

## CASE STUDY



This 64-year-old female with history of coronary artery disease, insulin-dependent diabetes, and peripheral vascular disease status post bilateral revascularization procedures presented to the Brevard Regional Hyperbaric Center for non-healing wounds postoperatively.

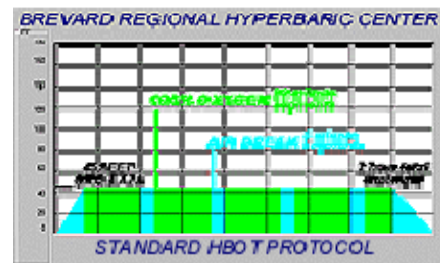


The patient underwent left great toe amputation with poor healing as well as having multiple bilateral wounds involving the right foot. Her past medical history was also significant for renal insufficiency. Her past surgical history included carotid endarterectomy, coronary artery bypass graft, and appendectomy.



On examination, the patient was non-ambulatory and examination of the multiple wounds found a non-healing great toe amputation of the left foot as well as multiple wounds of the right foot including the great toe and the calcaneus. Please review digital photography.

At that point in time, given the fact that the patient had undergone revascularization, a transcutaneous oximetry mapping study was employed finding local periwound cutaneous hypoxia demonstrating a good 100% oxygen challenge. The patient was enrolled into a trial of 20 hyperbaric oxygen treatments at 2.4 atmospheric pressure receiving 90 minutes of 100% oxygen with four ample air breaks to avoid the potential for central nervous system oxygen toxicity.



The patient was compliant and 20 HBO treatments were provided and then Regranex as platelet-derived growth factor was employed. The wounds began to granulate well and epithelialization developed with good healing of the great toe amputation site on the left foot, distal great toe on the right foot, and right calcaneus wounds. After 20 HBO treatments, the patient was followed at the *WoundCare Center* for approximately two months at which point the patient was discharged from further wound care requirements.

**COMMENT:** Elderly patients with multiple comorbidities who are status post peripheral vascular surgery with non-healing states tend to be particularly good candidates for HBO therapy. The fundamental principle of perfusion must always be addressed before employing additional treatment for non-healing wounds. In any evaluation of a non-healing wound involving the lower extremities, appropriate identification of peripheral vascular disease must be addressed first before engaging in what can be long-term and expensive wound care management strategies. However, some patients who undergo appropriate revascularization still are not able to mount sufficient healing and these candidates become appropriate for additional wound care strategies including HBO therapy, growth factors which now include platelet-derived growth factor, TGF (transforming growth factor), Apligraf, and Thrombograft.

*Dr. Paul W. Buza, DO, ACN Medical Director*

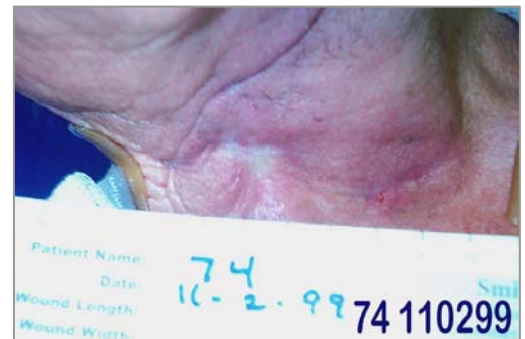
## The WoundCare Center at the **Brevard Regional Hyperbaric Center**

### CASE NO. 1

This 61-year-old male presented to the Brevard Regional Hyperbaric Center with multiple non-healing fistulas of the right neck status post pectoral cutaneous flap. The patient was identified with tonsillar carcinoma in 1996 by biopsy and underwent full dose radiation therapy in December of 1996. Subsequently, he developed osteoradionecrosis of the right mandible and underwent pectoral myocutaneous flap transposition to the right lateral neck two months prior to presentation to the hyperbaric center.

On examination, he had multiple patent fistulas with exudative drainage with evidence of early ischemic changes along the graft margins.

Hyperbaric oxygen therapy commenced at 2.4 atmospheric pressure which is the equivalent of 45 feet of sea water receiving 90 minutes of 100% oxygen with ample air breaks to avoid the potential for central nervous system oxygen toxicity. Within his first two weeks of therapy, there was resolution of his exudative drainage from his underlying infection and subsequently with two additional weeks for a total of 20 treatments led to complete resolution of his patent fistulas. Five additional HBO treatments were provided from complete closure of his non-healing wound margins.



### CASE NO. 2

This 51-year-old female developed invasive squamous cell carcinoma of the lower lip in 1998 and underwent 6,480 cGy of radiotherapy in June of 1998. The patient was scheduled for a vermilionectomy with mucosal advancement flap reconstruction with wedge resection of the lower lip.



She completed 20 hyperbaric oxygen treatments at 2.4 atmospheric pressure which is the equivalent of 45 feet of sea water receiving 90 minutes of 100% oxygen with four ample air breaks to avoid the potential for central nervous system oxygen toxicity followed by 10 additional treatments postoperatively.

Her surgery proceeded well without complications and she was able to achieve full healing postoperatively with 10 additional HBO treatments.

**Both cases as described above** are typically seen here at the **Brevard Regional Hyperbaric Center** addressing issues of late effect radiation either of bone and/or soft tissue. *Preoperative and postoperative HBO therapy in tissues which have been subjected to prior radiation improve clinical surgery outcomes and avoids significant potential for complications from non-healing states either from graft preservation and/or surgical dehiscence.* The incidence of late effect radiation, especially of the head and neck, is increasing as more people are surviving aggressive cancer therapy in the form of chemotherapy and radiation but often are left with soft tissue radiation injury and/or osteoradionecrosis. HBO therapy is instrumental in the clinical management for these patients who require postradiation surgical flaps and/or bone grafts of the head and neck following radiation therapy.

-Paul W. Buza, DO Medical Director

**CASE NO. 1**

This 59-year-old male with history of insulin-dependent diabetes was referred to the **Brevard Regional Hyperbaric Center** for hyperbaric oxygen therapy for a non-healing wound involving the great toe of the left foot considered at high risk for amputation. Subsequent transcutaneous oximetry mapping found severe local periwound hypoxia without evidence of concomitant peripheral vascular obstruction.

- PAST MEDICAL HISTORY:** His pertinent past medical history included insulin-dependent diabetes of 19 years in duration with associated underlying severe diabetic polyneuropathy.
- CURRENT MEDICATIONS:** His medications included insulin and his antihypertensive regimen.
- ALLERGIES:** No known drug allergies.
- SOCIAL HISTORY:** The patient denied the daily use of alcohol or tobacco.

Digital photography was taken throughout the course of his hyperbaric oxygen treatments. His HBO therapy consisted of 2.4 atmospheric pressure which is the equivalent of 45 feet of sea water receiving 90 minutes of 100% oxygen daily Monday through Friday. Over several months, the mainstay of his treatment included an appropriate antibiotic regimen after cultures were obtained as well as weekly debridement and meticulous wound-care dressing changes. Regranex, a platelet-derived growth factor, was also applied to the wound daily. At the time of discharge from the hyperbaric program, the depth of the wound was filled and is now superficial requiring epithelialization for complete closure.



**CASE NO. 2**



This 61-year-old female was referred to the **Brevard Regional Hyperbaric Center** for further evaluation of a non-healing wound involving the left foot which was suspected to be related to an envenomous bite, possibly brown recluse spider. Initial and appropriate therapy included debridement and antibiotics without significant improvement of the 2-cm ulcer.

- PAST MEDICAL HISTORY:** Her past medical history is otherwise unremarkable Without significant comorbidities.
- CURRENT MEDICATIONS:** Included Advil.
- ALLERGIES:** No known drug allergies.
- SOCIAL HISTORY:** She denied the daily use of alcohol.



Hyperbaric oxygen therapy was initiated at 2.4 atmospheric pressure which is the equivalent of 45 feet of sea water receiving 90 minutes of 100% oxygen daily Monday through Friday for a standard of 20 treatments. Wound care management included chemical debridement and sharp debridement as well as an appropriate antibiotic regimen based on culture reports and meticulous daily wound-care dressing changes. Once the wound was sufficiently debrided, Regranex, a platelet-derived growth factor, was added to the wound daily. In a slow fashion over four to six weeks, granulation tissue formation was noted.

**In both cases as described above,** appropriate wound care management includes meticulous wound-care dressing changes with appropriate debridement which often must be weekly. At times, debridement can be achieved with chemical debridement and/or sharp debridement. Cultures to identify local infections with appropriate antibiotics are also very important. *When wounds continue to demonstrate no significant improvement despite appropriate wound-care management strategies, hyperbaric oxygen therapy should be considered and determined based on transcutaneous oximetry mapping studies to determine the presence of local periwound hypoxia.* If it is present and the readings are below 40 mmHg at the site of the wound and if there is no evidence of significant peripheral vascular obstruction, HBO therapy is considered to be appropriate at that point in time. Recent literature has now demonstrated a synergistic effect between HBO and platelet-derived growth factor, Regranex. HBO has been shown to up-regulate endothelial growth factor receptors within the wound for which Regranex is specific. A typical course of treatment begins with 20 treatments but in difficult and challenging cases is often extended to 30 and sometimes 40 treatments.

-Paul W. Buza, DO Medical Director

## CASE PRESENTATION

This 74-year-old male presented to the Brevard Regional Hyperbaric Center with a chronic right non-healing wound over the Achilles for approximately four to five months prior to his presentation. The patient had received very good wound care management strategies including whirlpool, antibiotics, and frequent twice-daily wound care dressing changes. He had also been treated with Regranex, platelet-derived growth factor, with persistence of a non-healing state. His past medical history found no prior evidence of diabetes mellitus and/or other potentially associated immunocompromised states.

Finding no contraindications to hyperbaric oxygen therapy, a transcutaneous oximetry mapping study was performed finding significant local periwound hypoxia without evidence of proximal peripheral vascular obstructive disease. HBO therapy was initiated at 2.4 atmospheric pressure which is the equivalent of 45 feet of sea water receiving 90 minutes of 100% oxygen with four ample air breaks to avoid the potential for central nervous system oxygen toxicity daily for 20 treatments.

His wound care management program continued to include whirlpool therapy, twice-daily wound care dressing changes, and continued Regranex, platelet-derived growth factor, with wound cultures finding no significant ongoing infection.

Serial digital photography is taken of the wound, see Figures 1, 2, and 3. No significant change in granulation tissue formation was noted for approximately the first 10 treatments which is the typical experience in these types of cases. Towards the end of his HBO treatments, significant granulation tissue formation was appreciated and the patient was able to achieve full closure of the wound in several months following his HBO treatment.

**COMMENT:** Historically, Achilles wounds are very difficult to treat. The skin and subcutaneous fascia overlying the Achilles region is relatively avascular and subject to repetitive biophysical stress making wound healing quite difficult. His comprehensive wound care management program which included twice-daily wound care dressing changes, Regranex (platelet-derived growth factor), whirlpool therapy, and the absence of an immunocompromised state in addition to his HBO treatments achieved a positive clinical outcome. In addition, addressing issues of biomechanical stress to the Achilles region was also an important element of his treatment plan. Achilles wounds are typically very difficult to treat and often require meticulous wound care management strategies as described above. Achilles wounds associated with immunocompromised states are very challenging and would normally take twice as long if not longer to heal with the same wound care management program.

Paul W. Buza, D.O., A.C.N., Medical Director



Figure 1



Figure 2

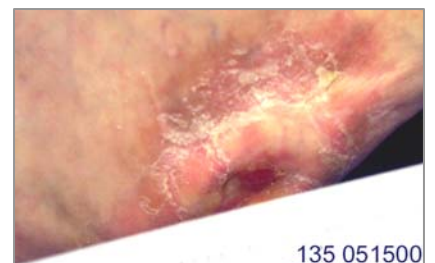


Figure 3

## PLATELET RICH PLASMA (PRP) PRESENTATION NO. 3

PATIENT: 309

CASE STUDY

This 67-year-old female presented to the center for a non-healing ulcer due to large vessel arterial occlusive disease along the right medial leg which had been problematic and progressively getting worse over the past six to eight months. Her wound care management program up to that point included intermittent debridement, antibiotic therapy, and twice-daily wound care dressing changes. Nutritional issues had been addressed and the patient demonstrated failure of conventional wound care management strategies.



**PAST MEDICAL HISTORY:** Was significant for a left below-knee amputation secondary to peripheral vascular large arterial occlusive disease. Her past medical history was also significant for hypertension, coronary artery disease, and hypothyroidism.

**CURRENT MEDICATIONS:** Included Prilosec, Cardura, Thiazide diuretic and Synthroid.

**SOCIAL HISTORY:** Found no abuse of alcohol or tobacco.

**PHYSICAL EXAMINATION:** Vital signs were stable. The patient was afebrile. Ear, nose, and throat examination was unremarkable. The heart was regular in rate and rhythm. Lungs were clear to auscultation.

**WOUND EXAMINATION:** Included digital photography for serial review. The wound was irregular with surrounding erythema with moderate granulation tissue formation with significant fibrin deposition.

**TREATMENT PLAN:** The patient was engaged with 20 hyperbaric oxygen treatments at 2.4 atmospheric, receiving 90 minutes of 100% oxygen. At the completion of her HBO treatments, the tissue began to granulate and autologous platelet gel was employed twice weekly for two weeks and then once weekly for an additional four weeks. The wound continued to granulate in a progressive manner and the wound was able to achieve primary closure.



**COMMENT:** Patients with significant large vessel arterial occlusive disease status post revascularization remain at risk for developing non-healing cutaneous ulcers secondary to poor perfusion. In this particular case, the patient demonstrated a good clinical response to combination HBO therapy and autologous platelet gel tissue grafting. Given the fact that the wound was approximately nine months in duration justifies aggressive intervention for lower extremity wounds which are at risk for amputation as this patient had undergone a left below-knee amputation five years prior.



## PLATELET RICH PLASMA PRESENTATION (PRP) NO. 5

PATIENT: 296

CASE STUDY

This 84-year-old male presented to the Center with a large non-healing wound involving the medial left anterior tibialis region which was approximately four months in duration and was not responding to conventional wound care management strategies including twice-daily wound care dressing changes with antibiotic dressings and intermittent debridement status post excision of melanoma with full and complete resection with no evidence of recurrence of tumor.



**PAST MEDICAL HISTORY:** Was significant for moderately advanced dementia and hypertension.

**CURRENT MEDICATIONS:** At presentation to the Center included Keflex, Accupril, vitamin E and Aricept.

**SOCIAL HISTORY:** Found the cessation of tobacco in 1964 with no prior history of alcohol abuse. The patient remains at home but requires supervision due to his moderately advanced state of dementia.

**PHYSICAL EXAMINATION:** Vital signs were stable. The patient was afebrile. The patient did demonstrate neurocognitive dysfunction. Ear, nose, and throat examination was unremarkable. Heart was regular in rate and rhythm. Lungs were clear to auscultation.

**WOUND EXAMINATION:** Involving the left anterior tibialis regions was photographed with digital photography for serial review. The wound was quite deep with poor granulation tissue formation without significant exudative and/or purulent drainage. Dorsalis pedal pulses were present and capillary refill was brisk.



Cultures were obtained finding no evidence of bacteria but was positive for yeast. Subsequent cultures and sensitivities demonstrated *Candida* and Diflucan was initiated at 100 mg two tablets for the first day and then one tablet daily for the following two weeks. Hyperbaric oxygen therapy was initiated and the patient received 20 treatments of HBO therapy at 2.4 atmospheric pressure. The patient began to demonstrate early signs of granulation and at that point in time autologous platelet gel tissue grafting was initiated twice weekly for the first two weeks and then once weekly for the next six weeks. The wound demonstrated rapid granulation formation and subsequent epithelialization allowed full primary wound closure with no recurrence.



**COMMENT:** Yeast infections can be seen in problematic non-healing wounds, especially within the elderly. Wounds which do not respond to appropriate conventional therapy should be cultured carefully for unusual superimposed nonbacterial infections. The combination of HBO and autologous platelet gel was considered due the gentleman's advanced age. Elderly patients typically within the eighth decade are significantly immunocompromised and warrant more aggressive outpatient therapy when conventional wound care management strategies are ineffective.



## PLATELET RICH PLASMA PRESENTATION NO. 2

PATIENT: 277

CASE STUDY

This very healthy, physically active 80-year-old female presented to the Center with a chronic non-healing wound involving the medial aspect of her left leg despite appropriate wound care management strategies including twice-daily wound care dressing changes with antibiotic dressings and intermittent debridement. Some concerns as to the possibility of a venomous bite possibly from a brown recluse spider were raised but never confirmed. Her wound was painful and at times demonstrated exudative drainage.



**PAST MEDICAL HISTORY:** Was significant for Polycythemia Vera, coronary artery disease and cardiac dysrhythmia. Past medical history was also significant for hypertension and mild to moderate peripheral vascular disease involving the bilateral lower extremities not considered to be a surgical candidate.

**PAST SURGICAL HISTORY:** Included cataract surgery.

**SOCIAL HISTORY:** Found the discontinuation of tobacco 30 years prior and the current denial of daily alcohol usage.

**PHYSICAL EXAMINATION:** Her vital signs were stable. The patient was afebrile. Ear, nose, and throat examination was unremarkable. Heart was regular in rate and rhythm. Lungs were clear to auscultation.

**WOUND EXAMINATION:** Of the wound found a poorly granulated ulcer along the medial left leg without exudative or purulent drainage.

Autologous platelet gel was initiated twice weekly for two weeks and then once weekly for the next six weeks. Her wound began to granulate and the margins of the wound, which were quite avascular, began to demonstrate erythema with capillary blanching on palpation. (Please review digital photography for serial review.)

**COMMENT:** It is interesting to note that the patient's medical condition of polycythemia vera which is a state of elevated platelet levels may have contributed indirectly to the treatment in this particular case for autologous platelet gel. High levels of platelet concentration are the objective of the procedure to achieve sufficient levels of multiple growth factors contained in the alpha granules of the platelets, which may have contributed to a rapid healing phase in this particular case.

## PLATELET RICH PLASMA (PRP) PRESENTATION NO. 1

PATIENT: 151

CASE STUDY

This 72-year-old male presented to the Wound Care Center with a large non-healing diabetic ulcer involving the dorsum of the right foot with multiple bone exposure and was being considered for full-thickness skin graft. Digital photography is available for review of his initial presentation.



**PAST MEDICAL HISTORY:** Was significant for insulin-dependent diabetes, peripheral vascular arterial disease status post revascularization and history of prostate cancer status post radiation therapy.

**PAST SURGICAL HISTORY:** Appendectomy, cardiac pacemaker placement, and prostatectomy.

**CURRENT MEDICATIONS:** Included insulin, Norvasc, nortriptyline, Trental, Lanoxin, Zestril, Prevacid, and Plavix.

**ALLERGIES:** No known drug allergies.

**PHYSICAL EXAMINATION:** Of the mid dorsum of the foot revealed a large non-healing ulcer with multiple bone exposure with poor granulation tissue formation without exudative and/or purulent drainage. Dorsalis pedal pulses were intact. Capillary refill was brisk.



**TREATMENT PLAN:** A course of 20 hyperbaric oxygen treatments beginning at 2.4 atmospheric, receiving 90 minutes of 100% oxygen was initiated in addition to conventional wound care management strategies including twice-daily wound care dressing changes with wet-to-dry dressings. During his course of therapy, he demonstrated no evidence of local infection.



At the completion of his course of HBO therapy, autologous platelet gel grafting commenced twice weekly for the first three weeks and then once weekly thereafter. (Please review digital photography for serial review demonstrating the ability for granulation tissue and migration over exposed metatarsal bone.)

At this point in time, a decision was made to cancel full-thickness skin grafting and the patient has been doing well with appropriate follow-up for foot care and addressing the issues of biomechanical orthotics with appropriate footwear.



**COMMENT:** Bone exposure in the distal lower extremity indicates poor prognosis for primary granulation tissue closure. Typically, these patients are scheduled for full-thickness skin graft due to the inability of the distal lower extremity to mount sufficient angiogenesis and granulation tissue for primary closure. Of note in this particular case is the achievement of his primary closure with nonsurgical intervention as a result of the combination of HBO therapy and autologous platelet gel treatment plan.