Duke Emergency Services

In This Issue

Vol. XI, No. 1 ❖ 2003

Hypertensive Stroke: Pressure In The Box

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Duke LifeNet

"Duke ER, Duke ER…this is Life Flight 1 how do you copy?" "This is Duke ER go ahead Life Flight." "Life Flight 1 has a 10 minute ETA to your facility with a 78 year old African-American male that presented to the outside hospital with a headache, vision changes and decreasing mental status about 3 hours ago. The patient is intubated, tolerating the ventilator well after sedation and has vital signs as follows – BP 189/119, HR 89 and pulse oximetry reading is 100% on 100% Fi02. His pupils are 3mm and sluggish bilaterally. He had decreased movement of his right side and decreasing mental status at the referring facility prior to intubation. The patient is being treated with labetolol and gentle hydration in flight. He has two peripheral IV sites that are patent. Again, our ETA is about 9-10 minutes…if no questions, will give further upon landing." "Life Flight, no questions…see you in 9 minutes." "Life Flight 1 clear." "Duke ER clear."

Sound familiar. It probably does if you work in the ER at a tertiary center or at a referring facility ER. Hypertensive stroke is responsible for thousands of deaths each year. Patients that present to emergency departments with the above complaints unfortunately have no say as to their risk factors. Stroke usually is not discriminative to race, age or sex. Some risk factors can be controlled such as diet, cessation of smoking, low salt diets and compliance with medical regimens. The preceding lifestyles

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Duke Trauma Center
Duke Life Flight
Duke Emergency Department
Duke Transfer Center
Duke Disaster Planning
Duke University Hospital
Durham, North Carolina

We are pleased to feature three articles in this issue of LifeNet. The first is a discussion of the "Endpoints of Resuscitation" by Dr. Tim Hayward. He highlights the importance of obtaining early, and serial, lactate or base deficit values as a measure of oxygen debt and the response to resuscitation.

The second article, by Dr. Victoria Thornton gives a brief review and treatment of hypothermia, an entity not commonly seen in North Carolina, but one that is important to recognize and treat promptly.

The third article by Kevin Mumma, RN and Carmelo Graffagnino, MD discusses hypertensive stroke, a commonly seen and potentially devastating condition in which the choice of treatments may have a dramatic affect on neurologic outcome or survival.

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Duke Emergency Services

Duke *LifeNet* *is published by Duke University Medical Center*

If you have comments or suggestions for future articles, please contact Claudia McCormick at DUMC 3402, or via e-mail at mccor019@mc.duke.edu.
www.dukehealth.org/emergency_services/trauma

Designed and produced by: Duke Publications Group

are very popular causes of hypertensive stroke. The patient usually shows up at the ER via EMS or by personal vehicle. Many times the patient is brought in by family members because initially the symptoms at home were mild, but on the way to the emergency room, they have progressed to severe. The family member driving will pull up frantically and honk the horn because the patient now has gotten much worse. The pathophysiology involves blood vessel walls that cannot hold such pressure and start to leak or aneurysm. This pressure causes movement of the only three components in the skull (blood, brain tissue and cerebrospinal fluid). The "Monroe-Kellie Doctrine" states that if one of these components increases, one must decrease. Because the skull is a non-pliable container, the increase of the blood in this container causes pressure on the other components. The blood that is released is very caustic to the surrounding tissues. The cytotoxins released during the development of this cerebral edema may cause a wide variety of symptomatology. The presenting symptoms usually manifest themselves on one side and include, vision changes, headache, numbness, tingling and mental status changes if progressing to severe. These patients are in need of advanced life support and should have their ABC's addressed immediately. The ER physician will then order a battery of tests including but not limited to blood work, CXR, brain CT scan and certain medicines if needed. The patient's primary problem is usually the hypertension and treating this is a very complicated process. This process consists of alleviating the hypertension without making more room for bleeding, controlling intra-cranial pressure (ICP) and balancing hydration status. Nitroprusside still remains the "gold standard" for hypertensive crisis although it may not be the best regimen for the patient with hypertensive crisis that has now developed an intra-cranial bleed with increasing intra-cranial pressure (IICP).

The patient with hypertension (SBP >160mmHg) and a documented head bleed on a brain CT scan will benefit mostly with adequate hydration and lowering of the BP with agents such as Labetolol and Nicardipine (depending on the patients risk for vasospasm- this is not the case in hypertensive bleeds. Limiting factors determining the choice between labetolol or nicardipine are issues such as pre-existing bradycardia, asthma, heart failure, and failure of one of these agents to control BP therefore requiring a change of drug). Other agents used widely such as nitroprusside and nitroglycerin are potent vasodilators and could potentially cause the patients ICP to reach caustic levels secondary to the increasing cerebral edema caused by the vasodilatory effects of these medicines. The patient should be hydrated with crystalloid fluids such as NSS at a gentle rate; unless hypotension occurs, and avoiding dextrose containing fluids as they cause fluid shifts into the brain tissue causing increasing cerebral edema. Dextrose containing fluids should not be

used unless profound hypoglycemia is present. If the patient is to be transported either by ground or by air to a tertiary center, the patient must have a maintained patent airway, 100% oxygen to decrease the risk of increasing ICP because hypoxia can cause brain swelling, head of bed elevated to a 45 degree angle (if no trauma noted) and the head midline and secure. Other interventions beneficial to this patient are sedation, paralytics (if intubated) and as quiet an environment as possible. If the patient progresses to severe symptomatology of IICP such as papillary changes or posturing, then the patient may receive IV Mannitol, an osmotic diuretic to combat IICP that can lead to herniation of the brain through the lower hole in the skull. For the intubated hypertensive head bleed patient, the latest literature supports end tidal C02 (ETC02) levels kept at 35-40 with augmentation of ventilatory rate and tidal volume. If the symptoms of herniation occur, increase in ventilation rate or tidal volume may be needed to keep the ETC02 level at 30. Active hyperventilation to the patient that is not herniating has been shown to cause hypoxia and damage to viable parts of the brain not yet affected. The other important patient management issue is that of seizure prophylaxis. Patients who have seized or are seizing will receive Phenytoin IVor Phosphenytoin IV or IM (decreased absorption) slowly watching for hypotension and cardiac dysrhythmias along with the administration of an anxiolytic for the seizure activity.

The patient that presents to the ER with the above disease process is in severe need of our aggressive emergency care as healthcare workers. These patients should receive the highest level of care supported by the latest literature to combat secondary brain damage and to administer the advanced life support that they need. Family members should be well informed of what has happened, what will happen and the course of medical management so that they too can make informed decisions if needed. There are many resources available at The Duke University Health System for the hypertensive head bleed patient. Advance life support air and ground transport services, advanced radiological imaging techniques and tertiary Neurosurgical and neurological nursing care. Other resources at Duke University Health System involve cutting edge research such as "head cooling" studies and the like. Further research is always needed in this arena and the research being performed now will help the medical management of these patients in the future.

13th Annual Duke Trauma Conference

March 13, 2003

Contact John Duskey:

919-684-2197

Join Duke Life Flight!

Duke Life Flight is a comprehensive air/ground critical care transport program with bases in Lumberton, Smithfield, Burlington, and Durham North Carolina. The program is currently seeking RN's and EMT Drivers to join our team! **RN Requirements include:** 3 years of current ICU/ED experience and the ability to work in a diverse autonomous environment, satisfactory completion of physical fitness standards, ACLS, PALS, and PHTLS/TNCC preferred, maximum weight 257lbs, and a 2-year minimum commitment to the program. Rotating 12-hour shifts available. **EMT Driver Requirements include:** 2 years of EMT experience, current North Carolina EMT certification, 25 Years of age, satisfactory completion of physical fitness standards, and a 2-year minimum commitment to the program.

If you are interested and would like to learn more about Duke Life Flight, contact one of the Clinical Operations Director nearest you!

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Cold and Confused: Hypothermia

by
Victoria Thornton, M.D.
Emergency Department
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In early December 2002, the North Carolina Triangle area fell prey to the wrath of a winter storm that enveloped trees with an icy embrace. Pine trees in particular bent under the weight of the ice, snapping and falling onto power lines. More than a million inhabitants were without electricity, and therefore without heat and stoves, many for at least a week, and some longer. Necessity is the mother of invention it is said, and so the residents of Durham did what they could to survive the cold. Some, however, were unaware or unable to respond to the dangers of the cold itself, or in fact, put themselves in harm's way through use of dangerous alternatives to publicly supplied electrical or gas sources of cooking and heating. During the first ten days of December, more than 203 patients were treated at the Duke Emergency Department for carbon monoxide exposure. There was only one victim of significant hypothermia, however she represented all that is typical of those most at risk for this cold exposure illness.

Hypothermia is defined as a subnormal temperature of the body, and that definition is further refined in the emergency medicine literature, with significant hypothermia occurring when the core body temperature is less than 35°C/95F°. Hypothermia was recognized as early as the second century B.C. in Hannibal's military campaign in Europe in which he lost more than half of his troops to cold injury/illness while attempting to cross the Alps.

It is important to realize that cold exposure illness and injuries can occur even when ambient temperatures are above freezing, and especially when cold and wet conditions exist simultaneously. When the body's extremities are exposed to these settings, and tissue temperatures reach or are below 15°C/59°F, fingers, hands, feet, toes, ears and noses are at risk of developing frostnip which can then progress to frostbite.

Euthermia, or normal body temperature, is maintained by several mechanisms, most of which are regulated either by the brain, or by the brain in conjunction with certain metabolic proteins. Radiation, conduction, convection and evaporation are the mechanisms by which the body attempts to maintain a temperature steady state. Loss of body heat through radiation can account for 55-65% of heat, which is lost to the environment, often through unprotected extremities, including the head. Conduction is usually a minimal contributor to heat loss, but becomes a more important factor if the situation involves cold-water submersion. Convection is related to loss of body heat through heating inhaled cold air, and can account for up to 10% of heat loss. Finally, evaporation of heat through skin and respiratory activities contributes up to 25% of heat loss, and is a more important factor in children and babies who have a higher body surface area.

Risks for primary hypothermia are associated with homelessness or lack of adequate housing, and outdoor athletic exposures. Primary hypothermia results when regulatory mechanisms are simply inundated, and the body is unable to continue heat production that can overcome the degree of heat loss. Hypothermia occurs rapidly over a period of minutes in a cold water environment, over a period of hours in cold, dry environments, and may be seen over a period of days even indoors in elderly patients.

Risk factors for secondary hypothermia, in which compensatory mechanisms do not function well, include conditions which impair insight, judgment and discernment, such as age (especially newborns and infants, and the elderly), alcohol or drug use, acute head injury or stroke, mental retardation or mental illness including Alzheimer's disease.

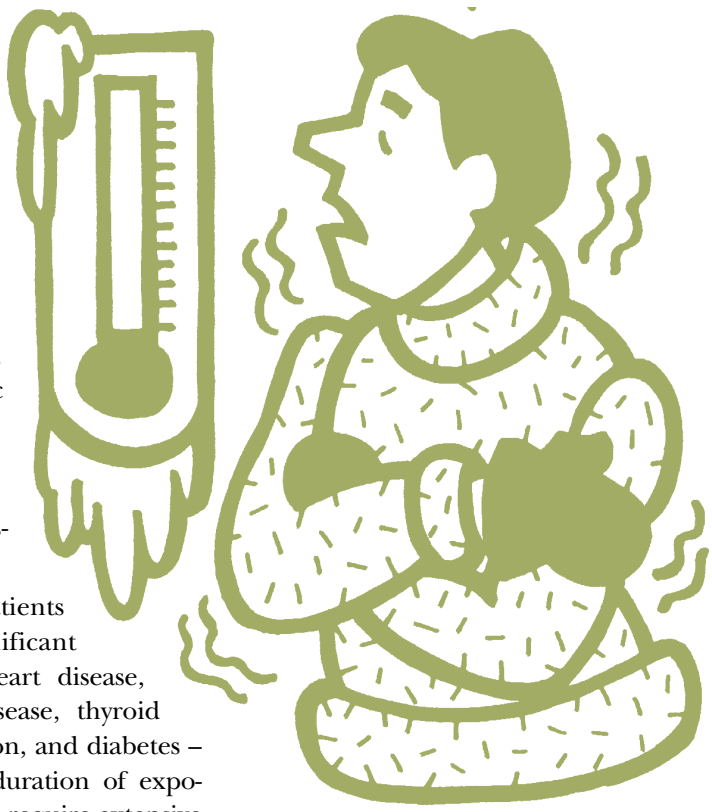
Shivering results from cold exposure and is a mechanism by which the body attempts to increase heat production, and can in fact, double heat generation. It is usually engaged when the core body temperature begins to drop and continues in the temperature range drop to 89.6°F/32°C. Mild symptoms are manifested by numbness, tingling, mottling of skin, and peripheral cyanosis. Shivering causes vasoconstriction of peripheral blood vessels, and shunting of blood to core areas of the body. Shivering also increases the basal metabolic rate, which in turn produces heat through release of hormonal proteins, which gears up the metabolism of glycogen stores. As core body temperature continues to drop, the shivering reflex tires, and all compensatory functions to produce heat simply slow down then stop once temperature reaches 75.2°F/24°C. Severe symptoms (core temperatures below 33.5°C/92°F) include confusion and altered mental status, ataxia, muscle rigidity, slowed breathing, and arrhythmias at tempera-

tures below 32°C/90°F, and bradyarrhythmias and coma at temperatures below 28°C/82°F with heart rates diminishing by 50%. Agonal findings comprise dilated and fixed pupillary responses and absent muscle reflexes, with the patient appearing dead; ventricular fibrillation, cardiac arrest and death occur at core temperatures below 25°C/77°F.

Initial attention should be paid to assessment for resuscitation – rescue breathing, CPR, ALS, defibrillation (maximum 3 attempts) and mechanical ventilation as indicated. Gentle handling is especially important in order to avoid any exertion of already comprised resources, and induction of arrhythmias.

Address the need to remove the victim from the cold environment, shelter from wind, rain and cold, remove wet clothing, cover with blankets, and employ all the tools for passive rewarming. Apply heat to the neck, axillae, groin and truncal areas of the body to avoid temporary core temperature afterdrop. When the extremities are warmed first and those blood vessels vasodilate, dumping blood into the central circulation, a temporary reduction in core temperature occurs. Avoid external heat sources such as radiant heat or hot water baths which may impair the shivering reflex, resulting in decreased heat production. Be sure to place in a warm environment and provide insulation which can encourage exogenous heat production of a few degrees per hour. Passive external rewarming is ineffective below a core temperature of 30°C/86°F.

Active core rewarming (ACR) is indicated when core temperature is below 32.2°C/89.9°F. It is particularly indicated in instances of secondary hypothermia (with thermoregulatory compromise) and/or when passive external rewarming efforts are inadequate. ACR utilizes a number of mechanisms including warmed (humidified) air or oxygen delivered through mechanical ventilation, warming of the circulation through a number of cycles of warmed peritoneal dialysis, or through extracorporeal transfusion of warmed blood, or ultrasonic diathermy, a newer methodology which delivers heat to the deeper tissues.



It is those patients who have significant comorbidities – heart disease, cerebrovascular disease, thyroid disease, hypertension, and diabetes – and a prolonged duration of exposure, and those who require extensive resuscitation, experience cardiac arrest and/or respiratory failure, whose prognoses are poor. Outcomes for victims of accidental or primary hypothermia who are essentially young and healthy, and who sustain only mild or moderate hypothermia are quite good, and in most cases resolve without sequelae.

The patient treated for significant hypothermia at the Duke Medical Center in early December, as referenced above, had several typical risk factors: she was elderly, age 84, living at home alone without heat during the ice storm, and had a history of mild dementia, coronary artery disease and hypertension. She was found in her nightgown on the front porch of her home by neighbors, and was said to be confused and shivering. Paramedics also noted that she felt extremely cold. It was unknown how long she was outside. Her core temperature in the emergency department was obtained through the use of a bladder probe and was initially recorded as 31.4°C, with mild shivering. Blood pressure and pulse were normal, and although drowsy, she was arousable, however mentation was somewhat altered. Through use of PER, her temperature was increased to 34.8°C within two hours of initiation of treatment, and by the fourth hour was 37.1°C. Diagnostic studies revealed a mild metabolic and respiratory acidosis, and elevation of creatinine kinase and urine myoglobin, reflecting the work of the muscles in combating the effects of hypothermia. Fortunately she did not develop renal failure, or any other significant permanent effects of cold exposure, and was able to be discharged on the fourth hospital day to a supervised residential setting.

In summary, recognition of this syndrome and application of measures appropriate to the degree of hypothermia are important in order to assure good outcomes for these patients.

References available upon request

Endpoints of Resuscitation

by
Thomas Z. Hayward III, M.D.

In order to talk about resuscitation one must first talk about the precedent state of shock. Shock according to the ATLS manual is an abnormality of the circulatory system that results in inadequate oxygen perfusion and tissue oxygenation. Resuscitation from shock is complete when oxygen debt has been repaid, tissue acidosis eliminated and aerobic metabolism restored.

Classically this is when blood pressure, heart rate and urine output have normalized after a period where one or all of the above variables were abnormal. However, this classic endpoint has two major problems: First, a majority of trauma patients don't have uncompensated shock and second, 80-85% of multisystem trauma patients have evidence of inadequate tissue perfusion despite a normalization of the classic endpoints.

This silent majority of trauma patients are not in uncompensated shock which leaves two groups: the first with minor injuries and the physiologic reserve to weather their injuries and a second group whose physiologic reserve is being depleted by the injuries. In this later group, the physiologic reserve of the patient or compensated shock is buying time for health care professionals to identify and treat the injuries and resuscitate the patient. Specifically, compensated shock is a state where maldistribution of blood and tissue oxygenation and perfusion is resulting in a disproportionately decreased oxygen delivery to organs, especially the splanchnic organs, in order to maintain oxygen delivery to other organs such as the heart and brain. Awareness of compensated shock gives insight in why many trauma patients who appear normal can have significant physiologic decompensations several hours after the start of a trauma evaluation, why a trauma evaluation can reveal previously unexpected severe injuries and why one-third of all trauma deaths occur as a result of multisystem organ dysfunction syndrome in the ICU.

Gastric Tonometry and Swan-Ganz Catheterization have been shown to help identify patients in compensated shock but they are invasive and cumbersome to use in the emergency room environment. For these reasons, these devices are not effective diagnostically. However, two blood tests have been shown to be effective in diagnosing patients with compensated shock.

The first is serum lactate which is an indirect measure of oxygen debt (the imbalance between oxygen delivery and consumption). While physiologists can debate the many biochemical pathways and pathophysiologic states that can lead to a state of lactic acidosis in trauma patients, a serum lactate level has been shown to be a more effective marker for compensated shock than classic hemodynamic parameters such as blood pressure, heart rate and urine output. Additionally, lactate level correction to normal has been shown to strongly correlate with trauma outcome. A lactate level normalizing in less than 24 hours has a > 95% survival, Normalization within 24-48 hours has a 78% survival rate and normalization requiring over 48 hours or never occurring has a 14% survival rate. The major downside of serum lactate for the community practioner is the laboratory test can take several hours or longer for a result making it less useful as a diagnostic test.

Another blood marker for compensated shock is the base deficit. This is a test that is readily and rapidly available at all U.S. hospitals on a standard blood gas. The blood gas test will also help to show whether the patient is oxygenating, ventilating and possibly help to estimate blood loss from injuries. Several studies in the trauma literature have shown that the admission base deficit is the single most important predictor of the probability of death. Additionally, the base deficit is an expedient and sensitive measure of both the degree and duration of inadequate tissue perfusion. Finally, the base deficit correlates with the amount of crystalloid and blood replacement over the initial 24 hours. A Mild base deficit 0 to -5 correlates with an 88% survival, 7.5 liters of crystalloid infusion and 401 cc of packed red blood cells transfusion. A Moderate base deficit -6 to -14 correlates with an 73% survival, 13 liters of crystalloid infusion and 1538 cc of packed red blood cells transfusion. A Severe base deficit >-14 correlates with an 71% survival, 16.4 liters of crystalloid infusion and 2476 cc of packed red blood cells transfusion. These numbers are especially significant for the community practioner where limited blood bank resources can be a limiting factor in caring for critically ill patients and transfer to a trauma center should therefore be considered immediately after a moderate or severe base deficit is detected. One additional point, worsening base deficit correlates with ongoing hemorrhage 65% of the time.

R Adams Cowley one of the twentieth century's trauma pioneers stated that "if you stay in shock for very long, you're dead. Maybe you'll die next week, but you're dead. If I can get to you, and stop your bleeding and restore your blood pressure, within an hour of your accident. . . Then I can probably save you. I call that the golden hour." While times have changed and therapies have advanced, insuring that trauma patients have all their injuries identified and treated and that they are completely resuscitated from a state of shock (uncompensated or compensated) saves lives. The Duke Trauma Center is willing to assist our broader community in caring for these injured patients.

References available upon request

Outreach Corner

by Ginger G. Wilkins, RN, BSN

Happy New Year to everyone! It's hard to believe we are already into 2003. With the New Year comes a renewed energy and commitment to providing you all with a resource and contact regarding trauma care. I want to thank all of you who have been so helpful in providing me with the various information I have needed to provide the NCOEMS throughout the fall. Thanks for taking the time to respond to my phone calls and e-mails in the midst of your busy days.

I enjoyed visiting each of your EDs during my December "Holiday Rounds." I certainly did not observe anyone taking it easy and having a relaxing holiday during work hours in any Emergency Department! Most were too busy with patients to say more than a quick hello. Traveling throughout the northern counties of our RAC just four days after the severe ice storm proved what a vital service you all provide to your communities. I heard story after story of the dedicated staff that came in and stayed over to provide care for patients despite their own problems at home. I had the pleasure of bringing Dr. Tim Hayward and Penny Cooper with me to all the hospitals south of and including Raleigh Community Hospital. For those of you who haven't met Dr. Hayward, he is our newest trauma surgeon here at Duke. Penny is our Trauma Clinical Coordinator, responsible for in-house patient care issues and Performance Improvement. We enjoyed touring all of your EDs and meeting many of your staff, medical directors and nurse managers. We heard over and over at every hospital of the problems you all are experiencing with high volume and the crunch for beds. While we feel your pain, we also experience this problem daily here at Duke. Thanks for your patience as the Transfer Center arranges for your patients to be transported to Duke as beds open up.

The Duke/Mid-Carolina Joint Subcommittee for Disaster Preparedness had its first formal meeting November 12, 2002. We had excellent representation from a broad range of stakeholders throughout the region who have vested interests in disaster planning issues. We introduced Fred Brown, the consultant hired to assist in constructing the working components of the committee and organizing the flow of work. He has given much thought and effort into breaking the large group down into smaller working groups. The smaller groups currently consist of: Clinical Issues, Communications, Public Health Surveillance, Materials and Equipment, Protection of Emergency Responders, and Facilities. This list is still evolving and can change or be added to as the need arises. Some of the issues that will be addressed include identifying our region's current response capability for mass casualty incidents, education of personnel, decontamination and equipment capabilities at each facility, anticipated materials and equipment needs, treatment protocols and protection of first responders and hospital employees, and evaluation and testing of plans, beginning with tabletop exercises. As you can see, we have been charged with quite a daunting task! It seems overwhelming when looking at the big picture, but it will be more manageable when viewed in the smaller groups that Fred has proposed and by remembering that the NCOEMS has estimated a 3 to 5 year timeline for the project. The main subcommittee will formulate a regional plan based on the findings and recommendations of the smaller groups within it; however this will not take the place of local planning. We recognize the need for each county's Emergency Management Office, LEPC's and county commissioners to be a part of the group to ensure that local and regional plans dovetail together. Doug Cline is the Chair of the joint subcommittee. He is a captain for the Chapel Hill Fire Department and will bring great experience to the group. Our Co-Chair is Gibby Harris, Director of the Wake County Human Services/Health Department. She brings the Public Health perspective and insight to the committee. We are fortunate to have such qualified leadership to guide this multi-faceted group. Again, if anyone wishes to join this subcommittee, feel free to begin attending meetings. It's not

(Continued On Back)

Outreach Calendar

March

13	**13th Annual Duke Trauma Conference**
23	**Society of Trauma Nurses Meeting, Las Vegas, Nevada**

April

25	**Duke RAC Meeting**
27-29	**ATS 30th National Trauma Conference, Arlington, Virginia**
30	**NC State Trauma Meetings**

May

13	**State EMS Advisory Meeting**
24	**Life Flight EMS Extravaganza Contact: Brenda McKee (919) 684-2261**

necessary that you join at the inception; we welcome your input at any time during the process. We will definitely be a "working group" with an aggressive timeline and measurable goals per our leadership. Understandably, different people have varying senses of urgency of the importance of producing a workable plan but we all need to realize that the threat to hospitals is very real. If you are not receiving information about the Joint Disaster Planning Subcommittee and would like to be added to the group e-mail listing, e-mail me at wilki029@mc.duke.edu.

Finally, here's the update on the Beta-sites for the State Trauma Registry. I have just spoken with Sharon Schiro to find out where we stand in setting up these sites. After satisfying HIPAA requirements by moving the server to a locked room, the beta-sites will be ready to go live. This move will be completed within the next several weeks. I need your help in educating your administration and IT department about what a RAC is. Sharon and I are happy to visit your hospital to meet with these people to explain the purpose and goal of having the beta- sites but it will be helpful if you get the chance to introduce the concept to them prior to our visit. The goal is to eventually have all hospitals in North Carolina included. Please contact me if you have not already done so, so that Sharon and I can assist you in establishing a site.

Looking ahead, thanks to our RAC members at Durham Regional Hospital, we were able to reserve their Main Auditorium for all of our meetings in 2003. This is a very nice facility with free parking and easier access than Duke. Please mark your calendars for the 2003 meeting dates: April 25, July 25, and October 24. The times have been changed slightly to 10:30-1:00 pm. As always, we will provide lunch. The RAC has taken on several new projects that will have a definite impact on trauma care across our region. The Education Subcommittee has put together several educational offerings related to trauma care issues that can be brought to your facility. The Performance Improvement Subcommittee has surveyed all EMS systems within the RAC to determine their Pediatric Transport Protocols and make RAC-wide recommendations on Pediatric Transport. Thanks to Brian Stephens, our product representative from Miami-J, pediatric C-spine immobilization equipment and inservicing were presented at our January RAC meeting. Dr. Karen Frush, Medical Director of Duke Pediatric Emergency Services gave a presentation on proper transport of pediatric patients. We are also reviewing scene-response protocols in each county in order to make future recommendations regarding triage of trauma patients to Level I Trauma Centers. We look forward to your participation in the RAC over the next year and thank you for your efforts in the past. I'll be around to visit each of your facilities over the next few weeks. Until then,

Take care and stay safe,

Ginger

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