Technology Introduction in Critical Care*

Just Knowing the Price Is Not Enough!

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Abbreviation: POCT = point-of-care testing

Acquisition and implementation of new medical technology in the critical care setting remains a paramount objective of all intensivists intent on delivering state-of-the-art, high-quality, and cost-effective patient care.1,2 Across many hospital networks and individual institutions, a corporate model has come to the hospital with regards to acquiring technology.3 In this paradigm, “just knowing the price is not enough.” Administrators are involved; business and not clinical priorities guide decision making; and competition for diminishing health care resources is brutal.4 In this corporate-hospital environment, intensivists are experiencing trials and tribulations in attaining their technology goals despite the availability of guidelines for technology assessment.5 This situation occurs because intensivists may not have the tools, skills, insights, management training, experience, or political savvy to approach the corporate process of technology acquisition.

The impetus to write this article is based on a desire to share our experiences and perspectives on issues of technology analyses, procurement, and implementation gathered from many years of service at a Department of Veterans Affairs Medical Center. We have participated as clinicians and administrators in the ICUs, stat laboratories, and emergency department, and served as members and chair of the hospital’s Critical Care Center and Technology Evaluation and Equipment Committees. Outside our institution, we were also involved with technology standardization and procurement in the New York–New Jersey Veterans Hospitals Integrated Service Network. An understanding and appreciation for the technology and marketing perspectives of industry were gained through formal and informal consultations with manufacturers. Additionally, we supplement our personal and professional experiences with a focused review of the pertinent literature.

Herein, we focus on guiding the intensivist through the treacherous terrain of introducing new technology or upgrading existing technology in the ICU. We use the word technology as a generic representation of diagnostic or therapeutic devices, medications, information systems, procedures, clinical protocols, and research proposals.6 Additionally, the word hospital represents a department, an individual hospital, or a health care network or system, as applicable.

Before discussing the process of technology introduction into the ICU, several fundamental issues relating to the hospital world, the hospital-ICU relationship, and the ICU environment need to be reviewed.

Hospital World

Hospital attitudes toward acquiring technology can sometimes be quite ambivalent. Hospitals have stated missions and goals, which set the operational tone for hospital activities. The hospital may wish to be perceived as maintaining a competitive position in the local, regional, or national health care marketplace and delivering high-quality care using the most advanced technology.7 These goals, however, may directly compete with other hospital objectives of using well-proven cost-efficient and reliable technology that is standardized across the hospital, while maintaining low operating costs and surviving decreasing reimbursements. An equitable allocation of scarce hospital resources may not be feasible or successful in the setting of numerous legitimate technology needs or political motivations. Even traditional hospital attitudes toward technology are changing. In the past, academic hospitals strove to be cutting edge despite the cost, whereas community...
hospitals sought to economically survive. Today, in vigorous efforts to secure a firm patient base, the opposite may be true.

Hospital-ICU Relationship

Years ago, the ICU represented the pinnacle of the hospital’s approach to high-technology sophisticated inpatient care. Recently, however, there has been a significant shift in hospital priorities from inpatient to outpatient care. Critical care represents > 20% of hospital inpatient budgets and is facing increased scrutiny in the current milieu of capitated funding and managed care. By comparison with other inpatient and outpatient areas, from the hospital’s perspective, the ICU has a minimal patient load, bloated labor force, technology overload, and maximal patient cost without equivalent revenue generation. The political strength of the ICU may be further diminished in the hospital-wide struggles for resource distribution. This occurs because ICUs usually function as a section, service, or division of a larger department and, therefore, are dependent on hospital-level representation by departmental chairpersons rather than directly by the ICU leadership. Additionally, hospital administrators may perceive that there is an excess of ICUs and a failure of the ICUs to take steps to actively contain costs and standardize technology among themselves. This lack of standardization itself engenders increased costs for the hospital for two reasons. First, the hospital must expend resources to support similar technologies from multiple manufacturers and second, the hospital does not attain the bargaining leverage achieved with bulk purchases from one vendor.

The issues discussed above color the hospital administrators’ viewpoint toward increasing support for the ICU. From their standpoint, further technology investment in the ICU may lead to inefficient utilization of scarce resources by comparison with investment in other non-ICU hospital areas.

ICU Environment

The critical care environment is never stationary as innovative technological advances are always being introduced. Although the intensivist must scrutinize new technology for its appropriateness in a particular setting, at times new technology must be introduced or existing but still functional technology must be upgraded to advance ICU practice, bring about efficiencies, or replace obsolete or expensive to maintain technology. The presence of up-to-date technology helps in recruiting and retaining high-quality ICU staff. If the ICU is participating in academic training programs, the intensivist, in the role of faculty or program director, must provide a modern educational experience that meets the requirements of the Accreditation Council for Graduate Medical Education. New technology may also have a salutary effect in the ICU by keeping the staff upbeat and excited in an environment that sometimes can be depressing.

The Hospital Structure for Technology Acquisition

A familiarity with the hierarchy and topography of the hospital’s administrative and committee structure and decision-making processes are necessary for success in navigating the hospital pathways for technology acquisition. The recognized hospital forum for technology evaluation, prioritization, and fund control is usually called the technology committee. Depending on the organization, several technology committees (ICU, departmental, hospital, and network) may concomitantly exist. The particulars of committee authority and membership may vary among hospitals and health care systems. Commonly, prioritization for new technology begins locally (ICU or department), where clinical representation is greatest, and then proceeds up the organizational ladder (hospital and network), where clinical input diminishes and corporate and fiscal considerations dominate.

Unfortunately, the distinctive organizational framework for technology evaluation mentioned above may be poorly defined in many hospitals or may not exist at all. While most, if not all, hospitals have a pharmacy and therapeutics committee, the existence of a defined, organized, and productive technology committee may not be as well established. Regardless of the formality of the hospital technology structure, the intensivist should strive to understand the nuances of hospital protocols that regulate new technology evaluation, prioritization, funding, and procurement.

Technology Assessment: Getting Started

Technology planning should start with a clinical and fiscal evaluation of the current state of technology and practice. Concomitantly, a comprehensive “needs analysis” that assesses the new technology or the upgrading of existing technology and its clinical and fiscal impact both within the ICU and the hospital must be undertaken. The difficult questions pertaining to the details of the technology’s science...
and performance, track record, evidence-based outcome data, and potential hospital infrastructure modifications that may be necessary to accommodate the new technology must be addressed (Table 1).\textsuperscript{5,14,15}

In the current health care environment, arguments stressing common sense reasoning or logical approaches as the rationales for the introduction of new technology do not alone justify the acquisition of new technology; evidence of cost-effectiveness and improved outcomes are required. Randomized, controlled clinical trials demonstrating such benefits, however, may not be available.\textsuperscript{16} This does not necessarily diminish the value of the technology.\textsuperscript{17,18} The technology may be fine; the outcome studies, however, may be poor, not applicable to your particular area, or not performed. In this latter scenario, hospital- and ICU-specific studies may be proposed for your own individualized evaluation and outcome process.

**TEAMWORK: COLLABORATIONS, PARTNERSHIPS, AND CONTROVERSY**

Intensivists are familiar with the principles of the multidisciplinary team approach to patient care and unit management. These same principles should be applied to developing two cohesive groups with members selected to achieve consensus among acute-care providers and success in technology acquisition. The first should be a permanent group composed of representative clinicians from all ICUs and all non-ICU areas that deliver care to acutely ill patients using ICU level or comparable technology. The second team should be assembled ad hoc and be responsible for individual critical care technology assessment and implementation projects. The capabilities of this group must be diverse and include expertise in vendor and technology assessment, vendor and hospital negotiation, cost determination, and eventual technology implementation.\textsuperscript{6}

The active presence of these multidisciplinary critical care teams would ensure that the ICU does not introduce technology that puts it at odds with other members of the critical care or acute care structure. For example, the purchase or upgrade of mechanical ventilators, infusion pumps, or physiologic monitors in one critical care area should be undertaken in collaboration with other users of these devices. A change in monitors in one ICU, for instance, implemented unilaterally by the local ICU leadership without the express knowledge of other critical care units, may adversely impact the standardization of staff training, supplies, biomedical support, and data transfer into the electronic medical record.

The introduction of technologies that appear to cross over from the ICU to other specialties can invite animosity between the critical care team and the other non-ICU services. For example, the introduction of transesophageal echocardiography, continuous renal replacement therapies, and point-of-care testing\textsuperscript{19} by intensivists may infringe on the territorial, clinical, financial, political, regulatory, and staffing domains of other departments that view these technologies as principally their own.

These problems may be averted through excellent teamwork and collaboration by the multidisciplinary teams previously described. More importantly, all involved parties may find that creative sharing arrangements can be fostered, and technology propos-

### Table 1—Questions To Address in the Assessment of New Technology

<table>
<thead>
<tr>
<th>Science and Performance</th>
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<tbody>
<tr>
<td>What is the basic science of the technology and its technical characteristics?</td>
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<tr>
<td>What are its capabilities, potential uses, and user requirements for safe and effective use?</td>
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<td>Does the technology really perform the basic function you are asking it to do?</td>
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<td>How does it compare with the way things were being done before?</td>
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<td>Are there alternative technologies or means to achieve similar goals?</td>
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<td>Track Record</td>
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<td>Is the technology a modification or improvement of existing and mature technology or is the technology entirely new?</td>
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<td>What is the technology’s track record?</td>
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<tr>
<td>Does anyone else use it? Why is its use not more widespread? Should you be the first in line to purchase it?</td>
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<tr>
<td>Have any legal or ethical factors been identified that may restrict use of the technology?\textsuperscript{2,15}</td>
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<tr>
<td>Outcome Data</td>
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<td>Is there any proof that the technology works as advertised and achieves any positive outcomes?</td>
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<td>Are studies available that support improved patient outcome at a lower cost with the technology?</td>
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<tr>
<td>Hospital Concerns</td>
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<td>Can the facility absorb the technology?</td>
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<tr>
<td>What adjustment in hospital infrastructure and staff personnel retraining or recruitment would be involved to implement the technology?</td>
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\textsuperscript{5} Opinions/Hypotheses

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als strengthened. Benefits may be accrued not only for critical care but for the hospital complex in general.

**CHOOSING AND Communicating With the Right Vendor**

The vendor’s ultimate goal is to sell a commercially available product to recoup investment and generate a profit. Vendors seek to improve health care but that is a secondary motivation. The intensivist, although proficient in critical care, must develop expertise in understanding the vendor mindset and vendor and product selection. Studying the vendor’s track record with the new technology, business history, reputation, support services, and ICU implementation and training programs can facilitate appropriate choices. Information about new technology and supporting documentation may be sought from a variety of sources. These include not only discussions with other users, but review of published reports in the critical care literature and vendor-supplied information. Among the most important sources of information on biomedical devices are the objective evaluations performed by nationally recognized organizations, such as the Emergency Care Research Institute and the US Food and Drug Administration. Reports from other ICUs, professional specialty societies, and colleges, as well as information from practice guidelines and consensus conferences, are also useful adjuncts.

A language barrier frequently complicates intensivist and vendor communication causing the intensivist and vendor to speak past each other. Intensivists use a medically oriented language. Vendors, trained primarily in marketing, use a sales-oriented language. On the part of the intensivist, a familiarity with vendor language and phrases will move the conversation forward. Notable among these are the terms acquisition, upgrading, trade-in, replacement, disposable, special pricing, discounts, and volume savings.

At times the intensivist may request vendor modifications in the technology to satisfy specific ICU needs. There are, however, significant vendor limitations in modifying products to meet particular customer requests that the intensivist should appreciate. By the time a product reaches the marketplace, it has been through a lengthy, complicated, and timeline-oriented development process. The marketed product is the result of many compromises between the vendor’s research and development and marketing divisions. Many regulations at both the national and international levels have been and must continue to be satisfied. The manufacturer assumes that most legitimate customer requirements have been met through the extensive and tedious processes of internal studies, customer consultations, market surveys, and advisory group meetings. Lastly, the product marketed may reflect the vendors’ perspective of the ICU marketplace and their own position within it. These views may be discordant with the intensivist’s outlook and preclude product modification by the vendor.

**Cost Assessment**

An integral component of both vendor and product selection process and internal hospital marketing is the cost determination. The intensivist is acquainted with obtaining competitive quotes, the starting point in the cost evaluation process. Quotes should include the capital and product cost, installation cost (if applicable), training, maintenance, and ongoing supply and contract costs. The quote, however, is only the first step in the cost determination. Cost estimates of the transition process of implementing new technology should include staff training and infrastructure absorption. Oftentimes, technology results in conceptual and intangible improvements. It is difficult, however, to assign monetary values to such benefits as better patient care, increased staff satisfaction, efficiencies of time and support, and perceived savings “down the road.” The final version of the technology proposal therefore should reflect the totality of the fiscal data including the costs of technology, technological transitions, and estimates of intangible improvements.

Regardless of the sophistication and packaging of the cost assessment, the price may still remain as a major obstacle to the purchase of technology. Common strategies for diminishing the fiscal impact of expensive technology include spreading the cost by staging the purchase, or leasing, rather than buying the entire technology at once. Transferring or hiding the cost of capital technology in the ongoing purchase of disposable supplies, the so-called cost-per-test approach, has recently gained popularity, especially in regard to the purchase of technology that rapidly becomes obsolete.

**Presentation Techniques: Education and Sales**

Technology committees and hospital administrators are frequently inundated with technology requests that are difficult to comprehend or poorly prepared. Improving your chances of obtaining approval to acquire technology can be greatly facili-
Gateways to Success

New technology introduction is facilitated if the intensivist and ICU are well integrated within the hospital’s political infrastructure. Direct communication and collaborative relationships with your department chairperson and the hospital administration are crucial in this process. Hospital leadership should be welcomed into the critical care environment to promote awareness of ICU activities and inculcate ownership responsibility. Establishment of a special care unit committee composed of a diverse group of clinical and nonclinical representatives is an excellent step to developing clear ICU goals, planning, and hospital networking. Likewise, participation of the intensivist in select non-ICU committees facilitates ICU acceptance into the hospital community and enhances the intensivists’ knowledge of hospital activities. Becoming a member of the club is a key to success in the corporate culture. We therefore recommend that the intensivist gain membership in the technology committee if it exists, or help to develop such a group if it is not present in your hospital. Participation in this venue assures that the intensivist acquires a working knowledge and experience in the methodology of technology introduction and possibly becomes an essential factor in it.

Implications of Technology Introduction

A collaborative, careful, and thoroughly planned assessment and introduction of new technology results in the delivery of modern and safe health care by the hospital and ICU. When the process is successful, the ICU team also gains long-term political credibility in future technology requisitions. Alternatively, an inadequate technology plan can lead to the imposition of inefficient, expensive, and potentially unsafe health care and the use of technology inappropriate for the ICU setting. In this latter scenario, the ICU team loses political credibility.

Management Skills for Intensivists

Future generations of intensivists should be educated in managerial skills, including training in techniques of technology diffusion. In theory, residency education in critical care medicine already requires formal instruction in administrative and management principles and techniques. Critical care practitioners should be offered programs developed by professional societies in collaboration with industry that address business and negotiation practices. To gain a practical understanding of the generic process presented in this article, we have prepared an example of the technology introduction, evaluation, and implementation process at our institution (Fig 1). A point-of-care laboratory testing task force was appointed by the Critical Care...
Center to assess the status of point-of-care testing (POCT) technology within the stat laboratories associated with the ICUs and operating room. This evaluation studied the continued need for POCT and the POCT technology performance, costs, utilization, contracts, and regulatory compliance. The group was further charged with recommending the technological future of the POCT program; continuation of the status quo, and upgrading of existing technology or introduction of new or different technology. The membership was broad and included representatives from critical care (ICU and anesthesiology, and surgical stat and respiratory laboratories), biomedical engineering, and the hospital’s central laboratory. Exploratory discussions were conducted locally at critical care sites and within the appropriate committees (Critical Care Medicine [CCM], Diagnostic and Ancillary Laboratory, and the Technology Evaluation and Equipment Committees).

The POCT task force met with POCT vendors and studied various product, their technological characteristics, as well as the training required for the daily operation and maintenance of each device. The group assessed the availability, quality, and perceived trustworthy and reliability of the vendors and local sales force, the reputation of the technical support programs and contracts, the pricing options for device acquisition, and cost of ongoing supplies. Formal evaluations of the most potentially interesting products were scheduled. Objective and at times subjective product evaluation and comparison literature were reviewed; colleagues were queried and cost assessments were performed.

Figure 1. POCT: an example of the technology introduction and upgrading process. For details, see text.
The representatives from the various acute-care areas had previously and continuously worked together to achieve a unified consensus on a variety of topics and successfully reached an agreement on the future of POCT technology in their areas. Concomitantly, a hospital-wide understanding on the future of POCT was developed through backroom discussions with the hospital administration and central laboratory management. The issues of territoriality and control were addressed. All options were placed on the table, including the possible discontinuation of POCT services. The parties agreed to continue POCT with specific recommendations, including a higher level of oversight from the Central Laboratory's ancillary testing coordinator and an agreement by the POCT task force to study and implement the standardization of POCT equipment, wherever possible. During these discussions, the POCT task force was also able to address a vital concern of the Critical Care Center, which was the lack of effective ICU specimen transport. This subsequently resulted in the installation of pneumatic tubes from the ICUs to the Central Laboratory to transport nonurgent samples.

With the tacit agreements of the hospital and Central Laboratory, the Critical Care Center placed the selected POCT devices into its annual equipment budget request for prioritization and funding from the hospital’s Technology Evaluation and Equipment Committee. Ongoing supply costs were presented to the Commodity Committee. However, the POCT task force was always searching for imaginative mechanisms to facilitate acquisition of the POCT devices and diminish any capital financial outlay by the hospital. This is especially important in the procurement of technology that is both constantly in transition and does not maintain long-term clinical or financial value. Finally, a no-charge trade-in of existing POCT equipment for the new devices was arranged, and the funding requests were then withdrawn from the hospital-level committee.

The implementation of technology, such as POCT devices, may have diffuse and long-lasting practical and political ramifications that can extend beyond the local sites of POCT implementation. With these thoughts in mind, the POCT task force identified two potentially problematic issues, namely, device connectivity and regulatory compliance. These were addressed by involving members of the hospital’s Information Resource Management Program and the vendor’s networking support group to meet and design connectivity solutions. Similarly, regulatory compliance was studied by the ancillary laboratory coordinator, the hospital quality assurance group, the hospital network’s own regulatory oversight group, and the national organization that certifies the medical center’s laboratories.

Vendor pressure and local politics sometimes drive the product selection process. Today, however, technology procurement may also be “guided” by corporate decisions of the healthcare network. Inasmuch as our hospital is a network participant, the POCT group also dealt with the concerns of the network acquisition team. Despite pressure from each of the above parties, the POCT task force focused primarily on the specialized clinical POCT needs of each acute care area. Technology was standardized through the acquisition of identical POCT devices from one vendor for placement in the ICU stat laboratories. The stat laboratory in the operating room was closed, and POCT devices that were more suitable for that area were selected from a second vendor.

Several lessons may be gleaned from this example of technology introduction. The first is the importance of building consensus to achieve success. The second is to recognize the political and financial pressures that influence both the selection and purchase of technology. The third is to understand that device connectivity is more easily drawn in a schematic rather than implemented. We found that despite intensive discussions on information management and transfer conducted before the POCT implementation, successful completion of this initiative has been elusive. This is because of a lack of universally accepted network interfacing standards and languages, and the continuous flux of hospital information-management systems. Lastly, we have learned that during the acquisition and implementation of new technology, there is rarely a period of stability when the technologic development and the market or institutional positions of the vendor, purchaser, hospital, and network are static. Our recommendation, therefore, is to appoint a project coordinator and schedule periodic meetings to assess the technology project's status and to plan for the future.

**Conclusion**

Intensivists must recognize the dynamic of the new hospital-corporate, or, more appropriately, the corporate-hospital, workplace. “Just knowing the price is not enough” to succeed within it. Herein, we have presented our thoughts on introducing new technology with the understanding that at certain times, inexplicably, no rules or logic apply to the process. There are great opportunities for hospital-based intensivists to increase their stature and suc-
cess owing to the full-time nature of the job, potential for high visibility through the multidisciplinary ICU concept, and active participation in select committees. If you have not begun to integrate yourself into the hospital and play the critical care and technology introduction games seriously, the time to act is now!

REFERENCES