

Original Article

Use of microbiological alerts in surveillance programs and therapy of CVC-related bacteremia: 1-year experience of an automated laboratory-based system in a comprehensive cancer center

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ABSTRACT: Catheter-related bloodstream infections are part of all nosocomial infections prevention and surveillance programs; in addition to periodic monitoring, continuous awareness and notification of sentinel events through the use of dedicated software are fundamental. In this paper we describe the impact of a software package based on microbiological alerts management on surveillance programs and therapy of CVC-related infections.

The Virtuoso Plus™ software (Metafora Informatica Srl, Milan, Italy) was used to extract information from laboratory files, using a list of alerts previously defined and shared with clinicians. One year of activity generated 134 alerts; in particular, a *Candida albicans* strain was isolated from central and peripheral blood cultures of the same patient. The actions taken were prompt CVC removal and antifungal therapy administration.

This study demonstrates that a nosocomial infections surveillance program based on microbiological alerts is also effective in facilitating the handling of patients with CVC-related infections. (*Nutritional Therapy & Metabolism* 2007; 25: 195-200)

KEY WORDS: CVC-related infections, Automated surveillance, Sentinel events, Alert

INTRODUCTION

Catheter-related bloodstream infections (CRBSIs) are the most serious nosocomial infections (NIs) with a steadily increasing trend in the last 3 decades (1); among patients with chronic illnesses like cancer, they may develop into a significant cause of morbidity and mortality, in addition to an increase in health-care costs (2).

CRBSI monitoring is part of all programs of NIs prevention and surveillance, which are currently based on clinically relevant infections monitoring by means of regular data collection and analysis. Besides retrospective control, laboratory-based surveillance allows prompt identification of sentinel events as defined by the Joint Commission standard requirements (3-5); such continuous surveillance is performed with the use of a software for NIs. In our institute, surveillance programs for the major NIs have been in place from the beginning. They are based on the application of standardized criteria addressing the category of infection to be monitored, the frequency and sources of data collection, data analysis,

and the distribution of reports by the Infection Control Committee (ICC). With regard to CRBSIs, the following data were collected once a month: i) the number of central and peripheral blood cultures that were positive for the same agent and their times to positivity (for evaluation of the differential time to positivity, DTP); ii) the number of peripheral blood cultures and central venous catheter (CVC) tip cultures that were positive for the same agent; iii) the dwelling time (in days) of short-term CVCs. All the data were analyzed by control charts (Fig. 1) and the reports were periodically distributed by the ICC.

Microbiological alerts surveillance and notification, instead, were not standardized until last year. In May 2006 we implemented a computerized system for the surveillance of microbiological alerts that was able to identify predefined sentinel events and promptly notify clinicians, the chief medical officer (CMO), and ICC members. The aim of this paper was to investigate the impact of this automated control system on the surveillance and therapy of CVC-related bacteremia.

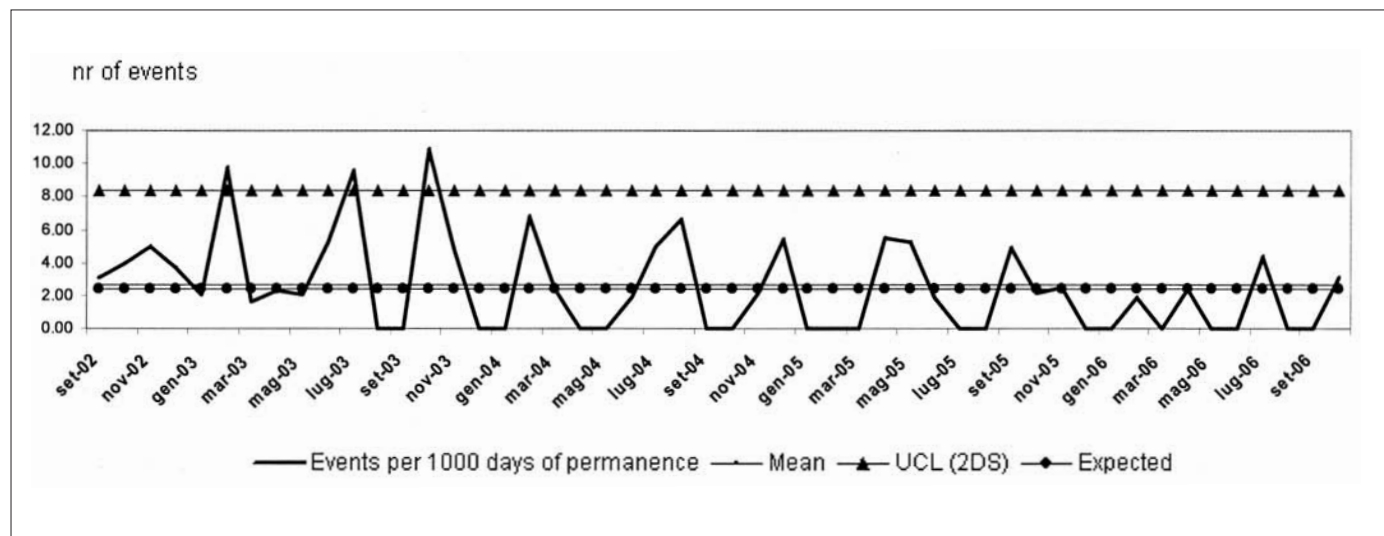


Fig. 1 - CVC-related bacteremia control chart. UCL, upper control limits.

METHODS

The European Institute of Oncology (IEO), based in Milan, Italy, attends to the prevention, diagnosis, research and treatment of cancer. The 226 hospital beds are distributed over 2 medical divisions (Medical Oncology and Hemato-Oncology), 8 surgical divisions (General, Abdominopelvic, Thoracic, Head and Neck, Senology, Urology, Gynecology and Plastic Surgery), and a 4-bed intensive care unit (ICU). NIs surveillance is ensured by an ICC assisted by a small operating group; chairman of the ICC is the CMO. The Committee meets on a regular basis every 3 months, and whenever a sentinel event prompts its activity. For NIs surveillance based on microbiological alerts, the Virtuoso Plus™ software (Metafora Informatica Srl, Milan, Italy) was used in our project. The first step was the compilation of a list of sentinel events based on guidelines and recommendations of national and international scientific societies (6), and integrating them with the specific demands of the IEO (Tab. I). Besides the universally accepted alerts including methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE), multidrug-resistant *Pseudomonas aeruginosa*, etc., there are some events that are critical for our patients; concerning in particular CRBSIs, besides the specific growth of fungi or *S. aureus* in blood cultures (7-10), there are also the alerts relative to unusual micro-organisms, or micro-organisms with unusual phenotypical traits (as the multidrug resistance), when found in the blood cultures and the cultures of CVC (11).

For exhaustive NIs control, a list of actions in response to each event was issued in accordance with the guidelines of the Centers for Disease Control (4, 12), the recommendations of the Istituto Superiore di Sanità (corresponding to the NIH in the USA) and the Regione Lombardia, and the specific demands of the IEO. The list specified what should be done to contain the risk of transmission, to cure patients with infections, and, when needed, to notify the CMO and the local health-care authority. In regard to blood cultures positive for fungi or *S. aureus*, the suggested action was CVC removal if the CVC was the source of infection (13-20).

The recipients of the alert messages were the head of the microbiology laboratory, the director, the representative for nosocomial infections, the head nurses of the involved divisions, the CMO, and the operating group of the ICC. Extraction criteria were defined regarding the bacterial strain isolated, the sample, and the patients and divisions involved. A standardized alert message was created to be automatically sent by e-mail to the above-mentioned recipients. The message included a description of the alert event, the patient's data, the division of hospital admission, the examined sample, and the results of microbiological analysis. At the same time, the system automatically generated a list of all extracted alerts in the current session; this allowed to locate the presence of the same event in different wards at the same time, thus providing a tool to search for a common source of infection (for example, the same operating room, surgical staff or ICU stay). This report was saved in a directory on the central server available to all ICC members. To ensure

TABLE I - LIST OF ALERTS AND RELATED CORRECTIVE ACTIONS

Alert	Suggested action
<i>Acinetobacter baumannii</i>	Contact precautions until the end of therapy and culture negative
<i>Aspergillus</i> species	Alert
<i>Mycobacterium tuberculosis</i>	Notification to the Medical Officer + ASL* + possible airborne precautions
<i>Mycobacterium tuberculosis</i> by the microscope	Notification to the Medical Officer + ASL* + possible airborne precautions
ESBL-producing Bacteria	Contact precautions until the end of therapy and culture negative
<i>Clostridium difficile</i> (toxin A)	Standard precautions until negative
<i>E faecalis</i> resistant to ampicillin	Alert
Fungi in blood culture	Possible CVC removal
Enterococcus resistant to vancomycin	Contact precautions until the end of therapy and culture negative
<i>H influenzae</i> resistant to ampicillin	Alert
Urinary antigen Legionella positive	Notification to the Medical Officer + ASL*
Liquor culture positive	Notification to the Medical Officer + ASL* + possible airborne precautions
<i>Listeria monocytogenes</i>	Notification to the Medical Officer + ASL*
<i>Neisseria gonorrhoeae</i>	Notification to the Medical Officer + possible notification to ASL*
<i>P aeruginosa</i> multidrug resistant	Contact precautions until the end of therapy and culture negative
<i>S aureus</i> resistant to methicillin	Contact precautions until the end of therapy and culture negative
Methicillin-resistant coagulase-negative staphylococci	Alert
<i>S aureus</i> intermediate to vancomycin	Contact precautions until the end of therapy and culture negative
<i>S aureus</i> resistant to vancomycin	Contact precautions until the end of therapy and culture negative
<i>S pneumoniae</i> resistant to cephalosporins	Alert
<i>S pneumoniae</i> resistant to penicillin	Alert
<i>Salmonella</i> species in feces	Notification to the Medical Officer + ASL* + standard precautions
<i>Shigella</i> species in feces	Notification to the Medical Officer + ASL* + standard precautions
<i>S aureus</i> in blood culture	Possible CVC removal
<i>Stenotrophomonas maltophilia</i>	Contact precautions until the end of therapy and culture negative
Streptococcus not susceptible to vancomycin	Alert

*ASL, Local Health Service (Azienda Sanitaria Locale)

TABLE II - NUMBER AND DIFFERENT TYPES OF SAMPLES ELICITING ALERTS

Alert	No. of alerts	Sample
Methicillin-resistant coagulase-negative staphylococci	33	Blood from CVC
	14	Blood from venipuncture
	10	CVC
	5	Bronchoalveolar lavage
	2	Bronchial aspirate
	15	Surgical site swab
	21	Other
<i>Mycobacterium</i> species	3	Biopsies
<i>Stenotrophomonas maltophilia</i>	1	Bronchoalveolar lavage
	3	Bronchial aspirate
<i>Pseudomonas aeruginosa</i> , multidrug resistant	2	Bronchoalveolar lavage
	3	Bronchial aspirate
	2	Drainage fluid
	1	Surgical site fluid
Methicillin-resistant <i>Staphylococcus aureus</i>	1	CVC
	1	Abdominal fluid
	1	Surgical site fluid
	2	Bronchial aspirate
	4	Other
	1	Bronchoalveolar lavage
Ampicillin-resistant <i>Enterococcus faecalis</i>	1	Blood from CVC
ESBL strain	4	Various (same ward)
Candidemia	1	Blood from CVC
	1	Blood from venipuncture
<i>Salmonella</i> species	1	Feces
<i>Acinetobacter baumannii</i>	1	Biopsy

the correct use of the new system by all health operators, an institutional statement containing the list of alerts and suggested actions was issued. After a 6-month testing period from May 1, 2006 to October 31, 2006, the program was introduced into the hospital routine.

RESULTS

From May 1, 2006 to April 30, 2007, 4,020 samples were sent to the laboratory for microbiological testing. Five hundred and six samples were positive, 389 from surgical or ICU patients and 117 from patients admitted to the 2 medical divisions. Samples were sent to the microbiology laboratory if patients showed clinical signs and/or symptoms of infection and if it was necessary to identify the causative agents or to carry out in vitro sensitivity tests to antibiotics. One hundred thirty-four alert notifications were generated (Tab. II). Most alerts dealt with isolation of methicillin-resistant coagulase-negative staphylococci (MRCoNS) (74.6%); the remaining concerned the growth of *Mycobacterium* species (2.2%), *Stenotrophomonas maltophilia* (3%), multidrug-resistant *Pseudomonas aeruginosa* (6%), MRSA (6.7%), ampicillin-resistant *Enterococcus faecalis* (1.5%), extended-spectrum beta-lactamase (ESBL) strains (3%), *Salmonella* species (0.7%), and *Acinetobacter baumannii* (0.7%). In particular, a *Candida albicans* strain was isolated from central and peripheral blood cultures of the same ICU patient.

Infected or colonized patients were promptly placed in isolation in order to reduce the risk of direct or indirect transmission (6) and the CMO and local health-care authority was notified of *Mycobacterium* and *Salmonella* detections; CVC-related candidemia (demonstrated by DTP) prompted clinicians to immediately remove the infected catheter and start antifungal therapy (21, 22). MRCoNS notifications prompted strict clinical monitoring for a possible reservoir of antimicrobial resistance; however, this infection did not present an immediately relevant problem (23-26).

DISCUSSION

The use of CVCs is one of the most essential features of modern medical care: in addition to accurate measurement of hemodynamic variables, it allows delivery of medications and nutritional support. In cancer patients in particular, the use of reliable CVCs allows chemotherapy administration, blood sampling and increasing application of supportive care measures including intravenous antibiotics, antiemetics, analgesics and parenteral nutri-

tion. Unfortunately, the use of intravascular devices is associated with a significant potential for producing adverse events that are dangerous to patients and expensive to treat (27-29); more than 15% of patients have complications, particularly CVC infections and subsequent bacteremia and candidemia (30-35). To guide the management of CRBSIs, an accurate and early microbiological diagnosis is essential, both if the device can be kept in place with appropriate systemic and antibiotic-lock therapy (13), and if the CVC should be removed to avoid possible complications such as endocarditis and endophthalmitis by *S aureus* and *Candida* species or complications related to unusual gram-negative bacteremia (11). For best support of clinicians in patient care, it is also required that prompt notification follows the diagnosis.

In our institute about 800 short-term CVCs are placed yearly, with a mean CRBSI incidence of 3.01 events per 1,000 days of catheter dwelling time (against an expected ratio of 2.4 per 1,000) (36). The diagnosis of CRBSI is established by means of the DTP (21, 22). In case of a positive culture, the microbiologist enters into the patient's laboratory report the time to positivity, that is determined by a continuous blood culture monitoring system, and a preliminary gram stain identification. A first microbiological result is therefore promptly available, with timing depending only on the colony forming units and strain.

As the growth of most clinically significant pathogens warrants earlier notification of the clinicians, the implementation of a laboratory-based NIs control system also took this problem into account. Among the alerts, items were listed related both to hospital epidemiology and patient care and the flexibility of the software made it possible to personalize the extraction criteria according to the users' requirements. It was also fundamental to issue and distribute recommendations for action in response to each event, in order to support the clinicians in their choice of actions to be taken to contain the risk of transmission and cure the affected patients.

CONCLUSION

In our 1-year experience, automated monitoring of critical situations through a system for NIs control produced significant benefits also in the surveillance and therapy of CRBSIs. In fact, continuous surveillance of CVC infections allows promptly alerted clinicians to implement all the therapeutic measures required and to immediately remove devices and start appropriate treatment. Hours are gained in this way compared to the previous approach, with a significant clinical advantage for the patients. A further advantage in patient

care is obtained by the standardization of these measures, which should be known and shared by all hospital staff.

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