibrillation	29 (38.7)	22 (29.3)	.301
Bleeding	0	0	-
Death	0	0	-
Delirium	0	3 (4.0)	.245
Pleural Effusion	5 (6.7)	4 (5.3)	1.000
Hospital Readmission	7 (9.3)	4 (5.3)	.533
Stroke	0	0	-

Results: Primary Outcome





Measures of Compliance



56% had chest tube removal on POD#1



63% had pacer wire removal by POD#3



45% had PT sign-off by POD#3

Results: Barriers to Success

Barrier to CVICU POD#1 Discharge	Affected Patients n=9 (%)
Delirium	1 (11.1)
Hemodynamic Instability	2 (22.2)
Low Output State	4 (44.4)
Rhythm	1 (11.1)
Seizure	1 (11.1)

Barrier to Hospital Discharge by POD#4	Affected Patients n=28 (%)
Delirium	2 (7.1)
Mobility	4 (14.3)
Myocardial Infarction	1 (3.6)
Rhythm Control	
Atrial Fibrillation	8 (28.6)
Pacemaker Insertion	3 (10.7)
Respiratory	
Oxygen Requirement	4 (14.3)
Pneumonia	1 (3.6)
Pneumothorax	1 (3.6)
Pain	4 (14.3)

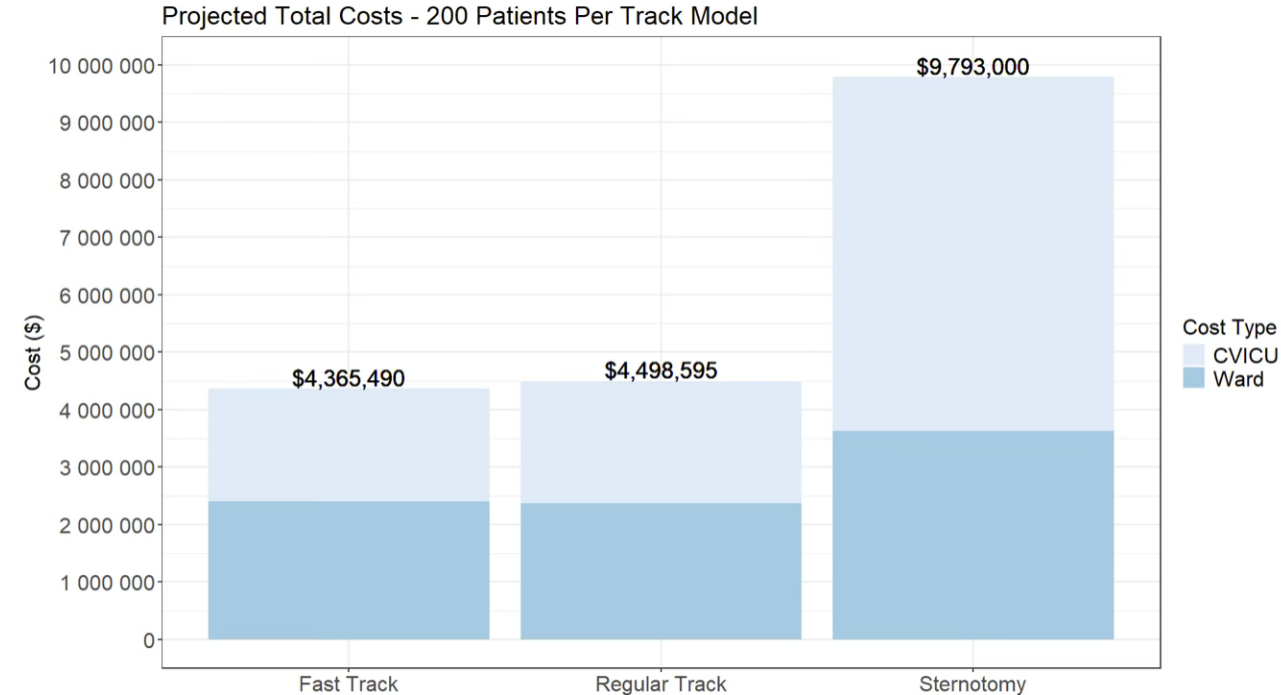
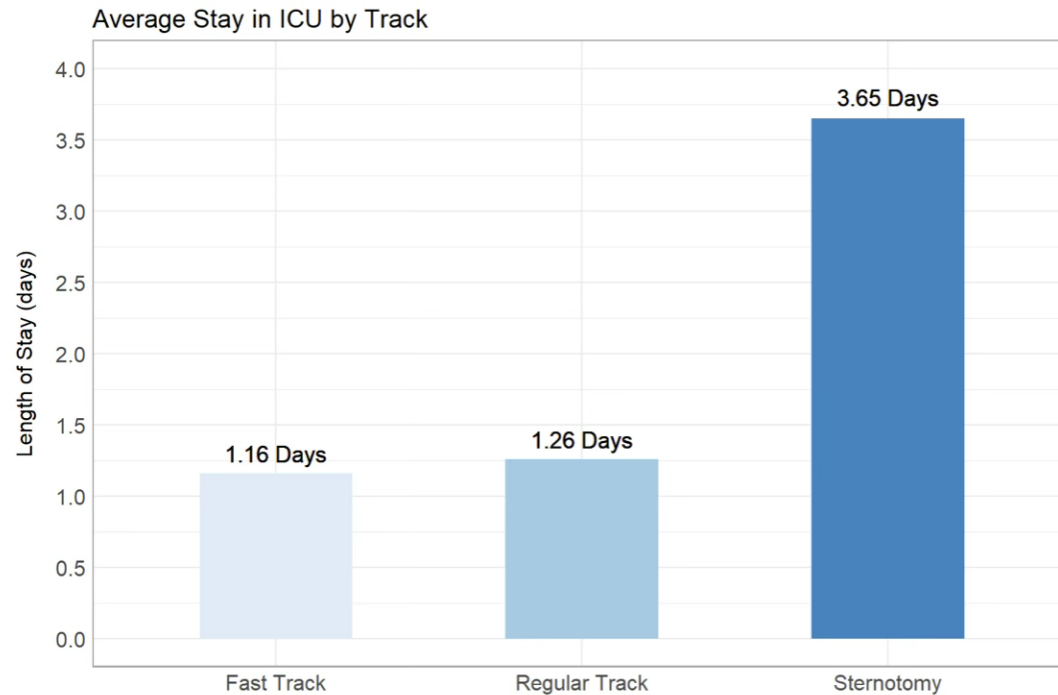
Reason for 30-day Readmission	Affected Patients n=4 (%)
Pericarditis	1 (25.0)
Pleural Effusion	2 (50.0)
Gastrointestinal Bleed	1 (25.0)

Discussion

- **Rapid-recovery protocol was associated with significantly higher rates of the primary composite outcome of discharge from the ICU by POD#1, discharge home by POD#4, and no readmission by 30-days**
- **No difference in postoperative complications**
- **Novel approach to cardiac surgery perioperative care**

Results 1

- The Fast Track protocol reduces the average ICU length of stay to 1.16 days compared to 3.65 days via conventional median sternotomy.
- CVICU costs (\$8,442.40/day) are 2.83 times more expensive than the daily Ward cost (\$2,978.75/day).

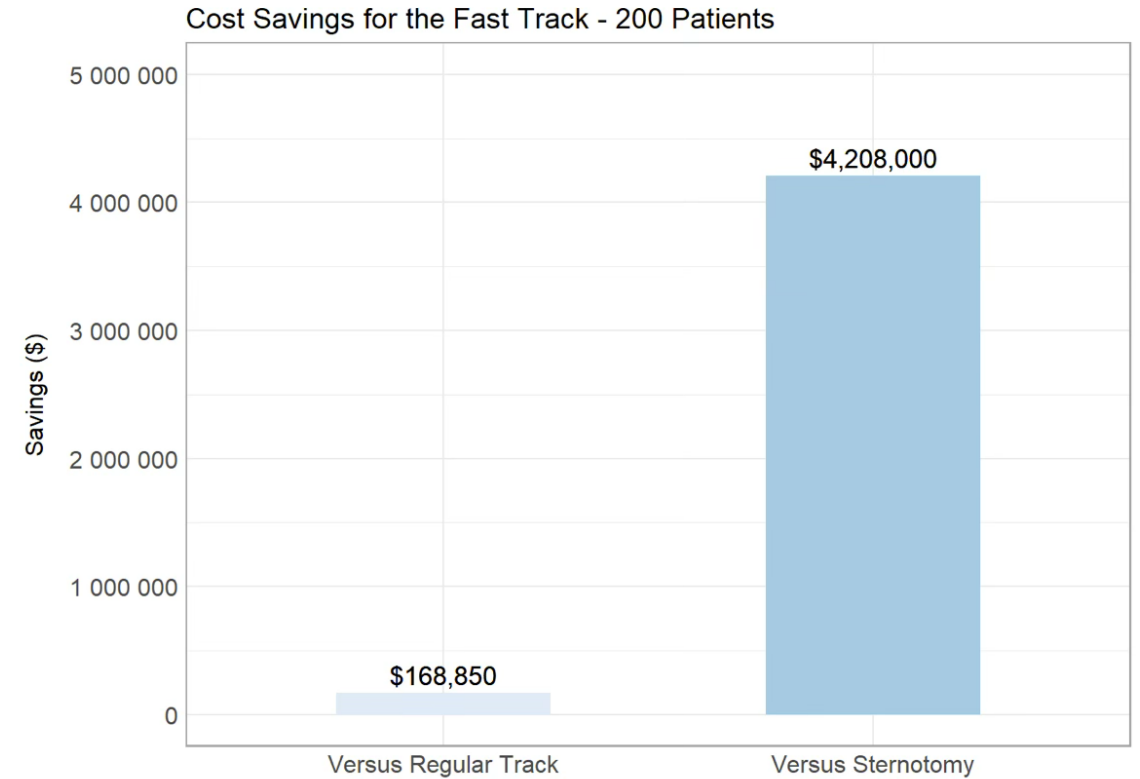
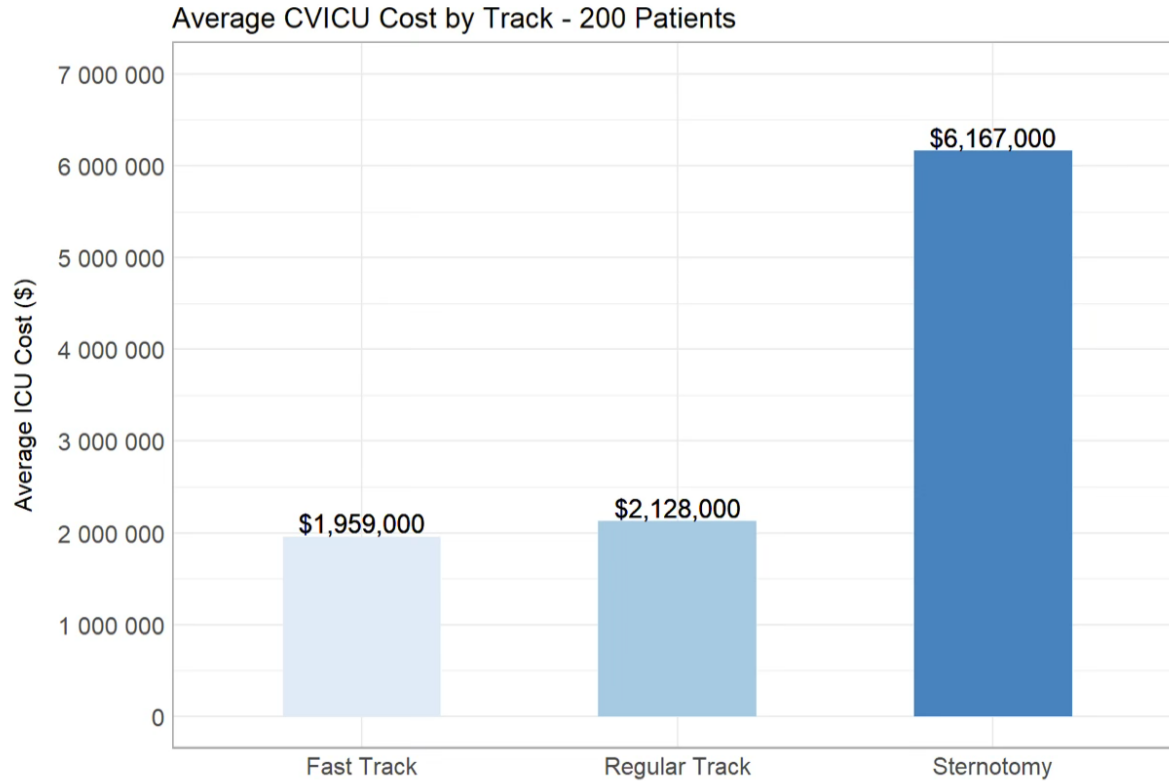


We observed post operative CVICU savings of \$21,021.58 per patient using the Fast Track protocol compared to Sternotomy.



Results 2

- CVICU costs were forecasted for 200 patients per track and are displayed below in the graph on the left.



- The Fast Track model demonstrates savings of \$4.208 million and \$168,850 respectively, when compared to the Sternotomy and Regular Track models.



Early Patient Reported Outcomes following Minimally invasive Mitral repair

Importance of Patient reported outcomes

- PROMs provide a structured approach to define physical, mental, and emotional components of the patient experience and can help determine health-related quality of life (QoL).

Research

JAMA | **Original Investigation**

Minithoracotomy vs Conventional Sternotomy for Mitral Valve Repair A Randomized Clinical Trial

Enoch F. Akowuah, MD; Rebecca H. Maier, MSc; Helen C. Hancock, PhD; Ehsan Kharatikoopaei, PhD;
Luke Vale, PhD; Cristina Fernandez-Garcia, PhD; Emmanuel Ogundimu, PhD; Janelle Wagnild, PhD;
Ayesha Mathias, BSc; Zoe Walmsley, MSc; Nicola Howe, PhD; Adetayo Kasim, PhD; Richard Graham, MBChB;
Gavin J. Murphy, MD; Joseph Zacharias, MD; for the UK Mini Mitral Trial Investigators

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JAMA

QUESTION Is minimally invasive mitral valve repair better at improving physical function at 12 weeks than conventional sternotomy mitral valve repair for degenerative mitral regurgitation?

CONCLUSION Minithoracotomy is not superior to sternotomy in recovery of physical function at 12 weeks. The results provide evidence to inform shared decision-making and treatment guidelines.

PRIMARY OUTCOME

Change in physical functioning and return to usual activities from baseline at 12 weeks after surgery measured by the 36-Item Short Form Health Survey version 2 physical functioning T score

Akowuah EF, Maier RH, Hancock HC, et al; UK Mini Mitral Trial Investigators. Minithoracotomy vs conventional sternotomy for mitral valve repair: a randomized clinical trial. *JAMA*. Published June 13, 2023. doi:10.1001/jama.2023.7800

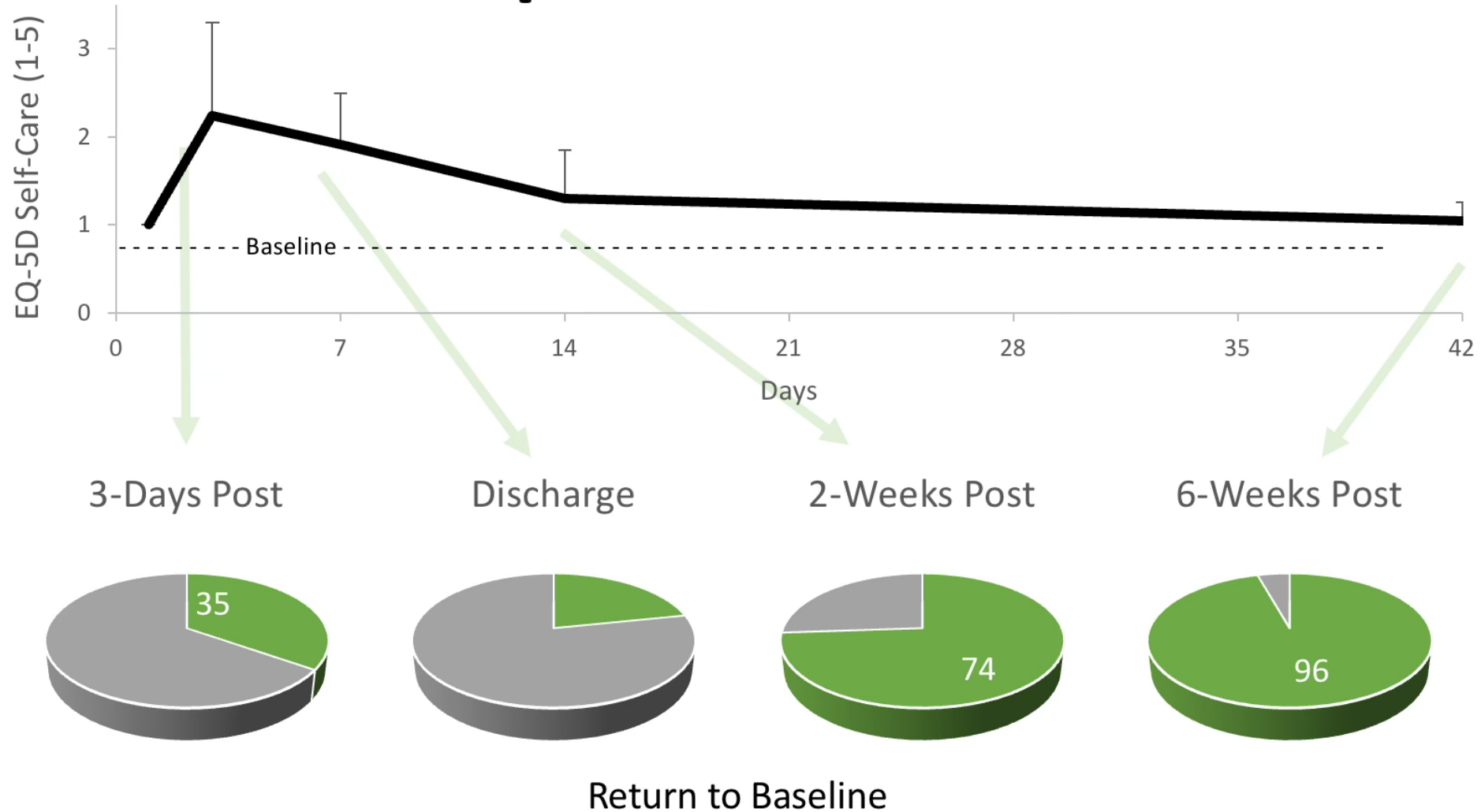
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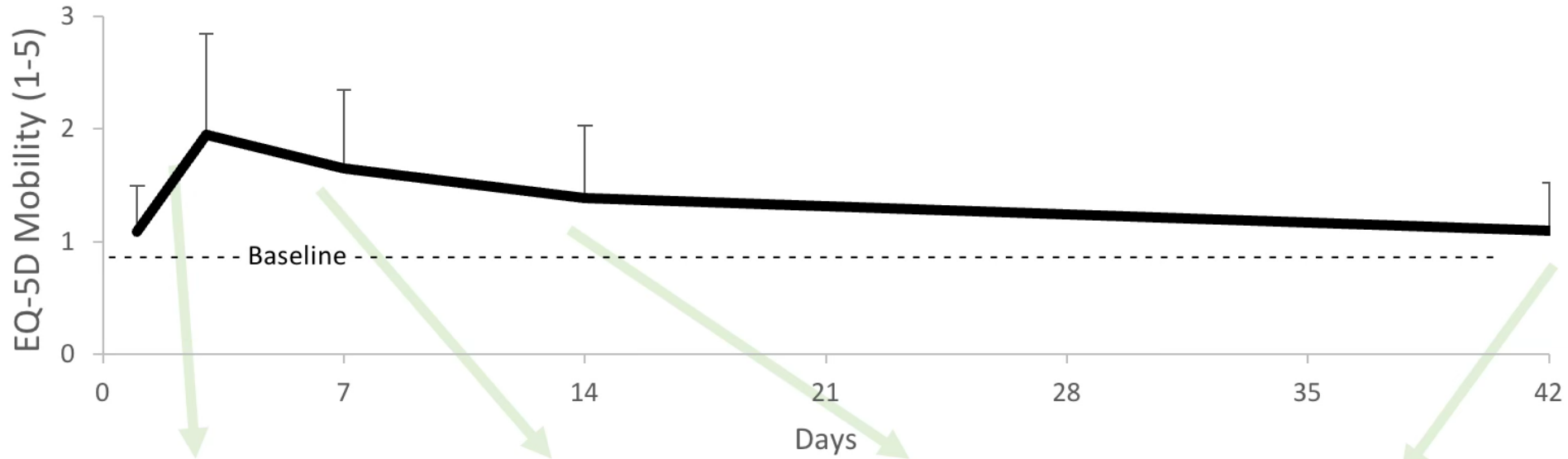
Methods

- 50 consecutive minimally invasive mitral repairs with EQ5 quality of life scale assessment early after surgery
- Research coordinator follow up at
 - 3 days post op
 - Discharge
 - 2 weeks
 - 6 weeks
 - 12 weeks

Post-op MICS: EQ-5D QOL



Post-op MICS: Mobility

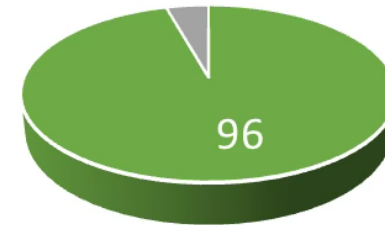
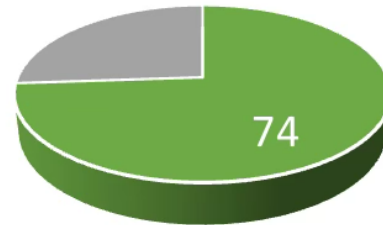
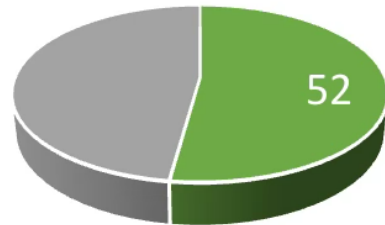
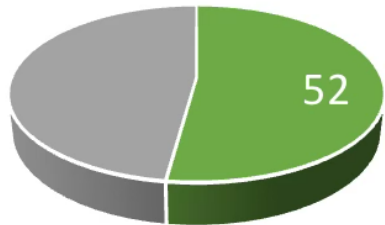


3-Days Post

Discharge

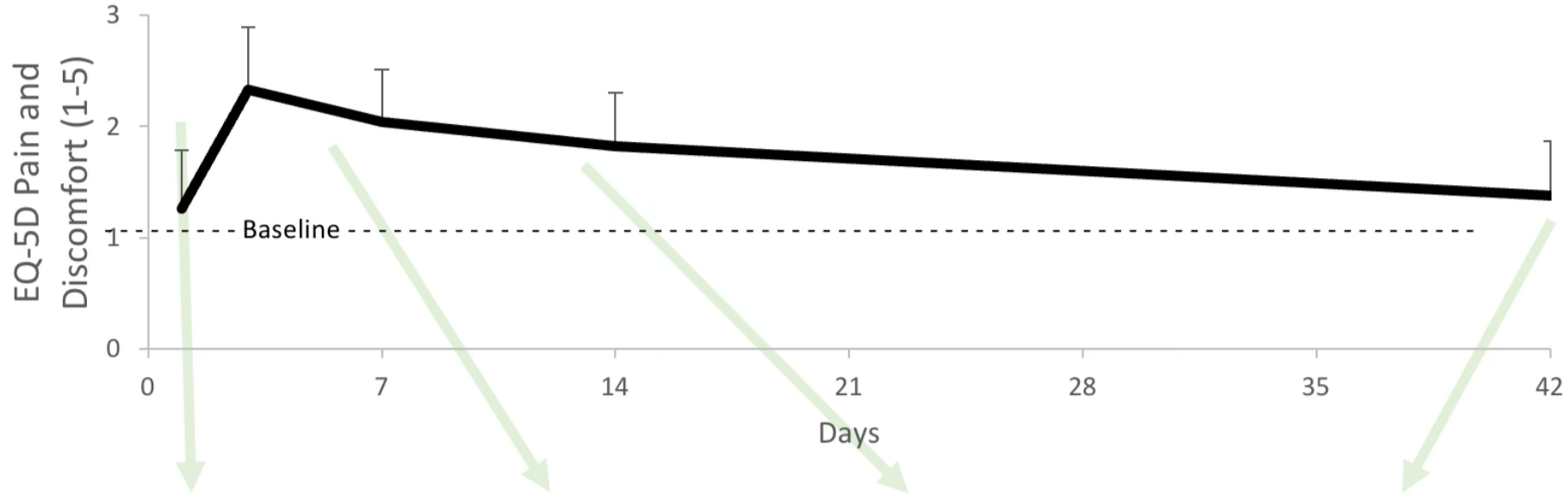
2-Weeks Post

6-Weeks Post



Return to Baseline

Post-op MICS: Pain and Discomfort

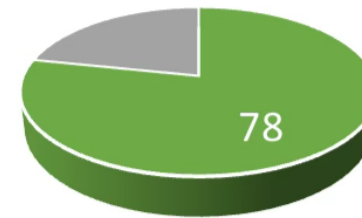
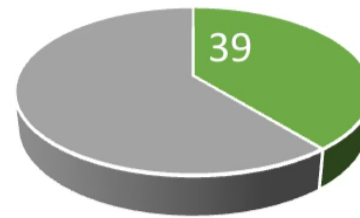
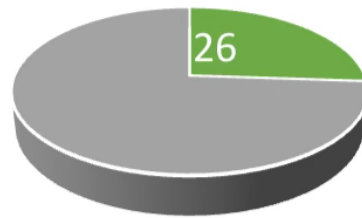
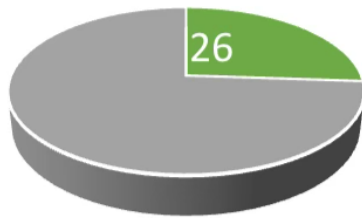


3-Days Post

Discharge

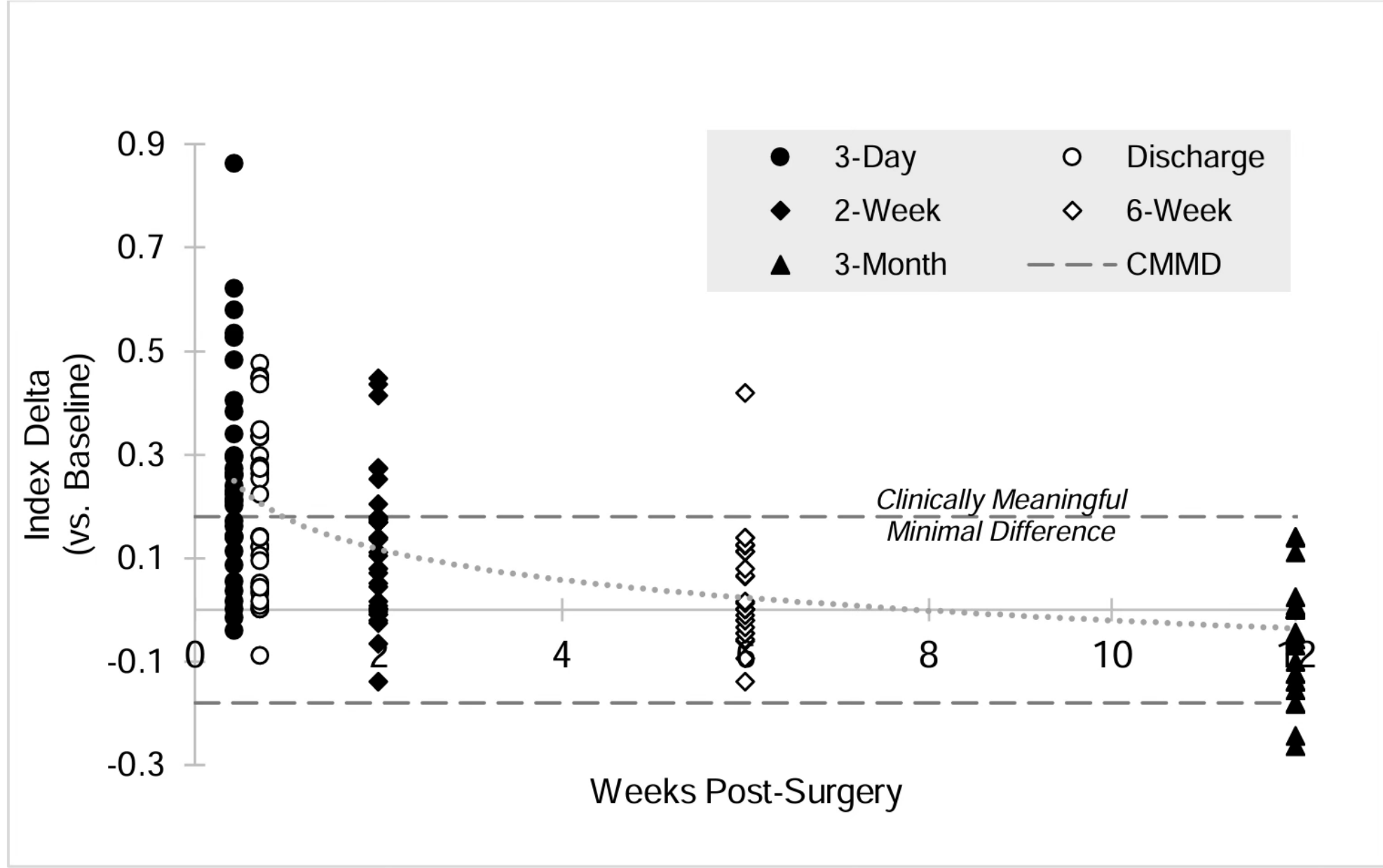
2-Weeks Post

6-Weeks Post

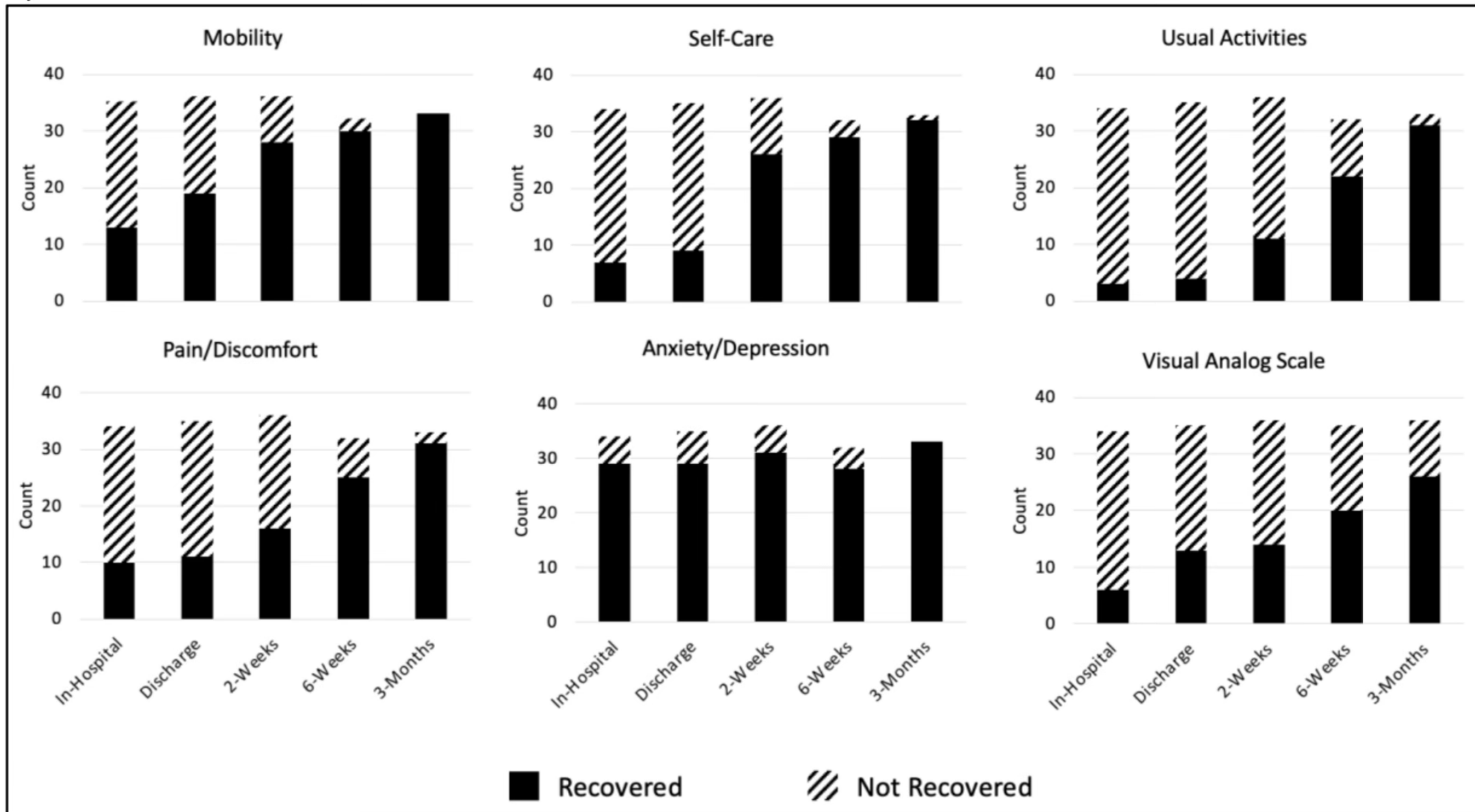


Return to Baseline

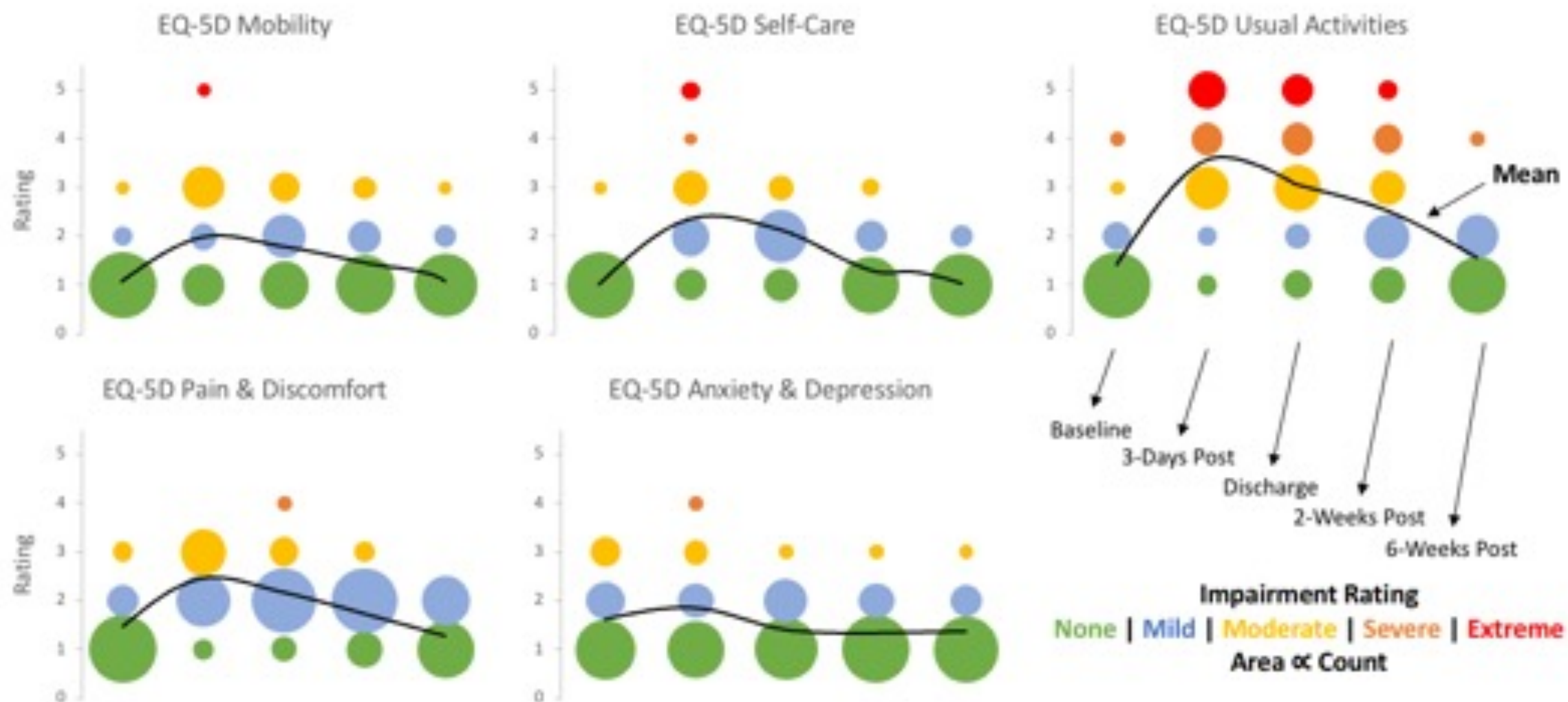
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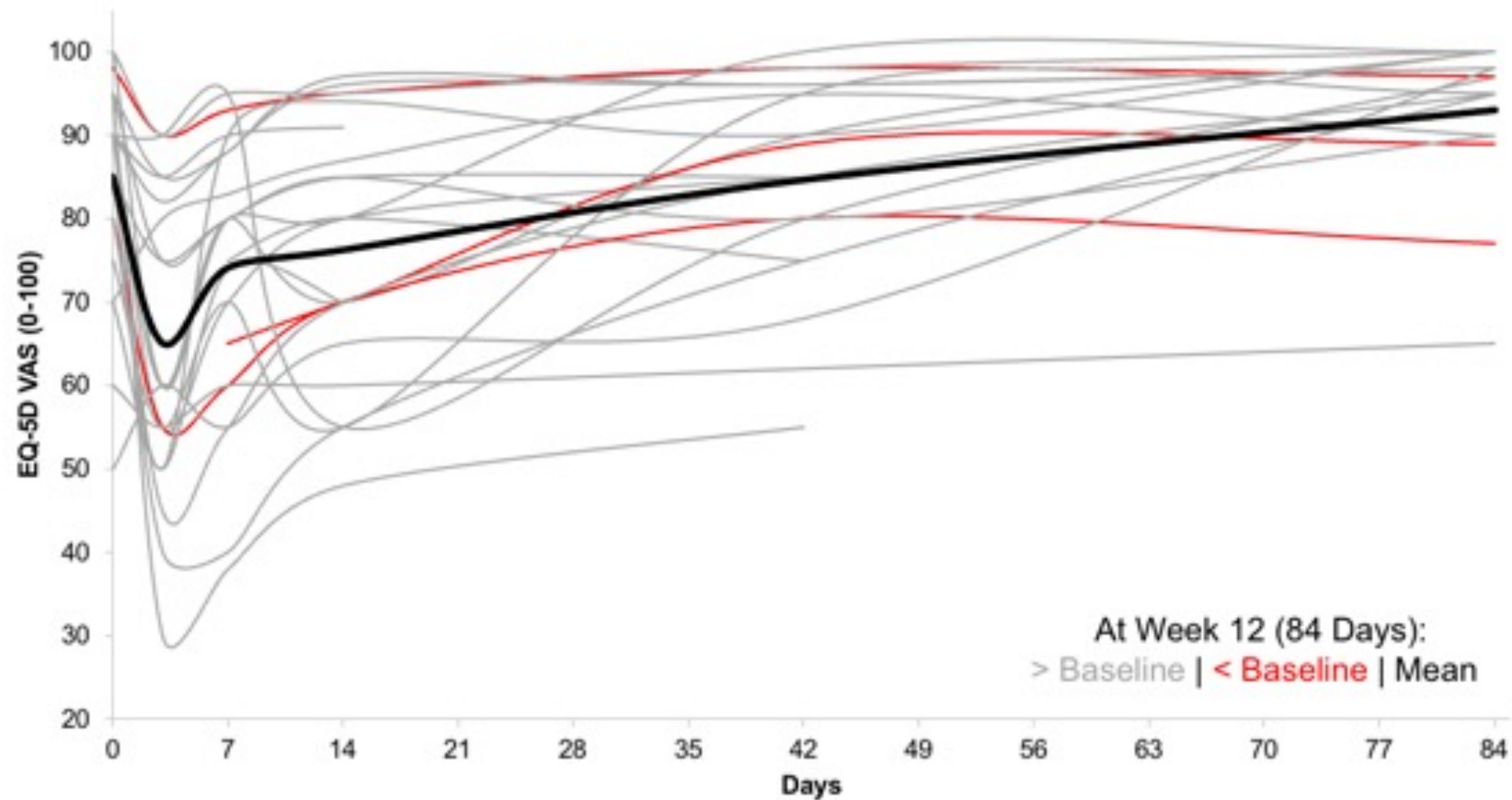
b)



Index Component Score Distributions



VAS: Individual Data



Results summary

- At 2-weeks post-surgery, 81% of patients reported QoL similar to baseline
- All of the individual components of the EQ-5D-5L showed progressive recovery over time.
- 2-weeks post-operation, 78% of patients reported that their mobility returned to baseline
- 6-weeks postoperative, 69% of patients had returned to baseline usual activities
- 100% of patients returning to within the clinically insignificant deficit range by 12-weeks follow-up, indicating recovery