

SUSTAINED REDUCTION IN PROLONGED VENTILATION AFTER ISOLATED CABG FOLLOWING MULTIDISCIPLINARY IMPROVEMENTS ACROSS ALL PHASES OF CARE

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Project Selection

Coronary artery bypass graft (CABG) surgery is one of the most frequent and costly cardiac surgical procedures performed today. According to the Society of Thoracic Surgeons (STS), an organization formed in 1964 to improve the quality of care for patients undergoing heart disease through education, research, and advocacy, the 2022 benchmark for postoperative prolonged ventilation (PV) is 6.66%. The STS defines PV as any patient who is on mechanical ventilation greater than 24 hours for the entire hospitalization following CABG surgery. CABG PV is associated with increased morbidity, length of stay and cost. The Society of Thoracic Surgeons (STS) and the Medicare Merit-based Incentive Payment System cite PV as a modifiable, publicly reported, pay-for-value quality metric.

Additionally, patients experiencing prolonged postoperative ventilation will have longer intensive care stays accompanied by longer hospital length of stay, higher treatment costs due to increased risk of complications, and an overall lower quality of life. In some cases, prolonged postoperative ventilation is driven by patient factors. However, in others it results from variability in management strategy or adherence to care protocols.

The table below, showing PV data at all 3 sites, from 2016-2018 when we struggled to meet the STS benchmark across all 3 sites.

	CY 2016	CY 2017	CY 2018
STS Avg	7.9%	7.8%	7.6%
AH Cabarrus	9.2%	10.4%	11.8%
AH CMC	10.9%	11.8%	9.5%
AH Pineville	11.9%	5.10%	9.4%

Goal: CABG Postop Prolonged Vent

Target: $\leq 7.5\%$ at all three sites (AH CMC, AH Pineville and AH Cabarrus) for the timeframe Oct 2021 to Sept 2022

Stretch: $\leq 7.03\%$ at all three sites (AH CMC, AH Pineville and AH Cabarrus) for the timeframe Oct 2021 to Sept 2022

Improvement Process

From 2017-2022, a multidisciplinary continuous quality improvement (QI) initiative was applied to the phases of care for CABG patients in the Atrium Health Greater Charlotte Region. Multiple interventions have been demonstrated to reduce the combined endpoint postoperative pulmonary complications which includes the need for prolonged ventilation. Postoperative pulmonary complications commonly reported in the clinical literature include respiratory failure, respiratory infection, atelectasis, pleural effusion, pneumothorax. The literature includes patients who have undergone varying forms of major surgery including cardiothoracic surgery. We have incrementally addressed each

of these areas to reduce postoperative pulmonary complications and by extension the need for prolonged ventilation.

Preoperative Phase

The STS has a risk calculator that provides a statistical assessment of the patient's risk of PV. Patients with an STS predicted PV risk greater than 10% are deemed high-risk. These high-risk patients trigger a Heart Team review. In 2017 SHVI initiated a Heart Team conference to identify optimal therapeutic interventions for cardiac patients. Leveraging the expertise of multiple clinical specialists (cardiac surgeons, interventional cardiologist, heart failure cardiologist, advanced cardiac imaging physicians and critical care physicians) provided a patient-centered collaborative evaluation approach. A pulmonary risk mitigation strategy was developed for these patients that included a criteria-based preoperative pulmonary consultation and outlined therapies to optimize care for high-risk patients.

Intraoperative Phase

The team utilized Plan-Do-Study-Act (PDSA) with rapid cycles of change to optimize care delivery. A literature review allowed the team to complete a gap analysis and identify areas of opportunity. Standardized protocols were created, tested, and modified to become the new way to care for CABG patients.

1. Goal-directed hemodynamic management is the administration of fluids, inotropes, and vasoactive agents to augment blood flow and achieve specified hemodynamic targets. This management is associated with a reduction of postoperative pulmonary complications most likely through avoidance of excess fluid administration.
2. Lung protective ventilation refers to the use of tidal volumes ≤ 8 cc/kg IBW (ideal body weight), at least 5 cm H₂O PEEP, and recruitment maneuvers. The lungs are at risk for injury following cardiac surgery and cardiopulmonary bypass and additional data support lung protective ventilation for the prevention of postoperative pulmonary complications.
3. Multimodal pain management is the use of two or more non-opioid medications or interventions to provide analgesia. Inadequately treated pain may be associated with poor pulmonary hygiene, atelectasis, and impaired post-surgical recovery. However, excess opioid use is associated with multiple complications including ileus and respiratory depression. Balancing these concerns, current Enhanced Recovery After Surgery (ERAS) Guidelines for Cardiac Surgery advise the use of an opioid sparing pain regimen.
4. Routine reversal of neuromuscular blockade: Residual postoperative neuromuscular blockade is associated with increased pulmonary complications; we routinely administer pharmacological reversal of neuromuscular blockade.
5. Maintenance of post-bypass normothermia: post-bypass hypothermia is associated with multiple forms of increased morbidity (e.g., bleeding) which indirectly prolong the use of mechanical ventilation. We instituted an institutional standard goal body temperature at ICU admission of > 36 C. OR initiatives to preserve body temperature have included increased ambient temperature and

prevention of cutaneous heat loss. In the ICU we secured multiple forced-air warming devices to ensure ready availability at the time of ICU admission. The Anesthesia service and ICU team review our process measure of $\geq 80\%$ CABG patients will be admitted from OR to CTICU with initial temperature $> 36\text{ C}$.

6. Restrictive transfusion strategy- Perioperative blood transfusion is independently associated with postoperative pulmonary complications. Outside of uncontrolled hemorrhage, we use a restrictive transfusion guideline with transfusion of packed red blood cells (PRBC) routinely suggested only for a hemoglobin $< 7.5\text{ g/dl}$. Additionally, to reduce blood loss we routinely administer anti-fibrinolytic therapy in the OR and the immediate postoperative period.

Postoperative Phase

This team developed the below interventions to optimize patients being extubated in a timely manner. The team had an early extubation process measure $\geq 60\%$ of CABG patients will be extubated within the first six hours of arrival to ICU.

After multiple PDSA cycles the below initiatives became standard work.

1. Scheduled Multidisciplinary Huddles: Nurse, Respiratory Therapy and APP/MD round on CABG patients at frequent intervals to evaluate progress towards extubation and address any obstacles.
2. Noninvasive ventilation and High Flow Nasal Cannula: Although the data are inconclusive, the use of noninvasive ventilation and high flow nasal cannula following extubation is safe and may be associated with improved respiratory parameters and a reduced rate of reintubation.
3. Lung expansion protocol: Respiratory physiotherapy has broadly been associated with reduced postoperative pulmonary complications following cardiac surgery. At Atrium Health we developed respiratory therapist driven lung expansion and bronchial hygiene protocols to address atelectasis and secretion clearance. We routinely employ these protocols following cardiac surgery.

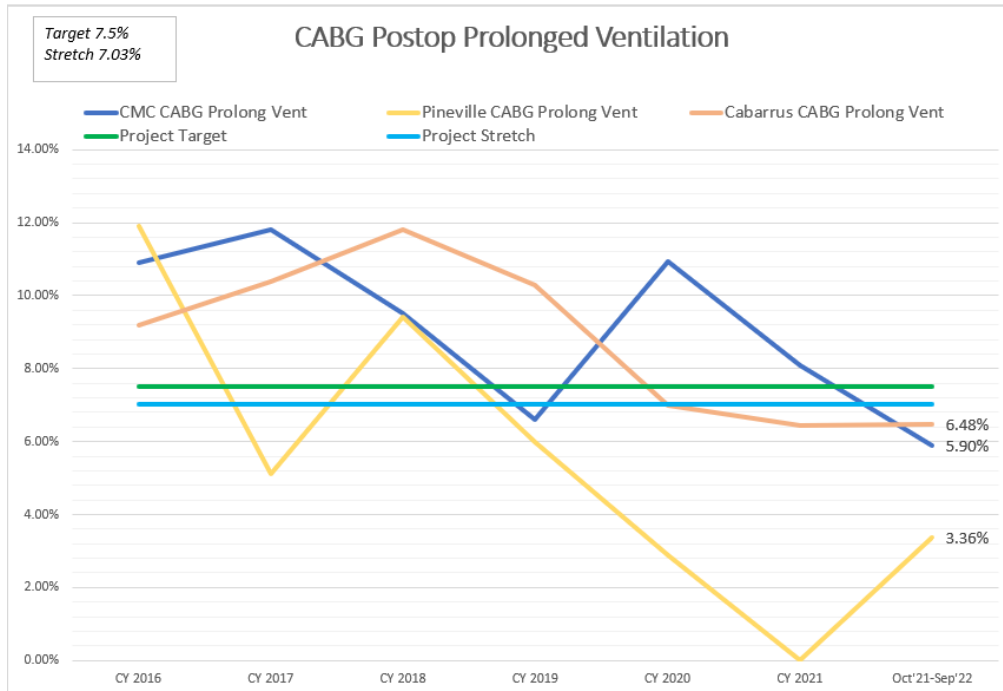
Results/Outcomes

Goal CABG Postop Prolonged Vent

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Stretch: $\leq 7.03\%$ at all three sites (AH CMC, AH Pineville and AH Cabarrus) for the timeframe Oct 2021 to Sept 2022

Stretch goal obtained. All three sites (AH CMC, AH, Pineville and AH Cabarrus) Postop Prolong Vent rate was $< 7.03\%$ for the timeframe Oct'21-Sept'22



Through the phase of care approach, the front-line staff became involved in the solution of decreasing postop CABG PV. Through the various PDSA cycles the team developed ownership of the process. Standard work was created that became the “new” way of caring for the cardiac patients. With ownership by the front-line staff involved barriers are easier to address. Continuous multidisciplinary quality improvement across all three phases of care led to sustained reduction in CABG PV.

	CY 2019	CY 2020	CY 2021	CY 2022
STS Avg	7.60%	7.20%	7.03%	6.81%
Project Target	7.5%	7.5%	7.5%	7.5%
Project Stretch	7.03%	7.03%	7.03%	7.03%
AH Cabarrus	10.30%	7.0%	6.43%	6.48%
AH CMC	6.60%	10.93%	8.09%	5.90%
AH Pineville	6.00%	2.87	0%	3.36%

Higher than STS Avg
Below STS Avg

A phase of care approach to quality improvement successfully led to sustained reduction in CABG PV and can be applied to other clinical areas.

References:

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2. McCarthy C and Fletcher N. Early Extubation in Enhanced Recovery from Cardiac Surgery. *Crit Care Clin* 2020; 36: 663–674
3. Engleman DT et al. Guidelines for Perioperative Care in Cardiac Surgery Enhanced Recovery After Surgery Society Recommendations *JAMA Surg* 2019; 154(8): 755-766.