

A comparison of two methods of treatment for central catheter tunnel phlegmon in home parenteral nutrition patients

Michał Ławiński¹, Karol Forysiński², Agnieszka Bzikowska³, Justyna Z. Kostro⁴, Aleksandra Gradowska⁵,
Marek Pertkiewicz¹

¹Department of General Surgery and Clinical Nutrition, Medical University of Warsaw, Warsaw, Poland

²Department of General and Vascular Surgery, Medical University of Warsaw, Warsaw, Poland

³Department of Human Nutrition, Faculty of Health Science, Medical University of Warsaw, Warsaw, Poland

⁴Department of General, Endocrine and Transplant Surgery, Medical University of Gdansk, Gdansk, Poland

⁵Department of Personality, University of Social Sciences and Humanities, Warsaw, Poland

In memory of late Prof. Marek Pertkiewicz

Gastroenterology Rev 2016; 11 (3): 170–175
DOI: 10.5114/pg.2015.56556

Key words: parenteral nutrition, tunnel catheter phlegmon.

Address for correspondence: Michał Ławiński MD, PhD, Department of General Surgery and Clinical Nutrition, Medical University of Warsaw, Poland, e-mail: michal-lawinski@wp.pl

Abstract

Introduction: The ESPEN guidelines on long-term (> 3 months) parenteral nutrition recommend the use of tunnelled central venous catheters (CVCs) to minimise the risk of insertion site infection. A developed symptomatic infection of the soft tissue tunnel surrounding a CVC may rapidly become directly life threatening if the infection progresses along the catheter tunnel towards its end inserted into the venous system. This requires immediate management to eliminate infection and limit its effects.

Aim: To compare two surgical techniques for the treatment of suppurative inflammation of a CVC tunnel: conventional drainage of the infected tissues (surgical technique A) vs. radical *en bloc* excision of the infected tissues together with the infected central catheter (surgical technique B).

Material and methods: Seventy-three patients hospitalised due to CVC tunnel phlegmon between April 2004 and May 2014 were included in the retrospective study. Thirty-four (46.5%) patients underwent surgical procedure A and another 39 (53.5%) underwent procedure B.

Results: The mean duration of antibiotic therapy following procedure A was 8 ± 3 days, whereas procedure B required 7 ± 2 days of antibiotic therapy (NS). The mean hospitalisation period following procedure B was over 8 days shorter in comparison to that following procedure A (16.54 ± 7.59 vs. 24.87 ± 10.19 , $p = 0.009$, respectively).

Conclusions: The surgical treatment of CVC tunnel phlegmon involving radical *en bloc* excision of suppurated tissues along with the infected CVC shortens hospitalisation, expedites the insertion of a new CVC, and potentially reduces treatment costs.

Introduction

According to ESPEN (European Society of Enteral and Parenteral Nutrition) guidelines, in the case of long-term (> 3 months) parenteral nutrition, the liquid nutrient solution should be administered via a central venous catheter (CVC). Long-term parenteral nutrition requires the use of totally implantable subcutaneous port systems or tunnelled CVCs (e.g. Broviac, Broviac Expert, Groshong). Tunnelled CVCs have been suggested as preferable in patients requiring long-term parenteral nutrition [1]. The choice between a tunnelled catheter and a totally

implantable port depends on a number of factors: the preferences and experience of the parenteral nutrition team, the patient's decision and consent, and the required frequency of venous access. Complications associated with home parenteral nutrition (HPN) can be divided into metabolic, mechanical, and septic. Catheter infections are among the most common and most dangerous HPN complications. It may be reasonable to differentiate catheter related infections in exit site/tunnel infection and catheter-related blood stream infection. The term 'exit site infection' is well known in peritone-

al dialysis patients [2]. Alcohol consumption, smoking, a low level of education, cultural factors, underlying disease, and the type of venous access are considered to be factors potentially contributing to the development of such complications [2, 3]. Tunnelled CVCs with anti-septic coating are effective in preventing infections [1]. Septic complications of indwelling CVCs include exit site and tunnel infection, which may in some cases rapidly become directly life threatening. Soft tissue suppurative inflammation (phlegmon) may develop soon after CVC insertion, when it is usually due to improper skin preparation prior to CVC insertion in an operating room setting or inexpert CVC insertion by an inexperienced doctor. The CVC tunnel phlegmon that develops long after catheter insertion is an exogenous infection typically resulting from distant migration of cutaneous bacteria along the external surface of the catheter. In both cases the infection typically starts at the catheter exit site and spreads along its tunnel up to the site of its intravenous insertion [4, 5]. Our observations demonstrated that an exit site infection in the chest wall develops as a result of a local soft tissue infection around the catheter cuff, with suppurative discharge at the exit site. If CVC tunnel infection involves the soft tissue tunnel proximal to the CVC cuff, we hypothesise that the cuff may act as a “stopper”, preventing the outflow of the infected suppurative discharge via the catheter exit site. In this type of infection, the antibacterial cuff of the catheter plays a role opposite to preventing infections, for which it was designed. This facilitates the spread of the infection along the CVC tunnel and into the venous lumen, which results in systemic infection – septicæmia. Such an infection is potentially life threatening. The conventional and most common management of phlegmon includes drainage of the suppurated tissues and removal of the infected CVC [6]. Due to unsatisfactory treatment outcomes and the long hospitalisation required in the conventional approach, we introduced a novel technique for the treatment of indwelling CVC tunnel phlegmon. This technique involves a radical excision of the infected soft tissues along with the CVC, i.e. an *en bloc* excision.

Aim

The purpose of this paper was to analyse the causes of CVC tunnel phlegmon, as well as to describe and compare two surgical approaches to treating this complication: conventional drainage vs. *en bloc* excision of the infected tissues together with the catheter. Hospital stay duration, antibiotic therapy duration, and time from CVC tunnel phlegmon diagnosis to new HPN CVC insertion via either of the two compared surgical techniques were included in a comparative analysis.

Material and methods

Materials

Seventy-three patients were included in the retrospective study (33 females – mean age 57 ±15 years and 40 males – mean age 54 ±14 years) and hospitalised in the Department of General Surgery and Clinical Nutrition of the Medical University of Warsaw in the period from January 2007 to May 2014 due to suppurative inflammation (phlegmon) of the CVC tunnel. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Local Committee on Health Research Ethics.

Prior to the index hospitalisation, all patients had been receiving long-term HPN, with the most common indication for HPN being short bowel syndrome (86.3%; $n = 63$) and much less commonly Crohn's disease (9.5%; $n = 7$) and cancer-induced cachexia (4.1%; $n = 3$).

Types of catheters

The following types of tunnelled single-lumen CVCs were removed from the HPN patients hospitalised due to CVC tunnel phlegmon:

- Broviac catheters (Broviac 6.6 Fr Single-Lumen CV Catheter; Bard Access System) – in 72.6% of patients ($n = 53$). These catheters have a tissue ingrowth cuff, which helps to secure the catheter stays in place.
- Groshong catheters (Groshong 7 Fr Single-Lumen CV catheter; Bard Access System) – in 20.5% of patients ($n = 15$). These catheters have a built-in three-way valve near the catheter's tip, preventing both backflow of blood and air embolism. The valve also eliminates the need for a heparin flush to maintain catheter patency. Thus, these catheters are typically installed in patients with comorbidities precluding catheter heparinisation, such as haemophilia, thrombocytopenia, gastrointestinal haemorrhage, symptomatic portal hypertension, and diabetic retinopathy. These catheters are also equipped with antimicrobial VitaCuff or SureCuff, the latter promoting tissue in-growth in the catheter tunnel.
- Broviac Expert catheters (LifeCath Broviac Expert 6.6 Fr; Vygon) – in 6.8% of patients ($n = 5$). These catheters have a silver-impregnated antibacterial cover and, additionally, a tissue in-growth cuff.

Because of patients' or caregivers' training in (and familiarity with) the use of a specific type of CVC, after successful treatment of catheter-induced infection, each patient received the same type of CVC as before.

Methods

Patients diagnosed with CVC tunnel phlegmon received peripheral blood culture and surgical treatment according to one of the following techniques:

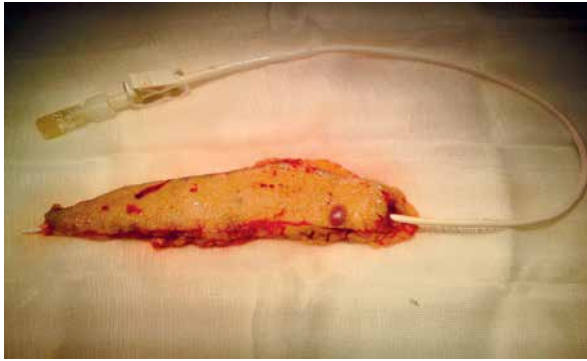


Figure 1. En bloc excision of the infected CVC tunnel tissue along with the CVC

- surgical procedure A – the patients received empirical antibiotic therapy, their CVC was removed, and the suppurated tissues were drained (46.5%; $n = 34$). The infected CVCs were removed in an operating room setting under local anaesthesia with 2% lidocaine. Subsequently, the soft tissue along the catheter tunnel was incised to evacuate the suppurative discharge, the wound was irrigated with antiseptics (hydrogen peroxide, Betadine, Octenisept), and rubber drains were inserted to completely evacuate the suppurative discharge. Intraoperatively, pus swabs were collected from the wound for culture. The procedure lasted 10–15 min, on average. Compression dressing of sterile gauze was applied and, subsequently, changed daily with daily wound irrigation until complete healing by granulation was achieved.
- surgical procedure B – the patients were given empirical antibiotic therapy and underwent radical *en bloc* excision of suppurated tissues along with the infected CVC (53.5%; $n = 39$). The radical *en bloc* excisions of suppurated tissues along with the CVC were

Table I. The most common types of targeted antibiotic therapy

Targeted antibiotic therapies	Number of patients
Linezolid	29
Vancomycin	21
Cloxacillinum	13
Teicoplanin	8
Amoxicillin	2
Imipenem	34
Cefoperazone with Sulbactam	23
Sulfamethoxazole – trimethoprim	10
Ceftazidime	6

conducted in an operating room setting under local anaesthesia with 2% lidocaine (Figure 1). These procedures involved excising the infected tissues along the entire length or a fragment of the infected tunnel with a 2-mm margin of healthy tissue, down to the chest muscle fascia. The procedure did not involve electrocautery, in order to limit any iatrogenic necrotic tissues that could constitute a focus of additional infection. Intraoperatively, pus swabs were collected from the wound for culture. The post-excision wound was closed with a continuous non-absorbable monofilament suture without prior suturing of the subcutaneous tissue. The procedure lasted 15–30 min, on average. Compression dressing of sterile gauze was applied and then changed daily. The date of cutaneous suture removal was set for each patient between post-procedure days 7 and 10 depending on the rate of healing by first intention.

Phlegmon diagnostics

The diagnosis of CVC tunnel phlegmon was established if the following manifestations were detected:

- local: redness and swelling at the catheter exit site as well as redness and swelling along a part of or the entire length of the catheter tunnel; suppurative discharge from the catheter exit site on the chest wall; pain along the catheter tunnel.
- systemic: fever, rigor, signs and symptoms of severe infection, systemic inflammatory response syndrome (SIRS).
- laboratory: elevated C-reactive protein levels, white blood cell count leucocytosis.

Antibiotic therapy

Due to unknown aetiology, all patients ($n = 73$) diagnosed with CVC tunnel phlegmon received empirical antibiotic therapy against gram-positive and gram-negative bacteria within the first 24 h of hospitalisation prior to surgical treatment. Following the pus culture results from the catheter tunnel and catheter tip, as well as the peripheral blood culture results, the treatment was changed to targeted antibiotic therapy. The targeted antibiotic therapies are presented in Table I. Criteria for stopping antibiotic therapy, consideration of a new central catheter, and discharge from the hospital are shown in Table II.

Results

Aetiological factors of CVC tunnel phlegmon

The most common causative pathogen of CVC tunnel infections was *Staphylococcus aureus* – 64.3% of cases ($n = 47$); a less common causative pathogen was

Table II. The criteria to finish antibiotic therapy, insert a new CVC, and discharge the patient

Variable	The criteria		
	to finish antibiotic therapy	to insert a new CVC	for discharge of the patient
Normal wound healing, lack of outflow of pus from the wound, no redness or swelling of the wound skin	x	x	
Complete healing of the wound skin after central catheter removal			x
Stitches removed from the skin, skin drains removed			x
Negative blood cultures from the periphery	x	x	x
Negative cultures from wound of skin	x	x	x
No fever	x	x	x
Normal C-reactive protein levels	x	x	x
Normal leucocytosis	x	x	x
Two-day observation after the start of TPN by the new CVC			x

Pseudomonas aeruginosa 15.2% of cases ($n = 11$). The remaining cases were caused by 8.2% ($n = 6$) *Klebsiella pneumoniae*, 5.4% ($n = 4$) *Staphylococcus epidermidis*, 4.1% ($n = 3$) *Escherichia coli*, and 2.7% ($n = 2$) *Serratia marcescens*.

Antibiotic therapy duration

Student’s t test for independent samples did not reveal any significant differences in terms of antibiotic therapy duration between both types of surgical procedures $t(63) = 1.577$; $p = 0.120$. The mean duration of antibiotic therapy was 8.3 ± 3 days in the drainage group and 7.3 ± 2 days in the radical *en bloc* excision group. The results are presented in Figure 2.

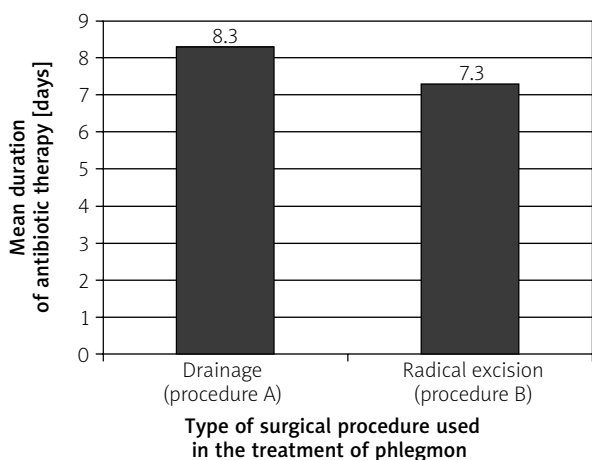


Figure 2. Antibiotic therapy duration

Time from the surgical procedure to new CVC insertion

Student’s t test for independent samples also revealed significant differences in the time from infected catheter removal and phlegmon resection/drainage to new catheter insertion, depending on the type of the surgical procedure performed $t(42.096) = 4.375$; $p < 0.001$. In patients who underwent radical *en bloc* excision, the time to new tunnelled CVC insertion was shorter by nearly 4 days than that in patients who underwent conventional drainage of the suppurated tissues (12.6 ± 4.2 vs. 8.7 ± 2.34), which is shown in Figure 3. Cohen’s $d = 1.36$ indicates a very large effect size.

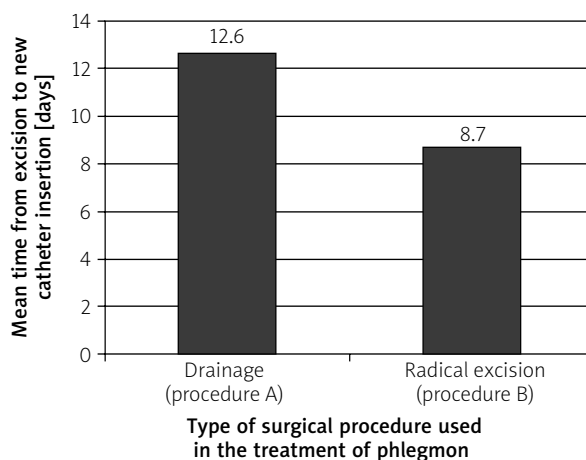


Figure 3. The mean time from phlegmon resection to new CVC insertion

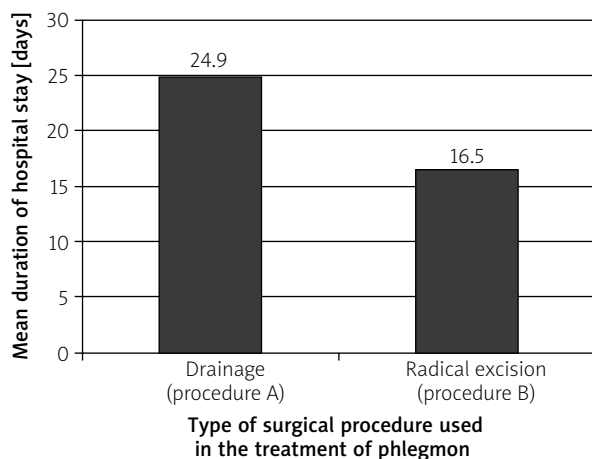


Figure 4. Mean duration of hospital stay

Duration of hospital stay

Student's *t* test for independent samples revealed significant differences in hospital stay duration between the two surgical procedures $t(41.140) = 2.725$; $p = 0.009$. The mean hospital stay of patients undergoing radical resection was found to be shorter by over 8 days than that of patients undergoing drainage ($M = 16.5 \pm 7.59$ vs. 24.9 ± 10.19), which is shown in Figure 4. Cohen's $d = 0.85$ indicates a large effect size.

Discussion

The available literature contains many articles on catheter-induced infections in long-term HPN patients. For the critically ill, educational interventions for preventing vascular catheter bloodstream infections have been recently discussed and evaluated in an economic model [7]. For HPN patients a clear therapeutic distinction between CRBSI and exit site infection seems to be reasonable and has not been implemented so far. Just a few reports concern the treatment of CVC tunnel phlegmon, a potentially fatal complication associated with venous access. The high significance of the data presented here is due to the large sample size, which, in turn, is associated with the profile of this Department and its 10-year experience in HPN. The literature contains no data on the incidence of CVC tunnel phlegmon; thus, it was impossible to compare the results of our study involving 73 diagnosed cases of phlegmon with the analyses conducted by other HPN centres. A number of available articles indicate the high prevalence of catheter-induced blood infections, which should also include CVC tunnel phlegmon cases described here. The data on the prevalence of this phenomenon vary widely, with the mean of 0.85–16.44 infections per 1000 days of treatment (0.31 to 6.0 per year of treatment) [8]. In

the analysed clinical material the average time between central catheter insertion to phlegmon central tunnel catheter formation was 507 parenteral nutrition days. This diversity is mostly due to the quality of catheter care, accuracy of monitoring, and the management of suspected infections. The CVC tunnel infection can be caused by any microorganism, either gram-negative or gram-positive, as well as fungi, most commonly of the genus *Candida* [9]. It was shown that infections in HPN patients were most commonly caused by coagulase-negative staphylococci (mainly *S. epidermidis*) and other gram-positive bacteria, as well as fungi of the genus *Candida* [10, 11]. Staphylococci have been suggested to be a possible cause of up to 60% of septic infections in HPN patients. The data and guidelines published by the Infectious Diseases Society of America also indicate that catheter-induced infections are most commonly due to coagulase-negative staphylococci, *S. aureus*, and *Candida* spp. [12]. This is consistent with our data, which showed *S. aureus* to be the most common cause of CVC tunnel phlegmon in our patients (65% of cases). Catheter-related bloodstream infections (CRBSI) are often caused by *S. epidermidis* and are relatively easy to treat. In our clinical material we analysed the presence of bacteria in the subcutaneous central tunnel catheter. It is a completely different infection than CRBSI and is often caused by *S. aureus*. Treatment must be more aggressive. Our studies indicate that the antibiotics that seem to be most suitable for empirical treatment include: Linezolid, Cloxacillin, and Teicoplanin, with their antibacterial spectrum including gram-positive bacteria of the genus *Staphylococcus* [13]. Our studies demonstrate that the proposed radical treatment of indwelling CVC tunnel phlegmon involving *en bloc* excision might help to reduce the duration of hospital stay and treatment costs. Catheter-induced infections have been estimated to increase treatment costs by over 6000 USD per infection [14, 15]. Shorter hospital stay also affects the psychological wellbeing of the patient and thus accelerates convalescence. In our opinion, the new method of treatment of phlegmon central catheter tunnel used accelerates healing and leads to shorter hospital stay and psychological well being.

Conclusions

The most common cause of CVC tunnel phlegmon is *S. aureus* infection. In comparison to the conventional drainage, radical *en bloc* excision of suppurated tissues with a healthy tissue margin may help shorten the hospital stay, expedite new CVC insertion, and thus reduce treatment costs associated with patient hospitalisation and antibiotic therapy. However, this has to be elucidat-

ed in a multicentric, prospective randomised study with homogenous criteria for the insertion of a new CVC and discharge from hospital.

Conflict of interest

The authors declare no conflict of interest.

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Received: 23.02.2015

Accepted: 11.05.2015