The Kent Hospital Wound Recovery and Hyperbaric Medicine Center: A Brief Overview, 1998–2013

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ABSTRACT

A brief description of the Wound Recovery and Hyperbaric Medicine Center, now in its second decade of service, will inform the general medical community of this valuable asset.

Demand for wound care services is predicted to grow steadily over the next several decades. Kent Hospital's vision for wound care is embodied in its thriving Wound Recovery and Hyperbaric Medicine Center. New cost-effective wound healing therapies must be developed and evidence-based practices established. New physicians and support staff must be trained. Only through a blending of high quality clinical care with research and education will these objectives be achieved and future successes in the management of patients and their wounds be made possible.

KEYWORDS: Chronic wound care, hyperbaric medicine, diabetic foot ulcer, radiation tissue injury, decompression illness, Undersea and Hyperbaric Medicine Society

HISTORICAL

The Kent Hospital Wound Recovery Center (KHWRC), established by Dr. Robert Baute (President 1995–2006), opened July 30, 1998. Dr. Baute recognized the need to develop a program that could meet the growing demand for wound care services. Diabetes, venous, arterial, and autoimmune diseases, necrotizing infections, and recalcitrant healing in previously radiated tissue of cancer survivors is a partial list of chronic wounds for which the established systems of medical care were ill prepared to manage.

Historically wound care practice has been driven by the nursing profession, out of a combination of need and as a natural extension from that profession's responsibility for skin care. With the growing incidence of chronic wounds and new regulatory oversight focused on pressure ulcers, physicians have become more proactive. Comprehensive wound care programs began to flourish, as did the knowledge base related to wound healing and care. The average physician is unprepared to manage chronic wounds and cannot devote the necessary time and effort required in the management of these patients. Wound centers add value to the institutions and communities in which they serve.

As the field has expanded, the science of chronic wound care has also grown. The increased utilization of hyperbaric oxygen therapy (HBOT) is one example of this new growth. Approximately 10-15% of patients presenting to wound care centers will qualify for HBOT. Oxygen deficiency is a critical component of many wound types for which HBOT may provide the cure or substantially boost other healing interventions. Under the direction of Dr. Stephen Cummings, Kent Hospital acquired three hyperbaric chambers in March 2002, prompting a name change to the Kent Wound Recovery and Hyperbaric Medicine Center (KWRHMC) (**Figure 1**). The KWRHMC quickly took on a life of its own, extending treatment to include emergent and critical care therapies. Kent Hospital made a decision to offer HBOT services on a 24/7 basis and treat emergencies such as carbon monoxide poisoning and diving injuries. Board certification of physicians became a standard and programs in fellowship training and research were established.

Figure 1. Three single-person (monoplace) chambers in use.

KENT HOSPITAL

THE PRESENT

Today KWRHMC performs over 8,000 wound care treatments per year (**Figure 2**). The KWRHMC has achieved Undersea and Hyperbaric Medical Society (UHMS) accreditation *with distinction* and is one of only two programs in the northeast region that provide 24/7 critical care therapy. The KWRHMC provides over 2,000 hyperbaric treatments per year primarily to treat diabetic foot ulcers and radiation-related tissue injuries while offering 24/7 access to manage emergent conditions such as carbon monoxide poisoning, necrotizing fasciitis and compromised myocutaneous flaps (**Figure 2**). The hyperbaric unit is staffed by 4 physicians, 4 registered nurses (RNs), 1 respiratory therapist (RT), and 1 certified hyperbaric technologist (CHT).

Current Indications

The KWRHMC treats all of the labeled indications recognized by UHMS and Centers for Medicare and Medicaid Services (CMS). Fifteen diagnoses are recognized as valid indications for HBOT (**Table 1**). The list appears to be a grouping of unrelated medical diagnoses, reflecting the diverse effects HBOT has been shown to have on tissues. It is often stated there is little or no evidence for the use of HBOT in medical care. The evidence is listed in **Table 1**.

Hyperbaric oxygen therapy is defined as the exposure of the entire patient (not just a limb or digit), within an enclosed, rigid chamber that contains 100% oxygen at greater than 1 atmosphere pressure absolute (1 ATA). For most diagnoses, therapeutic pressures range from 2.0 to 3.0 ATA. Typical time spent inside the chamber is 90-120 minutes per treatment. Prior to initiating HBOT, all patients receive a comprehensive medical evaluation by a certified physician. During this assessment, appropriateness of therapy is confirmed and contra-indications excluded (**Table 2**). Risk-benefit ratio is determined for each individual. A comprehensive informed consent process is performed to fully educate the patient about expected benefits and potential adverse effects of HBOT. It should be emphasized that *topical* oxygen therapy is not *hyperbaric* and is not recognized by UHMS or CMS as an effective therapy.

Figure 2.

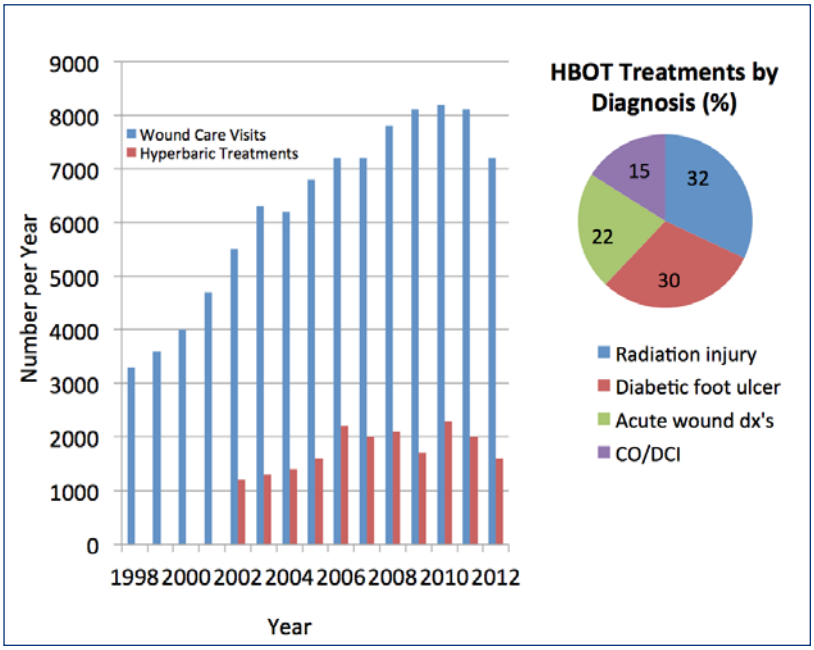

Table 1. UHMS approved diagnoses for HBOT.[4]

Diagnosis	Level of Evidence	Class of Recommendation	Citation
Arterial insufficiencies*	A	I	5,6
Air embolism	C	I	7
Refractory osteomyelitis	B	IIa	8
Compromised grafts/tissue flaps	C	IIb	9
Crush Injury, acute traumatic ischemia	A	IIa	10
Decompression illness	C	I	11
Delayed radiation tissue Injury- ORN and soft tissue radionecrosis	A	I	12,13,14,15
Diabetic foot ulcer	A	I	16,17
Idiopathic sudden sensorineural hearing loss	A	IIa	18
Severe anemia	C	IIb	19
Severe carbon monoxide poisoning	A	IIa	20
Severe soft-tissue infections- Clostridial and other necrotizing infections	B	IIa/b	21,22
Acute thermal burn	C	IIb	23
CNS abscess	C	IIb	24

According to Methodology Manual and Policies from the ACCF/AHA Task Force on Practice Guidelines 2010. Briefly, Level of Evidence: A – randomized controlled trials, meta-analysis; B – case-control study, clinical series; C – case reports, standard of care, expert consensus and laboratory studies. Class of Recommendation: I – is recommended; IIa – is reasonable; IIb – may be considered; III – not beneficial or may be harmful. [25]
*Includes acute central retinal artery occlusion, acute arterial embolism or thrombosis and selected problem wounds.

Table 2. Contraindications to HBOT

Absolute
Current or recent bleomycin therapy
Untreated pneumothorax
Relative
Acute upper respiratory tract infection/sinusitis
Adriamycin-related cardiotoxicity
Bullous lung disease
ESRD – if volume overloaded
Fever
History of spontaneous pneumothorax
Need for supplemental oxygen therapy (FiO_2 > 50%)
Remote bleomycin therapy

Table 3. Risks associated with HBOT

Condition	Frequency	Severity**
Otic barotrauma	40-60%	mild
Myopia	20-30%	mild
Confinement Anxiety	10-20%	mild
Seizure-CNS oxygen toxicity*	0.01-0.02%	severe
Pulmonary barotrauma	Essentially nil	NA
Pulmonary oxygen toxicity	Essentially nil	NA
Fire	Essentially nil	severe

* Incidence is 10-fold less than that reported for some antibiotic and antidepressant medical therapies.

** Definitions are from the January 2007 OHRP *Guidance on Reviewing and Reporting Unanticipated Problems Involving Risks to Subjects or Others and Adverse Events*, OHRP Guidance, http://www.hhs.gov/ohrp/policy/advevntguid.html.

Dive Medicine

The KWRHMC provides regional support to the diving community. The program is a member of the Diver's Alert Network (DAN, Duke University, Durham, NC), which is an international organization that provides information and therapy to divers. The KWRHMC serves the region's recreational SCUBA, civil service, research and commercial dive teams. The medical support for divers ranges from performing fitness-to-dive evaluations to the management of critically ill diving accident victims. Breathing compressed air (78% nitrogen) while diving quickly places the individual at risk. Most cases of decompression illness ("the bends") are mild; however, the only effective treatment is recompression in a HBO chamber. Comprehensive evaluation of the diver is essential prior to their entry into the hyperbaric chamber. The KWRHMC evaluates 3-6 diving accidents each year, of which one or two require treatment.

Risks

The adverse events associated with HBOT are well described in the hyperbaric medical literature. In short, the potential risks associated with HBOT are minimal in both their frequency and severity (**Table 3**.) A seizure, due to CNS oxygen toxicity (Paul Bert effect), is the only serious adverse event that a patient may experience during HBOT (1 in 5-10,000 treatments). Implications for the patient are relatively minor as the seizure abates by discontinuing the oxygen therapy and no short- or long-term disability is seen.

HBOT chambers meet very exacting manufacturing standards coupled to a rigorous system of inspection and safety as regulated by the guidelines from the American Society of Mechanical Engineers' Pressure Vessel for Human Occupancy (ASME-PVHO). The National Fire Prevention Association defines the safety guidelines as they relate to hyperbaric chambers within medical facilities, (NFPA-99, Chapter 14 "Hyperbaric Facilities"). HBOT facilities are required to have a certified Safety Director, who is a Certified Hyperbaric Technologist (CHT) and has obtained additional training to perform the role as Safety Director.

Registered Nurses and Certified Hyperbaric Technologists

Nursing Standards for care during HBOT have been established by the Baromedical Nursing Association. Hyperbaric staff nurses obtain advanced training in hyperbaric nursing and become Certified Hyperbaric Registered Nurse (CHRN). The hyperbaric nurse is responsible for the initial and daily assessment and education of the patient. The nurse identifies and addresses HBOT-specific barriers to treatment to ensure comfortable and safe treatment and is present at all times during the patient's treatment. The nurse's primary goal is to be fully informed of the patient's current status and ensure the highest level of safety possible. Close communication with the supervising technologists and physicians allows for a collaborative practice. All nursing staff are required to be ACLS-certified to support the 24/7 critical care activity.

Hyperbaric technologists represent a key component to the safe and efficient daily delivery of HBOT. Technologists typically have a prior background in a healthcare-related field such as emergency medical technician or respiratory therapist. These individuals must obtain formal didactic training and practical experience before being qualified to take a certifying examination administered by The National Board of Diving and Hyperbaric Medical Technology. The technologist serves an integral role as a member of the hyperbaric team and provides patient treatments. The technologist is responsible for the safe operation and daily maintenance of the hyperbaric chamber. A technologist or nurse is always present during patient treatments to provide monitoring and support. The patient-to-staff ratio is always 2:1.

Status of Graduate Medical Education in Hyperbaric Medicine

Currently, the teaching of wound care in medical schools and residencies is paltry at best, focusing primarily on acute wound healing. Presently there are no ACGME-accredited wound care fellowships nor is there board certification; however, both are available for hyperbaric medicine.

Board certification in Undersea and Hyperbaric Medicine (UHM) is co-sponsored by the boards of Emergency Medicine and Preventive Medicine and recognized as a subspecialty by the American Board of Medical Specialties. There are approximately 12 fellowship training programs in the US. Kent Hospital has the only UHM fellowship in the US supported by the American Osteopathic Association. Board certification requires holding an active board certification in a primary discipline, such as medicine or surgery, plus completion of a one-year approved fellowship and successful board examination.

Kent Hospital is a major teaching affiliate of the University of New England College of Osteopathic Medicine (UNECOM) with residencies in emergency medicine, family medicine and internal medicine. The Kent Hospital Osteopathic Fellowship in UHM was established in 2011. The one-year fellowship combines the theory and practice of diving and hyperbaric medicine and emphasizes research, teaching and evidence-based medical practice. Fellows are required to successfully complete a 40-hour National Oceanic and Atmospheric Administration (NOAA)-sponsored course in dive medicine and spend several weeks training at an offsite, multiplace chamber facility. Fellows manage a wide array of complex wounds and become proficient in chronic wound care. Fellows also engage in independent research and are encouraged to present and publish their findings. Due to Kent Hospital's close ties with UNECOM, the fellows have teaching responsibilities and interact directly with UNECOM residents in family practice and internal medicine. Brown University family medicine and podiatry residents also rotate at the KWRHMC during their surgical clerkship, where a minimum of 24 residents per year learn the basics of wound care and hyperbaric medicine.

Lastly, KWRHMC staff and fellows provide educational outreach programs to the community that focus on dive medicine, diabetes care and enterostomal support. As the demand for wound care intensifies, the need has never been greater to prepare future doctors for this mission. This will only be achieved through programs that can blend clinical care with research and education.

The Future – What Research is Telling Us About HBOT

The application of HBOT to human disease was initially predicated on the reversal of tissue hypoxia. Since that time an understanding of the molecular and cellular effects of HBOT is emerging, including recognition that gene-expression changes are initiated during HBOT and continue beyond the patient's brief stay within the chamber. One of us (LG) has recently reported HBOT-induced alterations in tissue biochemistry that supports the favorable wound healing responses seen clinically.[1] Our ongoing collaborative investigations with University of Connecticut (Storrs, CT) scientists have demonstrated the remarkable effect HBOT can have on the gene expression and function of human microvascular endothelial cells. Following a single 60-minute exposure of human cells to HBOT, over 8,000 genes alter their baseline expression to increase cell proliferation and cytoprotection.[2] Basic science studies in wound healing have recently recognized the important role being played by bone marrow-derived stem cells. These pluripotent cells appear to be defective in diabetic patients and may contribute to poor wound healing responses. HBOT stimulates the mobilization and proliferation of endothelial progenitor cells in both diabetic and non-diabetic patients.[3] This stem-cell effect is receiving significant scientific attention and will likely extend the applications of HBOT well beyond its current state.

SUMMARY

Kent Wound Recovery and Hyperbaric Medicine Center is maturing. The future is bright given the growing need for cost-effective wound care services. New knowledge from the lab and clinic will improve the current standard of care and allow wounds to heal more reliably and quickly than ever before.

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Kent Wound Recovery

OUR COMMITMENT TO EXCELLENCE

George A. Perdrizet, MD, PhD, FACS *is medical director of the Wound Recovery and Hyperbaric Medicine Center at Kent. Dr. Perdrizet is board certified in general surgery and hyperbaric medicine. He is a Fellow of the American College of Surgeons. He is also a former professor of trauma surgery/emergency medicine at The University of Connecticut and an adjunct lecturer in hyperbaric medicine at the University of Hartford.*

For more than two decades, Kent Hospital has been making a difference to people suffering from wounds that won't heal due to co-morbidities such as peripheral vascular disease, diabetes, trauma, cancer, and burns. Wound care at Kent helps speed healing, reduce pain and dramatically improve the quality of our patients' lives.

HIGHEST MEDICAL STANDARDS

- The Kent program has been awarded Certification with Distinction by the Undersea and Hyperbaric Medical Society (UHMS) for the second consecutive time.
- Our physicians are board certified in surgery, family medicine, and plastic surgery and are Fellows of the American College of Surgeons and national leaders in the Wound Healing Society.
- Our hyperbaric oxygen technicians are UHMS certified.
- Three state-of-the-art chambers are staffed at all times by an MD and a certified nurse or certified technician.
- We are the only regional center that provides critical care and 24/7 access.
- The ostomy clinic is staffed by certified wound, ostomy, continence (WOC) nurses.

Our Wound Recovery and Hyperbaric Medicine Center is conveniently located with doorside parking. Call 401-736-4646 or visit kenthospital.org.

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