OSTEOMYELITIS & SOFT TISSUE INFECTIONS

by Kenneth Capek RRT, CHT, MPA

I probably speak for many respiratory therapists when I say most of my healthcare knowledge has been specific to the pulmonary system. That changed when I started a hyperbaric service. I was now exposed to diseases that were completely foreign to me and naturally it was uncomfortable. But learning is growth and usually rewarding. So let us explore some infections outside the respiratory field but seen in the hyperbaric center starting with osteomyelitis.

Osteomyelitis (osteo-bone, myleos-marrow, itis-inflammation) is an inflammatory process of the bone caused by an infection. It can be acute or chronic and may be localized or spread throughout the bone and surrounding tissue. It is pyogenic (pus producing) and has a bacterial, fungal or mycobacterial origin. The main two categories of osteomyelitis are hematogenous (spread by the blood) and direct inoculation (caused by direct contact as by trauma or surgery). The acute hematogenous type is more common in children and occurs as a result of blood slowing through vessels that have sharp turning pathways which can be seen with rapidly growing bones. Direct inoculation osteomyelitis tends to be more localized and can affect multiple organs. Another type is classified as chronic osteomyelitis because it can persist and resist various aggressive treatments. PVD (peripheral vascular disease) commonly predisposes this type along with diseases such as diabetes mellitus, AIDS and others.

The prevalence of osteomyelitis with a foot puncture may be as high as 16% and 35% in patients with diabetes. This can be a devastating disease process that can spread to other areas of the body resulting in pain and disability and even worse amputation of an extremity. Fortunately, mortality rates are low unless sepsis is involved. Males are associated with this disease twice as often as women. Osteomyelitis presents as a slow progression of a non-healing ulcer, swelling, redness and warmth, wound drainage, pain, fatigue and malaise. Patient testing will include bone scan (indicated infected bone), CBC (elevated WBC), blood cultures to determine causative organism, bone biopsy, and culture of surface lesion. Most commonly seen pathogens are group A and B streptococci, aerobic gram-negative bacilli and bacteroides fragilis, among others. Osteomyelitis has also been seen in sternal wounds following median sternotomy for cardiac surgery, although rare.

Primary treatment for osteomyelitis is intravenous antibiotics and surgical debridement (removal of dead bone tissue). Hyperbaric oxygen therapy (HBOT) is considered an adjunct, but should always be considered when these alone fail to cure. The standard protocol is a 90-minute treatment at 2.0 to 2.4 ATM pressure for 20 - 40 treatments on a once-per-day basis. Clinical studies have demonstrated improved healing rates when HBOT is added to the treatment regiment. Some studies have shown a usual finding that bone healing can be impaired if HBOT exposure is extended beyond the standard protocol above. The primary benefit of HBOT is that it increases the oxygen tension in infected tissue, including bone. Typically osteomyelitic bone has low oxygen tensions in the range around 25 mmHg. HBOT has been able shown to increase these levels from 30 to over 1,000 mmHg, which is important for healing processes. These higher or normalized levels promote the killing of aerobic and anaerobic organisms by leukocytes. It has been shown to improve the efficiency of certain antibiotics such as tobramycin, gentamycin and others. HBOT also has the ability to improve fibroblast activity. Fibroblasts must have oxygen tensions of at least 20 mmHg in order to synthesize collagen. HBOT ultimately increases vascularization and wound healing in previously hypoxic tissues. These mechanisms have benefits for fighting soft tissue infections as well.

Soft tissue infections are typically seen in patients who are immunosuppressed due to underlying problems such as diabetes mellitus, vascular insufficiency, alcoholism and others. These infections may be caused by anaerobic bacteria and in combination with aerobic Gram-negative organisms. When multiple bacterial are involved, they can actually have a synergistic (enhanced) effect, which present additional challenges for treatment. In order to categorize these infections they are differentiated by; microorganism causing the infection, type of tissue involved, kind of therapy required, rates of progression, and clinical findings. One classification system used divides these infections into three groups; Progressive Bacterial Gangrene, Necrotizing Faciitis, and Myositis/myonecrosis. These infections typically occur after trauma or surgery but may be spontaneous in origin. They also can result in high morbidity and mortality

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treatment of sleep disordered breathing. National standards have now defined compliance as therapy that is used 5 hours per night for 5 days a week. Most insurances will not continue reimbursement or purchase the unit for the patient unless compliance meets this standard. While home care providers may have their own specific policies, most compliance is generally monitored during the first 2 weeks and then at one month and three month intervals. This monitoring is done by questionnaires, telephone calls, patient visits and most commonly by "smart card" technology. The small card that comes with the CPAP unit is mailed back to the company or sleep lab and the information is downloaded for interpretation. Some units use a modem or a computerized number the device provides.

Reasons for non-compliance include: problems with interface comfort (mask or nasal prongs/pillows), humidification, pressure level, aesthetics or belief the treatment is not really necessary or that weight loss or change in lifestyle will correct one's apnea. These concerns can be addressed with proper mask fits, daily care of the interface, changing masks or prongs on a routine basis, using cool or heated humidity based on patient comfort and good patient education and explanation for need of therapy. Involvement in a sleep/awake group is very helpful with regard to a patient's perception of equipment use and need for treatment.

There is no panacea when it comes to patient compliance with prescribed care, whether in the hospital or the home. As clinicians, we know patients need to follow their therapeutic regimen and it is up to us, as professionals, to educate, explain the need for treatment and to follow-up on the prescribed therapy. Oftentimes, patients look to their respiratory therapist for direction and as a source of knowledge. RTs, especially in the home care setting, need to accept this role and meet the challenge of improving patient compliance with home care therapy.

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rates especially among elderly debilitated diabetic patients. Therapy for these infections is a combination or surgical debridement of dead tissue (or amputation), antibiotics, nutritional support and adjunctive hyperbaric oxygen when appropriate. The benefits of HBOT are improvement of tissue oxygen needed for healing, improvement of phagocyte function (to kill organism), reduce edema and improve circulation of affected areas. Treatment protocols vary slightly among these infections. For example, with one of the most common and serious of these infections, gas gangrene, also called clostridial myonecrosis the individual treatment is 2.5 to 2.8 ATA for 90 minutes. Three treatments are given the first day (usually after surgery), followed by two additional on the second and third days. The maximum number to treatment days is usually 10. Gas gangrene can be categorized as traumatic or spontaneous and is a rapidly spreading infection with mortality from 25% (traumatic) to 67-100% (when caused by C septicum).

For necrotizing faciitis (referred to in the newspapers as the "flesh-eating bacteria") a rapid spreading inflammatory process located deep in the skin, the protocol is similar at 3 ATA for 90 minutes. Three treatments are given in the first 24 hours after surgery. After that, two are given daily until improvement seen and the schedule can be reduced to once daily. Typically the maximum number of treatments are 10-15 total. These types of cases, although seen infrequently, are considered urgent and time must be made available in a busy HBOT schedule to accommodate them. These patients are truly benefited by adjunct HBOT, but unfortunately it still is not always considered due to lack of awareness in the medical community. The marketing of HBOT benefits is a certainly a challenge but efforts must continue for improved outcomes.

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"You report to Anderson. Anderson reports to me...Who do I report to?"

Up With PEEP... *Continued from page 54*

Using high PEEP when few unstable units exist or plateau pressure is kept below levels which fully "unfold" the lung and begin to overstretch it is not likely to help. If lung tissue is not inherently recruitable (or has not been opened by enough airway pressure), even high PEEP will not be effective; if plateau pressure is not in a threatening range (generally, above 25 cmH2O), high PEEP is not needed to avoid VILI—even if collapse persists and/or tidal re-opening recurs. In fact, using high PEEP in such settings alters blood flow, raises mean alveolar pressure, and may actually increase overall collagen strain. But when unstable and potentially recruitable units are prevalent and plateau pressures are high, applying sufficient PEEP is vitally important to minimize junctional stresses. It does so by reducing the number of units "at risk" (via sustained recruitment) and by preventing repeated cycles of tidal collapse/high pressure reopening. Therefore, when considering the potential value of PEEP in preventing VILI, three vital elements are in play: 1) recruitability of injured tissue 2) magnitude of the end-inspiratory tidal plateau and 3) level of PEEP in relation to lung unit closing pressures. Just how much tissue can be recruited by using high airway pressure and sufficient PEEP is a topic currently under hot debate. Whatever their opinions on the prevalence of unstable units and inherent recruitability of the acutely injured lung, most knowledgeable investigators would agree that the lung should be exposed transiently to "high enough" pressure to open the collapsed units most at risk by some type of recruiting maneuver that involves high PEEP, and many would set PEEP decrementally as tidal pressures are ratcheted downward, depending on response. The process should be an empiric one and not governed by rigid numerical mandates.

Although the last word has not been written about PEEP's value and risk, we are coming progressively closer to reconciling VILI theory, laboratory science, and RCT confirmation. Considering what's clinically at stake and given the enormous expenditure of investigational effort and resources, it's about time.

Dr. Marini, MD, Professor of Medicine at the University of Minnesota, is a clinician-scientist whose investigative work has concentrated in the cardiopulmonary physiology and management of acute respiratory failure. In the majority of his research, he has been positioned at the interface between basic physiology and clinical medicine so as to develop insights into advancing clinical practice.