

## Thoracic catheter-related infections\*, \*\*

Infecções relacionadas a cateteres torácicos

Ekrem Senturk, Murat Telli, Serdar Sen, Salih Cokpinar

### Abstract

**Objective:** To determine the incidence of local and systemic infection in a sample of patients catheterized with thoracic catheters (TCs) and to identify the prognostic factors for catheter-related infection. **Methods:** A retrospective study involving 48 patients (17 females and 31 males) catheterized with TCs between December of 2008 and March of 2009 in the Thoracic Surgery Department of the Adnan Menderes University Hospital, located in Aydin, Turkey. Blood samples for culture were collected from the distal end of each TC and from each of the 48 patients. We looked for correlations between positive culture and possible prognostic factors for catheter-related infection. **Results:** Culture results were positive in TC samples only for 3 patients, in blood samples only for 2, and in both types of samples for another 2. Advanced age correlated significantly with positive culture in TC samples and in blood samples ( $r = 0.512$  and  $r = 0.312$ , respectively;  $p < 0.05$  for both), as did prolonged catheterization ( $r = 0.347$  and  $r = 0.372$ , respectively;  $p < 0.05$ ). There was a significant correlation between having undergone surgery and positive culture in TC samples only ( $p < 0.05$ ). However, having an inoperable malignancy correlated with bacterial growth in blood and in TC samples alike ( $p < 0.05$  for both). **Conclusions:** Risk factors, such as advanced age, prolonged catheterization, comorbidities, and inoperable malignancy, increase the risk of catheter-related infection. It is imperative that prophylaxis with broad-spectrum antibiotics be administered to patients who present with these risk factors and might be catheterized with a TC.

**Keywords:** Catheter-related infections; Thoracic surgery; Bacterial infections.

### Resumo

**Objetivo:** Determinar o status de colonização de uma amostra de pacientes que recebeu cateteres torácicos (CTs) e correlacionar esse status a possíveis fatores prognósticos. **Métodos:** Estudo retrospectivo com 48 pacientes (17 mulheres e 31 homens) que receberam CTs no Departamento de Cirurgia Torácica do Hospital Universitário Adnan Menderes, localizado na cidade de Aydin, Turquia, entre dezembro de 2008 e março de 2009. Amostras de sangue para cultura foram coletadas da porção distal dos CTs e de cada um dos 48 pacientes. Procuramos por correlações entre culturas positivas e possíveis fatores prognósticos de infecção. **Resultados:** Resultados positivos de cultura em amostras de CT ocorreram somente 3 pacientes, em sangue em 2, e nas duas amostras em outros 2. A idade avançada correlacionou-se com culturas positivas das amostras de CT e sangue ( $r = 0,512$  e  $r = 0,312$ , respectivamente;  $p < 0,05$ ), assim como o uso prolongado do CT e com culturas positivas das mesmas amostras ( $r = 0,347$  e  $r = 0,372$ , respectivamente;  $p < 0,05$ ). Houve uma correlação significativa entre o status cirúrgico dos pacientes (aqueles submetidos a cirurgias) e culturas positivas somente das amostras de CT ( $p < 0,05$ ), mas a presença de malignidade inoperável correlacionou-se com o crescimento bacteriano em ambos os tipos de amostras ( $p < 0,05$  para ambos). **Conclusões:** Os fatores de risco acima citados aumentam o risco de infecções. No caso de pacientes com CTs e que apresentam tais fatores de risco, é imperativo que se utilize uma profilaxia com antibióticos de amplo espectro.

**Descritores:** Infecções relacionadas a cateter; Cirurgia torácica; Infecções bacterianas.

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## Introduction

In thoracic surgery, the postoperative introduction of a thoracic catheter (TC) by means of percutaneous tube thoracostomy, in the operating room or elsewhere, is an indispensable tool for the diagnosis, treatment, and follow-up of patients. One of the most common complications of the use of TCs is infection. Investigations regarding catheter-related contamination and infection have typically been carried out in patients having undergone surgery in which central venous catheterization was used (vascular, urinary, abdominal, and other types of surgery).<sup>(1,2)</sup> However, studies regarding TC-related infection are scarce. It has been reported that the risk of infection is 0.2-0.5% when a peripheral i.v. catheter is used and 10.0-20.4% when a subclavian hemodialysis catheter is used.<sup>(3)</sup> In a study involving 100 patients having undergone surgery in which a pleural catheter was used, 5 of the patients developed infection.<sup>(4)</sup>

Like other types of catheters, TCs have the potential to become a direct route of transmission for pathogenic microorganisms from the environment into the body.<sup>(5)</sup> In addition, catheters in general constitute a focus for microorganisms that are transmitted via the blood.<sup>(6)</sup> The dissemination of microorganisms colonizing catheters can result in the infection of the surrounding skin and the infiltration of microorganisms via the external surface of the catheter, which is the most common mechanism of catheter-related infections (cutaneous colonization is generally considered a contributing factor to systemic infection). In addition, such dissemination can result in an infection arising from the internal surface of the catheter, and hematogenous diffusion can occur from a distal infection focus.<sup>(6)</sup>

Coagulase-negative staphylococci (CNS) are the most common cause of catheter-related infections, although they primarily appear as contaminant bacteria.<sup>(7)</sup> There are differing views regarding the use of prophylactic antibiotic therapy to avoid TC-related infections.<sup>(8-10)</sup> In a study involving severe chest trauma patients who underwent chest tube placement, the reported risk of empyema was greater than 6%, and antibiotic therapy was therefore recommended. The authors also recommended antibiotic prophylaxis in cases of prolonged catheterization.<sup>(11)</sup> For patients

undergoing thoracic surgery and catheterized with a TC for reasons other than empyema, prophylactic treatment with cefazolin sodium has been recommended.<sup>(12,13)</sup>

The objective of the present study was to determine the incidence of local and systemic infection in a sample of patients having been catheterized with a TC and to identify the prognostic factors for catheter-related infection.

## Methods

This was a retrospective study of 48 patients (17 females and 31 males) submitted to catheterization with a TC. All of the surgical procedures were performed between December of 2008 and March of 2009 in the Thoracic Surgery Department of the Adnan Menderes University Hospital, located in the city of Aydin, Turkey.

All of the patients included in the study had received prophylactic treatment with sodium cefazolin. Patients with findings of known infection or empyema were excluded, as were those for whom blood culture results were not available. Demographic and clinical patient data were collected from medical records.

The placement of the TCs was carried out by means of thoracostomy, under sterile conditions. The removal of the TCs was also carried out under sterile conditions, and a 5-cm piece of the distal end of the TC was sent to the microbiology laboratory in a dry sterile tube. The TC samples were analyzed in accordance with the semi-quantitative culture technique described by Maki et al.<sup>(5)</sup> The samples were incubated, with rolling, at 37°C for 18-24 h on an agarose gel supplemented with 5% sheep blood. The cultures containing  $\geq 15$  colonies after incubation were considered positive.

The blood samples were collected under sterile conditions and cultured using an automated medium system (BACTEC 9120; Becton Dickinson, Sparks, MD, USA). The bacteria were identified with a fully automated identification and antibiogram system (Phoenix; Becton Dickinson).

We investigated the following possible prognostic factors: age; gender; duration of catheterization; having undergone surgery; having an inoperable primary or metastatic pulmonary malignancy; and comorbidities.

Data were analyzed with the Statistical Package for the Social Sciences, version 15.0 (SPSS Inc., Chicago, IL, USA). We used Kendall's tau-b test in the analysis of categorical variables. The level of significance for the correlation coefficient was set at  $r < 0.05$ . We used the chi-square test and Fisher's exact test in the analysis of the other variables. The level of significance was set at  $p < 0.05$ .

## Results

Demographic and clinical data are displayed in Table 1. Of the 48 patients, 17 were female and 31 were male. The mean age of the patients was  $48.8 \pm 11.5$  years (range, 27-73 years). Of the 48 patients, 18 (37.5%) had undergone thoracic surgery: tumor excision, in 14; lung volume reduction, in 2; or esophagectomy, in 2. The TC samples collected from 3 of the patients showed bacterial growth (positive culture), as did the blood samples collected from 2 other patients. In another 2 patients, positive cultures were obtained in both types of samples (TC and blood). One of those 2 patients showed clinical signs of infection (*Klebsiella pneumoniae* proliferation), and the infection was managed with appropriate antibiotic therapy. No clinical complications, pleural reactions, or increases in drainage were observed in the other 47 patients.

Proliferation of CNS was identified in six samples and was attributed to contamination. Table 2 shows the microorganisms identified in the TC and blood samples.

There was a significant correlation between advanced age and positive culture results in TC and blood samples ( $r = 0.512$  and  $r = 0.312$ , respectively;  $p < 0.05$  for both). However, gender did not correlate significantly with positive culture results in either type of sample ( $p > 0.05$  for both). There was also a significant correlation between prolonged catheterization and positive culture results in the blood and TC samples ( $r = 0.347$  and  $r = 0.372$ , respectively;  $p < 0.05$ ). There was a significant correlation between having undergone surgery and positive culture results in the TC samples ( $p < 0.05$ ) but not in the blood samples ( $p > 0.05$ ). The presence of comorbidities, such as chronic pulmonary diseases, chronic cardiac diseases, and diabetes mellitus, correlated with bacterial growth in the culture of both types of samples ( $p < 0.05$  for

**Table 1** – Demographic data and clinical findings of the 48 patients included in the study.

Variable	Result
Age, years <sup>a</sup>	$48.8 \pm 11.5$ (27-73)
Male/Female, n/n	31/17
Patients submitted to thoracic surgery, n	18
Patients with comorbidities, n	18
Patients with inoperable malignancy, n	10
Positive thoracic catheter culture, n	5
Positive blood culture, n	4
Length of catheterization, days <sup>a</sup>	$5.42 \pm 1.50$ (3-9)

<sup>a</sup>Values expressed as mean  $\pm$  SD (range).

both). Having an inoperable malignancy also correlated with bacterial growth in the culture of both types of samples ( $p < 0.05$ ). The correlations between the possible prognostic factors and the culture results for the two types of samples are shown in Table 3.

Advanced age, having been submitted to prolonged catheterization, comorbidities, and having an inoperable malignancy were effective prognostic factors for catheter-related infection. However, having undergone thoracic surgery was a prognostic factor for positive culture results only in the TC samples.

## Discussion

Recognizing the factors that have an effect on catheter contamination can guide clinicians in taking the necessary precautions, administering the appropriate prophylaxis, and determining

**Table 2** – Microorganisms identified in the thoracic catheter and blood samples.

Microorganism	TC sample	Blood sample
<i>Staphylococcus aureus</i>	1	-
<i>Staphylococcus aureus</i> and <i>Pseudomonas aeruginosa</i>	1	-
<i>Klebsiella pneumoniae</i> <sup>e</sup>	1	1
<i>Enterococcus</i> sp. <sup>a</sup>	2	1
<i>Escherichia coli</i>	-	1
<i>Staphylococcus epidermidis</i>	-	1
CNS	4	2

TC: thoracic catheter; and CNS: coagulase-negative staphylococci. <sup>a</sup>The microorganism was detected in both sample types (TC and blood) in one of the patients.

**Table 3** – Correlations between the possible prognostic factors and positive culture results in the thoracic catheter and blood samples.

Possible prognostic factor	Positive TC culture		Positive blood culture	
	r	p	r	p
Advanced age	0.512	< 0.05	0.312	< 0.05
Gender		> 0.05		> 0.05
Prolonged catheterization	0.347	< 0.05	0.372	< 0.05
Undergoing thoracic surgery		< 0.05		> 0.05
Comorbidities		< 0.05		< 0.05
Inoperable malignancy		< 0.05		< 0.05

TC: thoracic catheter.

the best approach, as well as saving time and reducing costs.

Hospitals, and intensive care units in particular, are the most suitable settings for the emergence and transmission of antibiotic-resistant bacteria.<sup>(13)</sup> Catheters can be a route of transmission, as well as providing an environment for bacterial growth. Catheters can be a direct route of transmission for pathogenic microorganisms to migrate from the skin into the blood,<sup>(5)</sup> and such organisms can directly infiltrate the thorax via a catheter. The thoracic cavity, like the blood, can be a pathway for the dissemination of microorganisms. In patients catheterized with TCs, infection at the access site and pleurocutaneous fistula have been reported.<sup>(14,15)</sup>

In one study, gram-positive bacteria were reported to be the most common cause of catheter-related infection.<sup>(16)</sup> In recent years, CNS, especially *Staphylococcus epidermidis*, have been the foremost agents in nosocomial infections. This is because CNS are part of the normal flora and can easily be transmitted as a result of invasive interventions.<sup>(17)</sup> One of the major problems is that methicillin-resistant CNS are widely transmitted in hospitals. The most common agent detected in our study was *Staphylococcus aureus*. Although the proliferation of CNS in catheters is common and is usually attributed to contamination, it can nevertheless complicate the situation.

A number of factors, such as advanced age, impaired immune status, comorbidities, and inappropriate patient self-care, can promote the proliferation of bacteria in catheters and blood. It should be borne in mind that the majority of the patients who undergo thoracic surgery are old. In our study, advanced age was found to

increase the risk of proliferation of bacteria in both types of samples.

Prolonged catheterization correlated with positive culture results in TC and blood samples alike. In our study, the length of catheterization was directly proportional to the length of hospital stay. Therefore, the risk of catheter contamination and colonization was elevated. The mere presence of a TC increases the risk of infection.<sup>(3,10)</sup> Cases of empyema due to methicillin-resistant *S. aureus* have been reported as a complication of the use of TCs.<sup>(18)</sup> In vascular catheter-related infection, antibiotic resistance is considered a significant problem.<sup>(19)</sup> However, in patients who do not respond to clinical therapy and are candidates for surgery, complications, such as infections in the thoracic cavity and the formation of empyema, can appear, and antibiotic prophylaxis should therefore be considered.

Surgery itself is a risk factor. This risk is increased by the postoperative use of TCs, which can cause contamination of the surgical wound, and antibiotic prophylaxis is therefore recommended.<sup>(20)</sup> However, for patients with TC-related pneumothorax, some authors counsel against antibiotic prophylaxis.<sup>(21)</sup> Although all of the patients in our study received prophylactic treatment with i.v. cefazolin sodium (1 g/day for 3 days), TC contamination was observed. It is obvious that the routine use of TCs following thoracic surgery can introduce a new potential source of contamination.

In the presence of comorbidities, the risk of infection increases independently of any other risk factor. In the patients with comorbidities evaluated in the present study, there was significantly greater contamination of blood cultures but not of TC cultures. We believe that the preoperative examination of the patients

and the monitoring of comorbidities, such as diabetes mellitus and COPD, as well as the use of antibiotic prophylaxis, have improved this situation.

The presence of an inoperable primary/metastatic pulmonary malignancy generally increases the risk of infection. In addition, when a tumor is located within a local focus of infection in the thorax, this situation becomes more complicated.

In general, TC-related contamination is limited to the pleura, which delays the detection of the infection. In addition, there is a high risk of empyema in such cases.<sup>(3,10)</sup>

In summary, TCs are a gateway into the thorax and provide a suitable environment for the proliferation of microorganisms. Risk factors, such as advanced age, having been submitted to prolonged catheterization, comorbidities, and having an inoperable malignancy, increase the risk of catheter-related infection. Patients who present with these risk factors and will likely be catheterized with a TC should receive antibiotic prophylaxis, preferably with broad-spectrum antibiotics.

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## References

- Gosbell IB, Duggan D, Breust M, Mulholland K, Gottlieb T, Bradbury R. Infection associated with central venous catheters: a prospective survey. *Med J Aust.* 1995;162(4):210-3.
- Inal SA. Intravascular kateterle ilişkili enfeksiyonlar. In: Proceedings of the X Türk Klinik Mikrobiyoloji ve Enfeksiyon Hastalıkları Kongresi; 2001 Oct 15-19; Adana, Turkey. Adana: Kongre Kitabı Press; 2001. p. 69-72.
- Putnam JB Jr, Walsh GL, Swisher SG, Roth JA, Suell DM, Vaporciyan AA, et al. Outpatient management of malignant pleural effusion by a chronic indwelling pleural catheter. *Ann Thorac Surg.* 2000;69(2):369-75.
- Ozturk R, Damar İci kateter enfeksiyonları. In: Bakir M, Akova M, Dokmetas I, editors. *Hastane Enfeksiyonları I. İleri Hekim Eğitim Kurs Kitabı*. Sivas: Kurs Kitabı press; 1999. p. 79-97.
- Maki DG. Pathogenesis, prevention and management of infections due to intravascular devices used for infusion therapy. In: Bisno AL, Waldvogel FA, editors. *Infections associated with indwelling medical devices*. Washington: American Society for Microbiology; 1989. p. 161-77.
- Greene JN. Catheter-related complications of cancer therapy. *Infect Dis Clin North Am.* 1996;10(2):255-95.
- Maki DG, Weise CE, Sarafin HW. A semiquantitative culture method for identifying intravenous-catheter-related infection. *N Engl J Med.* 1977;296(23):1305-9.
- Grover FL, Richardson JD, Fewel JG, Arom KV, Webb GE, Trinkle JK. Prophylactic antibiotics in the treatment of penetrating chest wounds. A prospective double-blind study. *J Thorac Cardiovasc Surg.* 1977;74(4):528-36.
- Neugebauer MK, Fosburg RG, Trummer MJ. Routine antibiotic therapy following pleural space intubation. A reappraisal. *J Thorac Cardiovasc Surg.* 1971;61(6):882-4.
- Brunner RG, Vinsant GO, Alexander RH, Laneve L, Fallon WF Jr. The role of antibiotic therapy in the prevention of empyema in patients with an isolated chest injury (ISS 9-10): a prospective study. *J Trauma.* 1990;30(9):1148-53; discussion 1153-4.
- Gonzalez RP, Holevar MR. Role of prophylactic antibiotics for tube thoracostomy in chest trauma. *Am Surg.* 1998;64(7):617-20; discussion 620-1.
- LoCurto JJ Jr, Tischler CD, Swan KG, Rocko JM, Blackwood JM, Griffin CC, et al. Tube thoracostomy and trauma--antibiotics or not? *J Trauma.* 1986;26(12):1067-72.
- Tilley PA, Roberts FJ. Bacteremia with Acinetobacter species: risk factors and prognosis in different clinical settings. *Clin Infect Dis.* 1994;18(6):896-900.
- Ball CG, Lord J, Laupland KB, Gmora S, Mulloy RH, Ng AK, et al. Chest tube complications: how well are we training our residents? *Can J Surg.* 2007;50(6):450-8.
- Lin MT, Shih JY, Lee YC, Yang PC. Pleurocutaneous fistula after tube thoracostomy: sonographic findings. *J Clin Ultrasound.* 2008;36(8):523-5.
- Haslett TM, Isenberg HD, Hilton E, Tucci V, Kay BG, Vellozzi EM. Microbiology of indwelling central intravascular catheters. *J Clin Microbiol.* 1988;26(4):696-701.
- Archer GL. Staphylococcus epidermidis and other coagulase-negative staphylococci. In: Mandell GL, Bennett JE, Dolin R, editors. *Principles and Practice of Infectious Diseases*. Philadelphia: Churchill Livingstone; 2000. p. 2092-100.
- Dellinger EP, Ehrenkranz NJ. Surgical Infections. In: Bennet JV, Brachman PS, editors. *Hospital Infections*. Philadelphia: Lippincott-Raven; 1998. p. 571-85.
- Laupland KB, Zygun DA, Davies HD, Church DL, Louie TJ, Doig CJ. Population-based assessment of intensive care unit-acquired bloodstream infections in adults: Incidence, risk factors, and associated mortality rate. *Crit Care Med.* 2002;30(11):2462-7.
- Torres HA, Hanna HA, Graviss L, Chaiban G, Hachem R, Chemaly RF, et al. Chest tube-related empyema due to methicillin-resistant Staphylococcus aureus: could the chest tube be coated with antiseptics? *Infect Control Hosp Epidemiol.* 2006;27(2):195-7.
- Olgac G, Aydogmus U, Mulazimoglu L, Kutlu CA. Antibiotics are not needed during tube thoracostomy for spontaneous pneumothorax: an observational case study. *J Cardiothorac Surg.* 2006;1:43.

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