Staphylococcus aureus bacteraemia with septic emboli: an important complication of a radial artery catheter

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Abstract. In recent years it has been recognized that not only central venous catheters but also arterial catheters are a frequent source of hospital-acquired bloodstream infection. Staphylococcus aureus bacteraemia with septic emboli is a serious complication of a radial artery catheter.

We describe a patient with arterial catheter-related Staphylococcus aureus bacteraemia.

Introduction
Arterial catheters are frequently used in intensive care units for continuously monitoring blood pressure and drawing blood samples. In recent years it has been recognised that not only central venous catheters but also arterial catheters are an important source of local infection, bacteraemia and sepsis. Localized infection occurs in 0.5-4% of cases and only 0.6% go on to develop bacteraemia [1, 2]. The most frequent causative microorganisms are gram positive cocci, mainly coagulase-negative staphylococci and Staphylococcus aureus. The percentage of Staphylococcus aureus bacteraemias resulting from central venous- and arterial catheters is increasing.

We report on a patient who developed Staphylococcus aureus bacteraemia with septic emboli from a radial artery catheter and discuss the subject of catheter-related Staphylococcus aureus bacteraemia.

Case report
A 67-year-old, morbidly obese, male was admitted to the Intensive Care Unit with respiratory failure due to congestive heart failure, COPD and Wallenberg syndrome. The ICU stay was characterized by difficulties securing his airway, with multiple fibreoptic intubations and a difficult weaning period for which tracheostomy was performed. There was a high level of suspicion of the existence of a tracheal-oesophageal fistula. Most importantly, seven episodes of nosocomial infection occurred, with ventilator-associated pneumonia and infections of the central venous lines. These infections were confirmed by positive cultures of gram negative microorganisms and coagulase-negative staphylococci. During his ICU stay different arterial and venous sites were cannulated to gain arterial and venous access. Following repeated infection, the arterial catheter was placed in the left radial artery. The central venous catheter was placed in the right femoral vein.

The patient developed pustules on his left hand in the area of distribution of the cannulated radial artery (Fig 1). This finding was consistent with septic emboli. The insertion site of the radial artery catheter showed signs of inflammation. The radial artery catheter and central venous catheter, that had been in place eight and four days respectively, were removed. Cultures of both the arterial and venous catheter grew Staphylococcus aureus. Two blood cultures, drawn before removal of the catheters grew solely Staphylococcus aureus. One day after removal of the catheters one of two blood cultures still grew Staphylococcus aureus. All blood cultures were drawn from separate peripheral venous punctures. Cultures of the pustules were also Staphylococcus aureus positive. The left hand was the only localization where pustules were seen. Histological examination of a biopsy taken from one of the pustules was consistent with arthritis and septic emboli (Fig 2).

Extensive investigations were done to detect the source of the Staphylococcus aureus. Using ultrasound a thrombus in the left radial artery was visualized (Fig 3). There were no signs of aneurysm and there was still little flow distally. Repeated chest x-rays showed no signs of infection. Computed Tomography of the neck was performed because of the possibility of a tracheal-oesophageal fistula. All major neck vessels were free of thrombi. Ultrasound detected no thrombi in his legs, or in the right femoral vein. The potential tracheal-oesophageal fistula was considered to be a contraindication for trans-oesophageal echocardiography. Transthoracic echocardiography (TTE) was performed on three separate occasions but no signs of endocarditis were seen. As soon as septic emboli were diagnosed, treatment with flucloxacillin 12 grams per 24 hours intravenously was started. This therapy was continued for 19 days. Control blood cultures drawn in this period remained sterile. After 19 days the flucloxacillin was changed to meropenem due to a new sepsis. Blood- and sputum cultures now grew Pseudomonas aeruginosa and Enterobacter cloacae. After 119 days in the ICU our patient finally died of this gram negative sepsis. None of the blood cultures had grown Staphylococcus aureus again. Autopsy was not permitted.

Discussion
Arterial catheters are used routinely in the ICU for haemodynamic monitoring. The radial artery is the most common site for cannulation which is considered a safe procedure [1, 2]. The main complications are temporary occlusion of the artery, pseudoaneurysm and infection.

Nowadays intravascular devices are the main cause of hospital-related bloodstream infections. The risk of infection is higher in central venous catheters (4.4%) than in arterial catheters (0.6-0.8%) [3,4]. However, arterial catheters are the most manipulated catheters...
in the ICU and the risk of arterial catheter-related infection remains underestimated.

A serious complication of a radial artery catheter is the occurrence of *Staphylococcus aureus* bacteraemia with septic emboli. In a Medline-database search, only six patients with *Staphylococcus aureus* bacteraemia with septic emboli associated with a radial artery catheter were described [5]. All catheters were in place for five days or more. Septic emboli are a frequent complication of *Staphylococcus aureus* bacteraemia. However, the arterial catheter is not often recognized as the portal of entry.

*Staphylococcus aureus* is one of the main causes of hospital-acquired bloodstream infection. More than 50% of these bacteraemias result from indwelling venous- or arterial catheters. Catheter-related *Staphylococcus aureus* bacteraemia is associated with high morbidity and mortality (20%) [6,7,8]. Risk factors include an indwelling central venous catheter, immunosuppressive conditions, anaemia, hypotension and treatment with corticosteroids.

The insertion site of intravascular catheters is the main source of infection. *Staphylococci* produce exopolysaccharides, resulting in the formation of a biofilm. This biofilm helps the microorganisms to adhere to and survive on the surface of a foreign body [9,10]. Microorganisms in this biofilm cannot be reached by antimicrobial therapy. In addition to the biofilm a thrombin layer covers the surface of the catheter. This layer contains host-derived proteins, such as fibrin and fibronectin. *Staphylococcus aureus* binds to these proteins. As a result of these processes it is almost impossible to eradicate the infection without removal of the catheter [10].

Several preventative measures can reduce the rate of blood stream infection. Among these are full sterile barrier precautions during insertion, antimicrobial/anticoagulant flush solutions and silver- or antimicrobial therapy. Several studies on the optimal duration of antimicrobial therapy have been published. Uncomplicated *Staphylococcus aureus* bacteraemia treated with appropriate parenteral antimicrobial therapy for less than ten days is associated with a high rate of relapse [7,8,9]. For uncomplicated bacteraemia a course of at least 14 days of antimicrobial therapy appears to be sufficient. For complicated bacteraemia, as in our patient with septic emboli, the duration of therapy should be four to six weeks.

In cases of catheter-related *Staphylococcus aureus* bacteraemia it is important to rule out metastatic foci. However, the diagnosis of complicating infectious foci is difficult. There is no structured diagnostic protocol and approximately one third of patients do not have guiding symptoms [12,13].

The diagnostic work up should consist of multiple blood cultures, drawn from separate peripheral punctures. Control blood cultures have to be obtained until eradication of the microorganism has been demonstrated. When catheter-related bacteraemia is suspected, all indwelling arterial- and venous catheters should be removed and cultured to confirm the diagnosis. Since endocarditis is the most serious consequence, echocardiography should be performed promptly in high risk patients. TEE has a higher sensitivity than TTE, 92 versus 62%. This has led to the recommendation that a TEE should be performed on every patient with *Staphylococcus aureus* bacteraemia. Other possible intravascular foci can be assessed by Computed Tomography of the major vessels. Further diagnostic tests should be guided by clinical symptoms. In patients with persistent fever or bacteraemia, abdominal ultrasound and Computed Tomography of chest and abdomen are mandatory [13] as clinical signs of metastatic foci are often absent in these patients. Therefore, scintigraphic techniques can be used in an active search for complicating infectious foci. Positron Emission Tomography might play a role in the near future [12].
Unfortunately some of the tests mentioned were not carried out in our patient. A contraindication for TEE was present and for this reason TTE was performed on three separate occasions. After a negative TTE, a repeat procedure can add diagnostic information e.g. vegetation or abscess, in 26% of patients (14). With three independent TTE examinations sensitivity increases to 78%. Furthermore the percentage of endocarditis in in-hospital acquired Staphylococcus aureus bacteraemia is approximately 10% (8). Taking into account this relatively low percentage, the echocardiographic results and another known endovascular focus, we considered endocarditis to be unlikely. Since cultures of the arterial catheter, blood and pustules all grew Staphylococcus aureus and the septic emboli occurred in the area of distribution of the radial artery, we considered the radial artery catheter to be the portal of entry for this infection.

This case illustrates that arterial catheters are an important source of hospital-acquired infection. The high mortality and morbidity of Staphylococcus aureus bacteraemia warrants an active search for complicating infectious foci. As mentioned in the article of Cuijpers et al, there is the need for a structured diagnostic protocol.

Conclusion
Staphylococcus aureus bacteraemia with septic emboli is a serious complication of radial artery catheters. The incidence of infection and sepsis can probably be reduced using proper aseptic techniques during insertion and daily care. All catheters should be removed as soon as they are no longer needed for patient care.

Treatment of catheter-related Staphylococcus aureus bacteraemia consists of immediate removal of the catheter and proper anti-staphylococcal antibiotics. Arterial catheters, just as central venous catheters, are one of the main causes of hospital acquired blood stream infection. Therefore, not only the central venous catheter, but also the arterial catheter should be considered as a source of bacteraemia whenever a patient with indwelling catheters develops a fever. Although the risk of complicating infectious foci is lower than in non catheter-related bacteraemia, an active search for these complications seems justified.

It is unclear if the same measures that can be used to prevent central venous catheter-related infection can also be applied to the prevention of arterial catheter-related infection. For this and for addressing the optimal duration of antimicrobial therapy future studies are needed.

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