Critical care departments are generally the most expensive and resource-intensive areas of medical care. In the United States alone, annual critical care medicine costs nearly doubled from 2000 to 2010—from $56.6 billion to approximately $108 billion. This represents 4.14% of national healthcare expenditure, 0.74% of the total GDP, and 13.2% of total hospitals’ costs.¹

A major contributor to these costs is how critical care departments operate. Despite efforts to deliver first-rate care by highly qualified and well-trained personnel, many critical care departments are slow to evolve from traditional care models. Most departments lack evidence-based protocols, do not adhere to best practices, and operate without centralized oversight. Thus, quality suffers and high operating costs and financial penalties are the norm. Additionally, healthcare providers and departments often deliver care in isolation. While the highly-qualified healthcare providers can offer knowledge and expertise, the lack of cross-specialty collaboration limits care possibilities, leads to redundancies or gaps in treatment, and can result in avoidable medical errors. Each year, between 44,000 and 98,000 deaths result from preventable medical errors in the United States.²

With this in mind, a greater New York City hospital tasked the Director of Cardiac Surgery to review the existing processes in critical care and implement any changes needed. He created a Critical Care Committee comprising key hospital stakeholders whose mission was to assure the best possible care for patients admitted to all critical care units and beyond. The Director of Cardiac Surgery, who is also the Director of Critical Care for Quality, took the following 3 steps, which radically improved patient outcomes, drove collaboration at the bedside, created workflow efficiencies, and reduced cost.

“While formation of the Critical Care Committee represented the first step, implementing the strategies they suggested, including with-patient testing, are where the real savings occur.”

DIRECTOR OF CRITICAL CARE FOR QUALITY
STEP 1: LEAD A CULTURE CHANGE
Transforming healthcare models starts with transforming culture. To this end, critical care departments need to (i) create a culture of accountability where people are encouraged to take ownership over their actions and empowered to make positive changes; (ii) create a culture of trust to foster teamwork, openness, and transparency; and (iii) create a culture of recognition where people feel valued and acknowledged to drive higher performance. By being a model of this culture, a stakeholder can create a workplace that sets employees up for success.

STEP 2: INTEGRATE DEPARTMENTS
To improve patient care and institutional accountability, the critical care department needs to work together to make and implement decisions. This starts with creating a new role—Director of Critical Care for Quality—who will be the Chair of the Critical Care Committee.

The Critical Care Committee should comprise directors of key departments, within and beyond critical care, such as medical intensive care, surgery, neurosurgery, cardiac surgery, emergency, anesthesiology, obstetrics, step-down units, laboratory, radiology, ancillary services, nursing, and clinical documentation. Involving nurses is particularly important, as they know the processes well and know what works and what does not.

ROLE OF THE CRITICAL CARE COMMITTEE
The Critical Care Committee should meet once a month to perform these key functions (Figure 1):
- Identify issues that hinder optimal patient care and set goals for improvement
- Determine solutions to address those issues
- Evaluate solutions in small trials
- Measure the impact of changes using predetermined metrics
- Decide whether to implement a solution broadly, revise it, or abandon it
- Oversee daily operations to ensure continued quality and efficiency

STEPS TO INTEGRATE DEPARTMENTS

1. IDENTIFY STAKEHOLDERS
   by determining which key critical care departments (and beyond) need to be involved

2. ENGAGE AND CONVINCE DEPARTMENT HEADS
   that improvements are needed

3. LAY OUT A PLAN
   connecting the vision and expectations for practical changes

4. CREATE A CRITICAL CARE COMMITTEE AND DIRECTOR OF CRITICAL CARE FOR QUALITY
   to determine the practical changes to be made, the methods to implement them, and the metrics to measure the outcomes
Proven solutions recommended by the Critical Care Committee are given in Table 1 and 2.

“The Critical Care Committee brought people together in ways I didn’t expect. It built momentum and confidence in reaching our goals.”

DIRECTOR OF CRITICAL CARE FOR QUALITY

### Table 1. Solutions Implemented

<table>
<thead>
<tr>
<th>Type of Solution</th>
<th>Solution</th>
<th>What Does It Consist Of?</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol changes</td>
<td>Implement an ED scoring system</td>
<td>Assigns a score to each patient, based on their status. Score is shown on screens throughout the ED: • Critically ill • Stable enough for step-down • Stable enough for floor • Terminal issue</td>
<td>• Enhances patient tracking and movement between units • Relieves the need for physicians to convene to discuss every patient • Reduces length of stay</td>
</tr>
<tr>
<td>Patient-flow control</td>
<td>Hire an ‘intensivist’</td>
<td>An intensivist is a board-certified physician who provides special care for critically ill patients. Also known as a critical care physician, the intensivist has advanced training and experience in treating this complex type of patient.</td>
<td>Reduces risk of patients dying in the ICU by 40% • Shortens length of stay in critical care units • Reduces the number of critical care admissions3</td>
</tr>
<tr>
<td>New technology</td>
<td>Set up a physician order-entry computer system</td>
<td>A computer system that enables hospital staff to enter medication orders and uses a software designed to prevent prescribing errors</td>
<td>• Increases efficiencies because it links to pharmacies • Integrates with the patient data • Reduces serious prescribing errors in hospitals by &gt;50%</td>
</tr>
<tr>
<td>New technology</td>
<td>Implement with-patient testing (see section below)</td>
<td>Uses portable devices that allow laboratory testing at the patient’s bedside</td>
<td>• Reduces turnaround time to results • Decreases length of stay • Reduces cost of testing • Reduces testing errors</td>
</tr>
</tbody>
</table>
TABLE 2. IMPROVEMENT MEASURING METRICS

<table>
<thead>
<tr>
<th>CLINICAL DATA AND CLINICAL RESOURCES USAGE</th>
<th>OPERATIONAL DATA</th>
<th>HEALTH ECONOMICS DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to initiation of treatment</td>
<td>Turnaround time to completing procedures</td>
<td>Length of stay</td>
</tr>
<tr>
<td>Incidence of complications (eg, wound infections, ventilator-associated pneumonia)</td>
<td>Complexity of procedures and workflows</td>
<td>Cost of complications</td>
</tr>
<tr>
<td>Blood product utilization</td>
<td>Number of personnel needed for procedures</td>
<td>Readmissions and related penalties</td>
</tr>
<tr>
<td>Ventilator time</td>
<td>Patient flow between departments</td>
<td>Cost associated with resource utilization</td>
</tr>
<tr>
<td>Mortality rates</td>
<td>Employee turnover</td>
<td>N/A</td>
</tr>
</tbody>
</table>

“Don’t focus on saving money. Focus on maximizing the well-being of every patient. With higher quality care, the savings will follow.”

DIRECTOR OF CRITICAL CARE FOR QUALITY

FIGURE 1. CRITICAL CARE COMMITTEE PROCESS FOR IMPLEMENTING SOLUTIONS TO IMPROVE QUALITY OF CARE, INCREASE EFFICIENCIES, AND REDUCE COSTS

IDENTIFY ISSUES IN QUALITY OF CARE, COST, AND EFFICIENCIES

OVERSEE BROAD IMPLEMENTATION AND COLLECT LONG-TERM DATA

ADOPT SOLUTION ABANDON SOLUTION AMEND SOLUTION

DETERMINE (NEW) SOLUTION

IMPLEMENT SOLUTION IN A SMALL TRIAL

MEASURE IMPACT USING HEALTH AND FINANCIAL METRICS
**STEP 3: INVOLVE ADMINISTRATION**

Hospital administration should be involved in the process to align initiatives with institutional goals, request extra funding, bring awareness of the initiatives to the greater institution, and maximize the chance of success. The following members of the administration should be involved:

- **Chief Executive Officer**, to optimize institutional leadership and growth
- **Chief Medical Officer**, to optimize care quality and patient outcomes
- **Chief Financial Officer**, to minimize the cost of care while maximizing revenue
- **Chief Information Officer**, to optimize the transmission of information

The Director of Critical Care for Quality should meet with the administration quarterly to build a close relationship and pave a path for implementing the committee’s recommendations. One such change brought into the critical care pathway is with-patient testing to accelerate the availability of laboratory results.

**RATIONALE FOR WITH-PATIENT TESTING**

Critical care units care for critically ill patients, which makes operational efficiency imperative. The traditional blood analysis process can be slow, complex, and inefficient, delaying clinical decision making when time is crucial. Delays in treatment greatly affect quality of care, leading to greater morbidity and mortality, and escalate the cost of care due to longer stay.

With-patient testing, also termed point-of-care or bedside testing, is a technology that provides rapid (usually in less than 1 hour), simple, and portable diagnostic testing at the patient's bedside. Results can be delivered in real-time when and where they are needed—within the patient-care pathway. With this technology, the entire care team has the ability to test, interpret the results, and accelerate decision-making regarding the course of care in a collaborative manner.4

**OUTCOMES**

Comparison of outcomes of critical care matrices pre- and post-implementation showed that the use of the i-STAT System resulted in a 44% (~1.5 days) reduction in length of stay, a 36% decrease in blood product utilization (Table 3), a decrease in mean mechanical ventilation time from 6 to 7 hours to 2.7 hours, a 0.1% decrease in mortality, and a decrease in complications and morbidity (including hospital-acquired infections, ventilator-associated pneumonia, sepsis, stroke, and myocardial infarction). Altogether, these improvements led to a 47% decrease in overall patient care costs (Table 3).

**ADOPTION OF WITH-PATIENT TESTING RESULTED IN**

- **3.3 HOUR REDUCTION** in mean mechanical ventilation time
- **36% DECREASE** in blood product utilization
- **0.1% DECREASE** in mortality
The turnaround time for laboratory results (from tests ordered to results received) decreased from 4 hours pre-implementation (traditional laboratory testing) to less than 1.5 hours after implementation of the i-STAT System, enabling clinicians to view data quickly. The i-STAT System also relieved healthcare professionals the burden of manually documenting results because the system captures data digitally and integrates with the electronic medical record system. This increased efficiency and quality of care, while reducing the risk of errors. Above all, it improved patient care and patient outcomes by reducing time to results and enabling faster treatment decisions, all of which contributed to decreased length of stay in the ICU and reduced per-patient costs.

“Shortly after implementing i-STAT, we were able to prove, without exception, that volume and acuity level went up, while costs went down.”

DIRECTOR OF CRITICAL CARE FOR QUALITY

The turnaround time for laboratory results (from tests ordered to results received) decreased from 4 hours pre-implementation (traditional laboratory testing) to less than 1.5 hours after implementation of the i-STAT System, enabling clinicians to view data quickly. The i-STAT System also relieved healthcare professionals the burden of manually documenting results because the system captures data digitally and integrates with the electronic medical record system. This increased efficiency and quality of care, while reducing the risk of errors. Above all, it improved patient care and patient outcomes by reducing time to results and enabling faster treatment decisions, all of which contributed to decreased length of stay in the ICU and reduced per-patient costs.

### TABLE 3. HEALTH ECONOMIC RESULTS PRE- AND POST-IMPLEMENTATION OF THE i-STAT SYSTEM

<table>
<thead>
<tr>
<th></th>
<th>NO. OF CASES</th>
<th>CMI (MEDICARE)</th>
<th>PRBC USE (UNITS)</th>
<th>CTICU Rx COST*</th>
<th>CTICU Rx COST PER PATIENT</th>
<th>LENGTH OF STAY (DAYS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009 (pre i-STAT)</td>
<td>177</td>
<td>5.84</td>
<td>618</td>
<td>$784,887</td>
<td>$4,242</td>
<td>2.97</td>
</tr>
<tr>
<td>2010 (post i-STAT)</td>
<td>183</td>
<td>6.04</td>
<td>397</td>
<td>$413,363</td>
<td>$2,309</td>
<td>1.65</td>
</tr>
</tbody>
</table>

CMI=Medicare Case Mix Index; CTICU=cardiothoracic intensive care unit; PRBC=packed red blood cells. *≥95% of patients stay in CTICU until hospital discharge.

PATIENT CASE: ABG

**ISSUE**
- 56-year-old female underwent a routine laparoscopic hernia repair and was sent to the post-operative recovery room on ventilatory support for weaning and extubating

**USE OF WITH-PATIENT TESTING**
- A routine ABG was done just prior to extubation using an i-STAT CG8+ cartridge
- The ABG was normal; however, the i-STAT CG8+ cartridge showed an Hg of 6, indicating ongoing bleeding related to the surgery

**IMPACT ON CARE**
- The critical care team was contacted and collaborated to act on this information
- Patient remained intubated on ventilatory support and returned back to the OR for exploratory surgery, which quickly identified the bleeding blood vessel

**BENEFITS**
- Care team was able to proceed in an integrated fashion directly at the bedside
- Time to clinical decision making was decreased, which accelerated the resolution of a critical issue
- Resources (staff, time, spending) were efficiently managed

ABG=arterial blood gas.
“Don’t be afraid to aim high. **Design your protocols for zero events. Only then can you achieve it.**”

DIRECTOR OF CRITICAL CARE FOR QUALITY

**TABLE 4. INCIDENCE OF HOSPITAL-ASSOCIATED ADVERSE EVENTS BEFORE, DURING, AND AFTER TRANSFORMATION**

<table>
<thead>
<tr>
<th>CATHETER-ASSOCIATED UTIs</th>
<th>CENTRAL LINE BLOODSTREAM INFECTIONS</th>
<th>HOSPITAL-ACQUIRED PRESSURE ULCERS</th>
<th>NO. PATIENTS WITH ULCERS</th>
<th>NO. ULCERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>25</td>
<td>6</td>
<td>79</td>
<td>117</td>
</tr>
<tr>
<td>2015</td>
<td>0</td>
<td>10</td>
<td>23</td>
<td>50</td>
</tr>
<tr>
<td>2016</td>
<td>0</td>
<td>1</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

**CONCLUSION**

Our experience shows that improving quality of care and workflow and decreasing costs can be achieved in the most expensive and resource-intensive areas of medical care: critical care departments. The impact of these results goes far beyond the walls of critical care, as the improvement in quality of care and efficiency as well as the costs savings are felt throughout the entire institution and, most importantly, by the patients themselves.
