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 "Benchma
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

**INTRA-OPERATIVE**
- 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 anesthesiologist to enhance post-op pain control and early extubation in CVICU

**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 3h 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)

   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, if opioids reserved for 2nd line PRNs
   - FIRST CHOICE
     - Ketorolac 10mg IV q4h 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
   - Ondansetron 4 mg IVPB q8h PRN
   - Haloperidol 0.5-1.5 mg IV q6-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 (medication 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 IABP for patients with normal LV/RV function on post CPB; do not initiate IABP 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 references; assess chest incision and groin incision daily and pm. If percutaneous cannulation was used: Removal 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
<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-protocol (n = 75) mean ± SD or n (%)</th>
<th>Post-protocol (n = 75) mean ± SD or n (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>60.4 ± 12.1</td>
<td>59.9 ± 12.8</td>
<td>.987</td>
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<tr>
<td>Female Sex</td>
<td>30 (40.0)</td>
<td>26 (34.7)</td>
<td>.613</td>
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<tr>
<td>Body Mass Index (kg/m²)</td>
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<td>NYHA III-IV</td>
<td>13 (17.3)</td>
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<td>Dyslipidemia</td>
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<td>Coronary Artery Disease</td>
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<tr>
<td>Diabetes</td>
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<td>Smoking</td>
<td>8 (10.7)</td>
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<td>Chronic Kidney Disease</td>
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<td>Previous Stroke or TIA</td>
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<td>Atrial Fibrillation</td>
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<td>12 (16.0)</td>
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<td>LVEF ≥60%</td>
<td>58 (77.3)</td>
<td>61 (81.3)</td>
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<tr>
<td>Tricuspid Regurgitation</td>
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<td></td>
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<tr>
<td>None/trivial</td>
<td>55 (73.3)</td>
<td>57 (76.0)</td>
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<tr>
<td>Mild</td>
<td>17 (22.7)</td>
<td>15 (20.0)</td>
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<tr>
<td>Moderate</td>
<td>3 (4.0)</td>
<td>4 (5.3)</td>
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<tr>
<td>Severe</td>
<td>0 (0)</td>
<td>0 (0.0)</td>
<td>1.000</td>
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<tr>
<td>Aortic Regurgitation</td>
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<tr>
<td>None/trivial</td>
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<td>63 (84.0)</td>
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<tr>
<td>Mild</td>
<td>6 (8.0)</td>
<td>11 (14.7)</td>
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<tr>
<td>Moderate</td>
<td>1 (1.3)</td>
<td>1 (1.3)</td>
<td>1.000</td>
</tr>
<tr>
<td>Severe</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>1.000</td>
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<tr>
<td>Clinical outcome</td>
<td>Pre-protocol (n = 75) median (IQR) or n (%)</td>
<td>Post-protocol (n = 75) median (IQR) or n (%)</td>
<td>P-value</td>
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<tr>
<td>----------------------------------------</td>
<td>---------------------------------------------</td>
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<tr>
<td><strong>Postoperative Data</strong></td>
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<td></td>
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<tr>
<td>Intubation Time (hours)</td>
<td>5.4 (4.4-9.6)</td>
<td>6.6 (4.4-11.2)</td>
<td>.265</td>
</tr>
<tr>
<td>ICU LOS (days)</td>
<td>1 (1-1)</td>
<td>1 (1-1)</td>
<td>.295</td>
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<tr>
<td>Postoperative Hospital LOS (days)</td>
<td>5 (4-6)</td>
<td>4 (4-5)</td>
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<td>ICU Readmission</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Reintubation</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Pacemaker</td>
<td>1 (1.3)</td>
<td>3 (4.0)</td>
<td>.620</td>
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<tr>
<td><strong>Complications</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Acute Kidney Injury</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Atrial Fibrillation</td>
<td>29 (38.7)</td>
<td>22 (29.3)</td>
<td>.301</td>
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<tr>
<td>Bleeding</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Death</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Delirium</td>
<td>0</td>
<td>3 (4.0)</td>
<td>.245</td>
</tr>
<tr>
<td>Pleural Effusion</td>
<td>5 (6.7)</td>
<td>4 (5.3)</td>
<td>1.000</td>
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<tr>
<td>Hospital Readmission</td>
<td>7 (9.3)</td>
<td>4 (5.3)</td>
<td>.533</td>
</tr>
<tr>
<td>Stroke</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>
Results: Primary Outcome

- **Discharge from ICU POD#1**
  - Pre-protocol: 79%
  - Post-protocol: 88%
  - p = 0.188

- **Discharge home ≤POD#4**
  - Pre-protocol: 49%
  - Post-protocol: 61%
  - p = 0.189

- **No 30-day readmission**
  - Pre-protocol: 91%
  - Post-protocol: 95%
  - p = 0.533

p = 0.022
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

<table>
<thead>
<tr>
<th>Barrier to CVICU POD#1 Discharge</th>
<th>Affected Patients n=9 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delirium</td>
<td>1 (11.1)</td>
</tr>
<tr>
<td>Hemodynamic Instability</td>
<td>2 (22.2)</td>
</tr>
<tr>
<td>Low Output State</td>
<td>4 (44.4)</td>
</tr>
<tr>
<td>Rhythm</td>
<td>1 (11.1)</td>
</tr>
<tr>
<td>Seizure</td>
<td>1 (11.1)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Reason for 30-day Readmission</th>
<th>Affected Patients n=4 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pericarditis</td>
<td>1 (25.0)</td>
</tr>
<tr>
<td>Pleural Effusion</td>
<td>2 (50.0)</td>
</tr>
<tr>
<td>Gastrointestinal Bleed</td>
<td>1 (25.0)</td>
</tr>
</tbody>
</table>
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.
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).
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
**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

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

EQ-5D Self-Care (1-5)

Baseline

Days

3-Days Post
Discharge
2-Weeks Post
6-Weeks Post

Return to Baseline

35
74
96

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Post-op MICS: Mobility

EQ-5D Mobility (1-5)

Days

0 7 14 21 28 35 42

Baseline

3-Days Post
Discharge
2-Weeks Post
6-Weeks Post

Return to Baseline

52
52
74
96
Post-op MICS: Pain and Discomfort

EQ-5D Pain and Discomfort (1-5)

Days

Baseline

3-Days Post  Discharge  2-Weeks Post  6-Weeks Post

Return to Baseline

26

26

39

78
VAS: Individual Data

EQ-5D VAS (0-100)

Days

At Week 12 (84 Days):
- > Baseline
- < Baseline
- Mean
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