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President's Column:

Critical Shortages Create Opportunities for Critical Care Anesthesiologists



Brenda G. Fahy, M.D., F.C.C.M.

Critical care medicine remains an integral part of inpatient care in every hospital and, with the aging population and advances in clinical care, the need for critical care physicians will continue to expand. As a result, the opportunities for anesthesiologists with subspecialty training in critical care medicine will continue to grow. There are predictions that the demand for highly trained critical care physicians will continue to increase and is expected to result in a shortage of well-trained critical care physicians worldwide. At the same time, the need for the expertise of the critical care physician extends beyond the walls of the intensive care units. For example, patients requiring stabilization and resuscitation on the emergency department clearly benefit from having critical care-trained physicians participating in their care. This escalating

need for critical care providers is being partially met by critical care anesthesiologists. SOCCA members in particular recognize that importance of the background of anesthesiology to the care of critically ill patients, but also value the training and experience provided by critical care fellowships – particularly those that are interdisciplinary in nature, reflecting the full gamut of the critically ill patient population. At the same time, critical care anesthesiologists alone will never fill all of the needed positions in intensive care units in the United States, so

Recently there have been some very interesting and encouraging discussions about defining new ways to better coordinate training and certification in critical care medicine. For example, emergency physicians are seeking a pathway to obtain critical care training and certification through the existing critical care anesthesiology fellowship programs and the American Board of Anesthesiology certification examination. Other specialties, including neurology, obstetrics and gynecology, have identified the value of the critical care training

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other models of training will be needed to meet patient and institutional demands.

In response to this expanding opportunity, physicians from many other specialties are seeking training and experience in critical care medicine. In addition to the formal accredited critical care fellowships in anesthesiology, surgery, medicine and pediatrics, neurologists, emergency physicians and numerous other specialists to gain the training and experience to care for critically ill patients have sought a variety of other training opportunities. Unfortunately, the history of critical care training has been checkered, in large part because of the silo approach to training – individual accredited programs with different content outlines, curricula and board-certification opportunities.

and expertise in the care of their patients both within and outside of the intensive care unit. The diversity of backgrounds and approaches to clinical problems provides different perspectives and approaches to clinical care that can benefit the diverse patient population. While some see the increasing interest of other physicians in critical care medicine as a threat, in reality it represents an opportunity for the critical care anesthesiologist to work collaboratively with physicians from other specialties to optimize care of the increasing complex critically ill patient. This multidisciplinary approach will benefit patients, facilitate our ability to work with colleagues to manage our practices under the new compensation models and ensure that

Continued on page 3

CONTENTS

PRO: 24-Hour In-House Intensivist Staffing Is the Right Thing!	4	Point-of-Care-Coagulation Testing (POCCT) in Management of Perioperative Coagulopathy: Review of the Current Literature	8
CON: The Argument Against 24/7 In-House Intensivist Coverage	5	How to Learn From a Distance	12
High-Frequency Oscillatory Ventilation in ARDS	6	Fellowship Review: Critical Care Anesthesiology at Cleveland Clinic	14

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President's Column Continued

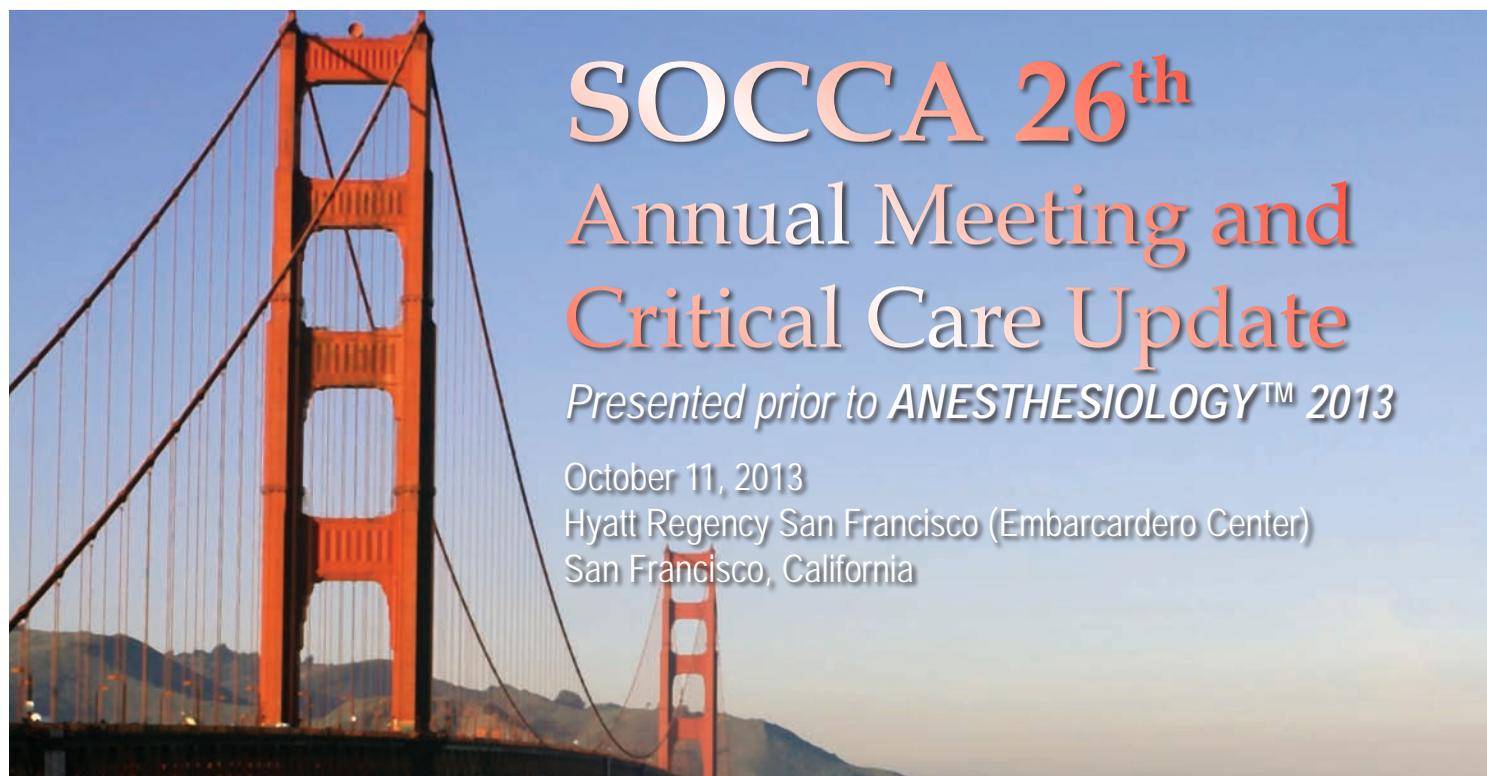
Continued from page 1

we manage the ICU care within the context of the overall continuum of care consistent with patient goals.

These multidisciplinary approaches to care also provide the critical care anesthesiologist with a challenge and opportunity mandating us to clarify the skills we bring to our patients, to document the value of our training and expertise and to reassess the clinical environments both within in the ICU and beyond in which our expertise can be most valuable. The foundation that anesthesiology and critical care fellowship training creates poise critical care anesthesiologists to provide care for a diverse critically ill patient population within

ICUs and provide opportunities to rethink our roles and responsibilities beyond the walls of the ICU within the larger health care systems. Opportunities include medical direction of ICUs, transfer centers, rapid response teams and respiratory therapy services. Recent emphasis on improving perioperative care delivery present opportunities for critical care anesthesiologists to design systems coordinating care of surgical patients through the continuum of preoperative, intraoperative and postoperative care periods. This is especially valuable for those patients at highest risk for perioperative complications. Critical care anesthesiologists have played a major role in research to improve critical care outcomes and are uniquely positioned to lead patient safety and quality initiatives. Research

opportunities exist to further advance our understanding of critical illness. Opportunities abound and are dependent upon us as critical care anesthesiologists to access where our training and expertise can be most valuable.



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PRO: 24-Hour In-House Intensivist Staffing Is the Right Thing!



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Although a large body of evidence suggests that care by dedicated intensivists improves patient outcomes and limits costs, debate continues around the merits of 24-hour in-house intensivist coverage.^{1,2} While the weight of the evidence arguably favors the 24-hour intensivist staffing model, it remains useful to step back and consider all of the potential effects of keeping an intensivist in the hospital at all hours.

The question of how around-the-clock intensivist staffing affects clinical outcomes remains an area of active investigation. One well-publicized retrospective cohort study recently found that nighttime intensivist staffing was associated with lower mortality (O.R. 0.62; $P = 0.04$) only in ICUs with low-intensity daytime staffing (optional intensivist consultation model), but found no such benefit in high-intensity daytime staffed ICUs (mandatory intensivist consultation, or intensivists as primary team).³ Unfortunately, this study examined only in-hospital mortality, leaving unaddressed questions about length-of-stay, ventilator days and patient-centered

long-term outcomes. In contrast, multiple previous observational studies demonstrate numerous improved outcomes associated with around-the-clock intensivist staffing, including decreased standardized mortality ratios, increased adherence to evidence-based care protocols, reduced rate of ICU complications and significantly shortened hospital length of stay.⁴⁻⁶

Even if these benefits hold true, however, many object to 24-hour in-house intensivist coverage based on cost. While it is true that salary costs would increase, the available data show that this additional cost would be more than offset by cost savings from shortened ICU length-of-stay.^{2,5,7}

Another common objection concerns the feasibility of expanding coverage given the current shortage of trained intensivists. There is fear that night shifts will further stretch the workforce and deter future candidates from pursuing critical care training. Like the previous objection, though, this one neglects to consider the relevant aggregate effect. Many candidates expressly seek out the flexible but defined work hours that shift scheduling provides. Indeed, longitudinal studies show high career satisfaction with shiftwork, and a recent investigation found less burnout among intensivists doing shiftwork than those working seven days in a row with night call.^{8,9} Beyond lifestyle concerns, providers also perceive the benefits of continuous coverage on patient care. Gajic et al. found that following the introduction of 24-hour intensivist coverage, the majority of providers considered 24-hour coverage "optimal" for patient care (78 percent versus 38 percent before the intervention, $p < .001$), and Banerjee et al. found not only improved staff satisfaction, but also more favorable perceptions of patient safety, education and unit organization.^{4,5}

In short, the weight of the evidence and common sense alike support implementation of 24-hour in-house intensivist care. It is no surprise, then, that SCCM guidelines do so as

well.¹⁰ Especially in centers that receive patients specifically transferred for a higher level of care, a truly expert critical care physician should guide the initial care of all critically ill patients, regardless of the time of day. After all, if your own loved one required transfer to the ICU in the middle of the night, would you really say it could wait until morning?

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CON: The Argument Against 24/7 In-House Intensivist Coverage



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Multiple studies have shown the benefit of the “high intensity” staffing model in ICUs; that is having a dedicated intensivist who manages or co-manages the critically ill patients in an intensive care unit.¹ In an effort to optimize care and reduce medical errors, the Society of Critical Care Medicine (SCCM) and the Leapfrog group have stated that intensivists should manage or co-manage all ICU patients. One conclusion from this data is that an intensivist should be available 24/7²; however, this idea is less well supported in the literature and may be unrealistic in the current health care environment.

There are multiple studies suggesting a mortality benefit and decreased length of ICU stay with intensivist management of ICU patients. The evidence for 24/7 coverage is not nearly as robust and may not apply to all ICUs. A study by Wallace et al., which looked at information from 65,752 patients,

showed a mortality benefit for 24/7 coverage in low-intensity units (those without mandatory intensivist consultation) but no mortality benefit in high-intensity units.³ Another study, by Banerjee et al., showed a cost benefit of nighttime intensivist coverage for the sickest patients admitted but not for less critically ill patients.⁴ For hospitals with a smaller number of such critically ill patients, implementing a nighttime intensivist may not have the cost benefits suggested.

As it is, there is a significant shortage of ICU physicians,⁵ and with the well-documented benefits of having an intensivist in the ICU during the day, efforts should be directed toward increasing the prevalence of ICUs that at least have an intensivist present for some of the time. A 24-hour-staffing model remains unrealistic, while the shortage of fellowship-trained intensivists continues. Angus et al. reported that only 2 percent of ICUs provide 24-hour dedicated in-house intensivist coverage.⁶

Other care models have been suggested to cover the shortage of critical care physicians. Nurse practitioners and physician assistants have been shown to be effective in implementing critical care protocols.⁷ Another possible alternative that has shown promise in a pediatric ICU is to utilize hospitalist services in house with an intensivist back-up from home.⁸ Such a system would likely be easier to implement in the current environment. Telemedicine, which leverages audiovisual technology to allow remote intensivist consultation, has been shown to decrease ICU mortality and length of stay.⁹ These options should be explored more fully, since little data exist to compare ICU patient outcomes utilizing these alternative staffing methods.

24/7 staffing of an ICU by an intensivist may be great in theory, but unfortunately in the current health care environment, it is neither ideal nor feasible. The current shortage of ICU physicians, which is only predicted

to get worse, does not readily allow for 24/7 intensivist coverage. Rather, efforts should be expanded to improve coverage of ICU patients during the day by an intensivist while we continue to evaluate methods of extending ICU physician coverage at night.

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High-Frequency Oscillatory Ventilation in ARDS



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Acute respiratory distress syndrome (ARDS) is a type of inflammatory lung injury that is an expression of myriad of other diseases that produce diffuse inflammation in the lungs.¹ It is a multi-factorial disease caused by a variety of insults, direct and indirect, leading to hypoxemic respiratory failure, which is characterized by poor lung compliance and diffuse, radiologic pulmonary abnormalities. It is a devastating condition associated with a mortality rate of approximately 30 percent, and survivors often suffer from long-term functional disability.^{2,3} The hallmark of ARDS includes bilateral pulmonary infiltrates, respiratory failure not fully explained by cardiac failure or fluid overload, acute onset and severe hypoxemia.⁴ The management of ARDS includes mechanical ventilation that may require elevated ventilator settings due to decreases in lung compliance leading to dangerous elevations in intrathoracic pressures. Prolonged intrathoracic pressures above 30 cmH₂O can be harmful, causing ventilator-induced lung injury (VILI), which can lead to systemic, multi-organ failure and death.^{2,5}

VILI is an important cause of poor clinical outcomes in patients with ARDS.⁶ Previous

research has shown that low tidal volume ventilation (LTVV) improves mortality. In its landmark study, the ARDS Network randomly assigned 861 mechanically ventilated patients with ARDS in multiple centers to LTVV (initial tidal volume of 6 mL/kg) or conventional mechanical ventilation (CMV) (initial tidal volume of 12 mL/kg). The LTVV group had a lower mortality rate (31 versus 40 percent) and more ventilator-free days (12 versus 10 days).⁷ The goal of LTVV is to keep plateau airway pressures below 30 cmH₂O to reduce VILI. Although, LTVV has been shown to reduce mortality, other ventilatory modes may be needed in cases of severe ARDS. One ventilator mode that has shown promise is high-frequency oscillatory ventilation (HFOV).

HFOV delivers small tidal volumes approximately 1 to 2 ml/kg at a respiratory rate between three to 15 breaths/second.⁸ There have been multiple clinical studies published characterizing the role of HFOV in adults with ARDS. Most of these clinical studies have been case series using HFOV as rescue therapy. Only two of these clinical

Bollen et al. found no significant difference in survival at 30 days between HFOV and CMV, but a post hoc analysis showed a benefit with HFOV in a subgroup of patients with the most severe hypoxemia.¹¹ Although these trials show improvements in oxygenation and survival with HFOV, they are limited by small sample sizes and outdated ventilatory strategies for the control group.⁸ For this reason, HFOV remains an unproven benefit for adults with ARDS who do not respond to CMV or when used early in the course of ARDS.

In a recent article published in the February 2013 issue of the *New England Journal of Medicine*, Ferguson et al. question the use of HFOV in moderate-severe ARDS. Ferguson's study was a multicenter, randomized, controlled trial conducted in 39 intensive care units in five different countries that compared HFOV versus CMV in patients with new-onset, moderate-severe ARDS. In the study, 548 patients who met criteria for ARDS were randomized into two groups, HFOV or CMV. In the CMV group, LTVV was used for all patients with pressure-control mode, tidal volume of 6 ml/kg, FiO₂ of 0.60

For now, based on the current evidence, it seems prudent to manage adults with early ARDS with LTVV with high PEEP and, if refractory hypoxemia occurs, HFOV can still be used as a rescue therapy to reverse the consequences of this devastating disease.

studies have been randomized controlled trials (RCTs) that compared HFOV with CMV in adult ARDS.⁹ Derdak et al. found no significant difference in adverse events or oxygenation and hemodynamic variables but did show a nonsignificant trend toward improved 30-day mortality in the patients who received HFOV compared to CMV (37 percent vs. 52 percent).¹⁰

with a positive end-expiratory pressure (PEEP) level of 10 cm of water or higher if needed for oxygenation. In the HFOV group, HFOV was initiated with a mean airway pressure of 30 cmH₂O, targeting a PaO₂ of 55 to 80 mmHg, minimizing tidal volumes by using the highest

Continued on page 7

High-Frequency Oscillatory Ventilation in ARDS

Continued from page 6

possible frequency to maintain an arterial blood pH above 7.25. The primary outcome of rate of in-hospital death from any cause was 47 percent in the HFOV group and 35 percent in the control group (RR of death in HFOV 1.33; 95 percent CI 1.09-1.64; $P=0.005$). They also found that the HFOV group received higher doses of midazolam (199 mg/day versus 141 mg/day, P less than 0.001), more patients received neuromuscular blockers (83 percent versus 68 percent, P less than 0.001). Also, they received more vasoactive drugs (91 percent versus 84 percent, $P=0.01$) and received them for a longer period (5 days versus 3 days, $P=0.01$). They initially planned to enroll 1200 patients into the trial but stopped after 548 patients had undergone randomization due to an increase in mortality in the HFOV group.

This article makes the argument that in adults with moderate-severe ARDS, early application of HFOV versus LTVV with high PEEP, does not reduce and, may increase, in-hospital mortality. The authors stopped the trial early due to the increased mortality with HFOV. They gave three reasons for the termination: 1) Consistent finding of increased mortality with HFOV in three consecutive analyses conducted after enrollment of 94, 300 and 500 patients; 2) Increased need for vasoactive drugs in the HFOV group suggesting harm; 3) Effect size was large enough to conclude that if early HFOV did not increase mortality, it was unlikely to reduce it. Continued enrollment would have put patients at risk with little likelihood of benefit. Some reasons for the poor performance of HFOV were attributed to higher mean airway pressures resulting in hemodynamic compromise by decreasing venous return and right heart function, vasodilatory properties of the sedative drugs and the possibility of barotrauma associated with HFOV. An explanation for the high mean airway pressures was the approach the authors took in adjusting the mean airway pressure and

the inspiratory:expiratory (I:E) ratio (1:2 in the study). They believe that this approach may have led to higher mean airway pressures and a protocol with lower mean airway pressures, different I:E ratio, or lower oscillatory frequency may have led to different results.

The results of this study are in stark contrast to previous RCTs involving HFOV in adult ARDS.^{10,11} This may be explained by the fact that different CMV protocols (not LTVV with high PEEP) were used in the previous RCTs. The CMV protocols used in these RCTs were most likely harmful to patients resulting in HFOV trending toward benefit. The finding of at least no benefit with HFOV versus CMV (LTVV with high PEEP) was consistent in another trial also published in the February issue of the *New England Journal of Medicine* that was conducted in the United Kingdom.¹²

In summary, this article proves that the early application of HFOV in adult ARDS does not reduce mortality and may cause harm, but looking more closely at the outcomes of the trial, two conclusions can be drawn. First, the number of patients with refractory hypoxemia was less in the HFOV group (19 percent versus 38 percent, $P=0.007$), showing that HFOV may still have a place as a rescue therapy when CMV has failed. Second, most of the patients in this trial had a P:F ratio between 100-200 mmHg. Therefore, we are still not sure how HFOV would perform in patients with severe ARDS (P:F ratio less than 100 mmHg). Whether HFOV has benefit in adults with severe ARDS will be a question for future clinical trials to answer. For now, based on the current evidence, it seems prudent to manage adults with early ARDS with LTVV with high PEEP and, if refractory hypoxemia occurs, HFOV can still be used as a rescue therapy to reverse the consequences of this devastating disease.

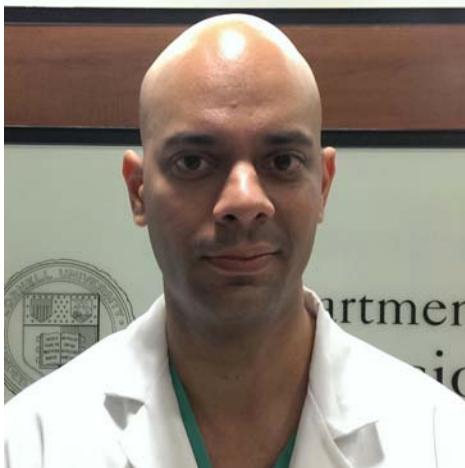
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Point-of-Care-Coagulation Testing (POCCT) in Management of Perioperative Coagulopathy: Review of the Current Literature



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The development of perioperative coagulopathy in surgical patients is influenced by multiple factors, and multiple etiologies have been described to date. Some of the more established etiologies include, but are not limited to, the effects of hypothermia, acidosis, hypocalcemia, coagulation factor dilution, factor deficiency (acquired or congenital), drugs, consumption of coagulation factors, contact activation with foreign surfaces (CPB) and hypoperfusion.¹ The fine balance that exists between clot formation and clot lysis necessitates thorough understanding of the hemostatic system in the appropriate management of perioperative bleeding. For this very reason, anesthesiologists and intensivists have evolved as leaders in this field alongside

cardiopulmonary bypass. Prompt and accurate diagnosis of coagulation disorders enabled by the point-of-care coagulation testing (POCCT) and the use of algorithm-based guided transfusion practices may alleviate transfusion-related morbidity, mortality and save costs.

We recognize that standard laboratory tests do not provide enough information in time to guide our transfusion practices in the operating rooms as well as in the intensive care units. This is particularly important when caring for patients with trauma, high-risk cardiac surgery, high-risk obstetric bleeding patients, and patients undergoing liver transplantation. We are also increasingly caring for patients receiving agents designed to effectively alter normal hemostasis such as potent platelet

The use of POCCT has been studied primarily in cardiac surgical patients. Recently published a single center, prospective, randomized clinical trial of efficacy of point-of-care testing in coagulopathic cardiac surgery patients demonstrated a reduced patient exposure to allogenic blood products.

our surgical colleagues, hematologists and transfusion medicine specialists (frequently pathologists).

Institutional, and even within institution, clinician inconsistencies in transfusion practices over the years have underscored the need for evidence-based guidelines. Traditional, empiric management “shotgun approach” for treating coagulopathy has been challenged in a number of studies.

It is well established that perioperative coagulopathy and the use of allogenic blood products in patients undergoing cardiac surgery were associated with increases in mortality and major perioperative cardiac and noncardiac adverse events in patients undergoing

inhibitors (clopidogrel), direct thrombin inhibitors (dabigatran). Several of these agents have no known direct reversal agent. This group of patients presents itself as a particular management challenge during emergency high-risk surgical procedures.

In addition, the safety of the currently used therapies for the management of perioperative coagulopathy such as antifibrinolytic Tranexamic acid, activated factor 7, Prothombin complex concentrates - PCC and concentrated fibrinogen concentrates are not fully understood.²

Continued on page 9

Point-of-Care-Coagulation Testing (POCCT) in Management of Perioperative Coagulopathy: Review of the Current Literature

Continued from page 8

This article reviews the currently available POC coagulation tests, when and where the POCCT testing can be used. We will also discuss benefits and limitations of POC coagulation management and hemotherapy algorithms.

As pointed out earlier, hemostasis is a complex process. There is no single POCCT that can evaluate all aspects of hemostasis. A combination of tests at the point of care yields a far broader and timely diagnostic spectrum than do conventional laboratory testing of coagulation.

1. Rapid POC PT (prothrombin time) test (CoaguCheck™ Pro DM) was validated with the standard central laboratory PT test in a direct comparison study.³ PT result can be expressed in seconds or as percent activity. This study showed good agreement of POC PT testing with the standard laboratory prothrombin time testing but expressed as percentage (r coefficient correlation 0.71-0.96, $p < 0.0001$). This POC test result is available in less than 5 minutes compared to 80-90 minutes turn-around time of the standard central laboratory testing.

2. Aggregometric POC Platelet function tests are the most cited platelet functional tests in studies conducted in the perioperative setting. Aggregometric measures allow assessment of platelet function by measuring the amount of platelet aggregation induced in the presence of common platelet agonists such as thrombin, arachidonic acid, ADP, epinephrine, or collagen. Light transmission aggregometry (LTA) measures the percent aggregation induced by selected activators: Collagen (COL), adenosine diphosphate (ADP) and arachidonic acid. Whole blood impedance aggregometry, measures changes in electrical resistance, as aggregation units over time after exposure to classic platelet activators: Collagen (COL), adenosine diphosphate (ADP) and arachidonic acid. These assays have been validated in the

POC setting to detect cardiopulmonary bypass induced changes in platelet aggregation, even in the presence of dual antiplatelet therapy when (ADP) was used as an activator.⁴

The available aggregometric POC tests (Multiplate®, PFA-100®, TEG® Platelet Mapping™ Assay, VerifyNow®) differ in the agonists that are used to activate the platelets in the test cells, such as collagen, adenosine phosphate, epinephrine, arachidonic acid, and thrombin, and in the shearing forces that are generated in the test cells.

3. Viscoelastic POC techniques (ROTEM®, TEG®) are based on thromboelastography (Hartert H: Thromboelastography, a method for physical analysis of blood coagulation.)⁵

Currently validated and most widely used POCCT systems that measure in-vitro viscoelastic properties of a whole blood sample are: TEG® thromboelastography (Haemoscope Corporation, Niles, IL, USA) and ROTEM® thromboelastometry (Pentapharm GmbH, Munich, Germany).

These tests provide rapid and comprehensive dynamic information on the speed of coagulation initiation, kinetics of clot generation, clot strength and clot break down.

Clotting dynamics are assessed with CT (clotting time), CFT (clot formation time) and alpha angle, clot firmness with amplitude after 5, 10, 15 minutes (A5, A10, A15) and maximum clot firmness (MCF). Clot stability over time is assessed with the following measures: lysis onset time, clot lysis index at 30, 45 and 60 minutes (cli30, cli45, cli60) and maximum lysis (ML).

Several ROTEM assays allow clinicians to analyze hemostasis at different steps. These assays are known as EXTEM, FIBTEM, APTEM, INTEM and HEPTEM.

EXTEM test serves as a screening test sensitive to deficiencies in Vitamin K dependent coagulation factors, fibrinogen, factor XIII and platelets.

FIBTEM test by inhibiting platelet function, allows for the detection of Fibrinogen deficiency or fibrin polymerization disorders, induced by factor XIII deficiency, infused colloids or dysfibrinogenemia.

APTEM assay detects hyperfibrinolysis, by blocking fibrinolysis with aprotinin.

The results obtained with EXTEM and APTEM assays can be used together to aid clinicians in the diagnosis of hyperfibrinolysis and can be used to monitor the efficacy of antifibrinolytic therapy.

INTEM assay is based on intrinsic activation of the coagulation cascade by Ellagic acid. This assay provides information on the coagulation factors involved in the intrinsic pathway.

HEPTEM: Is an INTEM-based assay with heparinase added to detect heparin effect.

Early available values of clot firmness (A5, A10 or A15) serve in approximating the MCF achieved in ROTEM. Clot strength is determined by interactions between fibrin network, activated platelets and activated factor XIII.

Review of literature:

Cardiac Surgery Patients:

The use of POCCT has been studied primarily in cardiac surgical patients. Recently published a single center, prospective, randomized clinical trial of efficacy of point-of-care testing in coagulopathic cardiac surgery patients demonstrated a reduced patient exposure to allogenic blood products. In this study transfusion practices were guided either by the use of conventional tests (platelet count, fibrinogen concentration, international normalized ratio [INR], aPTT, and activated clotting time [ACT]), or by the POC coagulation testing that included repeated thromboelastometry and whole blood impedance aggregometry. Secondary outcomes such as 6- month mortality, ventilator days and ICU stay were all decreased in the intervention group. However, in addition to being a single

Point-of-Care-Coagulation Testing (POCCT) in Management of Perioperative Coagulopathy: Review of the Current Literature

center trial, a small number of subjects limited the ability to draw final conclusions concerning morbidity and mortality. (Note: study was never powered to detect mortality and morbidity and in fact was cut short because there was such a significant benefit noted in the POCCT group).⁶

Trauma and Liver Transplant Patients

Trauma patients pose a significant coagulation management challenge. These critically ill patients require massive transfusion that by dilution leads to clotting factor deficiency (hypofibrinogenemia). This in turn can be corrected by the use of large volumes of FFP's with all associated risk factors such as infection risk, acute lung injury (ALI), and volume overload. Therefore goal-directed transfusion therapy is much needed. Two POCCT techniques have been very useful in this clinical setting: thromboelastography or thromboelastometry. Fibrin-based test (FIBTEM) that measures the maximum clot firmness (MCF) and clotting time measured by extrinsic activation test (EXTEM) can be used for rapid and reliable diagnosis of the underlying coagulopathy. These tests are the bases for the POC-guided hemostatic therapy with fibrinogen concentrate as first-line hemostatic therapy (maximum clot firmness [MCF] < 10 mm and clotting time > 1.5 times normal).⁷

Thromboelastography analysis was also helpful in guiding transfusion management in patients with bleeding problems following liver transplants and in trauma patients.⁸⁻⁹

ICU Setting

The POCCT testing may also be valuable in the ICU setting in the management of patients undergoing mechanical circulatory support. The need for a patient/device specific anticoagulation protocol underscores the utility of the POC coagulation testing. For example different types of ventricular devices (VADs) and extracorporeal membrane oxygenation systems (ECHMOs) are known to cause different coagulation problems at

different times in patients requiring repeated coagulation measurements. In particular, POCCT such as whole blood viscoelastic tests (thromboelastometry/-graphy) and platelet function tests (impedance or turbidimetric aggregometry) were valuable in guiding anticoagulation and antiaggregation therapy in these patients.¹⁰

In addition, a potential use of the POCCT –thromboelastometry has been described in patients with sepsis, both as a more reliable biomarker of severe sepsis when compared with procalcitonin, IL-6 and CRP, or as a better predictor of 30-day survival in severe sepsis than did the simplified acute physiology system (SAPS) II and sequential organ failure assessment (SOFA) scores.

Although recently published meta-analysis revealed that the use of these POCCT-guided transfusion strategy significantly reduced bleeding in massively transfused patients, morbidity and mortality in these patients were not improved.¹¹

Practical aspects of POCCT use:

Persistent Bleeding

Bleeding due to newer small molecule anticoagulants with no specific reversal agents represents a great challenge when patients require emergency surgical procedures. Prothrombin complex concentrates might be beneficial for the treatment of anticoagulant-associated coagulation factor deficiencies (dose ranges from 25 to 100 U/kg depending on the product used). In patients with life-threatening bleeding, hemodialysis should be considered to remove selected small-molecule anticoagulants (e.g., lepirudin, dabigatran)¹²

Low fibrinogen level: if plasma levels of fibrinogen decrease below 150-200 mg/dl, or if viscoelastic tests indicate a deficiency (if maximum clot firmness measured by FIBTEM is < 10 mm), it is necessary to administer fibrinogen substitute. FFP (15-30 ml/kg),

cryoprecipitate (1 unit increases fibrinogen by ~0.06g/U) or fibrinogen concentrate can be used as a source of fibrinogen replacement. Fibrinogen concentrates are not FDA approved for this indication in the United States. Currently the only FDA approved indication is congenital fibrinogen deficiency.

Fibrinogen dosage(g) = targeted change in MCF in FIBTEM(mm) X body weight(kg)/140

Clinically relevant deficiency in Vitamin K dependent coagulation factors results in a prolongation of the coagulation time (CT) in EXTEM ROTEM assay. With a goal-directed approach with use of POCCT, a therapeutic intervention is recommended in a bleeding patient with a CT EXTEM > 80 sec by administration of PCC (prothrombin complex concentrate). A dose of 25 IU PCC /kg body weight is recommended.

Administration of PCC in the amount of 1 IU/kg usually results in an increase of corresponding coagulation factors by 0.6-1.0%.

Although Gorlinger et al. have published multiple hemostatic algorithms where FFP is administered as part of POCCT algorithm for a variety of situations, FFP based on the POC-goal -directed algorithm should be reserved for patients with detected or expected V, VIII or XI factor deficiency.¹³

Early identification and treatment of coagulopathy are the principles of the MTP (massive transfusion protocol) in trauma. Implementation of the MTP has decreased the blood bank delays in dispensing blood products and early initiation of treatment, a strategy shown to improve patient outcome. Appropriate practice of transfusing PRBC: FFP and Platelets 1:1:1 or 1:2 or 1:3 ratio has been debated over the years, practice originating from whole blood transfusion experience. MTP and goal-directed transfusion practice based on POCCT testing has gained increasing interest.¹⁴

Continued on page 11

Point-of-Care-Coagulation Testing (POCCT) in Management of Perioperative Coagulopathy: Review of the Current Literature

Continued from page 10

Limitations of the POCCT

Some of the limitations of TEG and ROTEM assays are:

- 1) Endothelial components are not evaluated.
- 2) The activators used in the testing may mask the effect of certain anti-thrombotic agents such as ASA and thionopyridines, or GP IIb/IIIa inhibitors.
- 3) Most are not responsive to the effect of von willebrand disease.
- 4) They are often less sensitive than traditional clotting assays.
- 5) POCCT testing, such as thromboelastometry, needs expert interpretation which may limit when it can be used.
- 6) There must be staff in the OR/ICU who are proficient and competent at using the equipment.
- 7) QC must be performed regularly and External Quality Assessments must be performed to meet accrediting body standards.

Effects of hypothermia and acidosis

In an in vitro study with the use of thromboelastometry (ROTEM), hypothermia showed coagulation changes that were worsened by acidosis, however, acidosis alone did not show any effect on coagulation. Thus thromboelastometry performed at 37 °C overestimated integrity of coagulation during hypothermia in particular in combination of acidosis. This effect is attributed to inhibition of coagulation factors and platelet function.¹⁵

Conclusions

All vested work in this area certainly represents an important step in our pursuit to improving patient outcomes from excessive bleeding resulting from coagulopathy and associated transfusion. What the future may hold is a “multimodal management strategy”¹⁶ POCCT, early administration of individual factors such as currently available Prothombin Complex Concentrates - PCC, and administration of fibrinogen concentrates, together with superior prevention and treatment of excessive fibrinolysis, excessive systemic inflammation and ensuring adequate microcirculatory perfusion.

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How to Learn From a Distance



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There are certain abilities fundamental to the practice of medicine, such as knowledge of anatomy and physiology, proper technique when performing the physical exam, and facility with history-taking. By practicing these skills, physicians-in-training learn how to gather information and formulate an accurate assessment and plan. But while this process forms the bedrock of becoming a good physician, this is no longer the end of the educational line. As medicine evolves to meet new challenges, such as alternative reimbursement structures, increased requirements for efficiency, and maintenance of quality despite scarce resources, new practice styles and skill sets will have to be developed. Unfortunately, it is no longer enough to be a good doctor; one has to be a well-integrated part of the healthcare system to provide the best patient care.

One of the new paradigms in medicine, particularly in critical care, is “telemedicine,” the use of closed-circuit video, real-time vital sign monitoring, and smart technology to help care for patients that may be miles away from the clinician. With current demographic trends, the supply of intensivists is not adequate to keep up with the growth of the number of patients requiring critical care, and this situation will likely worsen over the next 10 to 20 years. Because intensivists, more so than many other practitioners, tend to be clustered in certain larger metropolitan areas, the use of “tele-ICU” is growing in favor as a way to better connect critical care specialists to patients. But the skills required for good tele-ICU practice are not necessarily the same that lead to good bedside outcomes, and it takes some time to develop them.

So what does it take to be a good tele-intensivist, and how can learning this style of practice inform bedside critical care? The most fundamental skill necessary for good tele-ICU care is one that is certainly helpful in any medical context: the ability to multitask. In

move on to the next one in a linear fashion. Therefore, it is critical to learn techniques so that one can remember and maintain focus on many different informational elements simultaneously. This is entirely consistent with the practice of medicine in a busy hospital or clinic environment, where efficient time management is valuable. And while studies have implicated excessive multitasking as underlying worse job performance, addressing the needs of a busy healthcare system necessitates it to some degree.

One of the ACGME’s core competencies is to develop “awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value.” Because telemedicine frequently requires close cooperation between providers of many different backgrounds, it helps facilitate learning to work as part of a balanced team, not as a “lone wolf” capable of doing everything without help. When taking care of a patient a hundred miles away, there are certain things that the intensivist cannot accomplish,

Taking optimal care of the patient requires that intensivists work closely with RNs, advanced-practice nurses, respiratory therapists, consulting physicians, and other on-site actors to shepherd the patient through their illness.

a given tele-ICU shift, an intensivist may have to cover as many as nine or ten different ICUs and up to 100 patients. At any given time, there are numerous labs and studies to be followed up, notes to be written, and unstable patients to be evaluated. It is rarely possible to identify a discrete task, complete it, and

even things as basic as a complete physical exam. Taking optimal care of the patient requires that intensivists work closely with RNs, advanced-practice nurses, respiratory therapists, consulting physicians, and other on-site actors to shepherd the patient through their illness.

Continued on page 13

How to Learn From a Distance

Continued from page 12

Additionally, covering multiple hospitals that may have very different structures, practice patterns, and (sometimes most frustratingly) electronic medical records engenders an awareness of the often-shocking variability across the healthcare landscape. There are few better ways to teach someone the gaps and disconnects in the healthcare system than to make them work at multiple hospitals at the same time, particularly when those hospitals may have radically different geographic and socioeconomic environments. When you are used to practicing in an academic tertiary-care center, it's quite a wake-up call to learn that you need to wait four days before getting a nephrology consult or that a hospital only stocks one type of insulin.

Conversely, practicing tele-ICU care provides many opportunities to standardize and improve care on a broader scale, and this process can be a great educational experience in and of itself.

Indeed, telemedicine can present an ideal structure for learning about quality improvement in healthcare. In telemedicine, many interventions and events are clearly logged. If mechanisms for data collection and analysis are properly incorporated into the organization, they can be a powerful tool for analyzing processes and outcomes and improving care. Some more evolved tele-ICU providers employ numerous practitioners (frequently RNs or NPs) who are primarily tasked with ensuring that best practices for such items as thromboprophylaxis, sedation, and glycemic control are followed. Again, the scale of larger tele-ICU operations enables standardization of care that is difficult in a smaller context.

Another skill that is honed by practicing tele-ICU is the ability to quickly develop a rapport and gain the trust of practitioners and

patients with whom the intensivist may have little or no past experience. In many cases, one may be required to run a code for a patient that has not yet been evaluated, working with nurses and physicians that you have never met before. This is a situation that is not unfamiliar to most anesthesiologists, since we frequently only meet patients the day of surgery or ICU admission. However, telemedicine ups the ante somewhat: not only are the patient and caregivers unfamiliar to a tele-intensivist, but the comfort of being able to lay hands on the patient is also absent, as is the ability to perform procedures oneself. Therefore, the intensivist has to be able to quickly assess the situation, maintain a calm and productive environment, and delegate duties effectively in the midst of a developing crisis.

This type of "thinking on your feet" does not come naturally to everyone and takes practice to hone.

All physicians must engage in some sort of continuing education and on-the-job learning. While practicing telemedicine does not come naturally to every practitioner, it is based on skills that can be developed over time, and this skill set may then serve to inform the rest of one's practice. While nothing will ever supplant the experience of hands-on learning at the patient's bedside, there is nonetheless much potential educational value in stepping outside one's comfort zone and approaching the patient from miles away.

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Fellowship Review

Critical Care Anesthesiology at Cleveland Clinic

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Cleveland Clinic has proudly trained anesthesiologists for careers in critical care medicine for nearly 40 years. In the more recent decades since recognition of critical care as a bona fide specialty by the ACGME, our fellowship program has trained more than 100 anesthesiologists, all of whom share a passion and interest in critical care as the basis for their careers. For most of the past 10 years, we have seen a growing interest in critical care among graduating anesthesiology residents, both from within our own program and from others around the country, such that we have maintained full classes of eight fellows annually. We have also experienced a substantial growth in interest in critical care among women anesthesiologists, who have comprised from 25 percent to more than 60 percent of our classes in the last five years. Currently, the program integrates multidisciplinary clinical care, education and administrative and investigative opportunities to ensure that graduating physicians are confident in their clinical skills, prepared for appropriate certification and supplied with communication and relationship skills to grow into administrative and leadership positions.

Clinical Curriculum

The 12-month training program is divided into core rotations among multiple anesthesiology-directed ICUs at both the main campus and affiliated community hospitals. At the main campus, fellows spend a significant portion of their training in the surgical intensive

care unit (SICU), which is a 30-bed, closed, quaternary care unit, anesthesiology-directed, and attended by a multidisciplinary group of trained and board-certified intensivist anesthesiologists and acute care surgeons. Admissions to the SICU include transplants (liver, intestinal, pancreatic), and a multitude of complex septic and ARDS patients from general, colorectal, ENT, orthopedics and urologic services. In the SICU, fellows have a long-defined clinical role as triage officers and leaders of the house staff care teams in concert with the attending faculty. Fellows also train in the cardiothoracic intensive care unit, where they gain experience in managing complex cardiac surgery patients and devices, including balloon pumps, extracorporeal membrane oxygenation, ventricular assist devices and artificial heart applications. Fellows complete a rotation in the neurosciences ICU, with learning objectives including neurocritical care physical examination, interpretation of CT, MRI, EEG and transcranial Doppler, and management of complex hemodynamic situations.

Because there is a growing need for intensivists in community hospitals, we recently introduced a clinical rotation called "Community Critical Care," where fellows gain experience in the vastly different environment of a cardiac surgery ICU in a non-teaching hospital. Fellows are under supervision of our attending faculty who administratively direct the ICU and provide continual clinical coverage.

Fellows also complete rotations in bronchoscopy and transesophageal echocardiography and have two elective months, where they are able to choose from a multitude of options, including medical and pediatric ICUs as well as critical care infectious disease and critical care nephrology; several trauma elective choices are available as well. Fellows may attain additional echocardiographic experience during their Community Critical Care rotation both in

operative TEE and in transthoracic echo in the cardiology lab. In addition, fellows develop competency in managing patients who are out of the ICU environment but require critical interventions via their assignment with the hospital medical emergency rapid response team, which is staffed by nurse practitioners, respiratory therapists and registered nurses.

Educational Curriculum

The program faculty continues to strongly believe that bedside clinical teaching remains a mainstay in critical care education. As such, three groups, headed by a faculty member and fellow with additional housestaff and medical students, conduct comprehensive daily teaching rounds at the bedside, to include not only patient examination and traditional clinical topics but also electronic health record utilization, multidisciplinary reviews with nurses and clinical pharmacists, and discussions with family members. Teaching opportunities also occur during fellow-conducted, attending faculty-supervised morning and evening formal signout sessions. Admissions, procedures and triage duties are completed throughout the day.

Fellows attend a weekly conference designed especially for their level of training; each week is scheduled to include faculty-presented didactic sessions, book chapter and board-type question reviews or fellows' presentations. Fellows also actively organize and participate in "Journal Clubs," also held weekly, and which, with attending faculty contribution and guidance, allow critical review and interpretation of relevant recent vintage articles as an educational benefit. There are also ample opportunities for strengthening knowledge of important bioethical principles through monthly conferences with physician, attorney and psychologist staff members from the hospital's bioethics department. These conferences intermix didactic presentations

Continued on page 15

Fellowship Review Critical Care Anesthesiology at Cleveland Clinic

Continued from page 14

with discussions of complex and challenging patient ethical and psychosocial issues.

Though opportunities for ultrasonic exams occur clinically in the various ICUs throughout the year, we additionally hold an annual weekend critical care ultrasound retreat, using live models, to give fellows the opportunity to hone and fine-tune their ultrasound skills in a controlled environment. Fellows are also given opportunities to develop outcome and quality improvement initiatives via administrative sessions and ICU-specific morbidity and mortality conferences.

Post-Training Careers

While training anesthesiologists to be competent, capable and confident critical care physicians is a fundamental goal, we also recognize that our duty to the newest members of our specialist fraternity includes career development. It is gratifying to our faculty that we have been able to place our graduating trainees into desirable positions in hospitals throughout the country, and indeed throughout the world. We are equally pleased to see our former trainees grow and develop into leaders and prominence in our specialty.

For more information about our training program, please contact Dr. Marc Popovich, Program Director, at popovim@ccf.org, or our Program Coordinator, Debbi Kovacic, at (216) 444-3877 or kovacid@ccf.org.

Investigative Opportunities

Our program does not explicitly require fellows to complete research projects, but they are strongly encouraged to engage in a scientific endeavor as an educational exercise. The Cleveland Clinic Anesthesiology Institute houses a unique Department of Outcomes Research, which, in concert with the critical care faculty, provides resources to assist trainees in defining focused projects, preparing Institutional Review Board proposals, statistical analysis and planning presentations. The objective is for fellows to experience an understanding in the investigative process over the course of the yearlong program.

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