Barton Health

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Title: Capnography

Topical Area: Patient Safety

Executive Support Statement

Per Dr. Rhonda Sneeringer, Chief Medical Officer, "Barton Health System supports the application for this award. We believe that we are a patient centric organization focused on patient safety. Our work in Capnography has been very progressive and even life-saving and we hope that applying for this award will allow other organizations to evaluate our work and have the opportunity to apply it at their own institutions."

Executive Summary

Barton Health was propelled into our capnography journey after a significant patient event in 2012. At the direction of Barton's Board of Directors, a literature review was performed and best practices obtained. The need to increase services not only around capnography, but respiratory failure to minimize any future harm was apparent. Additional funding permitted Barton to increase capnography monitoring. The Capnography Workgroup revised the existing policy, developed evidence-based recommendations, and provided physician and staff education. The Workgroup further expanded upon this resulting in the development and launch of a Capnography Program integrating Obstructive Sleep Apnea screening and interventions across the organization's continuum of care. Challenges were identified and addressed. Combined, these efforts resulted in actual mortality rates that are consistently lower than the expected mortality rates and fewer hospital cardiac arrests equating to 30 lives saved per annum. Despite these great strides, work on the Capnography Program continues thus ensuring that not only Barton Health's patients and community benefit from a rigorous program, but, in partnership with the manufacturer, many more patients benefit from Barton's experience.

Background and Relevance

In 2012, when a serious patient safety event was reported to the Barton Health Patient Safety Committee, a request for evidence based studies regarding monitoring devices for patients potentially experiencing ventilatory compromise in an acute care setting was made.

Patient safety focuses on preventing harm. However, current literature suggests respiratory compromise in acute care settings are projected to increase resulting in additional monies spent on this phenomenon. Research which analyzed more than 700,000 elective surgeries found nearly 11.6% of postoperative patients suffer from respiratory compromise (Argawal, Erslon, & Bloom, 2011; Medtronic, 2015). By 2019, this number is projected to increase by 31% (Argawal, Erslon, & Bloom, 2011; Medtronic, 2015). Inpatient stays related to respiratory compromise surpassed $7 billion annually in the US in 2007 and are expected to surpass $37 billion by 2019 (Argawal, Erslon, & Bloom, 2011; Medtronic, 2015). Patients admitted to general care floors with respiratory compromise events require on average three additional days in the ICU and seven days in the hospital (Kelley, Agarwal, Parikh, Erslon, Morris, 2012). Patients with respiratory compromise cost hospitals an average of $18,208 more than patients without respiratory compromise (Kelley et al., 2012).

In 2011, the American Society of Anesthesiologists revised and updated their recommendations to include the monitoring of exhaled carbon dioxide in moderate and deep sedation unless precluded or invalidated by the nature of the patient, procedure or equipment (American Society of Anesthesiologists, 2011; Kodali, 2013). A literature review including the Journal of PeriAnesthesia Nursing (2012), recommended capnography to detect early signs of ventilatory compromise. In addition, The Joint Commission released a Sentinel Event Alert on the safe use of opioids in hospitals (The Joint Commission, 2012).

A survey tool was designed and distributed to all hospitals insured with California Healthcare Insurance Company, Barton Health's liability insurance carrier, to determine the standard of care in like-size community hospitals. Ten hospitals responded to the survey; eight of ten utilized capnography. This combined information confirmed the need for action to prevent similar events at Barton Health.

Effort, Scope, Process, Strategies, Tactics Utilized and Challenges

According to the 2011 Emergency Care Research Institute research paper, "Capnography Outside of the Operating Room: Highest Priorities," capnography is a standard of care for patients receiving general anesthesia. Capnography utilization outside the operating room has expanded as evidence has shown its use can reduce adverse events in a variety of practice applications. Capnography's accessibility has increased as manufacturers have been able to cost-effectively integrate the technology into a variety of medical devices. At the start of this project, Barton Health was using capnography in the following areas:

- Operating Room (OR) for general anesthesia. The anesthesia monitoring equipment included capnography.
- Intensive care unit (ICU) for ventilated patients. The ventilators included capnography.
- Interventional Radiology (IR) for procedural sedation.
- Emergency Department (ED) for procedural sedation.
- Respiratory Therapy (RT) carried a portable capnography device for use throughout the hospital

The use of capnography in acute care hospitals is increasing nationwide. Suggested applications include:

1. On adult and pediatric crash carts for use in resuscitations
    - during and after insertion of an endotracheal tube
    - to assess the quality of cardiopulmonary resuscitation (CPR)
    - to monitor the patient for return of spontaneous circulation (ROSC)
2. In the post-anesthesia recovery room (PACU)
    - for patients who still have an advanced airway (endotracheal tube or laryngeal mask airway) in place (ASA "Standards")
    - for patients who received an intravenous (IV) opioid during the perioperative period, especially patients at high risk of an adverse respiratory event (obstructive sleep apnea (OSA))
    - for patients with OSA (ASA "obstructive sleep apnea")
    - for patients with obstructive sleep apnea (OSA) (ASA "obstructive sleep apnea")
3. In the emergency department
    - for procedural sedation and analgesia (PSA)
    - for management of mechanically ventilated patients
4. On adult and pediatric critical care areas, step down units and respiratory care units
    - for management of mechanically ventilated patients
    - during bedside procedures (e.g., tracheostomy) requiring PSA
5. On general medical/surgical units
    - for continuous monitoring of patients receiving IV opioids by patient-controlled analgesia (PCA)
6. In the hospital's diagnostic and therapeutic support areas

- for interventional radiology PSA
- for electrophysiology PSA
- in the cardiac catheterization laboratory for PSA
- in the MRI suite for patients receiving IV sedation
- for pulmonary PSA (moderate or deep sedation during bronchoscopy)
- for pediatric sleep studies (to diagnose obstructive sleep apnea and other breathing disorders)
- In the endoscopy suite for PSA, especially for patients receiving propofol, for patients at high risk of an adverse respiratory event, and for procedures in which ventilation cannot be visually monitored. These include endoscopic retrograde cholangiopancreatography (ERCP) procedures performed in the prone position.

7. In obstetrics

- during labor, for patients at higher risk of a respiratory event receiving neuraxial (epidural, and/or spinal) opioids [e.g., patient-controlled epidural anesthesia]
- post-operatively, for continuous monitoring of patients receiving opioids by PCA (PSA "patient-controlled analgesia")

Once the need to expand capnography was identified through Barton's Patient Safety Committee, an equipment needs assessment was completed. A proposal was sent to the Board of Directors by the Director of Risk Management and Patient Safety Officer. The request was approved as safety is a priority as outlined in Barton Health's strategic plan.

The multi-disciplinary Capnography Workgroup convened in 2012 and included the Anesthesia Medical Director, Risk Management, Patient Safety, Quality Management, Nursing

leadership, frontline nursing staff, Respiratory, and Biomedical Engineering. Some of the action items included:

1. Initial criteria development based on evidence-based research
2. Development of a policy to govern the Capnography Program
3. Development of performance improvement indicators
4. Education to hospital staff and medical staff
5. Designed an educational pamphlet for patients and caregivers
6. Updated the electronic health record system to include STOPBANG screening
7. Creation of a discharge letter to patients and their primary care provider regarding follow up
8. Increased capacity of the Sleep Studies lab to accommodate the increased volume of sleep studies
9. Adjustment of alarm parameters to reduce overall number of alarms
10. Implementation of hourly rounding to ensure patient safety and improve patient satisfaction
11. Employee satisfaction survey designed and implemented with follow up on identified issues
12. Creation of a black and white checkered wrist band to readily identify patients on capnography (Figure 1)
13. Designed a patient room door magnet alerting staff of the need for capnography (Figure 2)
14. Articles placed in the organization’s Patient Safety Newsletter to increase capnography awareness

15. Criteria updated as new evidence-based research became available

The Workgroup revised and updated the capnometry policy to include evidence-based criteria driving the application and removal of capnography on patients. A plan for equipment management and alarm settings, and high and low critical values was devised. The University of California San Diego Perioperative Management of OSA Patients Practical Solutions and Care Strategies (2011) document provided information to update medical and staff educational programs. A patient educational pamphlet was designed along with a follow up plan for patients identified as being at risk for sleep apnea. The Workgroup provided oversight of the STOP BANG assessment tool integration in the inpatient electronic health record. Most recently, the STOP BANG assessment tool was implemented in outpatient practices to facilitate identification of at risk patients prior to elective surgeries with the goal of completing a sleep study preoperatively as a best practice. A checkered identification band was implemented as a visual reminder to increase staff member awareness of patients at risk for sleep apnea when handed off from one caregiver to the next. Inpatient nursing leadership implemented an hourly rounding process to ensure patients on capnography have the device on after ambulating to the bathroom. An employee satisfaction survey was performed, and based on staff feedback, a partnership with the vendor was entered to complete an in depth alarm study with the goal of identifying improvement opportunities. Despite completion of these action items, the Capnography Workgroup remains ongoing and continues to refine the Capnography Program including integration of criteria from the San Diego Patient Safety Council (2014) (Figure 3).

The Capnography Program launched in October of 2013; several challenges arose. Overall alarm volume increased. Collaboration with physicians resulted in adjusting the default SPO2 parameters to 85% due to the organization’s high altitude and reinforcing with staff the

need for patient specific parameters when initiating capnography. Respiratory Therapists provided oversight on these changes. Despite these strategies, the number of capnography alarms remained significant. Future work involves the manufacturer performing an in-depth alarm audit. Another challenge experienced was devices not being replaced on patients upon return from the bathroom. Staff training was provided and nursing leadership implemented an hourly rounding process to observe practice. A slight increase in pressure injuries were observed behind patient's ears from the capnography tubing potentially due to its stiffness. Foam protectors were ordered and work continues with the manufacturer to develop a softer tubing product. Finally, limited capacity in the Sleep Studies lab to perform studies was identified. The department was expanded allowing studies to be performed in a timely manner and giving surgeons time to develop a treatment plan preoperatively to ensure a safe transition home post operatively.

Results and Significance

In 2012, Barton Health had limited capabilities for capnography monitoring. At the same time, there was growing evidence on the prevalence of respiratory compromise and The Joint Commission released a Sentinel Event Alert on safe opioid use in hospitals (2012). Barton Health approached these issues proactively and implemented the Capnography Program in October 2013. Capnography was initiated in the Orthopedic, Medical Surgical, Intensive Care, Post Anesthesia Care Units and the Gastrointestinal Lab. Initial compliance was low. By August 2014, compliance increased to 90% which has been sustained through December 2015 (Figure 4).

Barton assessed the impact on alarm volumes in response to The Joint Commission Sentinel Event Alert Issue 50 (2013), addressing hospital medical device alarm safety. Initially, the introduction of additional capnography units increased the overall alarm load. The Alarm

Management Workgroup made adjustments to the parameters and monitoring of the new process to help alleviate this. However, the impact remained significant. SpO2 low alarm limits were changed from 88% to 85%, which is permissible in high altitude climates. This resulted in a significant reduction in alarms. However, the number of alarms associated with capnography has continued to rise due to the increased use on patients (Figure 5).

The capnography manufacturer's initial data analysis revealed Barton's respiratory compromise rate is slightly higher than the national average (Figure 6). Alternatively, the analysis identified Barton's post-operative respiratory failure rate is significantly lower than the national average (Figure 7). The impact of this is apparent in Barton's length of stay and mortality data which are significantly lower than the national average for respiratory events (Figure 8).

In 2012, Barton had thirty-nine (39) in house cardiac arrests. By 2015, the number was reduced to nine (9) representing a 77% reduction in cardiac arrests. As of June 2016, there have been a total of three (3) in house cardiac arrests (Figure 9). This represents a 92% reduction in cardiac arrests since 2012 and approximately thirty (30) fewer patients requiring cardiopulmonary resuscitation while hospitalized annually.

Successful cardiac arrest resuscitation versus attempts went from 80% in 2012 to a sustained 100% year to date (Figure 10). A report from the American Heart Association, "Heart Disease and Stroke Statistics" (2013) published national survival rates for adults at 23.9% for in hospital cardiac arrests. This places Barton's in house cardiac arrest survival rates significantly higher than the national average.

ICU mortalities also declined. Prior to capnography, ICU mortalities were at twenty-five (25) in 2012. In 2015, mortalities decreased to two (2). As of June 2016, there have been zero (0)

ICU deaths (Figure 11). This represents approximately twenty-three lives saved in the ICU annually.

Finally, Barton's actual risk adjusted mortality rate has been consistently lower than the expected mortality rate from 2012 through the first quarter of 2016 (Figure 12). These findings suggest earlier identification of developing respiratory compromise using capnography equipment, Rapid Response Team interventions, and reduction in opioid use have led to a significant reduction in ICU mortalities and in house cardiac arrests.

Sustainability and Scaling

Use of the STOPBANG assessment tool to screen for obstructive sleep apnea was initially built into the electronic health record for use in the preoperative unit with later expansion to inpatient units and then to outpatient clinics in 2016. The tool allows earlier identification of patients at risk for respiratory compromise and enables completion of a thorough assessment and plan prior to elective surgeries. Barton's Sleep Study lab capacity was expanded to accommodate the increased demand for studies. Barton's Board of Directors have received regular feedback reports and are fully supportive of the program. As capnography and proactive screening is now system wide, Barton Health is confident the Capnography program will continue to be successfully sustained.

Lessons Learned

Many lessons were learned through this journey. A multi-disciplinary committee to oversee the work was paramount to the success of the program and provided opportunity for strong collaboration. This decreased unintended consequences that tend to arise with performance improvement projects. Key stakeholder involvement permitted feedback from

frontline staff and influenced adjustments as issues were identified. Alarm fatigue and overall alarm load remains an ongoing balance between noise and patient safety. Medical staff engagement early in the change process is vital to effective scaling and success. Capnography tubing discomfort was addressed and innovative solutions identified. Work with the manufacturer continues on redesigning the product. Patient and family education on the importance of follow up remains essential. Overall, the Capnography Program has significantly improved patient safety. Barton Health's early identification and response to deteriorating respiratory status saves lives and ultimately improves the overall health of our community.

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Figure 1. Example of wristband placed on patients with known OSA or a STOPBANG score of three or greater.

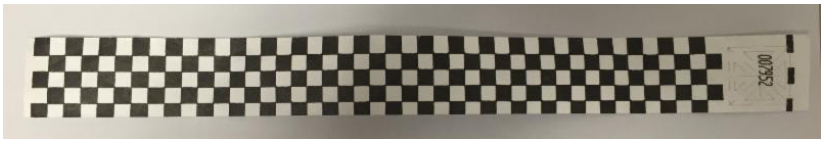


Figure 2. Example of magnet placed on patient room door signifying capnography monitor in use.

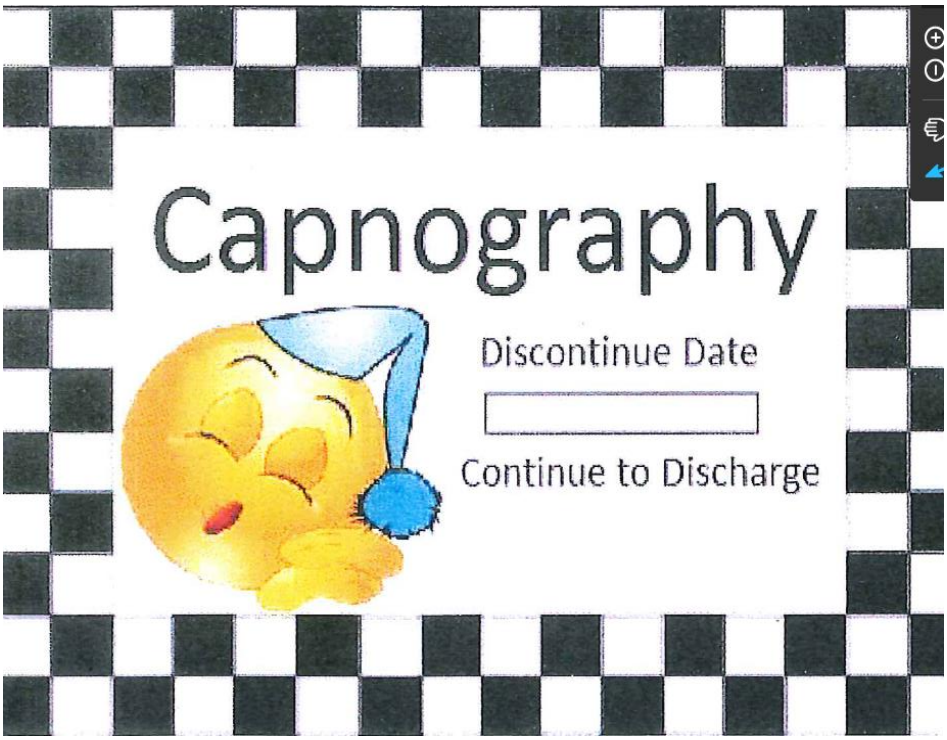
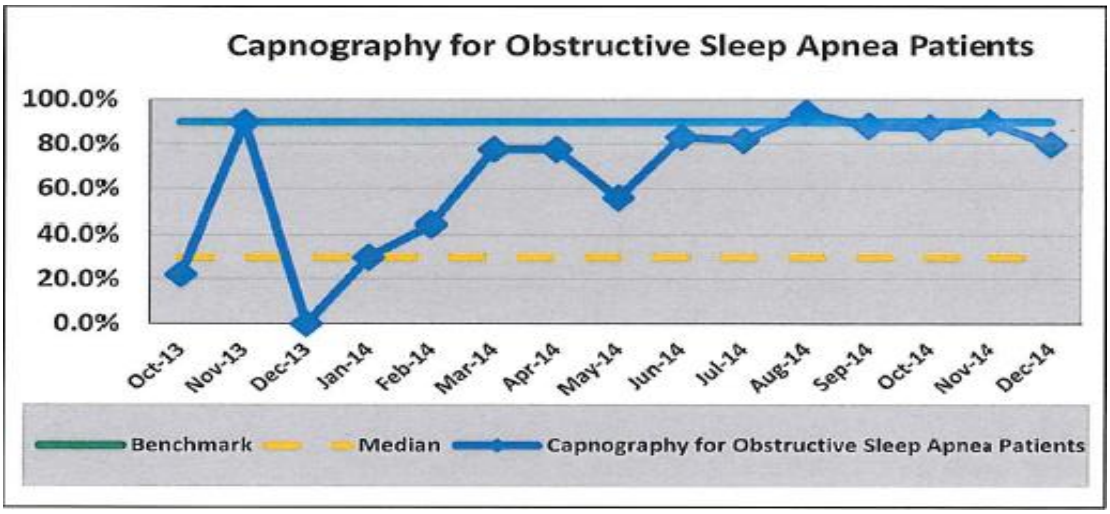


Figure 3. Capnography placement criteria from the San Diego Patient Safety Council Respiratory Monitoring of Patients Outside of the ICU Guidelines of Care Tool Kit.

High Risk* (EtCO2 & SpO2)	• Opioid Infusion Therapy-PCA (with or without basal), PCEA, Epidural • Recent Unplanned Administration of Reversal Agent • Known or Suspected OSA/Sleep Disorder (Not using PAP as prescribed) STOPBANG Score 5 or greater • General Anesthesia within 1 to 4 hours	**ESCALATING FACTORS** Other Medical Conditions/Diseases, Medical Hx/Physical State, or Other Considerations/Environmental Conditions
Intermediate Risk* (EtCO2 & SpO2)	• Opioids & Concomitant Sedatives/Medication Stacking/Other Sedating Meds • Moderate (a.k.a. Conscious) Sedation • Known or Suspected OSA/Sleep Disorder (Not using PAP as prescribed) STOPBANG Score 3-4 • General Anesthesia within 5 to 24 hours	
Low Risk* (SpO2)	• Opioids, Sedatives • Known or Suspected OSA/Sleep Disorder (using PAP as prescribed in facility) STOPBANG Score 1-2	
*When using supplemental oxygen, evaluate the patient need for EtCO2 monitoring independent of SpO2 values.		

Figure 4. Capnography utilization by patients that met OSA criteria October 2013-March 2016



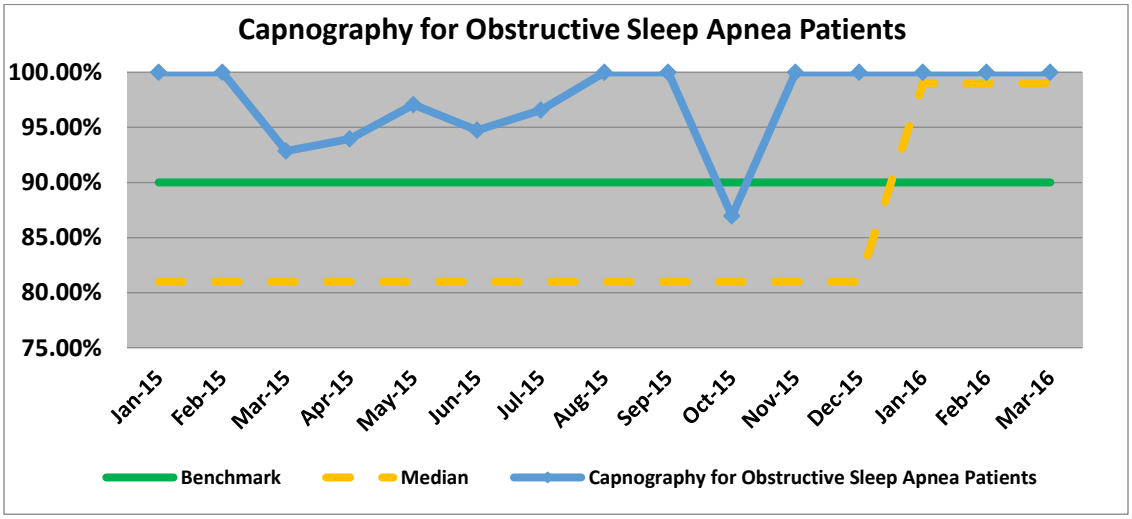
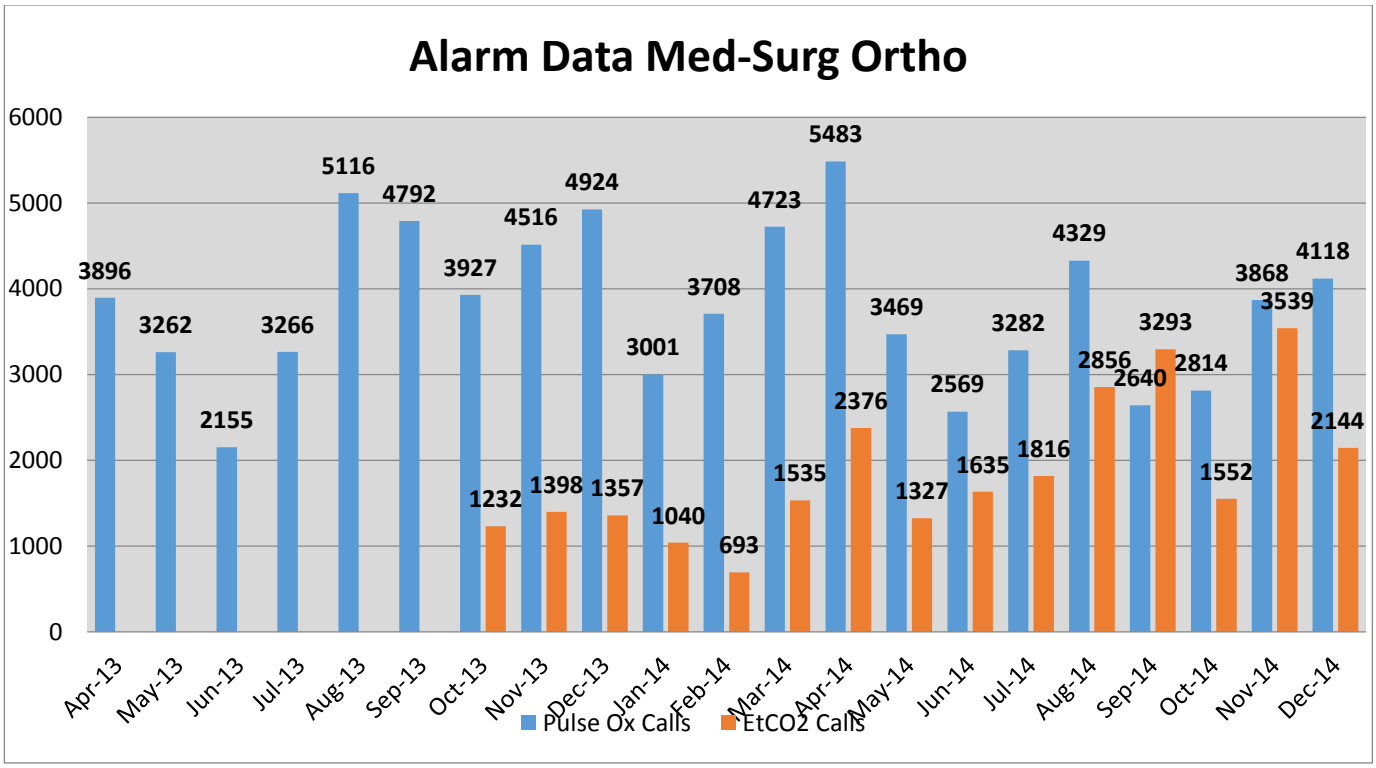


Figure 5. Clinical alarm management baseline data from capnography implementation October 2013 through December 2014 and January 2015 through March 2016.



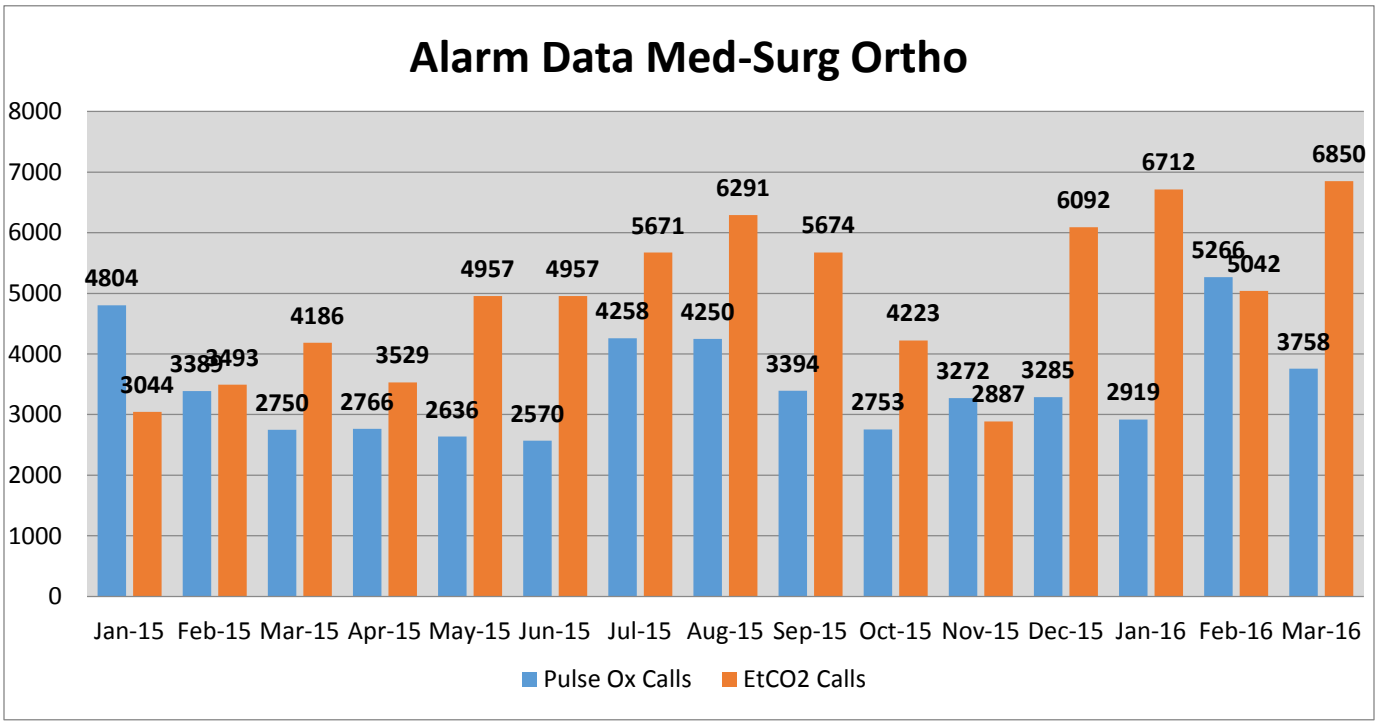


Figure 6. Barton Health's respiratory compromise rate as analyzed by Medtronic.

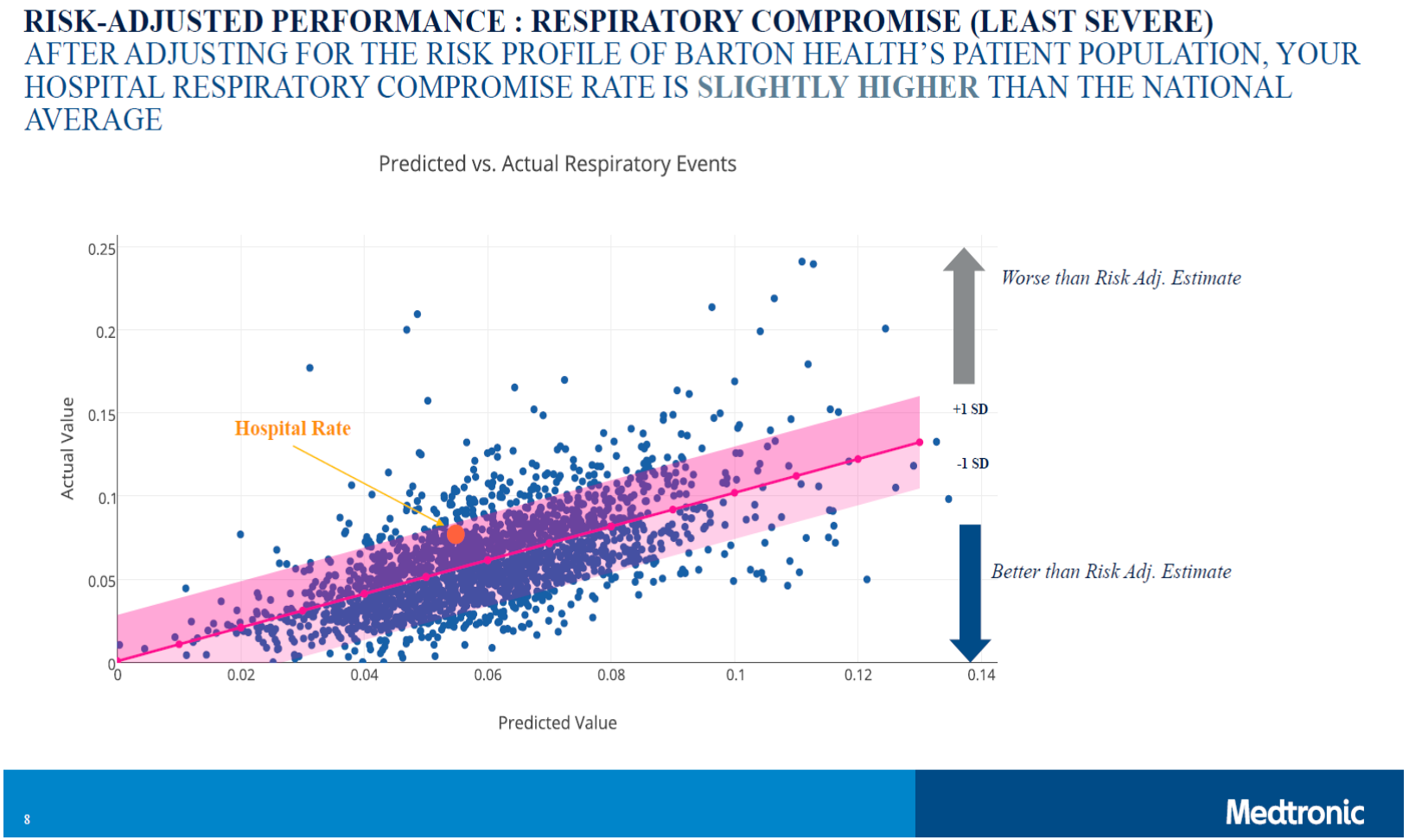


Figure 7. Barton's post-operative respiratory failure rate as analyzed by Medtronic.

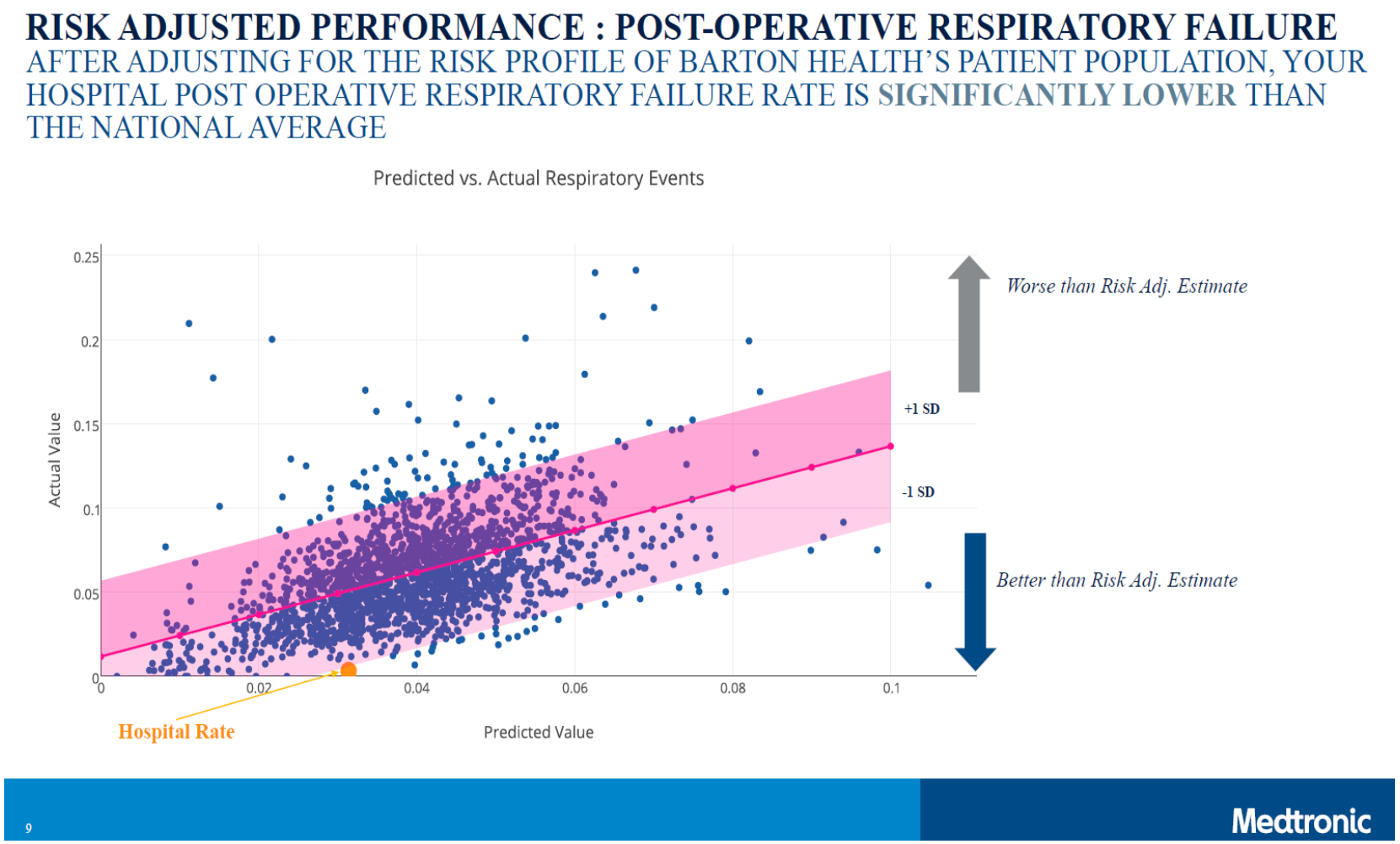
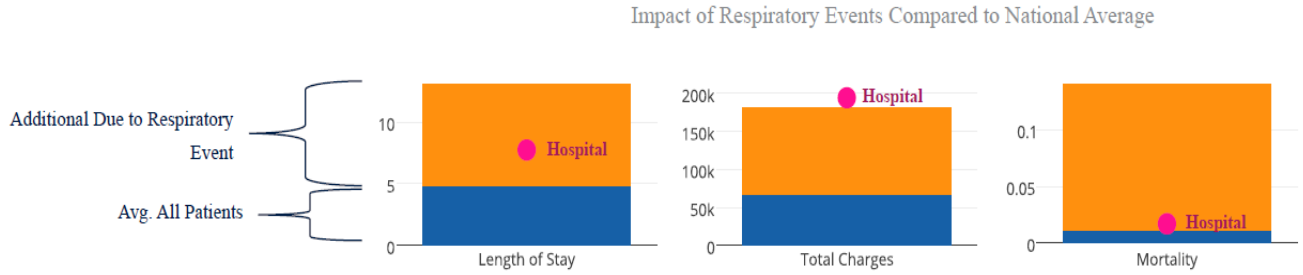


Figure 8. Mortality and length of stay data as analyzed by Medtronic.

IMPACT OF RESPIRATORY EVENTS ON YOUR HOSPITAL

WHEN ANY RESPIRATORY EVENT OCCURS, THE PATIENT ON AVERAGE REQUIRES 3.65 ADDITIONAL DAYS, $70,000 ADDITIONAL CHARGES AND 1.26% INCREASE IN MORTALITY. MORTALITY AND LENGTH OF STAY FOR THESE EVENTS ARE SIGNIFICANTLY LOWER THAN THE NATIONAL AVERAGE.



	Length of Stay	Total Charges	Mortality
Avg. all post-op patients	4.09	$124,814	0.44%
Avg. for any Respiratory Event	**7.74**	**$194,395**	**1.70%**
National Benchmark for Respiratory Event	*13.05*	*$181,297*	*13.97%*
Avg. Burden of Respiratory Events across all post-op patients	0.28	$5,423	0.10%

Figure 9. In house Code Blue (cardiac arrest) and Rapid Response Team calls 2012 through June 2016.

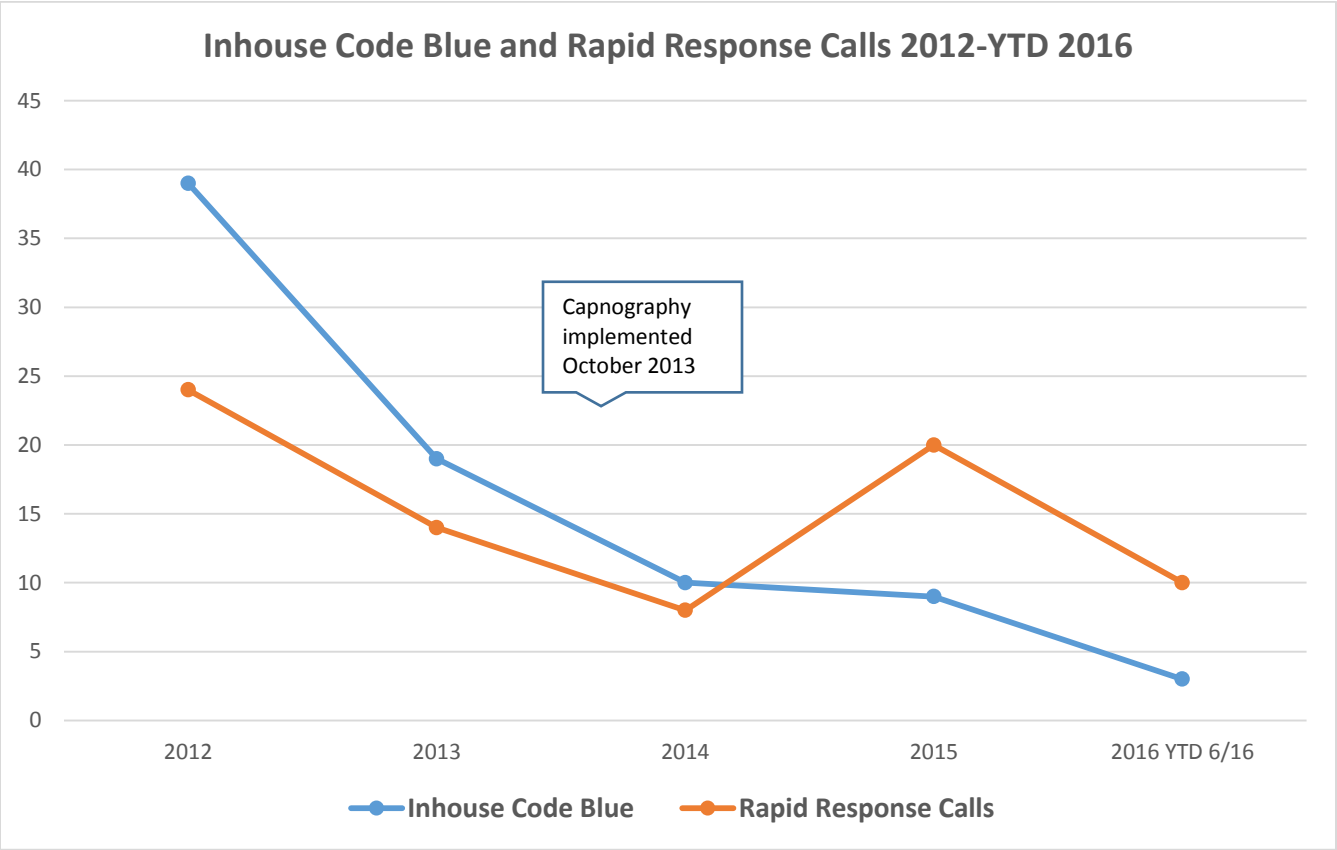
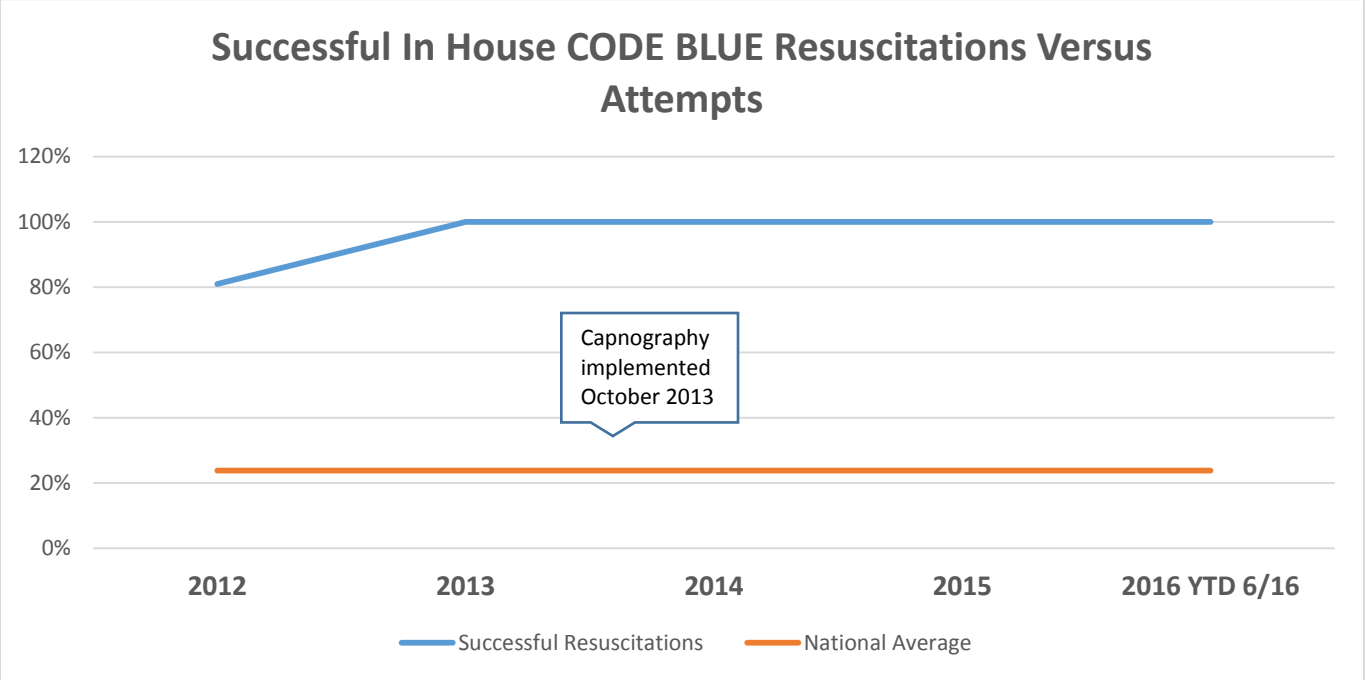


Figure 10. Successful resuscitations versus attempted resuscitations 2012 through June 2016



	2012	2013	2014	2015	2016 YTD 6/16
Total Number of CODE BLUE Calls	11	6	8	6	1

Figure 11. ICU annual mortalities from 2012 through June 2016.

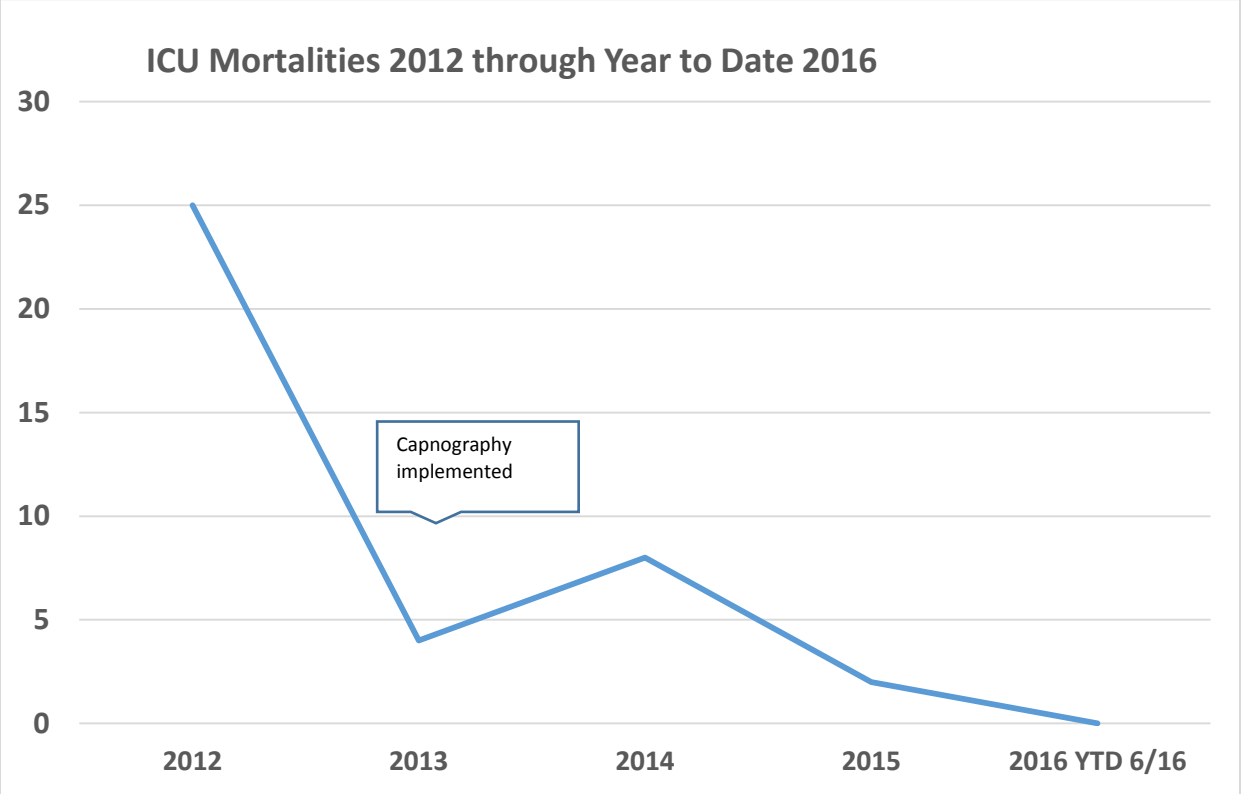


Figure 12. Actual versus expected mortality rate 2012 through June 2016.