Initiatives in Safe Patient Care

Enhancing patient safety through improved surveillance

In-Hospital Resuscitation: Early Intervention and Rescue

Interview with Elizabeth Hunt, MD, MPH, PhD

CONTINUING EDUCATION FOR NURSES (CE) AND RESPIRATORY THERAPISTS (CRCE)

Of the more than 300,000 cardiac arrests that occur annually in the United States, survival rates are typically less than 10% for out-of-hospital events and less than 20% for in-hospital events. Additionally, studies have shown that survival falls by 10-15% for each minute of cardiac arrest without CPR delivery. The chain of survival, first conceptualized for out-of-hospital sudden cardiac arrest, applies to in-hospital arrest as well. Successful resuscitation requires early recognition of cardiopulmonary arrest, early activation of trained responders, early CPR, early defibrillation when indicated, and early advanced life support. Hospitals create through rapid response teams (RRT) a coordinated response to treating patients with a cardiopulmonary emergency. In this issue, we interviewed Dr. Elizabeth Hunt on the reasons why these survival rates are so low and what is being done to improve in-hospital resuscitation. We convened a panel of experts in rapid response to discuss what works and what has not worked with regard to RRT improving outcomes.

In the event of a cardiac arrest, the difference between life and death often depends entirely on rapid, effective cardiopulmonary resuscitation. Although it is commonly believed – even among hospital employees – that in-hospital resuscitation is efficient and leads to high recovery rates, the truth is otherwise. Less than 20% of adults who experience a cardiac arrest in hospitals are successfully recovered. In this interview, Dr. Elizabeth Hunt, Director of the Johns Hopkins Medicine Simulation Center at the Johns Hopkins Hospital, Baltimore, Maryland, discusses the reasons why these survival rates are so low and what is being done to improve in-hospital resuscitation.

The public has the impression that almost every patient who has a cardiac arrest in a hospital is successfully resuscitated. How truthful is that?

Dr. Hunt: The in-hospital reality varies greatly from public perception. According to the National Registry of CardioPulmonary Resuscitation (NRCPR) – an international database of in-hospital resuscitation events sponsored by the American Heart Association – the in-hospital survival rate for adults who suffer a cardiac arrest in US hospitals is approximately 17%.[1] So the vast majority do not survive a cardiac arrest. In pediatrics, it is a bit better – 27% of children who have a pulseless arrest in the hospital will survive to make it home.[2]

TERMINOLOGY: The term, rapid response team (RRT) is sometimes used to denote an emergency response system (EMS) performed by hospital personnel without the presence of a physician, whereas medical emergency team (MET) is reserved for a rapid response team with a physician present. In this document, rapid response team (RRT), rapid response system (RRS), and medical emergency team (MET) are used synomously, without regard for the presence or absence of a physician.

Unfortunately, another factor may be that there are frequently signs and symptoms that precede a cardiac arrest that either go unrecognized and/or do not prompt a call for help.

Why is the survival rate so low? Is it due to poor timing, the severity of illness, or something else?

Dr. Hunt: It is due to many factors. The severity of illness is certainly a factor but there is more to the story. Unfortunately, another factor may be that there are frequently signs and symptoms that precede a cardiac arrest that either go unrecognized and/or do not prompt a call for help. For example, in one study of patients who had either a cardiac arrest or an unplanned ICU admission from the wards, these patients had vital signs abnormalities for a median of 6.5 hours before the ward staff finally called for help.[3] The

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Panel Discussion:

Rapid Response Systems: Consensus and Controversy

Moderator: Michael DeVita *MD*

Panelists: John Mailey *RN*
Andrew Ochroch *MD, MSCE*
Collen Schabacker *RRT, FAARC*
Karen Stewart *RRT, FAARC*
Bradford Winters *MD, PhD*

There is growing evidence that early detection and response to physiological deterioration can improve outcomes for hospitalized infants, children, and adults. A rapid response system (RRS) is a multidisciplinary system to decrease the incidence of in-hospital cardiopulmonary arrests by detecting a crisis event and triggering a response and by dispatching a responding team. Over the past decade, RRSs have been widely implemented in adult practice in the US and elsewhere. Since its inception, questions have been raised regarding the effect RRS has had on patient outcomes. A panel of experts has been asked to address some of these questions.

Is the question settled as to whether Rapid Response Systems reduce in-hospital mortality?

Mailey: The MERIT study by Hillman and associates showed improvement after implementing RRTs in their respective 23 Australian hospitals.[1] Many scholars call for more data before we all blindly ascribe to RRTs as a common place.[2,3] RRTs do reduce hospital mortality outside of the ICU setting. Many hospitals with a RRT experience a shift of mortality from general wards to the ICU after the patient has been moved to a higher level of care. Most RRTs results are measured against historical controls because rapid response medicine is a relatively new field requiring continued research to solidify the legitimacy of their existence. This is an indirect measure but this data can be captured through surveying your staff. Rapid response teams do not increase hospital mortality but with time and more evidence will justify the need for such a team to prove reductions in hospital mortality rates.

> Given these considerations, the overall answer seems to be yes, RRSs reduce mortality, though the data is not homogeneous and not every hospital will experience the same magnitude of improvement.
>
> — Winters —

Ochroch: The development of rapid response teams began in Australia in 1995. Teams have spread to virtually all large hospitals based on recommendations of the Institute for Healthcare Improvement. These teams represent a significant cost to the health system, and it has been difficult to show a real benefit. One study examined the association between interventions by rapid response teams and changes in cardiac arrests and deaths in a Kansas City hospital.[4] Cardiac arrests dropped from 11.2 to 7.5 per 1000 patients after the RRT was put in place. However, this promising outcome has not been seen in many of the studies, so RRTs are still an unproven expense

Schabacker: At times it is very difficult to tell if RRTs have or have not reduced mortality rates because the literature is very much in conflict. I believe one reason for the conflict is because different institutions have different policies. In some hospitals the RRT responds to all areas including critical care areas, emergency rooms, pediatric wings, etc. In some hospitals they respond only to adult acute care beds and nothing else. It would be good to see research from various institutions that are comparing apples to apples.

Stewart: In many organizations there are reports of decreases in cardiac arrests outside of the ICU when a well functioning system for rapid response is in place. Moving patients into a intensive care unit in a more controlled environment improves the chance for a positive outcome if the patient progresses to cardiac arrest. The additional resources and skill sets in the ICU is favorable to a better patient outcome. Many organizations have several initiatives that are reducing overall mortality. It is my opinion that the overall reduction in mortality is not solely tied to rapid response systems but to the overall improvement in patient safety.

Winters: Preventable mortality may be more appropriate for measurement purposes. Many patients admitted to hospital have a high predicted or even certain mortality. RRSs should not be expected to change this significantly. Unfortunately, this type of outcome data is not as readily available from most hospital databases and it is prone to bias as care providers may not be able to agree on what constitutes a preventable death. An additional confounder is the Not for Resuscitation (NFR) patient. Some studies control for NFR patients but some don't. These patients may or may not have a high predicted mortality. How to account for this can be difficult.

Given these considerations, the overall answer seems to be yes, RRSs reduce mortality, though the data is not homogeneous and not every hospital will experience the same magnitude of improvement. The MERIT study initially reported no significant change, however, subsequent reanalysis showed that mortality was reduced when "MET-like" activity was accounted for.[5] This is crucial since the Hawthorne effect led to control hospitals engaging in MET activities through their cardiac arrest teams (i.e. 50% of "code calls" were not for codes). When comparing mortality for patients who had MET or "MET-like" calls against patients who did not, there was a significant improvement in favor of the RRS strategy. This corroborates the result in the original MERIT report. The non-randomized mortality studies are also clearly favorable and while poor data quality prevents the inclusion of all studies in an aggregate analysis, meta-analysis of the studies providing adequate numerator and denominator data shows a significant reduction hospital mortality.

Of the two, which is more important, the afferent limb (event detection and response trigger),

or the efferent limb (the response team)?

Mailey: Trigger mechanisms are the event detection limb that activates the response limb of any RRS. Any failure of either limb of the RRS will result in failure to rescue.[6] Educating your staff on recognition of triggers coupled with effective timely communication, immediate response, and followed with proper research based early interventions are the important foundations for any rapid response system. You can recognize a problem (event detection) and not treat the underlying pathophysiology properly (response limb) which will result in outcomes (ineffective resuscitation) that may or may not be beneficial for the primary problem, which will result in system failure.

Winters: This question is difficult to answer because our ability to reliably and accurately identify the deteriorating patient is still in its infancy. If we would catch all events with high fidelity and with minimum false alarms, the afferent limb would be more important. The problem is that we still miss too many patients and catch problems far too late, despite our efforts. We need to focus on identifying who is at risk and who should get higher level monitoring and support the development of "smarter" monitoring systems. Some are of the opinion that it does not matter who gets to the patient's bedside, as long as someone does. In general, I would agree with this but I would say there are times when critical care expertise on the efferent limb can make a significant difference. It is also beneficial to have a team that has trained together using techniques such as simulation. As such, we need to strive to improve both ends of the system.

Ochroch: Although the MERIT study did not show any improvement in outcome in the hospitals where RRTs were initiated, a reanalysis of that study indicated that earlier intervention during the patient's decline did improve outcome.[5] These data indicate that the afferent limb may be critical to the overall efficacy of the RRT. Consequently, as the MERIT and other studies have relied on EKG telemetry and standard nursing vital sign checks to detect physiologic decrement, there have been calls for increased vigilance through enhanced electronic monitoring.

Schabacker: Both limbs are important. The afferent limb is responsible for recognizing the existence of a medical emergency and the activation of the rapid response team. The efferent limb is responsible for the initiation of the appropriate intervention and has the ability to make patient placement decisions and access the equipment and additional caregivers to provide definitive treatment.

Stewart: The event detection and response triggers are important in making sure that patients at risk are recognized early so a response can be activated. Having additional resources available when there is a change in patient condition allows expedited treatment for the patient. This is especially true of the rapid response system is set up with protocol responses for certain conditions or when a physician is part of the team.

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There are two predominant paradigms for response triggering: single parameter, and multiple parameter scores. Which is better?

Mailey: Single parameter triggers are able to capture deterioration in its early stages. Once physiological deterioration progresses, more compensatory mechanisms are induced or cascaded to maintain homeostasis. Multiple parameter scores detect advanced deterioration and are more specific whereas single parameter scores are less specific but significant enough to activate the RRS earlier. Single parameter triggers when activated lead to identification of any afferent limb variances that were undetected previously.

Winters: In my opinion, the answer is unknown. The sensitivity and specificity of physiological limits for preventing arrest is unclear. Many different alert or activation systems have been used; some successfully, but others have poor inter-rater reliability. Individual physiological triggers also have inter-rater variability. Simpler scores seem to work better but not necessarily better than specific vital signs. Extended criteria may have low specificity leading to numerous false alarms; more restrictive criteria may lead to missed opportunities for rescue. I think answers will be worked out as we develop the afferent limb.

Schabaker: It would be ideal for nurses to keep up with a "scorecard" where they would document multiple parameters. Recent research from the United Kingdom states that establishing early warning criteria would enable the nurse to take a lead in earlier detection of an at-risk patient.

Ochroch: Single parameter systems are easier to introduce and monitor, but systems like pulse oximetry have not impacted mortality. EKG telemetry impacts mortality only when it is strictly applied in the peri-myocardial infarction period. Systems that integrate multiple physiologic data sources have been studied and their results have not been spectacular. All of these systems tend toward high rates of false positive alarms (rather than false negatives) and this causes respondent burnout.

Stewart: Our system uses a number of triggers for calling the rapid response team, one of which includes the care giver is worried about the patient. Some calls are false positives but more frequently there is some treatment modality involved with each call.

If monitoring means the assessment of patients with the intention of triggering a response if a severity-of-illness threshold is reached, then is continuous monitoring or intermittent monitoring better?

Mailey: Continuous monitoring provides constant information of the patient's physiological status. Most patient's who fail outside of the ICU and die from cardiac arrest usually present with a non-cardiac issue prior to deterioration.[7-10] Survivability rates post cardiac arrest is only 17%. If continuous monitoring can lead to early activation of the RRS then continuous monitoring is better.

Schabacker: It is not feasible to continuously monitor all of the patients throughout any institution. The majority of patients who experience a cardiopulmonary arrest have evidence of deterioration within 8 hours preceding the event. Complications arising from opioid pain management are major contributors to respiratory-related adverse events, so I feel that post-operative patients receiving pain management should be continuously monitored with at least SpO2.

Ochroch: The advantage of intermittent monitoring is that a caregiver can interact with the patient. Even if the person collecting the data is relatively untrained their overall impression is probably more important than the data. Continuous monitoring without intelligent automated

data analysis for trend interpretation typically leads to data overload.

If monitoring is intended to detect deterioration and prevent every death possible, then is continuous monitoring or intermittent monitoring better?

Mailey: Some monitoring systems such as continuous pulse oximetry could be easily implemented on medical surgical wards without a large expenditure of resources or further education of staff. Most research indicates respiratory triggers supersede other parameters in frequency.

Schabacker: A concern we have about continuous monitoring are the amount of false alarms you get when you continuously monitor patients. Unfortunately, by monitoring everyone on a continuous basis the false alarms will cause all the alarms to be ignored.

Stewart: Continuous monitoring would be better for the patient even if the system created false alarms. Intermittent monitoring is solely dependent on the frequency of the monitoring.

Winters: If we seek to prevent every single preventable death, then to some extent the issue of risk stratification for monitoring becomes moot since even the most healthy young patient still has some risk and continuous monitoring becomes more desirable, costs and logistics aside.

Ochroch: We have not been able to determine when a patient is deteriorating based solely on physiologic data. Consequently either monitoring mode will not be sufficient on its own. Intelligent programs that look for trends will probably be able to focus a practitioner's attention rather than having the data overwhelm them.

Should respiratory monitoring supersede cardiac monitoring for earlier detection of deterioration?

Mailey: Research indicates that the majority of triggers prior to an adverse physiological event are respiratory. Both cardiac and respiratory monitoring are important. Respiratory monitoring is unable to detect unstable cardiac rhythms with specificity although cardiac rates can be detected through pleth waveforms. On the other hand, cardiac monitoring without respiratory monitoring of some sort gives an incomplete clinical picture. For example, if a patient is hypoxic and becomes bradycardic secondary to hypoxia, then clinicians may begin treating the slow heart rate incorrectly and do more harm than good with incomplete data.

Schabacker: Again, the majority of patients who require a rapid response are displaying some type of respiratory-related adverse event. This does not mean cardiac or hemodynamics should be ignored, but the majority are respiratory-related. Knowing that, I would have to say respiratory monitoring should supersede cardiac monitoring.

Some monitoring systems such as continuous pulse oximetry could be easily implemented on medical surgical wards without a large expenditure of resources or further education of staff.

Stewart: The leading cause of events in my organization is respiratory events followed by cardiac events with neurological change being third.

Winters: As it stands now, I would say yes. This is based on the evidence on specificity and sensitivity of vital signs as triggers alone or as a composite. The data, as well as our own experience, suggest a higher percentage of RRS activations involving respiratory changes (desaturation, tachypnea, dyspnea etc.) vs. cardiac changes as the trigger for the call.

REFERENCES

1 Hillman K, Chen J, Cretikos M, et al. Introduction of the medical emergency team (MET) system: a cluster randomised controlled trial. Lancet. 2005;365(9477):2091-7.

2 Winters BD, Pham J, Pronovost PJ. Rapid response teams - Walk, don't run. JAMA. 2006;296(13):1645-1647.

3 Teplick R, Anderson AE. Rapid response systems: move a bit more slowly. Crit Care Med. 2006;34(9):2507-9.

4 Chan PS, Khalid A, Longmore LS, et al. Hospital-wide code rates and mortality before and after implementation of a rapid response team. JAMA 2008; 300:2506-2513.

5 Chen J, Bellomo R, Flabouris A, Hillman K, Finfer S; MERIT Study Investigators for the Simpson Centre; ANZICS Clinical Trials Group. The relationship between early emergency team calls and serious adverse events. Crit Care Med. 2009;37(1):148-53.

6 Institute of Healthcare Improvement (2004). Available at: www.ihi.org/IHI. Accessed: September 15, 2009.

7 Franklin C, Mathew J. Developing Strategies To Prevent In-Hospital Cardiac Arrest: Analyzing Responses Of Physicians And Nurses Hours before The Event. Critical Care Medicine 1994;(22-2):244-47.

8 Perberdy M, et al. Survival from in Hospital Cardiac Arrest during Nights and Weekends. JAMA. 2008;299(7):785-92.

9 Schein RM, Hazday N, Pena M, Ruben BH, Sprung CL. Clinical antecedents to in-hospital cardiopulmonary arrest. Chest. 1990;98(6):1388-92.

10 Mailey J, Rubinfeld I, et al. Reducing Hospital Standardized Mortality Rates With Early Interventions. Journal Of Trauma Nursing. 2006;13(4):178-182.

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belief is that if these patients received care earlier we may either prevent cardiac arrests and/or it would make it easier to resuscitate the patient. If the code or medical emergency team (MET) were called because a patient was suddenly having frequent premature ventricular contractions or peaked T waves suggesting hyperkalemia, and were thus present in the room when the patient suffered a cardiac arrest, one could argue that patient would have a higher likelihood of surviving the event. For example, if the coronary arteries have been well perfused and the patient suddenly has an arrhythmia, it is relatively easy to resuscitate them if we defibrillate within a minute, for instance. For every minute delay in initiating defibrillation, there is a 10% decrease in survival.[4] There are areas in the hospital where people are not watched as closely and if they have a sudden event, it may not be recognized in a timely manner. Another key issue is that when CPR is given, it may not be given optimally. Studies show that is true even in hospital.[5] When the code team arrives, there may be a delay in defibrillation for some reason.[6] The reasons for low survival rates are multifactorial and are not just related to how sick the patient is.

People who have a cardiac arrest in the hospital are cared for by medical personnel who are experts in resuscitation. Does that increase their chances of survival compared to someone who has a heart attack on the street or in the airport?

Dr. Hunt: That is not as true as we might think. Out-of-hospital survival rates for cardiac arrest vary considerably from community to community. Overall, the rates are lower than hospitals, with survival-to-hospital discharge for people who suffer a sudden cardiac arrest and are treated by Medical Emergency Services (EMS) averaging about 8%. However, just as we see in hospitals it seems that the quality of care delivered to the victim, i.e. bystander CPR and time to defibrillation, are likely to be major contributors to the likelihood of a good outcome. In a recent analysis of 10 major North American EMS syestems, survival to discharge varied from 3 to 16.3%.[7] That means that the best EMS system in Seattle performs as well as the average hospital, i.e. 16.3% vs. 17%.[1,7] In communities that provide quick access to some of the resources we find in hospitals, we find higher rates of survival. For example, the use of automated external defibrillators (AEDs) in airports have yielded survival rates very similar to hospitals. Studies have found that having a rapidly deployable AED-equipped first responder service in airports enabled airport personnel to apply defibrillation very rapidly, before the EMS team arrived. In one study, an airport fire rescue crew was able to apply the defibrillator within 2 minutes. By contrast, the EMS response times were more than 5 minutes and advanced life support was applied at only 8 minutes.[8] All patients who survived to hospital admission and discharge received their first shock by the airport fire rescue crew. In 5 of the 8 survivors to hospital discharge, defibrillation by the airport crew alone achieved a return of spontaneous circulation. It follows the same premise as in the hospital setting – with rapid care you have the highest chance of bringing the patient back

> Studies show us that survival rates are lower on evenings and weekends, times when the staffing ratios change.
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> — Hunt —

What are the current challenges to successful in-hospital resuscitation of patients, in particular with regard to earlier intervention?

Dr. Hunt: It's commonly believed that hospitals are staffed with resuscitation experts. The reality is that most people who respond in the first few minutes of an event are not experts in resuscitation. Most nurses or doctors who work in the day-to-day environment of a hospital deal with living, breathing patients and do not have years of training in critical care. So we are trying to improve early intervention through several means.

Monitoring can be improved by raising the nurse-to-patient ratios so the nurse sees the patient more frequently. This is important because studies show us that survival rates are lower on evenings and weekends, times when the staffing ratios change.[9] Unfortunately, there are no clear data to identify the type of monitoring we should be using in hospitals, especially for non-cardiac patients. We know that not all cardiac arrests are in patients who have preceding cardiac disease.

In some patients we sometimes have hours or days of preceding symptoms with regard to heart rate, blood pressure, respiration, and so forth. If we had better ways of being alerted to these subtle changes, we could transfer these patients into an ICU before they have a cardiac arrest. In my mind, the major issues to address are nurse-to-patient ratios, better ways of monitoring that allow us to see trends, and encouraging people to call for help early.

What changes are necessary for improving the success rate of in-hospital resuscitation? Is it an issue of better training of nurses, better continuous monitoring, or better telemetry?

Dr. Hunt: It is all of these factors. The reality is that we cannot always predict who is going to have a sudden event, even with continuous monitoring. By far, the majority of patients who have a cardiac arrest show signs of deterioration hours before the event. We need to develop monitoring that alerts personnel to these trends, as well as effective programs to train personnel to recognize these deteriorations. Simulation of patient events can be very powerful in this regard. Certainly, whenever it is feasible, having our patients on continuous monitoring is currently the best way to pick up cardiac events as early as possible.

It is also very important to encourage ward staff to call for help early, whether it be for the charge nurse, the house physician, the intensivist and/or the code teams or METs. For many years, it was standard practice not to call the code team until the patient had no pulse. Now we tell staff to call at the first sign that something is wrong. For example, changes in mental status are an important trigger for calling a MET. A patient may be behaving abnormally due to low blood pressure that is causing inadequate perfusion of the brain, i.e. shock, or be hypoxemic and in impending respiratory distress or may have suffered a stroke that can be reversed with rapid assessment and treatment. That is, having a system in place for getting help to the bedside of a patient before they become apneic or pulseless so that we can try to avoid the arrest is the current challenge and one of the main reasons for the rapid spread of METs.[10]

Would respiratory monitoring improve survival rates?

Dr. Hunt: I don't think there are definitive data on the value of respiratory monitoring, per se, in preventing cardiac arrests, but disordered breathing and concomitant hypoxia clearly put the patient at increased risk. A recent analysis of NRCPR data evaluated patients with acute respiratory compromise that required treatment by medical emergency teams. They found that 1-in-6 patients who suffered one of these events progressed to cardiac arrest and that most of those arrests occurred within 10 minutes of the respiratory event. One quarter of these events were on in-patient wards.[11] This certainly raises the question as to whether closer monitoring could have prevented these events or at least decreased the likelihood of progression to cardiac arrest if patients were identified earlier. There is keen interest in developing systems that monitor all the vital signs and combine them to produce a global assessment of risk.

How has patient and family centered care changed the field of in-hospital resuscitation?

Dr. Hunt: This has had an impact in two areas. First, we have come to appreciate that families know the patient best and can recognize quite early when something is wrong with their loved ones. We are learning to act on their observations rather than just politely acknowledge them. In Pittsburgh, the UPMC Shadyside Hospital created a program called Condition H (HELP), which encourages families to call the MET directly when they detect a serious change in their family member. This program is also in place at Johns Hopkins. For example, when a child is admitted to our hospital, parents are handed a pamphlet that tells them about our pediatric MET with a number to call if they feel like they need help quickly. There are also posters with the number in every patient room. We ask them to be partners with us in keeping their loved one safe.[12]

We also allow families to be present during CPR, if they choose to do so. Research has shown that this has a positive impact on their perception of the emergency treatment of their family member and that a large proportion of the public would want to be present if their loved one was receiving CPR.[13] However, we should consider how to prepare nurses and physicians for this change in practice. For example, a recent study revealed that in simulated cardiac arrests, there was a delay to defibrillation in scenarios in which the family member was reacting very loudly as opposed to when there was no family member or a quiet family member.[14]

We know that earlier intervention is critical to improving resuscitation. Is there a role for telemetry in the noncardiac patient?

Dr. Hunt: We know that patients who have a cardiac arrest in an unmonitored setting have a lower chance of survival to discharge than those who are monitored.[15] Thus, if we had a low cost, low risk monitoring system available such that every hospitalized patient could be continuously monitored, then it would be hard to argue that they should not be in place. However, the potential risks to the patients and the unintended consequences have to be considered. For example, if we discovered that lack of routine monitoring was associated with less ambulation (i.e. due to being "tethered" in beds by monitoring wires) in certain postoperative patients, then we would have to be concerned about a higher incidence of deep venous thrombosis or pulmonary embolism. Having a low cost system in place where the patient can be ambulatory but also be monitored without wires would be ideal. We also have to be careful to limit the number of false alarms that can lead to alarm fatigue. This is certainly an exciting area of investigation right now. I don't think we are at the point where every patient can be monitored at low cost without too many false alarms, but I feel strongly that we need to move in that direction.

We know that patients who have a cardiac arrest in an unmonitored setting have a lower chance of survival to discharge than those who are monitored.

What are the essential elements in improving in-hospital arrests?

Dr. Hunt: Prevention of progression to cardiac arrest is very important, and this entails developing systems that enable us to recognize early when patients are in shock or are in respiratory compromise, for example. We know that the lower the nurse-to-patient ratio, the more difficult it is for the nurse to identify problems early. We should also acknowledge the importance of empowering our front line nurses and doctors to call for help when they do recognize that a patient is beginning to deteriorate. Unfortunately, any of us who have started and managed METs have repeatedly observed situations where the nurse did not call for help because of how she was treated by the team members the last time she called for help. This is unacceptable and is part of the difficult process of changing culture in a hospital. But it is important and we must keep studying ways to make it safe, acceptable and essential that the front line nurses and doctors call for help as early as possible.
Also, as I said before, we know that patients who have a cardiac arrest in an unmonitored setting have a lower chance of survival to discharge than those who were monitored.[15]

In addition to prevention of cardiac arrest, we need to focus on the quality of resuscitation we deliver once the patient has had a cardiac arrest. The 2005 AHA guidelines have taken us back to the basics.[16] For years, we have been focusing on advanced life support components, which are important, but the reality is that high quality CPR is what keeps the patient alive until you defibrillate or apply advanced life support medications, so we are focusing on improving the quality of in-hospital CPR.

It is an exciting era. We now have "smart" defibrillators that can measure the quality of CPR. They can give you feedback on whether or not you should press deeper, whether you have paused too long, and they will actually remind you to resume CPR. We are also training multidisciplinary METS to work in a more cooperative, integrated manner and use of these teams may either prevent cardiac arrests or allow these teams of experts to be at the bedside when the arrest occurs. This may be another mechanism for helping us improve the quality of care we deliver during cardiac arrests. Quality control programs such as the NRCPR are being used to inform hospitals about their shortcomings and suggest means for improving.[17]

At Johns Hopkins, how has staff education and training contributed to improved in-hospital resuscitation?

Dr. Hunt: For this question, I will focus on the work we have been doing in the children's hospital at Johns Hopkins. Several years ago, we came to believe that our patients who were deteriorating quickly and needed basic or advanced life support (BLS and ALS) were not receiving the highest quality of care possible, despite the best intentions of our staff, who we considered to be well trained. To define the magnitude of the problem, we decided to utilize simulated pediatric medical emergencies or "mock codes" as a method to investigate this issue.
Like many hospitals, we have done "in situ" simulations or mock codes in clinical environments for years. For this study, we conducted monthly mock codes and systematically measured how long it took the ward team and the code team to do a variety of maneuvers. We discovered some alarming findings. We realized that the ward teams were over focused on advanced life support and preparing for the arrival of the code team as opposed to actually doing the BLS. We also discovered that the ward team typically had to manage the patient for 5 minutes before the code team arrived, so they truly were the first link in the chain of survival and the most likely to impact the outcome of a child who becomes critically ill on the wards.[18] In response to this data, we created the "First Five Minutes Curriculum" to train the ward team to do high quality BLS and rapid defibrillation (i.e. use of the AED). We literally changed the job descriptions of the ward staff to highlight the importance of BLS, and we no longer expected them to prepare arrest medications. In response to this change, we added a pediatric pharmacist to the team with the sole responsibility of preparing medications for these calls. We also made sure that people understood the key process of care goals, such as the need to defibrillate any shockable rhythm within 3 minutes.

Third, we made a shift in priorities and focused on preventing respiratory and cardiac arrests. In October of 2004, we officially changed from a reactive to a proactive response by transitioning from a code team to a pediatric medical emergency team. We were one of the first children's hospitals in the nation to make this change so there was little data on how to do this for children. The data continues to evolve, but our key mantra has been to tell everyone to call us early and call us often, whenever there was a worry. We witnessed a decline in our rate of respiratory arrests, which was both unexpected and very exciting.[19]

We also focused on the quality of care that both the ward team and MET delivered when they arrived. For example, to further understand the problem, we did a series of mock codes where we tested each individual pediatric resident and discovered that one third of them did not start CPR on their own when managing a child who went into pulseless ventricular tachycardia. We once again observed that our healthcare providers focus on ALS and forget the basics, i.e. CPR. There were also long delays to defibrillation.[20] In response to these problems, we created a curriculum that allows residents to practice these skills during the month they carry their MET beepers. We were excited to see a dramatic improvement in their performance. We also discovered the importance of providing hands-on practice to our nurses and doctors. In our study, residents who had performed all the steps of discharging a defibrillator, on either a real patient or a mannequin, were 87% faster at defibrillating than those who did not have that opportunity.[20] This was exciting information because it changed the way we train our residents and nurses.

We have seen the same type of progress on the wards. It used to be that the ICU members of the Code Team were the first to start CPR on a child who had a cardiac arrest on the wards; now CPR is already in process when the MET arrives. In fact, sometimes the child has already been defibrillated before the MET gets there. We are sharing this information with other hospitals at national conferences but also offering a chance for staff members from hospitals in the Baltimore area to attend our simulation center for training. We also continue to publish our results so others can see if these approaches may be helpful for their hospitals.

REFERENCES

1. Peberdy MA, Kaye W, Ornato JP, et al. Cardiopulmonary resuscitation of adults in the hospital: a report of 14720 cardiac arrests from the National Registry of Cardiopulmonary Resuscitation. Resuscitation. 2003;58(3):297-308.
2. Nadkarni VM, Larkin GL, Peberdy MA, et al. First documented rhythm and clinical outcome from in-hospital cardiac arrest among children and adults. JAMA. 2006;295(1):50-7.
3. Buist MD, Jarmolowski E, Burton PR, Bernard SA, Waxman BP, Anderson J. Recognising clinical instability in hospital patients before cardiac arrest or unplanned admission to intensive care. A pilot study in a tertiary-care hospital. Med J Aust. 1999;171(1):22-5.
4. Valenzuela TD, Roe DJ, Cretin S, et al. Estimating effectiveness of cardiac arrest interventions—a logistic regression survival model. Circulation. 1997;96:3308–13.
5. Abella BS, Alvarado JP, Myklebust H, et al. Quality of cardiopulmonary resuscitation during in-hospital cardiac arrest. JAMA. 2005;293(3):305-10.
6. Chan PS, Krumholz HM, Nichol G, Nallamothu BK; American Heart Association National Registry of Cardiopulmonary Resuscitation Investigators. Delayed time to defibrillation after in-hospital cardiac arrest. N Engl J Med. 2008;358(1):9-17.
7. Nichol G, Thomas E, Callaway CW, et al. Regional variation in out-of-hospital cardiac arrest incidence and outcome. JAMA. 2008;300(12):1423-31.
8. MacDonald RD, Mottley JL, Weinstein C. Impact of prompt defibrillation on cardiac arrest at a major international airport. Prehosp Emerg Care. 2002;6:1-5.
9. Peberdy MA, Ornato JP, Larkin GL, et al. Survival from in-hospital cardiac arrest during nights and weekends. JAMA. 2008;299(7):785-92.
10. Devita MA, Bellomo R, Hillman K, et al. Findings of the first consensus conference on medical emergency teams. Crit Care Med. 2006;34(9):2463-78.
11. Wang HE, Abella BS, Callaway CW; American Heart Association National Registry of Cardiopulmonary Resuscitation Investigators. Risk of cardiopulmonary arrest after acute respiratory compromise in hospitalized patients. Resuscitation. 2008;79(2):234-40.
12. Shilkofski NA, Hunt EA. Use of a Pediatric Medical Emergency Team (PMET) to manage a complex child with hypoxia and a worried parent. Jt Comm J Qual Patient Saf. 2007;33(4):236-41, 185.
13. Mazer MA, Cox LA, Capon JA. The public's attitude and perception concerning witnessed cardiopulmonary resuscitation. Crit Care med. 2006;34(12):2925-8.
14. Fernandez R, Compton S, Jones KA, Velilla MA. The presence of a family witness impacts physician performance during simulated medical codes. Crit Care Med. 2009;37(6):1956-60.
15. Chan PS, Nichol G, Kruhmholz HM, Spertus JA, Nallamothu BK; American Heart Association National Registry of Cardiopulmonary Resuscitation (NRCPR) Investigators. Hospital variation in time to defibrillation after in-hospital cardiac arrest. Arch Intern Med. 2009;169(14):1265-73.
16. American Heart Association. 2005 American Heart Association (AHA) guidelines cardiopulmonary resuscitation (CPR) and emergency cardiovascular care (ECC) of pediatric and neonatal patients: pediatric advanced life support. Pediatrics 2006;117:e1005–28.
17. Hunt EA, Mancini ME, Smyth M, Truitt T for NRCPR Investigators. In-Hospital Resuscitation: Using the American Heart Association's National Registry of Cardiopulmonary Resuscitation (NRCPR) as a Performance Improvement Tool. Jt Comm J Qual Patient Saf. 2009;35(1):13-20.
18. Hunt EA, Walker AR, Shaffner DH, Miller MR, Pronovost PJ. Simulation of In-Hospital Pediatric Medical Emergencies and Cardiopulmonary Arrests: Highlighting the Importance of the First 5 Minutes. Pediatrics. 2008;121(1):e34-43.
19. Hunt EA, Zimmer KP, Rinke ML, et al. Transition from a Traditional Code Team to a Rapid Response Team in a Children's Center: A Before and After Intervention Trial. Arch Pediatr Adolesc Med. 2008;162(2):117-22.
20. Hunt EA, Vera K, Diener-West M, et al. Delays and Errors in cardiopulmonary resuscitation and defibrillation by pediatric residents during simulated cardiopulmonary arrests. Resuscitation. 2009;80(7):819-25.

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1. **According to data from the National Registry of CardioPulmonary Resuscitation (NRCPR), the adult survival rates for in-hospital resuscitation events is reported to be:**
   a. < 20%
   b. 20% - 40%
   c. 40% - 60%
   d. > 60%
2. **Factors that may contribute to the low in-hospital resuscitation rates include**
   a. delay in defibrillation, sub-optimal CPR and time of day
   b. unrecognized signs and symptoms, failure or delay to call for help and high patient-to-nurse ratio
   c. severity of illness, low patient-to-nurse ratios and failure or delay to call for help
   d. time of day, low patient-to-nurse ratios and delay in defibrillation.
3. **Which of the following has the most direct impact on patient survival?**
   a. Continuous ECG monitoring for all patients
   b. Early activation of a rapid response or medical emergency team
   c. Improving CPR skills for all hospital employees
   d. Lower nurse-to-patient ratios
4. **The wife of a 72 year old man with pneumonia, comes to your station and requests "if it is not too much trouble, would you please come and see my husband, he just does not look good to me." The most appropriate response would be:**
   a. Ask the name of the patient, tell wife that you will find his nurse.
   b. Explain that you are going to call for help, pick up the phone and activate the rapid response team.
   c. Reassure her that he is probably fine and that you will be there in a few minutes.
   d. Realizing that the family members can pick up important subtle changes, you calmly walk back to the room with her to further assess the patient.
5. **The majority of patients that require rapid response team interventions present with**
   a. cardiac triggers
   b. neurological triggers
   c. respiratory triggers
   d. vascular triggers
6. **The afferent limb of a rapid response system**
   a. addresses the data collection and analysis of outcomes of events
   b. defines the roles and responsibilities of the responding team members
   c. is described as event detection and activation of the rapid response team
   d. details the equipment and supplies that are used by the rapid response team
7. **The efferent limb of a rapid response system**
   a. addresses the data collection and analysis of outcomes of events
   b. defines the roles and responsibilities of the responding team members
   c. is describe as event detection and activation of the rapid response team
   d. describes when equipment and supplies are used by the rapid response team
8. **Despite inconsistent data to support that rapid response teams reduce in-hospital mortality, there is research to support that rapid response systems**
   a. decrease length of stay in specific patient populations
   b. decrease reportable adverse events
   c. decrease the number of cardiac arrest outside of the ICU
   d. decrease the number of patients admitted to the intensive care unit
9. **The possible benefit of using continuous monitoring for all hospitalized patients is a**
   a. decrease in false alarms that may cause alarm fatigue
   b. decrease in patient mobility
   c. increased revenue for the hospital related to monitoring charges
   d. increased vigilance and earlier recognition of patient changes
10. **Single parameter or multiple parameter scoring systems do not replace trained professionals examining the patient.**
    a. True
    b. False
11. **Changes in pulse oximetry readings can serve as an early warning trigger to activate the rapid response team.**
    a. True
    b. False
12. **There is definitive research to support that one type of monitoring, single parameter, multiple parameter scoring, intermittent or continuous monitoring of vital signs should be used for all patients.**
    a. True
    b. False

Participant's Evaluation

This program has been approved for 1.5 contact hours of continuing education (CRCE) by the American Association for Respiratory Care (AARC). AARC is accredited as an approver of continuing education in respiratory care.

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The goal of this program is to educate healthcare professionals on the management of OSA

What is the highest degree you have earned? Circle one. 1. Diploma 2. Associate 3. Bachelor 4. Masters 5. Doctorate

Indicate to what degree the program met the objectives:

1. List the factors that contribute to the low in hospital resuscitation rate.
   Strongly Agree 1 2 3 4 5 6 **Strongly Disagree**
2. Explain how early interventions may improve survival rates
   Strongly Agree 1 2 3 4 5 6 **Strongly Disagree**
3. Describe the efferent and afferent limbs in a rapid response system.
   Strongly Agree 1 2 3 4 5 6 **Strongly Disagree**
4. Describe the role of continuous monitoring in triggering a rapid response call.
   Strongly Agree 1 2 3 4 5 6 **Strongly Disagree**
5. Please indicate your agreement with the following statement. "The content of this course was presented without bias of any product or drug."
   Strongly Agree 1 2 3 4 5 6 **Strongly Disagree**

Answers

	A	B	C	D		A	B	C	D
1	☐	☐	☐	☐	9	☐	☐	☐	☐
2	☐	☐	☐	☐	10	☐	☐		
3	☐	☐	☐	☐	11	☐	☐		
4	☐	☐	☐	☐	12	☐	☐		
5	☐	☐	☐	☐	13				
6	☐	☐	☐	☐	14				
7	☐	☐	☐	☐	15				
8	☐	☐	☐	☐	16				

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