Routine Microbiological Screening in Septic Patients in a Cardiac Surgical Intensive Care Unit

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Abstract

   Introduction: Patients in a surgical intensive care unit (ICU) have a high incidence of nosocomial infections which often lead to septic shock and death. Since specific antibiotic treatment is often difficult, it is recommended that routine nose/throat swabs be obtained in order to have a better idea of the causative agent when a systemic inflammatory response occurs in a given patient. Materials and Methods: In 1435 patients in a cardiac surgical ICU, routine nose/throat swabs were taken thrice a week and tested for microorganisms and systemic inflammation. Blood cultures were also obtained. Antibiotic treatment was given to cover the microbes from the nose/throat swabs. Alternatively, an empirical antibiotic therapy was given to patients whose swabs had tested negative. Results: Of the 86 patients with systemic inflammation, 29 had blood cultures positive for microbes. Of these, 18 received a specific antibiotic therapy based on their positive nose/throat cultures prior to the return of the blood cultures from the laboratory. However, only 11 patients tested positive for the same microbes on routine swabs and blood cultures. While positive routine swabs are quite specific to sepsis when there is a systemic inflammatory response, routine swabs are not a suitable screening tool due to their low sensitivity. Conclusion: Routine nose/throat swabs led to earlier specific antibiotic treatment in only 22% of patients with clinical signs of systemic inflammation. In 36% of cases, the organisms detected in the routine swabs and blood cultures were not identical. Hence, we believe that routine swabs are of limited value in instituting earlier, specific antibiotic therapy in septic patients.

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Key words: Antibiotics, Routine diagnostic test, Sepsis, Systemic inflammatory response syndrome

Introduction

Compared to in-hospital patients, patients treated in an intensive care unit (ICU) have the highest risk of contracting an infection.[1] The risk correlates well with underlying and accompanying diseases and invasive monitoring. Apart from urinary tract infection, wound infection and bacteraemias with vascular cannulas, nosocomial pneumonia also plays a leading role.[2] The incidence of nosocomial pneumonia in patients in the ICU is estimated to be 9% to 38% depending on the population studied. The risk of nosocomial pneumonia is higher in intubated patients and it increases with prolonged ventilation.[2-5] This is because the important protective mechanisms, such as chewing, swallowing and the local commensal flora, which prevent the colonisation of pathogen microorganisms, are impaired in intubated patients. Also, the use of broad-spectrum antibiotics can promote a second infection with a pathogen species, as the balance of the local microorganism population is disturbed.[6] Pathogens that cause nosocomial pneumonia usually reach the lower respiratory tract via aspiration from the pharynx.

In order to diagnose and treat the causative agent for infection before the infective process occurs, routine microbiological nose/throat swabs have been

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recommended.[7] As this practice represents a considerable financial burden, the value and optimal method of bacteriological screening have been previously discussed.[8,9]

This study aims to find the correlation between microbes detected using routine nose/throat swabs or tracheal fluid samples and the microbes detected in blood cultures from patients with systemic inflammation. With the above results, we determine the benefits of an appropriate early antibiotic regime.

Materials and Methods

The study was carried out over 15 months in the cardiac surgical ICU of a university hospital. All patients underwent cardiopulmonary bypass and received an antibiotic prophylaxis with cefazolin after anaesthetic induction. A second dose was administered after cardiopulmonary bypass.

Routine microbiological screening was performed in all patients immediately on admission to the ICU. Nose/throat swabs were taken from each patient. If the patient was intubated, a tracheal fluid sample was taken on admission and then thrice a week. All samples were tested for growth of bacteria and fungi. If pathogens were detected, an antibiogram was made.

A blood culture specimen was taken if there was clinical suspicion of systemic inflammatory response syndrome (SIRS).[10] In patients with persistent clinical signs of sepsis, where cure or substantial improvement was not achieved via the initial antibiotic therapy, further blood cultures were taken. A gram stain was applied thrice to the aerobe and anaerobe blood culture samples as soon as they reached the laboratory and upon successful culture after 8 days of incubation. A blood culture automat (Bactec 660/860, Becton Dickinson, Sparks, MD, USA) was used to detect growth of microbes. The cultures of the microbes were performed on different nutrient media for aerobe and anaerobe growth. The microbial resistance to antibiotic agents was tested with the disk diffusion method on a

Mueller-Hinton nutrient medium.[11] The microbes were identified based on biochemical reactions and patterns of antibiotic resistance.

If the results of routine swabs for patients with SIRS were negative or not known at the time of blood culture sampling, an empirical intravenous antibiotic therapy was instituted. If the microbes have been identified from the routine swabs, a specific antibiotic agent was given according to its tested susceptibility and resistance.

Patients with SIRS were initially treated with ceftriaxone. If SIRS occurred after postoperative day 3, the patients received piperacillin-tazobactam as empirical antibiotic therapy.

All data are presented as mean ± standard deviation and as absolute and relative frequencies. Data analysis was performed using GraphPad InStat 3.0 (GraphPad Software, San Diego, CA, USA). Statistical significance was determined using Mann-Whitney U test and Fisher's Exact test. A value of $P < 0.05$ is considered statistically significant.

Results

Of the 1435 consecutive patients seen in the cardiac surgical ICU, 86 (6%) patients developed SIRS (Table 1). A total of 254 blood cultures were obtained from these patients. The duration of treatment in the ICU prior to sampling and the interval before the results were known are shown in Table 2.

In the 49 blood cultures from 29 (33.7%) patients with SIRS, microbes were isolated and sepsis was diagnosed. Seven patients did not grow the same microbes in several blood cultures, which were repeated within a few hours. Another 7 patients showed different microbes in a single blood culture. The other 57 patients had negative blood cultures for microbes (Table 1).

When SIRS was diagnosed, the results of the routine screening in all 86 patients were known. Nineteen (22.1%) patients had a positive swab for microbes. A specific antibiotic therapy, according to the susceptibility of the isolated microbe in the routine swab, was administered to these patients based on the assumption that the isolated microbe represents the cause of sepsis. For the other

Table 1. Mortality of Cardiac Surgical Patients in the ICU with SIRS or Sepsis

Variable	Mean ± SD of multiple dysfunction score	Mortality (%)	P value
SIRS patients (n = 57)	10.0 ± 2.86	16 (28.1)	<0.05
Sepsis patients (n = 29)	9.9 ± 2.83	16 (55.2)	<0.05
Empirical antibiotic therapy (n = 11)	10.1 ± 4.1	5 (45.5)	
Specific antibiotic therapy			
Correct pathogen (n = 11)	9.5 ± 1.92	7 (63.6)	
Wrong pathogen (n = 7)	9.9 ± 2.83	4 (57.1)	

ICU: intensive care unit; SIRS: systemic inflammatory response syndrome

Table 2. Duration of Blood Culture Sampling and Time Interval to Results

Variable	Mean ± SD of positive blood culture (n = 49)	Mean ± SD of negative blood culture (n = 295)	P value
Treatment before blood culture (days)	9.9 ± 6.59	6.3 ± 5.73	<0.05
Time interval to results (days)	3.6 ± 1.93	9.4 ± 1.45	<0.0001

patients with SIRS, a broad-spectrum intravenous antibiotic therapy was instituted, covering all pathogens that were likely to be involved.

The results of the blood cultures showed that only 1 (1.8%) patient with negative culture results had a positive nose/throat swab. However, 18 (62.1%) patients with positive results on blood culture had a positive nose swab ($P<0.0001$). In 11 (61.1%) patients, the microbe spectrum of the routine swabs was identical to that found in the blood cultures; in the other 7 patients, the spectrum differed from the routine swabs to the blood culture.

Thirty-two (37.2%) patients with SIRS died during their stay in the ICU. However, there was a significant difference in the mortality rate between the SIRS (28.1%) and sepsis (55.2%) groups, whereas the organ dysfunction score in both groups did not differ significantly (Table 1).[12]

Routine nose/throat swab and the tracheal fluid sample are not suitable as screening methods for the early diagnosis of sepsis due to their low specificity of 61.1%. However, a positive result in the routine swab of patients with SIRS indicates sepsis with a specificity of 94.7%.

Discussion

Infectious diseases, especially septicaemia, are the most frequent and serious complications in patients in the ICU. They contribute greatly to the mortality rate in this group of patients.[1,2,13] SIRS occurred in 6% of our patients. More than 30% of these patients also suffered from a bacteraemia. Hence, they are consistent with the diagnosis of sepsis. Since sepsis is a disease with high mortality, antibiotic therapy should be early and microbe-specific.

If the microorganism is not known, empirical antimicrobial therapy should be initiated according to the severity of the disease with a broad-spectrum antibiotic, such as carbapenem. If microorganisms were detected on an earlier swab or tracheal fluid sample and have already been tested for susceptibility, a specific antibiotic should be given.

In our study, infective microorganisms were identified in 61.1% of patients with SIRS using routine nose/throat swabs before blood cultures were obtained. Therefore, a specific antibiotic therapy was instituted. Usually, the results of a positive blood culture are known after 3 to 4 days. This means prolonged, suboptimal and empirical antimicrobial therapy, especially in critically ill patients. The antibiotic therapy can be optimised according to the results of the routine swabs in patients with SIRS.

This practice has the advantage that an antibiotic with "reserve" character is not used primarily. The pressure on the selection of pathogen agents is lowered, including the development of multi-resistant microorganisms.[13] The number of subsequent infections in intensive care medicine is also reduced by a specific antibiotic therapy.[6]

Nevertheless, 7 patients in our study received a specific antibiotic therapy according to the susceptibility of the pathogen agents found in their nose/throat swabs or tracheal fluid samples. However, analysis of the blood cultures showed different microbes that were susceptible to the administered antibiotic therapy. If this had not been the case, the choice of a wrong antibiotic might have led to a deterioration in the patient's status. We advise against an overly specific or narrow-spread antimicrobial therapy for systemic inflammation on account of the known pathogen agents in a routine swab.

The findings of throat swabs of patients in the ICU are usually normal. The loss of residential local flora indicates a biological vacuum, where exogenic and endogenic infective agents are able to migrate. In nasal or oropharyngeal swabs, potentially pathogenic microbes are detected which do not necessarily cause an infection.[14] The throat fluid of a healthy individual contains up to 10^9 microbes/mL, with an anaerobe-to-aerobe ratio of 30 to 1. The dominant specimens are corynebacteria, neisseriaceae, coagulase-negative staphylococci, and streptococci, and they formed 40% of all specimens in the blood cultures of suspected SIRS patients in our study.

A prophylactic antimicrobial therapy accelerates the loss of throat flora and induces the growth of opportunistic microbes. On the other hand, the anaerobe partners are reduced and substituted by anaerobes of faecal origin. Together with the colonisation of aerobe gram-negative bacilli, severe septicaemia can occur. Special mention is given to *Enterococcus faecalis*, a microbe that is able to colonise beyond its normal flora in the gastrointestinal tract. Despite hygienic prophylaxis and disinfection, there are numerous reports of endemic outbreaks of enterococci in ICUs.[7,15] In 5% to 20% of cases, *Enterococcus faecalis* is the causative agent for nosocomial-acquired endocarditis with a mortality rate of 20% to 40%.[15,16] The use of broad-spectrum antibiotics is responsible for the increased resistance of *Enterococcus faecalis*.[17]

Even if the incidence of an infection cannot be lowered by microbiological routine monitoring,[4] it allows an early and more sensitive antibiotic regime in 22% of the patients with SIRS or sepsis because, in 61% of the patients, the blood cultures and routine swabs showed identical microbes. However, the antibiotic regime should be broad-spectrum as the causative agent for sepsis does not match the one found in routine swabs in 38% of the cases. Hence, we conclude that the use of routine nose/throat swabs as a screening method is questionable because only 22% of the patients did not receive treatment with a blind broad-spectrum antibiotic therapy.

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