

## Femoral Vein Cannulation in Treatment of Osteomyelitis.

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The use of long term, out-patient, antibiotic administration to treat osteomyelitis, is an important part of wound care. This article reports the surprising finding that femoral venous access is a safe and efficacious method of delivering antibiotics for relatively long periods, of up to 70 days.

A small cohort of 8 diabetic patients is described. They initially presented to our Wound Care Center with Wagner stage 2 ulcers, and were subsequently found to have underlying osteomyelitis. They were chosen for this paper because of their need for a preliminary 6 week course of intravenous antibiotics; and secondly, because of the subsequent need for adjunctive hyperbaric oxygen treatment (HBO2). HBO2 therapy was used, because there had not been a distinct improvement in their scans after 4 weeks of antibiotic therapy.(Ref 1)

A history of a pneumothorax is a contraindication to hyperbaric medicine (Ref 2), and unfortunately iatrogenic pneumothorax complicates over 6% of subclavian vein central line placements, (Ref 3). Furthermore it is our opinion that this complication probably occurs more commonly even than this, but does not feature in the literature because of the reluctance of physicians to report untoward iterations. The creation of a pneumothorax defeats the whole object of the exercise, as it precludes the therapeutic combination of HBO<sub>2</sub> and antibiotics.

Even more ominously, the onset of the pneumothorax may be delayed several days, (Ref 4) and so go undetected in the immediate post operative chest X-ray.

In order to avoid the risk of a pneumothorax, we started using the femoral vein as the access to the central venous system. Indeed the main focus of this paper is to document the surprising finding that femoral lines, which are inserted in the Operating Room, with careful attention to technique, can be safely left in place for long periods of time, and that complications are minimal. We were also encouraged by a recent study that showed no difference in infection rates between subclavian and femoral lines (Ref 5).

Furthermore, it is our impression, that it is still not widely appreciated by the surgical community, that the main cause of line sepsis is biofilm production (Ref 6). Fortunately, the bacterial flora of the skin of the

groin, predominantly Propionibacteriaceae, lack the propensity for participation in biofilm production (Ref 7), and ipso facto, are not virulent in this regard.

## METHODS

### Detailed Description of Technique for Femoral Central Line Insertion

Since the avoidance of line sepsis is critically important, all the procedures were completed in the Operating Room, and treated like any other out-patient surgical procedure, with Monitored Anesthesia Care, the administration of 1 G vancomycin pre-op, and meticulous skin preparation. This consisted of a preliminary clipping of all hair in the areas over the femoral veins, then 8 minutes of scrubbing with betadine (Wet Premium Skin Scrub Trays. Medline), from umbilicus to knees, and finally a 30 second final scrub in the groin creases with ChloroPrep Skin preparation (CareFusion)

All surgeries were performed by the author (A.C.), at Sandhills Regional Medical Center, Hamlet, N.C., with the skilled assistance of an experienced Operating Room technician.

A Seimans Occuson Seqviq C-12 ultrasound machine, with a 6 L 3 probe in a sterile sheath, was used to confirm common femoral vein patency and to aid in needle insertion. The 3 ml syringe and the 2 ½ inch XTW needle from the ARROWgard Blue PLUS kit (Manufactured by Arrow International), were used to access the vein after infiltration of local

anesthetic. At this point the Spring-Wire Guide from the same kit was advanced to the right atrium to confirm its location in the inferior vena cava. A Phillips BV Pulsera SN 002286 C-arm was used to follow the progress of the wire, and to check for any unusual anatomy. In about 50% of cases this wire would not advance easily, so a 0.025 in ZIPwire (Boston Scientific) was used instead.

Then, after a small skin incision had been made, a 7F Super Sheath (Boston Scientific) was advanced over the wire and withdrawn, to make a tunnel to the vein. This was followed expeditiously by the ARROWgard Blue PLUS Catheter; after which an inferior vena cava venogram was recorded to confirm normal vena cava anatomy, with the position of the catheter tip in the center of the lumen of the common iliac vein, or inferior vena cava, and rapid, unimpeded flow of the dye.

The most critical part of the procedure was the securing of the catheter, to prevent sliding of the tubing, and the associated risk of dragging bacteria under the skin and into the tunnel leading to the vein. This was accomplished by making a purse string around the skin access site using 2-0 nylon, and tightening this to about 5 lb tension, not too tight, to avoid creating a rim of ischemic tissue, but tight enough to prevent the catheter sliding; and then looping the same suture around the distal part of the catheter hub, and tightening this to the point where the catheter was held snugly against the skin and could not move, (Figure 1). Two other sutures were placed using the holes

provided by the manufacturer; again, the direction of the sutures was such that they also helped prevent sliding.

### Vancomycin administration

The patients then came the following day, and were scheduled to come daily thereafter, for 40 more days, for vancomycin administration in the out-patient department. Each day the IV site was inspected by experienced nurses, and cleaned with Betadine (Purdue products) and ethyl alcohol. On Mondays and Fridays the entire dressing was changed and a fresh Hypafix (Smith & Nephew) was applied. The Pharmacy Department monitored the antibiotic levels and adjusted the dose to maintain the optimal serum concentration.

### Bone Scan, and Osteomyelitis Diagnosis

3 phase bone scans were performed using the Alegent Health Midlands Hospital imaging protocol (Ref 8), and read independently by the hospital Radiologist. In two cases the initial diagnosis of osteomyelitis was made from a biopsy of the bone; the other 6 cases had positive bone scans,

The osteomyelitis was judged to be cured when the 3 phase bone scan was negative (4 patients), or in the absence of a scan, (Patient G. J. refused), if there had been no clinical sign of recurrence for over a year.

In the case of patient M.F. he transferred to another Wound Care Center after his ulcer cured; at that center, they told me, he similarly has had no recurrence and is presumed cured of his osteomyelitis.

## Hyperbaric Medical (HBO2) Therapy

The HBO2 protocol involved 2 ATA for 90 continuous minutes, in a Perry Monoplace Hyperbaric Cylinder, (34-100-PVHO=BP-S3400). The patient was treated Monday through Friday for 8 weeks, resulting in a total of 40 dives.

## Patient Population

All the patients were type 2 diabetics with Wagner stage 2 lesions, most often involving the toes. All the patients were treated at the Sandhills Center for Wound Healing and Hyperbaric Medicine, Hamlet, N.C. All signed informed consent to use their data for research purposes.

Treatment between the end of HBO2 therapy, until ulcer and osteomyelitis cured

A series of silver impregnated dressings, gradually changing over to collagen dressings, was used to treat the skin ulcers until they closed.

Surface infections were treated with the appropriate oral antibiotic, and oral sulfa and ciprofloxacin were continued until the osteomyelitis was cured.

## RESULTS

The femoral lines were used for periods of up to 70 days, (range 38 to 70 days). None became infected. The complication that occurred was mechanical: in one case (patient G.J.) the line was inadvertently pulled out, and was replaced in the other femoral vein, (Table 1).

The age range of the patients was 50 to 71 years; there were 5 males and 3 females.

Patient S.B. did not want intravenous antibiotics initially, so there was a delay of over 3 months while he took oral antibiotics.

In two cases there was an inordinate delay between the first vancomycin infusion, and the start of HBO2 treatment. In the case of G.J., the delay was caused by the need to address a heart condition that developed; and a subsequent car wreck compounded the problem.

Patient B.S. needed angioplasty revascularization of his left leg prior to HBO2 treatment, then he was admitted to the hospital with a change of mental status; and finally the combination of his non-compliance, combined with his family's unwillingness to arrange transport, added months to the interval between his first vancomycin treatment (2/5/14), and the start of HBO2 (9/2/14).

In the case of D.V. she had been receiving oral antibiotic treatment for months from another physician prior to her referral to the Wound Care Center. A bone culture came back positive on 11/11/14, so she was able to start her HBO2 treatment on 12/9/14, before she received her femoral line on 1/7/15.

In three cases the lines were left in significantly longer than usual; these were patients M.F., M.M., and D.V., and this was primarily because of missed infusions and the need to make up for these. Lack of compliance, weather conditions, and lack of transportation were the main reasons for the missed appointments. Frankly, in these patients with refractory osteomyelitis who require daily attendance for so many months, and who have to travel long distances in our rural environment, to get to the Clinic, and given the price of gasoline and the poverty of our patient population, we are surprised that this situation is not more prevalent. So we can sympathize with patient K.L., who simply 'gave up' and refuses further treatment other than



palliation. Similarly patient B.S. was admitted to hospice care, and currently also gets palliative care.

After his skin ulcer healed, patient M.F. transferred to a wound care center nearer to his residence; when I contacted them, they told me he was cured of his osteomyelitis, but could not give me an exact date.

It took between 8 and 30 weeks from the time of presentation for the ulcer to heal; and between 20 and 38 weeks for resolution of the osteomyelitis, (Table 2). In 2 cases, Patients K.L. and B.S., the ulcer did not heal, nor did the osteomyelitis. In 4 cases we had radiological proof of a cure of the osteomyelitis, in the case of G.J. and M.F. we assume they were cured, because there has been no recurrence of clinical signs or symptoms for over a year.

This results in a 75% cure rate for the osteomyelitis component, and a 75% cure rate for the ulcer.

Patient D.V. subsequently developed another area of osteomyelitis and is currently undergoing treatment for this second problem.

## DISCUSSION

Currently blood stream infections from central line venous catheters can best be described as a medical disaster area, occurring in 250,000 patients in the United States each year and causing a staggering 62,000 deaths! And a single incident of such an infection can cost US \$ 56,000 to treat, (REF 9).

For these reasons, it is our opinion that central lines insertion should be taken very seriously, and that the procedure should be performed in the Operating Room with help from personnel experienced in maintaining a sterile field, and definitely not at the bedside. The last thing we should do, is to add to the “sea of troubles” already experienced by these diabetic patients.

In connection with groin cannulation, one concern is that the proximity of the perineum to the groin, would result in increased bacterial cross contamination. However a study of the skin flora shows that the bacteria in the groin are a stable population and quite different from the perineal flora (Ref 10).

Additionally a study of the route of perineal drainage shows that in the recumbent patient the flow is from the groin downward, *toward* the perineum, and when the patient stands, the drainage is down the inside of the thigh, *away* from the groin, (Fig 2). By way of contrast, with the patient’s head on a pillow, the subclavian insertion site is in direct line

of oral or nasal secretions from coughing or sneezing, especially when the recumbent patient is resting on their side. The bacteria from these sites are particularly prone to biofilm production. This is also true for PICC line insertion sites.

Another safety consideration that makes the femoral site attractive is that if the catheter cannot be advanced up the right side during surgery, then it is safe to proceed to try the left side during same anesthesia. Conversely, the risk of creating bilateral pneumothoraces, should preclude this dual approach by a prudent surgeon working in the subclavian area; thus causing delay and increased expense.

The femoral approach is also easier for the surgeon in an ever increasing population of obese patients, as the depth of the femoral vein in the thigh stays relatively constant (Ref 11). On the other hand, increasing obesity causes landmarks in the thoracic area to be increasingly obscured, as from the jaw line downward the morphology of some patient increasingly approaches that of a truncated cone of adipose tissue, and the surgery becomes correspondingly more difficult. Should a chest tube be required, this same thickness of fat overlying the rib cage, can also make this procedure quite difficult.

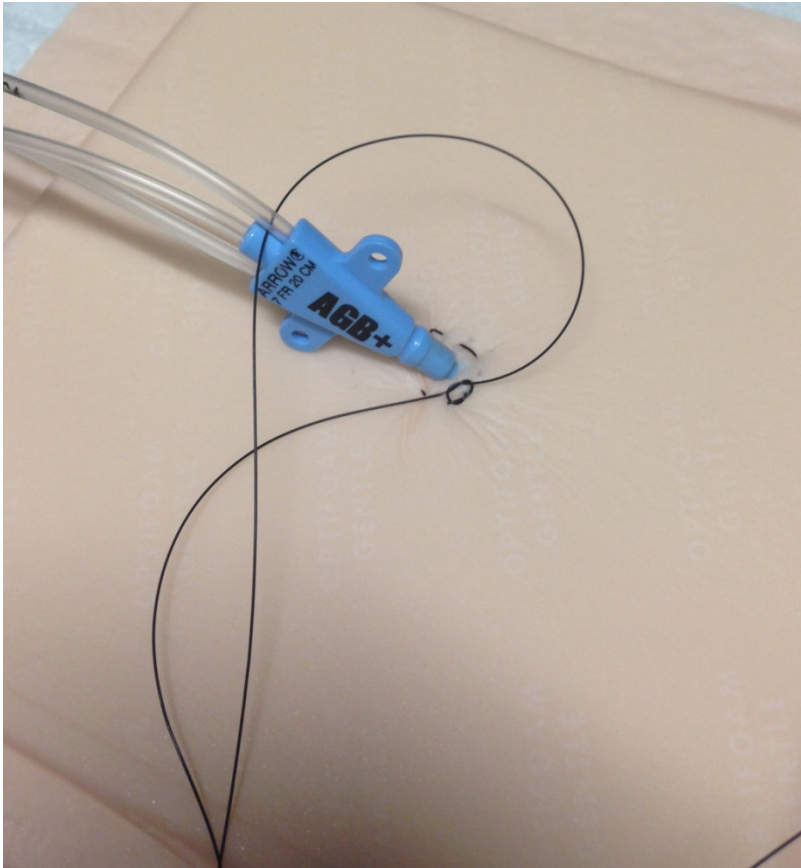
In a small hospital, a pneumothorax complication negatively impacts the program's reputation, and leaves it open to legal action; and because it was "hospital acquired", the costs are not reimbursed. Transferring a patient for a thoracoscopic surgery to repair a leaking

lung, may cost upward of US \$ 20,000 dollars. For these reasons also, the use of the femoral approach should gain increasing acceptance.

A recent article on PICC lines, also used to treat osteomyelitis, by Valbousquet Schneider et al (Ref 12), reported a mean duration of catheterization of 21 days; but they experienced a 8% infectious complication rate.

In our small series of patients, the time from clinic presentation to ulcer closure was between 8 and 30 weeks; and the time to cure osteomyelitis from the time of diagnosis was between 23 and 38 weeks. Thus our per cent cured using an initial combination of out-patient, intravenous antibiotics, and hyperbaric oxygen therapy was 75%. This falls in the 60 to 85% national range for cure by this combined technique, as outlined in Hart's review article, (Ref 13)

The most important finding was, that if inserted in the Operating Room, femoral lines are safe for long term antibiotic administration, and do not run the risk of expensive complications, or of interfering with HBO2 treatment by causing iatrogenic pneumothorax. Of all the branches of surgery, Wound Care Specialists are probably the most aware of biofilm dangers, so this may translate into a greater use of femoral access where the skin flora seems less conducive to infection.



CAPTION FOR FIGURE 1A:

The 2 'o' nylon suture used to make the purse string that secures the catheter, is brought round the hub of the catheter between the infusion tubes.

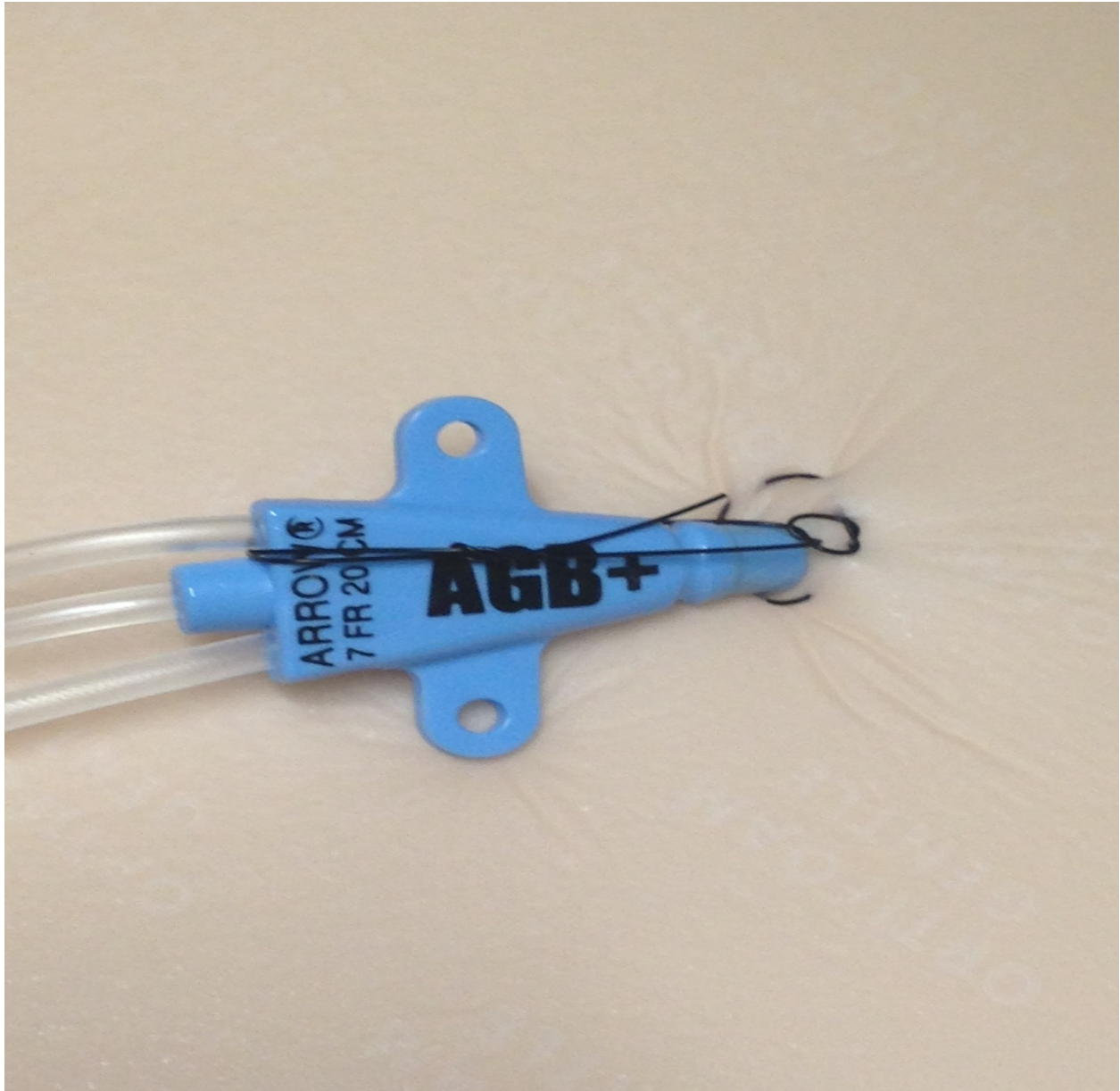


FIGURE 1B:

The nylon is then tied tightly to prevent any movement of the catheter in or out of the skin hole.



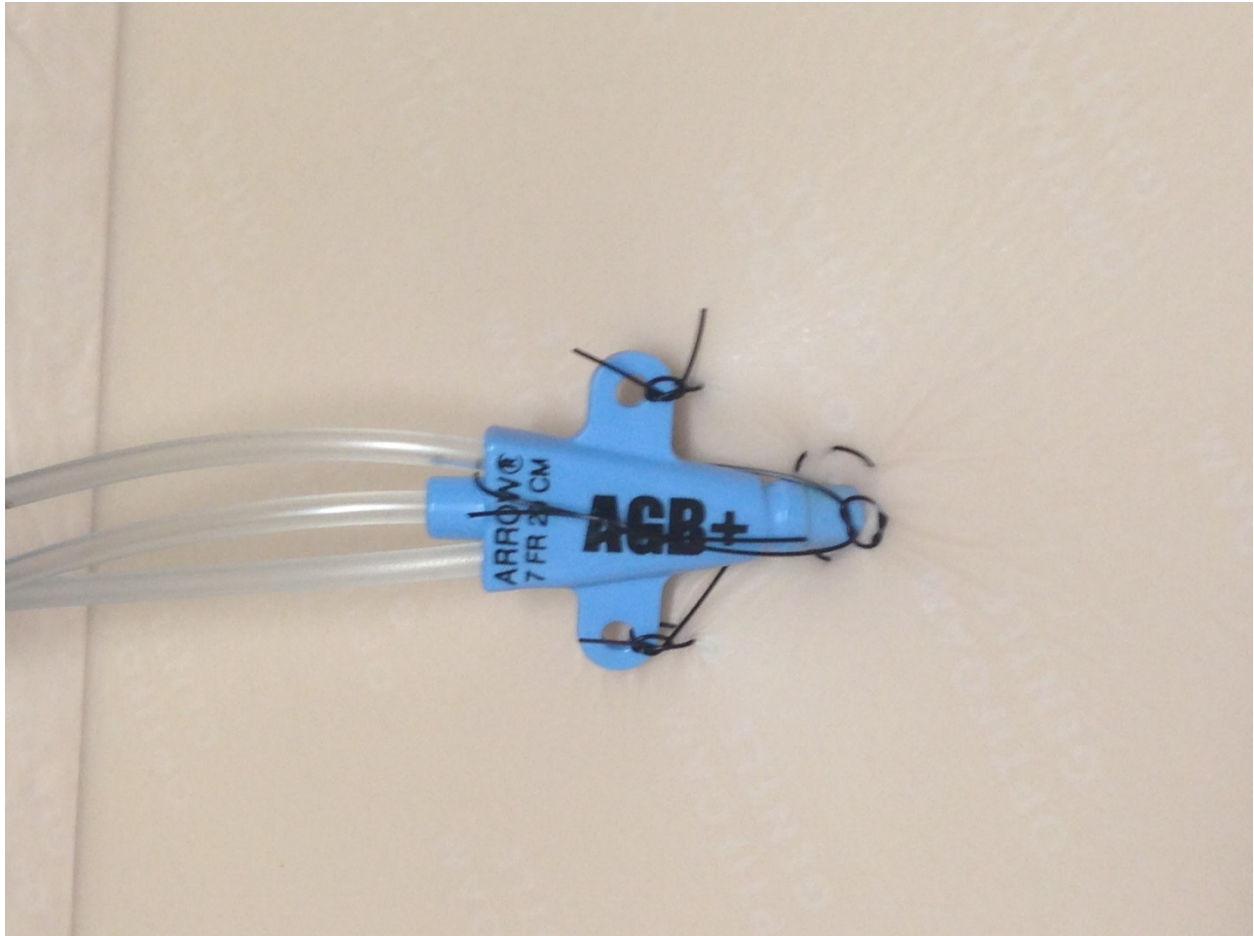


FIGURE 1C:

Final appearance of catheter, with 2 additional securing sutures inserted through the holes prepared by the manufacturer, and positioned to help prevent catheter sliding.



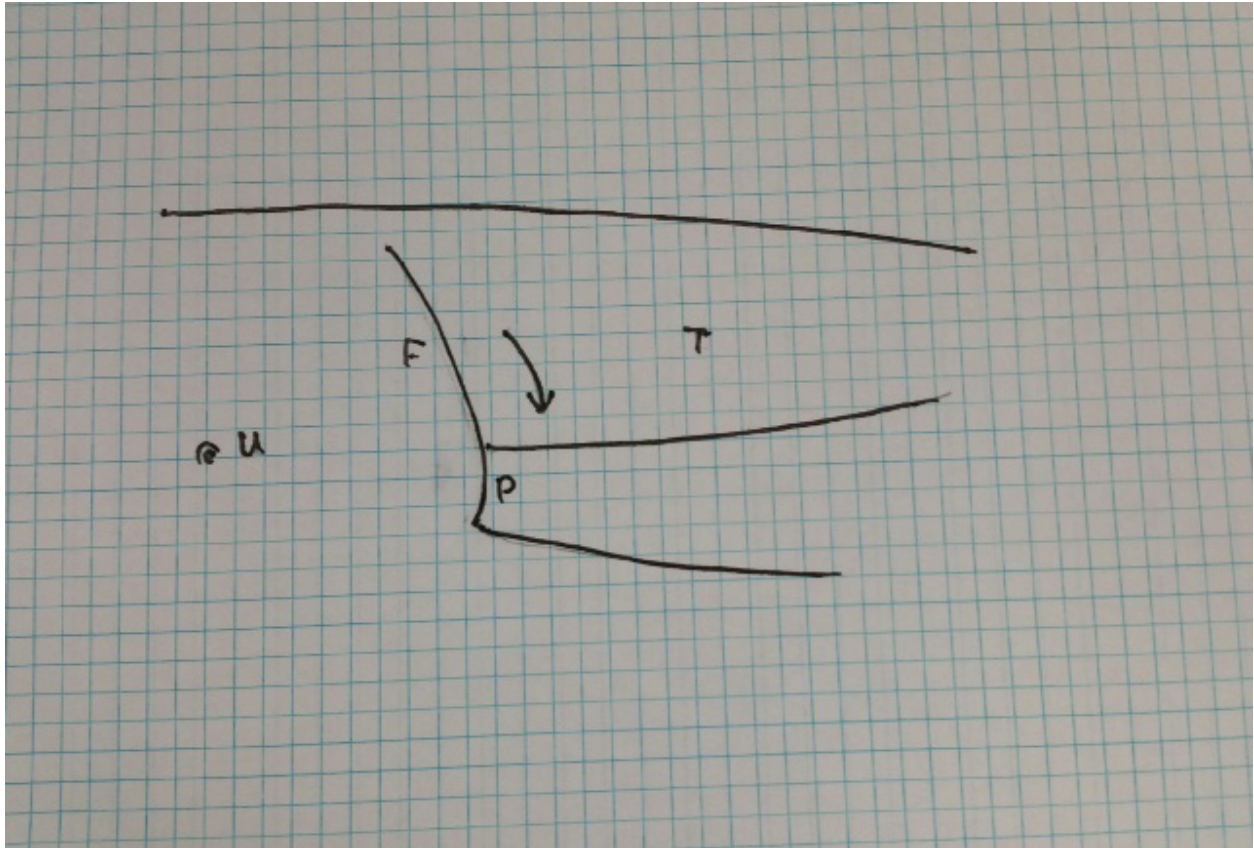


FIGURE 2A:

Diagram to illustrate drainage from groin to perineum in recumbent patient. U = umbilicus, F = area over femoral vein, T = inside of left thigh, P = perineum.

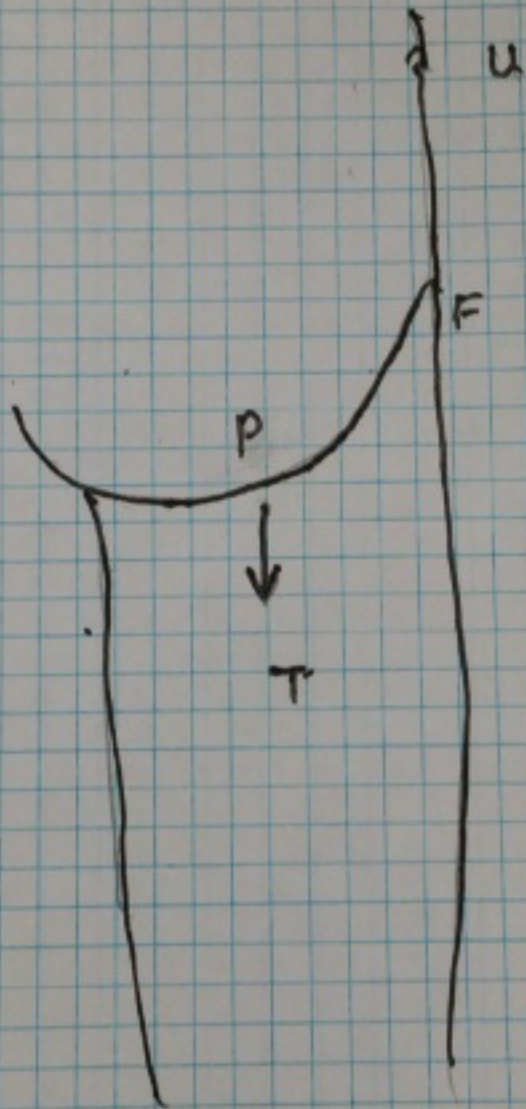


FIGURE 2B:

Diagram to illustrate drainage from perineum down inside of left thigh when patient is upright. U = umbilicus, F = area over femoral vein, T = inside of left thigh, P = perineum.

CAPTIONS FOR TABLES:

Abbreviations: M=male; F=female; Lt=left; Rt=right; N/A=not applicable

Table 1: Demographics, Data on Ulcer and Osteomyelitis, and Times of Central Line Insertion and Removal

Patient's Initials	Age	Sex	Date Ulcer Presented to Wound Center	Location of Wound	Date Osteomyelitis Diagnosed	Central Line Insertion Date	Central Line Removal Date	Days Central Line In Place
M.F.	51	M	12/17/12	Lt -5 Metatarsal	12/18/12	12/26/12	02/19/13	56
G.J.	54	F	07/09/13	Rt. Big Toe	07/09/13	07/15/13	08/24/13	41
K.L.	66	M	07/09/13	Rt. Foot Plantar	07/11/13	07/17/13	08/23/13	38
C.D.	60	F	08/13/13	Rt. Big Toe	08/14/13	08/14/13	10/01/13	49
S.B.	55	M	10/10/13	Rt. 2 <sup>nd</sup> Metatarsal	10/15/13	01/24/14	03/03/14	39
B.S.	71	M	02/04/14	Lt. Ankle	01/28/14	02/05/14	03/17/14	41
M.M.	58	M	03/06/14	Rt. 2 <sup>nd</sup> Toe	03/12/14	03/19/14	05/27/14	70
D.V.	50	F	10/22/14	Rt. Foot Lateral	11/11/14	01/07/15	03/02/15	54

Table 2 : Details of Hyperbaric Oxygen Treatment & Final Outcomes

<b>Patient's Initials</b>	<b>HBO Start Date</b>	<b>Date Ulcer Healed</b>	<b>Total Weeks for Ulcer to Heal</b>	<b>Dates Osteomyelitis Cured</b>	<b>Weeks from Diagnosis to Cure Osteomyelitis</b>
M.F.	12/27/12	04/21/13	18	Yes	Not Known
G.J.	10/04/13	12/13/13	22	Yes	Not Known
K.L	08/06/13	No	N/A	No	N/A
C.D.	08/20/13	10/10/13	8	05/09/14	38
S.B.	01/28/14	01/27/14	15	03/20/14	23
B.S.	09/02/14	No	N/A	No	N/A
M.M.	05/01/14	09/01/14	27	09/10/14	26
D.V.	12/09/14	05/08/15	30	05/20/15	27

## REFERENCES:

1. Fang RC, Galiano RD. Adjunctive Therapies in the Treatment of Osteomyelitis. *Semin Plast Surg.* 2009;23(2):141-147.
2. Neuman TS, Thom SR. *Physiology and Medicine of Hyperbaric Oxygen Therapy.* Philadelphia, PA: Elsevier Health Sciences; 2008: 593.
3. Tsotsolis N, Tsirgogianni K, Kioumis I, et al. Pneumothorax as a complication of central venous catheter insertion. [www.atmjournals.org/](http://www.atmjournals.org/) 2015;3(3)
4. Slezak FA, Williams GB. Delayed pneumothorax: a complication of subclavian vein catheterization. *J Parenter Enteral Nutr.* 1984; 8(5):571-4.
5. Marik PE, Flemmer M, Harrison W. The risk of catheter-related bloodstream infection with femoral venous catheters as

compared to subclavian and internal jugular venous catheters: a systematic review of the literature and meta-analysis. *Crit Care Med.* 2012;40(8):2479-85.

6. Ryder MA. Catheter-Related Infection: It's All About Biofilm. *Topics in Advanced Practice Nursing eJournal.* 2005;5(3)1-6.  
[www.medscape.com/viewarticle/508109](http://www.medscape.com/viewarticle/508109)
7. Holmberg A, Lood R, Morgelin M, et al. Biofilm formation by *Propionibacterium acnes* is a characteristic of invasive isolates. *Clinical Microbiology and Infection.* 2009;15(8):787-795.
8. Zeissman HA, O'Malley JP, Thrall JH. *Nuclear Medicine: The Requisites.* Philadelphia, PA: Elsevier Health Sciences; 2013:336.
9. World Health Organization: Preventing bloodstream infections from central line venous catheters.  
[www.who.int/patientsafety/impementation/bsi/en/](http://www.who.int/patientsafety/impementation/bsi/en/)
10. Grice EA, Segre JA. The skin microbiome. *Nat Rev Microbiol.* 2011;9(4):244-253.
11. Wallner SJ, Luschnigg N, Schnedl WJ, et al. Body fat distribution of overweight females with a history of weight cycling. *Int J Obes Relat Metab Disord.* 2004;28(9):1143-8.
12. Valbousquet Schneider L, Duron S, Arnaud F, et al. Evaluation of PICC complications in orthopedic inpatients with bone infection for long-tem intravenous antibiotics therapy. *The Journal of Vascular Access.* 2015;16(4):259-346
13. Hart BB. Refractory Osteomyelitis. In: Feldmeier JJ, ed. *Hyperbaric Oxygen 2003: Indications and Results, the Hyperbaric Oxygen Therapy Committee Report.* Kensington MD: Undersea and Hyperbaric Medical Society, Inc.; 2003: 60-85

## ABSTRACT

An important part of wound care is the use of long term, out-patient, intravenous antibiotic administration to treat osteomyelitis, using central lines. Unfortunately blood stream infection from such lines continues to be an enormous problem. For this reason we think it is important that central lines be placed in the Operating Room, and handled like a regular out-patient surgery; and the lines should be specially secured to prevent sliding. Surprisingly, we then found that



femoral lines placed in this fashion, remained free of infection for up to 70 days.

The choice of the femoral vein was determined by the propitious nature of the groin skin flora, Propionibacteriaceae, which seem less inclined to participate in biofilm production, the cause of central line infections. In addition there is no risk of creating an iatrogenic pneumothorax, which would prohibit the subsequent use of hyperbaric medical therapy, an important adjunctive therapy for refractory osteomyelitis.

This combined approach, intravenous vancomycin for 6 weeks, followed by HO<sub>2</sub>, was used to treat osteomyelitis underlying Wagner stage 2 ulcers, in 8 diabetic patients. We achieved a cure in 75% of the cases.

#### KEY WORDS

Femoral vein cannulation. Osteomyelitis. Wagner 2 diabetic ulcers. Biofilm. Pneumothorax.

