Hyperbaric Oxygen Therapy (HBOT) in Cancer Care

Hyperbaric Medicine
The Best Kept Medical Secret

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Hyperbaric Medicine: The Past, Present and Future

For the purposes of this presentation I have classified Hyperbaric Medicine into the 3 categories.

• I consider “The Past” to be from the first known use of Hyperbaric Oxygen in the late 1800s until 1980.

• Although the 1980s was over 30 years ago, I still consider this to be the beginning of “Present” day Hyperbaric Medicine as that decade really marked the advance in clinical HBOT use.

• The “Future” is where I believe we will see HBOT utilization growth in the next decade.
Hyperbaric Medicine: The Past

During this time we saw the initial appearance of HBOT in the U.S. as well as the first opposition to it. The predominate utilization was with the military and for treating scuba divers with the Bends.

- First clinical use of HBOT around 1890 was used to treat infection.
- In 1930s, Orville Cunningham established the Hyperbaric Hotel in Ohio. The facility later closed due to opposition from the AMA.
- Military medicine was the leader in HBOT use during this period.
- Outside the military, HBOT was predominately used for treating scuba divers with the Bends until the late 1970s.
- In the 1970s, scientific data confirmed value of HBOT for treating infection.
- Research was also conducted in administering radiation therapy while at pressure. Complications arose with the administration and patient survival rate did not increase.
Since 1980, Hyperbaric Medicine has experienced an extensive growth in the clinical sector. A national news story shed light on the use of HBOT. New research studies and clinical data continued to expand and confirm the utilization of HBOT.

- HBOT has continued to fight an uphill battle to prove its significance to and acceptance by the medical establishment.

- In 1987, HBOT received national attention after 18-month-old Jessica McClure (“Baby Jessica”) was treated with HBOT in Midland, TX after being trapped in a well for 2 ½ days.
  - HBOT saved her right foot, she only lost the tip of her 5th toe.
  - An editorial letter printed in JAMA later said it was wrong to have put her in HBOT and denied HBOT was effective in wound healing.
  - The authors of the editorial launched an animal experimentation to prove this opinion, however, results instead confirmed HBOT effectiveness in wound healing.
Additional HBOT points related to Jessica McClure story:

- The hyperbaric chamber that Jessica McClure was treated in at Midland Memorial Hospital was only there because it had been donated to the hospital by a private citizen.
- The donor had a daughter with Multiple Sclerosis and did not want her to travel to Dallas for HBOT treatments.
- To my knowledge she is the only MS patient ever treated in that chamber.
- The daughter has had a 30 year control of MS with HBOT.
- Despite his donation, the donor was later refused treatment in the hyperbaric chamber at the hospital when he was diagnosed with ALS.
HBOT: The Present (1980s to today)

- The growing field of Hyperbaric Medicine has caused differing opinions about the use of HBOT not only with the medical establishment but unfortunately even within its own community.
- In the late 1980s, Medicare removed Meleney Ulcers and Cerebral Edema from the approved list of HBOT indications based on recommendation from the Undersea and Hyperbaric Medical Society.
- HBOT is likely the only field in medicine that has had a decrease in the number of indications for a proven technology over the past two decades.
- Even though HBOT has produced significant results through the years for patients with non-healing ulcers, particularly in the diabetic patient, it was not until 2007 that HBOT became an approved indication for treating diabetic extremity ulcers.
- Currently, there are only 16 approved indications for HBOT in the U.S., far below the number in many other countries.
Although military medicine was the leader in HBOT in the past, today the military is not utilizing HBOT to its fullest potential.

- In 1997, the chief of Hyperbaric Medicine at Bethesda Naval Hospital was a prominent speaker at the Symposium on HBOT for Stroke at Wake Forest University.
- Today, however, it is my understanding that the hyperbaric facility at BNH is highly underutilized even for wound care.

- A recent example that occurred at Bethesda Naval Hospital:
  - Doctors at Bethesda recommended that the severely injured remaining leg of a Marine be amputated in 2 days.
  - The Marine refused amputation based on data from family friends working with Equine HBOT.
  - Doctors at Bethesda strongly urged against the Marine getting HBOT to try and save his leg from amputation.
  - The Marine sought outside HBOT treatments at University of Maryland Hospital.
  - After 25 treatments his leg healed and did not require amputation. He walks on it today with a prosthesis for his amputated leg.
Neurological conditions that have well-documented response with HBOT, which are not currently approved for reimbursement in the U.S. include:

- Cerebral Edema
- Stroke
- Traumatic Brain Injury
- Multiple Sclerosis
- Cerebral Palsy
- Autism
- Lyme disease
- Cortical Blindness
- Cognitive defects from Chemotherapy or surgery
- Post Traumatic Stress Disorder (PTSD)
HBOT: The Present (1980s to today)

HBOT & Cerebral Edema

- The use of HBOT for cerebral edema was once an approved indication in the 1980s based on data published by Michael Sukoff, M.D.

- Experimental work in both humans and animals had shown HBOT reduced intracerebral pressure while improving oxygenation.

- The removal of cerebral edema as an HBOT indication, likely due to political maneuvers within the hyperbaric medicine community, occurred just as CT and MRI technology had developed the ability to measure cerebral edema non-invasively.
HBOT: The Present  (1980s to today)

HBOT & Traumatic Brain Injury (TBI)

- Traumatic Brain Injury is the leading cause of death and disability among the young in the U.S.
  - 1.4 million brain injuries occur per year
  - Approximately 5.3 million people living with long term disability
  - Figures do not include Stroke or Anoxic injury

- TBI causes an altered state of consciousness and/or altered cognitive, emotional and/or physical function.

- TBI is the signature wound resulting from the war on terror in Iraq and Afghanistan.

- Data now shows that micro air embolization occurs with TBI from a blast explosion. The micro air embolization produced by a blast injury can cause disease similar to the bends in scuba diving.
HBOT & Traumatic Brain Injury (cont’d)

- HBOT decreases cerebral edema and increases delivery of oxygen to the brain.

- HBOT has been used in civilian practice in the U.S. and other countries with excellent results.

- An article from China documents HBOT for treatment of neuropsychiatric disorders following TBI. We have just reported use of SPECT brain scans to document brain injury in 3 veterans and response to HBOT.
  - SPECT brain scans were used to document clinical improvement.

- Data published in 2000 from the Spinal Rehabilitation Group in Melbourne, Australia also reports improvement of TBI patients treated with HBOT.
HBOT: The Present (1980s to today)

An example of HBOT & Traumatic Brain Injury from Ocean Hyperbaric:

- A 3 1/2 year old girl was hit by a car and thrown 80 feet.
- Although the hospital where she was transported to had hyperbaric chamber she was not given HBOT despite having TBI.
- She was unable to speak and was spastic in right arm and legs
- After 49 HBOT sessions she was talking & walking.
- A 10-year follow-up finds the patient an honor student with no CNS symptoms.
HBOT: The Present (1980s to today)

HBOT & Multiple Sclerosis (MS)

- HBOT has been used with some MS patients for over 30 years.

- HBOT can produce significant decreases in MS symptoms and slow progression of MS in most patients.

- Despite positive clinical results achieved by Richard Neubauer, M.D. as well as research produced in a double blind study by Bernard Fisher, M.D., HBOT is not an approved indication for MS.

- Data from England by Perrins and James also reported the value of HBOT for the MS patient citing 10-year positive follow ups of patients who received the HBOT treatments.

- My experience of improvements in MS patients treated with HBOT has paralleled that of reports from Dr. Neubauer, and Perrins and James as well as others.

- Despite these results and indications the MS Society remains negative about HBOT.
Genetic Neurological conditions that have also responded with HBOT include:

- Mitochondrial C disease
- Ataxia-Telangiectasia
- Lebers Cortical Blindness
HBOT & Ataxia-Telangiectasia Example:

- Male infant born in 1993 had seizure activity with physical and neurological delays beginning at 6 months.
- With varying periods of stability, growth and regression no clear diagnosis of condition could be determined.
- Ataxia-Telangiectasia was diagnosed in mid-1997.
- Patient began HBOT sessions in 1997.
- Received 70 HBOT treatments between 1997-present.
- Today patient is substantially ahead of peers of similar ages.
- Seizure activity is controlled and neurodegenerative symptoms stopped degenerating and improved.
- Based on current research indicating anti-cancer activity of HBOT, there may be decreased chance for development of malignances.
Other diseases and conditions that also respond well with HBOT include:

- **Asthma**
  - In one patient, hospitalization was avoided for three years with use of HBOT. Without use of steroids patient grew 5 inches.

- **Emphysema**
  - Patient given a 6-month prognosis, had 5 good years with HBOT.

- **Rheumatoid Arthritis**
  - HBOT decreased RA factor from 11,000 to under 1,000.

- **Colitis**
  - HBOT cleared symptoms present for 18 years.

- **Infected and migrating prosthesis**
  - Patient avoided need to surgically remove prosthesis with HBOT.

- **AIDS**
  - Equine HBOT is confirming value in treatment of pneumocystis carinii pneumonia.
HBOT: The Present (1980s to today)

HBOT & Reflex Sympathetic Dystrophy (RSD)

- RSD is a frequent severe complication of trauma.

- G. Lovisetti, et al (Italy) and A. Spiegel, M.D. (USA) have reported significant control of RSD symptoms with HBOT.

- State of Florida Workman’s Compensation now recognizes HBOT as a reimbursable treatment for RSD.
Frequent Miscarriage
- Data from equine HBOT centers in the U.S. has shown HBOT increased rates of conception for racehorse mares with failed conceptions or miscarriages.
- This data parallels the use of HBOT in Russia as an indication for chronic miscarriage.

AIDS
- Another learning from equine HBOT is the successful use of HBOT as an adjunct in the treatment of pneumocystis carinii, a common pneumonia in horses.
- This data would suggest that HBOT could benefit patients with AIDS particularly in treatment of pneumonia.
HBOT: The Present (1980s to today)

Documentation of HBOT response is an important aspect of Hyperbaric Medicine today and for the future. Particularly for indications where the response is not readily apparent on the surface. SPECT, PET & MRI technologies have advanced to allow for evaluation of HBOT.

- SPECT brain scans can monitor HBOT treatment response.

- SPECT brain scans do not give a specific diagnosis but can differentiate between normal and abnormal with proper technical factors and interpretation.

- SPECT brain scans can differentiate between encephalopathy and localized lesions.
HBOT: The Present (1980s to today)

HBOT & Documentation & Objective Confirmation

- SPECT brain scans can show abnormality in neurological conditions such as Stroke, Traumatic Brain Injury (TBI), and post traumatic stress disorder (PTSD).

- SPECT brain scans can be used to monitor the neurological response to HBOT treatments for Stroke and other neurological conditions as indicated.
HBOT: The Present (1980s to today)

HBOT & Documentation & Objective Confirmation

• An example of a Stroke patient’s SPECT brain scan, pre and post HBOT, can be seen in the next slide.

  – Stroke patient shows marked deficit on transaxial and sagital view of SPECT brain scan before HBOT. Deficit confirmed on 3-D view.

  – Post HBOT shows significant improvement on trans-saxial and sagital view. Improvement confirmed on 3-D view.
HBOT: The Present (1980s to today)

STROKE

PRE HBOT

POST HBOT

TRANSAXIAL

SAGITAL

3D RECONSTRUCTION
HBOT: The Present (1980s to today)

HBOT Documentation & Objective Confirmation

• As it has been done with Stroke patients, SPECT or PET brain scans could be utilized to demonstrate the cognitive defect or brain deficit in patients found to have “Chemo Brain.”

• HBOT can provide improvement for not only Stroke but other neurological disorders or cognitive deficit indications such as cerebral palsy, autism, Lyme disease, ataxia-telangiectasia, encephalopathy from meningitis, radiation myelitis, and postsurgical cognitive defects.

• Similar improvements for “chemo brain” and cognitive defect post surgery have been achieved with HBOT treatments.

• SPECT scans would serve as an confirmation and evaluation tool for results achieved with HBOT in the cognitive defect.
HBOT: The Present (1980s to today)

HBOT Documentation & Objective Confirmation

- PET is currently approved for staging & follow up of most cancers.

- In the future, there will be the ability to measure hypoxia and detect Alzheimer’s Disease before clinical symptoms develop.
HBOT: The Present (1980s to today)

HBOT & Moving to the “Future” with Anti-Cancer Activity


• This report shows that in an experimental animal breast cancer model HBOT produced twice the regression of the cancer as did the chemotherapy drug 5-FU.

• This report confirms the data presented by Dr. Otto Warburg in 1931 and opens the door for further evaluation of HBOT as a treatment for cancer.

• This data points to the probable increased use of HBOT for cancer treatments in the future.
HBOT: The Future

• Stem Cell Therapy
  – A course of HBOT produces an eight fold increase in a patient’s stem cell population.
  – Stem cell increase is likely the reason for rapid healing achieved with HBOT.
  – This increase in stem cell population likely contributes to reports from other countries of successful HBOT & stem cell therapies for spinal cord injuries.
    • Patients with paraplegia are reported to be walking post HBOT & stem cell therapy.
  – An issue for stem cell therapy is the low take of implanted stem cells.
  – In my opinion, HBOT will increase the take of stem cell implants.
  – With the development of imaging technologies the ability to document and evaluate the effect on HBOT on stem cell therapy will emerge.
HBOT: The Future

- HBOT Evaluation & Documentation: MRI Spectroscopy
  - Investigation is underway to document that MRI Spectroscopy can make a differential diagnosis between benign and malignant tissue as accurately as a pathological biopsy.
  - When MRI Spectroscopy is validated it will be possible to make a diagnosis without breaching the skin.
  - MRI Spectroscopy should allow for earlier diagnosis of cancer and demonstrate the need for HBOT as an adjunct to radiation therapy.
  - MRI guidance of high frequency ultrasound ablation of uterine fibroids is an approved technology that is gaining acceptance.
  - MRI Spectroscopy to guide the high frequency ultrasound ablation treatment of breast and prostate cancer is in the investigational stage.
  - Once there is confirmation of the effectiveness of this approach for breast and prostate cancer then the technique will be applied to other types of cancer such as brain, lung, kidney, liver, and thyroid.
HBOT: The Future

- HBOT Evaluation & Documentation: MRI Imaging

Atrophy in MS: Note enlarged, subarachnoid spaces (1), ventricles (2) and lesions (3)

28-year-old female, 6.5 years of MS

29-year-old female, 6 years of MS

Whole brain NAA spectra from each subject. Note the lower NAA level in the patient on the left, who has also sustained worse atrophy (see enlarged ventricles (1) and subarachnoid spaces (2)).
It is unfortunate that in the United States HBOT has been predominantly limited to the small number of indications approved by CMS. In Russia, there are 73 approved indications for HBOT while the U.S. has only 16.

There are many areas that could see significant recognition of the value of HBOT in the next decade. This is particularly true for neurological disease and cancer care.

HBOT needs to move from “the best kept medical secret” to a usual and customary therapy in this country. With expansion of HBOT indications there would not only be substantial patient benefit but decreased medical costs. We must work to increase recognition of the value and therefore reimbursement for HBOT in the future.

It is time for HBOT to move to the forefront of modern medicine.
HBOT: The Future

The field of Hyperbaric Medicine touches almost all segments of modern medicine. During the next decade we need to see increased clinical indications and utilization for HBOT. With advances in scanning technologies, evaluation and confirmation of HBOT should continue to expand.

In considering current research and reviewing data from the past, the following areas have a strong basis for expansion of HBOT utilization:

• Cancer Care
  – As stated previously, data reported out of Norway in 2007 showed HBOT was twice as effective as 5-FU in an animal breast cancer model.
  – Other data from Norway in an animal brain glioma model showed HBOT produced a 60% reduction in the glioma.
  – Reports from the past have shown decreased implantability of cancer cells with HBOT use.
  – Therefore, use of HBOT before and after invasive cancer related procedures should be considered to decrease metastasis.
HBOT: The Present (1980s to today)

Hyperbaric Medicine has many applications within Cancer Care. Not only for the healing of complications that arise with cancer treatments but potentially as an adjunct to or as a cancer treatment itself.

HBOT & Cancer Care: Radiation Necrosis

- HBOT is already recognized as a standard treatment for radiation necrosis of bone and soft tissue.
  - The most frequent use of HBOT is in head and neck cancer as an adjunct to reconstruction procedures.
  - Robert E. Marx, DDS and others reported successful results in 85-90% of radiation necrosis cases treated with HBOT vs 50% or less for cases without HBOT.
  - Dr. Marx also reported a 2-3% drop in cancer recurrence for those who received HBOT compared to those who did not have HBOT.
HBOT: The Present (1980s to today)

HBOT & Cancer Care: Radiation Necrosis Example

A. Stage I with exposed bone

B. Closure with 60 HBOT treatments for 2 hours at 2ATA
HBOT: The Present (1980s to today)

HBOT & Cancer Care: Radiation Necrosis Example

A. Radiation necrosis of mandible Stage II with fracture.

B. Healed mandible area after 60 HBOT treatments for 2 hours at 2ATA.
HBOT: The Present  (1980s to today)

HBOT & Cancer Care: Radiation Necrosis Example

A. Failure of full thickness skin and bone graft to heal post reconstruction with antibiotics and surgery.

B. Healed after 45 days of HBOT at 2ATA for 2 hours.
HBOT & Cancer Care: Radiation Myelitis

- HBOT also benefits radiation myelitis, both acute and chronic radiation cystitis and proctitis.

HBOT & Radiation Myelitis Example:
- 32 year-old white male developed transverse myelitis with paraplegia 10 days after completion of a radiation therapy course which included the thoracic spinal cord for seminoma of the testes.

HBOT Treatment:
- HBOT was started 2 days after the onset of paralysis.
- Received (40) 2-hour HBOT sessions.
- At six weeks post HBOT paraplegia had cleared.
- Patient had only slight numbness on soles of his feet.
HBOT: The Present (1980s to today)

HBOT & Cognitive Defect From Chemotherapy

• The syndrome termed “chemo brain” has been described as a significant decrease in cognitive function in patients who received full course chemotherapy.
  – This syndrome occurs in approximately 25% of patients receiving full course chemotherapy.
• Joyce M. O’Shaughnessy, M.D. has reported a 50% incidence of cognitive defect in patients receiving adjuvant chemotherapy for breast cancer.
  – Of these incidences, 25 percent were considered to have moderate cognitive defects and 25 percent presented severe cognitive defects.
HBOT: The Present (1980s to today)

HBOT & Chemo Brain Example:
- She had lumpectomy followed by six weeks of radiation therapy and six months of chemotherapy. Tamoxifen therapy was given for five years.
- Shortly after starting chemotherapy, patient noted gradual and progressive memory impairment with confusion, poor ability to recall recent events and understand information provided to her.
- She misplaced possessions and lost interest in many of her normal activities.
- Her reading comprehension deteriorated.
- Because of the cognitive defect she had to stop working in 1996.

HBOT TREATMENT:
- Patient received (20) one-hour treatments of HBOT in 2002.
- At her last evaluation, patient reported significant improvement in her memory and she was no longer in a “fog.”
- She had significant improvement in her ability to analyze and think out tasks she needed to perform that she had been unable to do before HBOT.

RESULT:
- With these improvements, the patient was able to return to work for the first time in six years.
HBOT: The Present (1980s to today)

HBOT & Cancer Care: Chemotherapy Extravisation

- The use of HBOT to decrease morbidity and speed healing after extravisation of chemotherapy agents into tissue is not as well recognized.

- HBOT can decrease morbidity from these extravisation cases by reducing edema and speeding recovery in the same way HBOT works for non-healing wounds.

- Without HBOT severe tissue loss can occur.

- The following slides are some examples of HBOT use with chemotherapy extravasiation.
HBOT: The Present (1980s to today)

HBOT & Chemotherapy Extravisation Example:

- A 77 year-old white male with undifferentiated small cell carcinoma in right upper lobe.
- Chemotherapy was Cytoxan, Adriamycin and Vincristine.
- Extravisation of IV Chemotherapy occurred on the back of the patient’s right hand.
- Seven days after extravisation the patient’s fingers were cyanotic and he could not bend his fingers.

HBOT Treatment

- After (3) two-hour treatments at 2 ATA there was a significant decrease in the swelling of the hand and fingers.
- Post (40) two-hour treatments at 2 ATA development of good granulation tissue occurred providing acceptable base for a skin graft.
- Received (20) two-hour treatments post graft. And then continued treatments for six months post graft.
- Skin graft healed and patient regained use of his hand.
B. Development of good granulation tissue post 40 HBOT 2 hours 2 ATA. Note tendon at edge ulcer.

C. Skin graft to area - received 20 HBOT post graft.

D. Saved usable hand due to HBOT. Six months post graft.
HBOT & Cancer Care: Fatigue & Anemia

Fatigue:
• A common complaint of the cancer patient likely from the cancer itself or a by-product from cancer treatments.
• HBOT has been used for patients with chronic fatigue syndrome and migraines with good results.
• Therefore the use of HBOT for the cancer patient with chronic fatigue could be a beneficial treatment.

Anemia:
• A frequent result of cancer and cancer treatment.
• HBOT is utilized for acute blood loss anemia as it is known to stimulate bone marrow.
• The anemia brought on by cancer or cancer treatment should also respond well to HBOT.
• HBOT as a treatment for anemia is now more important as the use of erythropoetin is now questioned.
HBOT: The Present (1980s to today)

HBOT & Cancer Care: Increase Bone Marrow Activity:

34-year-old female with Lupus who developed osteomyelitis of distal 5th finger. The surgical recommendation was amputation of the finger. The osteomyelitis was cured with antibiotics and 60 days of HBOT at 2ATA for 2 hours per day. Her hemoglobin increased 3.8 grams and the patient had her first period in 5 years.
HBOT: The Present (1980s to today)

HBOT & Cancer Care: Mucositis and Esophagitis

- Mucositis and esophagitis are debilitating complications of chemotherapy and radiation therapy with a higher incidence in concurrent or sequential treatment programs.

- Recent reports indicate a complicating factor is a superimposed pseudomonas infection.

- HBOT speeds healing, reduces edema and is very effective against pseudomonas infection.

- Adding HBOT to the mucositis and esophagitis treatments of Amifostine (Ethylol) and recombinant human kevatinocytce growth factor (rhukgforkgf) should significantly increase response.
HBOT: The Present (1980s to today)

HBOT & Cancer Care: Pseudomonas Infection Example

**PSEUDOMONAS RESPONSE TO HBOT**

*At Start of HBOT*

54-year-old diabetic who ruptured his achilles tendon. Post-operatively, he developed pseudomonas infection that progressed in spite of antibiotics. Achilles tendon is shown in infected wound before HBOT.

*Response at 2 Weeks*

Development of granulation tissue after 20 treatments of HBOT at 2ATA 2 hours per day.
HBOT: The Present (1980s to today)

HBOT & Cancer Care: Pseudomonas Infection Example (cont’)

Post Skin Graft
Skin graft doing well. HBOT was continued. Patient received 120 HBOT treatments.

One Year Post Graph
At one year follow-up there was 100% take of graft. Prior to HBOT patient had one to two TIA’s per month. Post HBOT, no TIA’s for one year.
HBOT & Cancer Care: Hand-Foot Syndrome from 5-FU, Doxorubicin, Docetaxel and Capecitabine

• An adverse reaction from 5-FU, Doxorubicin, Docetaxel and Capecitabine chemotherapy has been termed the hand-foot syndrome (HFS) and is also called palmar plantar erythrodysesthesia (PPE).

• HFS/PPE is a frequent toxic reaction which causes a painful erythema often proceeded by paresthesia in the palm of the hands and the sole of the feet.

• Histology shows mild spongiosis, scattered necrotic dyskeratotic keratinocytes and vascular degeneration of the basal layer of the skin.

• Dermal changes include dilated blood vessels, papillary edema and perivascular lymphohistiocytic infiltrate.

• In some severe cases there has been loss of hands and feet.
HBOT: The Present (1980s to today)

HBOT & Cancer Care: Hand-Foot Syndrome from 5-FU, Doxorubicin, Docetaxel and Capecitabine (cont’)

• Treatment has been drug withdrawal and supportive topical wound care.

• As some of the physiological effects of HBOT are vasoconstriction, edema reduction, stimulation of capillary formation and increased oxygenation, the use of HBOT for HFS/PPE (from chemotherapy) could significantly reduce amputations of the hand and foot as well as morbidity from this syndrome.
The physiological effects of HBOT which helps speed recovery in many types of injury and disease can also significantly benefit the cancer patient.

Some physicians believe HBOT stimulates cancer growth.

In 1931, Dr. Otto Warburg received the Nobel Prize for discovering that cancer cannot grow if oxygen levels are normal.

– The amount of oxygen in solution is determined by the voltage of the solution.
– If your voltage is low, the amount of oxygen in your tissue will be low.

A 2002 report by J.J. Feldmeier, DO, et al. (Netherlands) concluded, “The available evidence including the known mechanisms of tumor angiogenesis do not support fears that hyperbaric oxygen will enhance malignant growth.”
As mentioned earlier, the use of HBOT as an adjunct to radiation therapy was tried 40 years ago.

- At that time, radiation therapy was given while the patient was at pressure in the hyperbaric chamber.
- As both the normal cells and the cancer cells were hyper oxygenated, the expected increase in cancer control and decrease in mortality did not occur.

Thirty years ago I began using HBOT prior to radiation therapy treatment for difficult patient cases.

This technique of HBOT immediately before radiation therapy worked well for my patients.
In 1999, Drs. Kohshi, Kanugita, Kinoshita and Abe from Japan reported using HBOT before radiation therapy. They found a 50% increase in survival for brain tumor patients using the pre-radiation HBOT treatments.

Using HBOT before the radiation therapy treatment permits the normal tissue to return to standard oxygenation while the less vascular cancer will still have an increased oxygen level.

It is well documented that good oxygenation is needed for full response to a dose of radiation therapy.
HBOT: The Present (1980s to today)

HBOT & Cancer Care: Synergism with Radiation Therapy Example:

**THE RESPONSE TO HBOT AND RADIATION THERAPY**

34-year-old white female with synovial cell carcinoma of chest wall. Patient was given 4,000 rads to chest wall with HBOT 2 hours at 2ATA just before each radiation therapy treatment. At one month after completion of radiation, patient had wide surgical excision and skin graft followed by an additional 20 days of HBOT post graft.

Graft take was 100 percent as shown at one year post graft. Eighteen years post treatment, there is no recurrence.

Additional follow-up to 26 years and there has been no recurrence.
HBOT Evaluation & Documentation: PET for Imaging Hypoxia

- A basic principal of radiobiology is that adequate oxygen levels are needed for full effect of radiation.
- Now there is data suggesting that adequate oxygen levels are also needed for full chemotherapy response.
- A new technique for PET scanning is imaging of areas of hypoxia.
- Preliminary data shows that areas of hypoxia in tumors is a reason for radiation therapy failure.
- When clinical use of PET hypoxia scanning is available it will be possible to determine if a patient needs a higher dose of radiation or addition of HBOT to achieve optimal control of the cancer.
- The ability to image hypoxia, could also impact treatment of stroke and other diseases in addition to improving treatment of cancer.
  - One of the tracers for imaging hypoxia is Copper 64.
  - Copper 64 was 1 of 2 tracers used in positron brain scans in 1950s.
  - New data shows positron brain scans may have been imaging hypoxia.
Discussion

A concern expressed by some physicians is that HBOT will stimulate the growth of cancer. Experimental animal data by Matko Marusic, Ph. D. showed that HBOT given after inoculation of cancer cells decreased the take of the cancer cells. Again, the thousands of patients treated with the Marx protocol have demonstrated a lower recurrence of cancer in patients who received HBOT as part of their reconstructive process than those who had only antibiotics and surgery. The anti cancer activity of HBOT in an experimental breast cancer and clioma model reported by RAA et al, confirms the anti cancer activity of HBOT.
Conclusion

Based on the data above, HBOT has a significant role in cancer care, but it has been underutilized except for reconstruction of head and neck cancer. In the future, the value of HBOT in cancer care should be the basis for expanded use of HBOT in care of the cancer patient.