医薬品 研究報告 調査報告書

識別番号・報告回数			報告日	第一報入手日	新医薬品等の区分	機構処理欄
				2007. 5. 15	該当なし	

一般的名称	白血球除去人赤血球浮遊液	研究報告の公表状況	T. Sasahara, Y. Morisawa, A. Yoshimura, S. Hayashi, H. Gomi, Y. Hirai. American Society for Microbiology 107th Annual Meeting; 2007 May 21-25; Toronto.	公表国
販売名(企業名)	白血球除去赤血球「日赤」(日本赤十字社) 照射白血球除去赤血球「日赤」(日本赤十字社)			日本

研究報告の概要

○高度に汚染されたリネン類を原因とした病院内*Bacillus cereus*血流感染アウトブレイク

背景:日本の三次医療施設である自治医科大学病院(病床数1082床)において、入院患者と外来患者双方の全培養結果のモニタリングが感染症専門医により行われた。2006年8月1日～8月31日までの期間に、患者28名の血液培養から*Bacillus cereus*が検出された。当院での過去2年間の培養結果のベースラインデータに基づき、これらの症例をアウトブレイクとみなした。月間の*Bacillus*菌陽性血液培養検体数および患者数の平均±標準偏差は、それぞれ2.52±2.12、2.28±1.90であった。

方法:*B. cereus*が検出された患者28名の医療記録を調査した。患者のリネン類(タオル、シーツ)、止血帯、皮膚清浄綿、皮膚滅菌剤、看護師が注入用液剤を混合するワゴン台表面、手指消毒剤、血液培養ボトルおよび注入ラインから得られた環境検体の培養を行った。検体は65℃で20分間熱処理後、血液寒天培地に接種した。37℃で48時間培養した後にプレートを調べた。

結果:試験期間中8名の患者に「真の」*B. cereus* 菌血症の可能性を認めた。1名は眼内炎を発症し、2名は死亡した。末梢静脈ライン以外に共通した曝露はなかった。1例の注入ラインからは、大量の*B. cereus*が生育した。また、リネン類から得られた*B. cereus*の平均菌数(CFU/㎠)は、タオルが18,400 、シーツが103であった。他の検体からはほとんど検出されなかった。汚染されたリネン類は、特定の大容量連続槽洗濯機で洗浄されており、これが汚染を拡大したことが判明した。一時的にリネン類のオートクレーブ処理を行い(1回)、洗濯機を洗浄し、末梢静脈ライン管理について職員の教育を行ったことで、*B. cereus*陽性血液培養はその後検出されなかった。

結論:当院における*B. cereus* 血流感染アウトブレイクは、高度に汚染されたリネン類と末梢静脈ラインの不適切な取り扱いによって発生したと考えられた。複数の方法によって当該アウトブレイクを収束させた。

報告企業の意見	今後の対応
日本の自治医科大学病院における*Bacillus cereus*の集団院内感染は、リネン類の汚染と末梢静脈ラインの不適切な取り扱いが原因であると考えられたとの報告である。輸血後細菌感染症の調査には、院内感染など輸血以外の伝播ルートについて考慮する必要がある。	今後も情報の収集に努める。

使用上の注意記載状況・その他参考事項等

白血球除去赤血球「日赤」
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血液を介するウイルス、
細菌、原虫等の感染
vCJD等の伝播のリスク

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Nosocomial Outbreak of *Bacillus cereus* Bloodstream Infection Caused by Highly Contaminated Linens

T. Sasahara, Y. Morisawa, A. Yoshimura, S. Hayashi, H. Gomi, Y. Hirai;
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Presentation Number: L-004
Poster Board Number: 288
Keyword: Bacillus cereus, Contaminated linen, Bloodstream infection

Background: In the Jichi Medical University Hospital, a tertiary care center with 1082 beds in Japan, all the culture results obtained from both inpatients and outpatients have been monitored by infectious disease physicians. *Bacillus cereus* grew from blood cultures obtained from 28 patients between April 1 and August 31, 2006. We considered these cases as an outbreak on the basis of our baseline data on all culture results for the past 2 years; the average +/- standard deviation numbers of *Bacillus* species-positive blood culture specimens and patients per month had been 2.52 +/- 2.12 and 2.28 +/- 1.90, respectively. Methods: We reviewed the charts of 28 patients whose blood cultures grew *B. cereus*. Environmental cultures obtained from linens (towels and bed sheets), tourniquets, stocked skin prep swabs, skin disinfectants, ward table surfaces for nurses' mixing infusion solutions, hand sanitizers, blood culture bottles, and infusion lines from selected patients. Samples were inoculated into blood agars after 65°C heat-treatment for 20 min. Plates were examined after 48-h incubation at 37°C. Results: During the period of investigation, we found that 8 patients had possibly "true" *B. cereus* bacteremia. One patient had endophthalmitis and 2 patients had died. There were no common exposures excluding peripheral venous lines. An infusion line of one case grew a large quantity of *B. cereus*. In addition, the average numbers of CFU/cm^2 of *B. cereus* from linens were 18,400 for towels and 103 for bed sheets, respectively. Few were detected from other environmental specimens. The contaminated linens were handled with a specific large continuation tank washing machine, which was determined to have amplified contamination. By temporarily autoclaving linens (only once), descaling the washing machine, and staff education on peripheral venous line management, there were no additional *B. cereus*-positive blood cultures afterward. Conclusions: In our hospital, *B. cereus* bloodstream infection outbreak occurred probably due to highly contaminated linens and improper handling of peripheral venous lines. We contained the outbreak by a multi-modal approach.

Commercial Relationship:

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一般的名称	白血球除去人赤血球浮遊液	研究報告の公表状況	Rupp ME, Sholtz LA, Jourdan DR, Marion ND, Tyner LK, Fey PD, Iwen PC, Anderson JR. Clin Infect Dis. 2007 Jun 1;44(11):1408-14. Epub 2007 Apr 16.	公表国
販売名(企業名)	白血球除去赤血球「日赤」(日本赤十字社) 照射白血球除去赤血球「日赤」(日本赤十字社)			米国

研究報告の概要

○無針静注バルブの導入に伴う血流感染のアウトブレイク
背景:針刺し事故のリスクを最小限にするため無針静注カテーテルコネクターバルブが臨床現場に導入されている。しかし、これらバルブに関連する感染管理のリスクは過小に評価されている。2005年3月、ある病院の複数の病室において、特定の無針バルブが導入されていた期間中に血流感染の急激な増加が認められた。
方法:標準的方法を用い、病院全体の1次血流感染のサーベイランスを実施した。血液培養の細菌汚染率をモニターした。静注カテーテルコネクターバルブから採取したサンプルを用いて培養を実施した。
結果:ベースラインと比較した当該コネクターバルブ導入期間中の血流感染の相対リスクは2.79 (95%信頼区間、2.27-3.43)であった。重症集中治療室では一次血流感染の割合は、同バルブ導入によってカテーテル留置1000日当り3.87感染から10.64感染に増加し(P<0.001)、バルブ使用中止後の6ヶ月間では5.59感染(P=0.02)に減少した。同様に、入院看護室では、同バルブ導入によってカテーテル留置1000日当り3.47感染から7.3感染に増加したが(P=0.02)、使用中止後の6ヶ月間は2.88感染(P=0.57)に減少した。チーム治療室でも同様の事象が発生した。血液培養の細菌汚染率は、試験期間中それほど変わらなかった。細菌検体検査に供した37バルブのうち、24.3%に細菌が生育し、そのほとんどはコアグラーゼ陰性ブドウ球菌であった。
結論:一次血流感染と無針コネクターバルブとの有意な関連性が認められた。無針コネクターバルブの検討には、市場導入前に前向きランダム化試験で感染リスクを十分評価することを含めるべきである。

報告企業の意見	今後の対応
米国ネブラスカ州の病院で複数の病室において、特定の無針静注カテーテルコネクターバルブが導入されていた期間に血流感染の急激な増加が見られ、一次血流感染と無針コネクターバルブの有意な関連性が認められたとの報告である。輸血後細菌感染症の調査には、院内感染など輸血以外の伝播ルートについて考慮する必要がある。	今後も情報の収集に努める。

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vCJD等の伝播のリスク

MAJOR ARTICLE

Outbreak of Bloodstream Infection Temporally Associated with the Use of an Intravascular Needleless Valve

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Background. Needleless intravascular catheter connector valves have been introduced into clinical practice to minimize the risk of needlestick injury. However, infection-control risks associated with these valves may be underappreciated. In March 2005, a dramatic increase in bloodstream infections was noted in multiple patient care units of a hospital in temporal association with the introduction of a needleless valve into use.

Methods. Surveillance for primary bloodstream infection was conducted using standard methods throughout the hospital. Blood culture contamination rates were monitored. Cultures were performed using samples obtained from intravascular catheter connector valves.

Results. The relative risk of bloodstream infection for the time period in which the suspect connector valve was in use, compared with baseline, was 2.79 (95% confidence interval, 2.27–3.43). In critical care units, the rate of primary bloodstream infection increased with the introduction of the valve from 3.87 infections per 1000 catheter-days to 10.64 infections per 1000 catheter-days ($P < .001$), and it decreased to 5.59 infections per 1000 catheter-days ($P = .02$) in the 6 months following removal of the device from use. Similarly, in inpatient nursing units, the rate of bloodstream infection increased from 3.47 infections per 1000 catheter-days to 7.3 infections per 1000 catheter-days ($P = .02$) following introduction of the device, and it decreased to 2.88 infections per 1000 catheter-days ($P = .57$) following removal of the device from use. Similar events occurred in the cooperative care units. The rate of blood culture contamination did not substantially change over the course of the study. Of 37 valves that were subjected to microbiological sample testing, 24.3% yielded microbes, predominantly coagulase-negative staphylococci.

Conclusion. A significant association between primary bloodstream infection and a needleless connector valve was observed. Evaluation of needleless connector valves should include a thorough assessment of infection risks in prospective randomized trials prior to their introduction to the market.

Needleless intravascular access systems are mandated to reduce the risk of needlestick injuries in health care workers [1, 2]. There are 3 basic design types of needleless access systems: split-septum connectors; luer-activated valves; and positive-displacement, luer-activated valves. There are numerous commercially available products within each basic design type. Many of these needleless access systems are introduced into clinical use without thorough evaluation of associated infection control risks. Recently, concerns have been expressed regarding increased rates of bloodstream infection associated with the use of newer needleless mechanical valve systems [3–5].

Intravascular catheter–related bacteremia is a substantial clinical problem that results in an attributable mortality of ~3% and an attributable cost-per-incident of ~$25,000 among the estimated 250,000 patients annually who experience this complication in the United States [6–9]. Therefore, if any portion of the intravascular access system increases the risk of bloodstream infection, it must be thoroughly evaluated, and clinicians should be appropriately alerted.

A dramatic increase in the rate of primary blood-

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stream infection in multiple inpatient units was observed in our institution in temporal association with the introduction of a positive-displacement, luer-activated, needleless connector valve. Similarly, upon removal of the putative offending device, the rate of bloodstream infection decreased. Herein, we report these findings and other observations supporting the causative role of the intravascular needleless connector valve in the outbreak.

METHODS

Location and surveillance methods. The Nebraska Medical Center (Omaha) is a 689-bed academic medical center. Continuous active surveillance for bloodstream infections in critical care units and cooperative care units (step-down care facilities for bone marrow and solid-organ transplant recipients in which a patient and a care partner [a spouse or family member] are housed together in a home-like environment) has been conducted for years using Centers for Disease Control and Prevention methods and definitions [10]. Surveillance for device-associated bloodstream infections was implemented in other nursing units in November 2004. Initially, surveillance was conducted every third month; in May 2005, continuous surveillance was instituted. Bloodstream infection rates were monitored in 3 types of patient care areas: critical care and transplantation units (8 patient care units consisting of 132 beds), inpatient nursing units (9 patient care units consisting of 312 beds), and transplantation cooperative care units (2 inpatient care units consisting of 22 beds). A primary bloodstream infection was defined as occurring when ≥1 blood culture of samples obtained from a patient yielded a pathogen that was not present because of an infection at another site. Common skin contaminants (e.g., diptheroids or coagulase-negative staphylococci) were disregarded, unless they were recovered from ≥2 blood samples that were obtained separately or from a patient who had a central venous catheter and for whom the physician instituted appropriate antimicrobial therapy. Infections manifesting within 48 h after admission to the hospital were regarded as non–hospital acquired. Primary bloodstream infection rates were expressed in infections per 1000 central venous catheter–days. In the cooperative care units, accurate intravascular catheter census data were not reliably available, and the infection rates were expressed in infections per 1000 patient-days.

Devices and timing of clinical use. Prior to February of 2005, a split-septum intravascular access connector valve (Interlink IV Access System; Baxter) was in use in our hospital. During the last week of February 2005, a luer-activated, positive-displacement, intravascular access valve (SmartSite Plus; Alaris Medical Systems) was introduced into clinical practice throughout the hospital. Education on the proper use of the intravascular access valve was conducted on all units by nurse educators and manufacturer's representatives. No changes were instituted in catheter insertion or care protocol during the observation periods. The intravenous administration set and connector valves were changed every 7 days, or more frequently if the connector valve or tubing appeared to be damaged, showed signs of leakage, or was visibly contaminated with blood [9]. Administration sets were changed more frequently when blood products, lipids, or parenteral nutrition formulations were infused [9]. Intravenous access ports were cleaned with a swab containing 70% isopropyl alcohol before accessing the port. Following an observed increase in the rate of bloodstream infections, efforts to replace the positive-displacement intravascular access valve were initiated in late June 2005, and the previously used split-septum valve was returned to use throughout the hospital by 1 September 2005. Although there was widespread institutional recognition of the outbreak and increased vigilance with regard to compliance with vascular access insertion and care protocol, a formal, system-wide reeducation effort was not conducted during the period when the positive-displacement intravascular access valve was in use.

Blood culture contamination. The clinical microbiology laboratory routinely monitored the rate of blood culture contamination using a laboratory definition of contamination. Blood cultures were considered to be most likely contaminated when single blood cultures (1 of 1 blood culture) yielded *Bacillus* species, aerobic and anaerobic diptheroids (including *Corynebacterium* species and *Propionibacterium acnes*), or *Micrococcus* species. If a single blood culture among multiple blood cultures performed using samples obtained from the same patient yielded coagulase-negative staphylococci, it was regarded as being a likely contaminated specimen.

Catheter connector valve cultures. Intravascular access valves were removed from the central venous catheters of 12 adult critical care unit patients and replaced with new valves. The used valves were transported to the laboratory in individual sterile containers. The diaphragms of the used valves were disinfected with 70% isopropyl alcohol wipes (Kendall), and 1 mL of trypticase soy broth (Bacto; Difco Laboratories) was injected through the valves and collected in sterile 5-mL plastic test tubes. A 0.1 mL aliquot of the broth was inoculated onto trypticase soy agar plates (Difco Laboratories), and the plates and remaining broth were incubated at 37°C for 48 h. Standard microbiological testing techniques were used to identify recovered microbes.

Statistical analysis. Primary bloodstream infection rates were modeled over the 3 time periods (baseline [before March 2005], outbreak [March 2005–August 2005], and follow-up [September 2005–February 2006]) for the 3 types of patient care units (critical care and transplantation units [8 areas], inpatient nursing units [9 areas], and transplantation cooperative care units [2 areas]). The number of bloodstream infec-

tions that were observed was modeled using Poisson regression, with the rates assumed to be constant for each of the 6 patient-care-unit–time-period combinations. SAS GENMOD software, version 9.1.3 (SAS) was used for modeling. Comparisons of patient care units and time periods were expressed as relative risks.

RESULTS

As is illustrated in figure 1, the rate of bloodstream infection increased dramatically in all types of patient care areas in conjunction with the introduction of the positive-displacement connector valve. In the 8 critical care and transplantation units, the baseline bloodstream infection rate, which was calculated on the basis of 38,250 central venous catheter–days over a 26-month period, was 3.87 infections per 1000 central venous catheter–days. During the 6-month period when the positive-displacement connector valve was in clinical use in our facility (accounting for 10,340 days of central venous catheter use), the rate of bloodstream infection increased 2.82-fold (95% CI, 2.21-fold to 3.61-fold) to 10.64 infections per 1000 central venous catheter–days ($P < .001$). In the 6 months following the discontinuation of use and the removal of the positive-displacement connector valves, the bloodstream infection rate decreased to 5.59 infections per 1000 central venous catheter–days ($P = .02$, compared with baseline). In the 9 inpatient nursing units, the baseline rate of catheter-associated bloodstream infection, which was calculated on the basis of 2 one-month-long observation periods (November 2004 and February 2005) that involved 3745 central venous catheter–days, was 3.47 infections per 1000 central venous catheter–days. During the outbreak period, the rate of bloodstream infection increased 2.1-fold (95% CI, 1.15-fold to 3.86-fold) to 7.3 infections per 1000 central venous catheter–days ($P = .02$). During the postintervention period, the rate of bloodstream infection decreased to 2.88 infections per 1000 central venous catheter–days during 11,475 days of central venous catheter use, which is a similar rate to that observed at baseline ($P = .57$). Finally, in the 2 cooperative care transplantation populations, the baseline rate of bloodstream infection of 5.31 infections per 1000 patient-days that was demonstrated during 7535 patient-days of observation over 26 months of time increased 2.86-fold (95% CI, 1.69-fold to 4.85-fold) to 15.18 infections per 1000 patient-days during 1383 days of patient observation ($P < .001$). This rate decreased to 3.82 infections per 1000 patient-days over 1047 patient-days of observation in the postintervention period, which is a similar rate to that observed at baseline ($P = .53$). There was no statistical evidence that the increased risk differed across the 3 patient care units. The estimated relative risk of bloodstream infection for the 6-month period in which the positive-displacement connector valve was used in our facility,

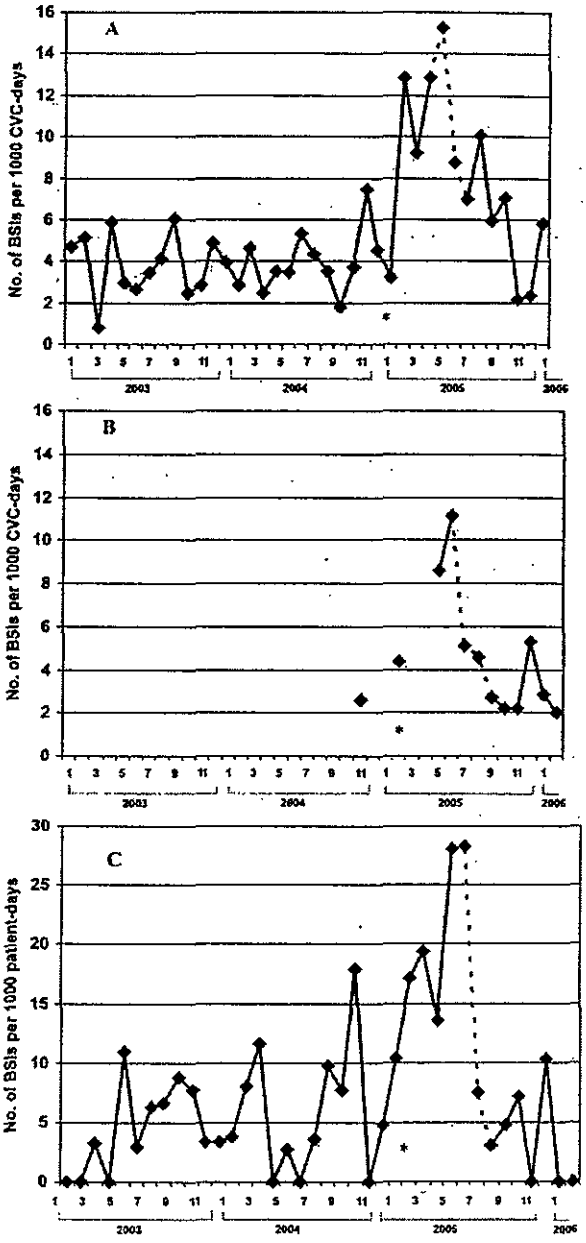

Figure 1. Rate of bloodstream infection versus time, January 2003 to February 2006. Numbers 1–12 in the x-axis refer to consecutive months (from January to December) of the year indicated. Bloodstream infections in critical care units (*A*), in inpatient nursing units (*B*), and in cooperative care units (*C*). Infections are expressed as bloodstream infections (BSI) per 1000 central venous catheter (CVC)–days in panels *A* and *B* and as bloodstream infections per 1000 patient-days in panel *C*. *Asterisk*, when the positive-pressure displacement valve was introduced; *dotted trend line*, the transition period as the valves were removed from clinical use. In panel *B*, the first 2 data points indicate separate observation months in November 2004 and February 2005; continuous surveillance was instituted in May 2005. The connector valve was introduced in late February 2005 and was completely removed from clinical use by September 2005.

compared with the baseline period, was 2.79 (95% CI, 2.27–3.43).

Table 1 documents the microbiological characteristics of the bloodstream infections that were observed during the overall investigation period. In the 26-month preoutbreak period, 201 bloodstream infections were defined, of which 24 (11.9%) were polymicrobic. Sixty-four percent of the infections were due to gram-positive cocci, and 33% were due to coagulase-negative staphylococci. Microbiological characteristics during the outbreak period were quite similar to those in the preoutbreak period. A total of 189 bloodstream infections were observed, of which 16 (8.5%) were polymicrobic. Sixty-four percent of the infections were due to gram-positive cocci and 34% were due to coagulase-negative staphylococci. In the postoutbreak period, 98 bloodstream infections were observed, of which 5 (5.1%) were polymicrobic. The proportion of bloodstream infections due to gram-positive cocci increased to 76%, and coagulase-negative staphylococci caused 45% of the infections. There was no substantial difference in the proportion of polymicrobic bloodstream infections during the observation periods ($P = .15$, by Fisher's exact test). The proportion of infections due to *Candida* species remained fairly constant throughout the periods of observation, at 6%, 6%, and 7% during the preoutbreak, outbreak, and postoutbreak periods, respectively.

The rate of blood culture contamination remained relatively constant over the course of the outbreak. In the 14 months prior to the outbreak, the rate of blood culture contamination was 3.00% (816 contaminated cultures of 27,172 blood samples obtained). During the 6-month outbreak period, the contamination rate was 3.02% (415 contaminated cultures of 13,742 blood samples obtained); during the 6-month follow-up period, the contamination rate was 3.13% (407 contaminated cultures of 12,994 blood samples obtained). The number of blood samples obtained per month increased by 18%, from 1941 samples per month during the preoutbreak period to 2290 samples per month during the outbreak period. In the 6 months following the outbreak, the number of samples obtained per month decreased modestly to 2166 samples per month.

Samples obtained from 9 (24.3%) of 37 positive-displacement intravascular catheter access valves in 7 (58.3%) of the 12 patients yielded positive results when cultured; all valves from multilumen catheters were sampled. The catheters had been inserted an average of 8 days before sampling (median, 5 days; range, 1–27 days). As previously noted, connector valves were routinely changed at 7-day intervals. All positive sample cultures yielded typical skin flora (e.g., coagulase-negative staphylococci or diptheroids) ranging in quantity from 10 to 1500 colony forming units/mL of broth flush solution. No gram-negative bacilli or yeast were recovered from the connector valves. In 1 instance, it was noted that the broth was bloody after being flushed through the connector valve.

DISCUSSION

Needleless vascular connectors have been widely introduced throughout the health care system in response to mandates for improvement in health care worker safety and avoidance of bloodborne pathogen exposure [1, 2]. Split-septum devices were the first needleless devices to be introduced to the market,

Table 1. Microbiological characteristics of central venous catheter–associated bloodstream infections (BSIs).

Pathogen	Percentage of total BSIs caused by specific pathogen		
	Preoutbreak period (n = 201)	Outbreak period (n = 189)	Postoutbreak period (n = 98)
Gram-positive cocci	64	64	76
Coagulase-negative staphylococci	33	34	45
Enterococcus species	19	19	19
Staphylococcus aureus	7	7	8
Other gram-positive cocci	5	4	4
Gram-negative bacilli	25	27	16
Enterobacter species	6	3	1
Klebsiella species	7	6	4
Escherichia coli	2	5	3
Pseudomonas species	2	8	4
Serratia species	2	2	1
Other gram-negative bacilli	6	3	3
Candida species	6	7	6
Other	5	2	2

and consist of a prepierced diaphragm that is accessed via a blunt cannula. Luer-activated devices control an antireflux valve and are compatible with standard twist-lock connector tubing or syringes. Most recently, to minimize catheter occlusion, positive-displacement devices have been introduced that expel a small volume of flush solution back into the catheter when the device is disconnected. Although needleless connectors have been shown to reduce the risk of needlestick injury [11, 12], the benefit of early-generation needleless connectors was questioned after reports of increased rates of primary bloodstream infections associated with their use [13–16]. Investigation of these outbreaks revealed that the risk of infection was increased when connectors were changed less frequently than is recommended, when specific infusates (such as total parenteral nutrition or lipids) were administered, and when other independent factors were considered (such as patient race and education, multilumen catheter use, or recent hematopoetic stem cell transplantation) [13–17]. In 2002, the Centers for Disease Control and Prevention reported that needleless connectors do not substantially affect the incidence of bloodstream infection when they are used according to manufacturer's recommendations [9]. More recently, increasingly sophisticated mechanical valve connectors have been introduced into clinical practice. Limited data are available regarding the risk of bloodstream infection that is associated with these devices. In studies comparing luer-activated valves with simple caps, rates of contamination and bloodstream infection were reduced with the use of the mechanical valves [18–20]. In 2004, Hall et al. [3] first reported infection-related concerns regarding the newer devices; reports from other institutions followed [4–5, 21, 22]. The device implicated in the outbreak described by Maragakis et al. [5] is the same brand of device temporally associated with the increase in rate of bloodstream infection described in this report. In addition, Shilling et al. [23] noted higher catheter occlusion rates associated with the use of a positive displacement needleless valve, compared with a simpler mechanical valve, as well as a trend toward higher infection rates when saline was used to flush the device.

The present report adds to the increasing attribution of unintended consequences to the introduction of various mechanical needleless catheter connectors into use. Several features of our study merit emphasis. There was a striking temporal relationship between introduction of the connector valve and a ~2.7-fold increase in primary bloodstream infection. Similarly, when the connector valve was removed from clinical use in our facility, the rate of bloodstream infection decreased toward baseline. The increase in bloodstream infection was quickly detected and was observed in all areas and in all patient groups where the device was used. The rapid detection of this outbreak emphasizes the value of well-functioning systems of surveillance for health care–associated infection. The widespread nature of the outbreak indicated a generalized problem, not one associated with a small group of health care workers or a limited point-source outbreak. As illustrated in table 1, the microbiologic etiology of the bloodstream infections was relatively constant and was most consistent with inoculation of the intravascular catheter system with skin flora. The variety of microbial species that were isolated and the lack of reports of similar outbreaks in the region argues against a generalized contamination of infusate as the causative factor. Likewise, no change in the protocol of intravascular catheter insertion or care occurred that could explain a generalized outbreak. Finally, additional support for the causative role of the connector valve came from the results of microbiological testing of samples obtained from the connector valves in clinical use. Microbes were recovered from 24.3% of the sampled connector valves. In comparison, 2 clinical studies examining the risk of microbial colonization of connector valves [18, 20] reported rates of colonization of 4.3% of patients and 6.6% of devices, whereas Danzig et al. [15] related a connector device colonization rate of 21.7% associated with a bloodstream infection outbreak.

Limitations of this study must also be emphasized. First, this was not a prospective, randomized trial. These data are retrospective, observational, and uncontrolled. In addition, our report details experience at a single institution. Although the connector valve was introduced into clinical use in conjunction with an extensive educational program, it is not known whether further education regarding catheter insertion and care would have ameliorated the outbreak. Although earlier studies [13, 14, 16] have indicated that lapses in intravascular catheter care could explain increased infection rates associated with the introduction of new connector valves, other investigators have found repeated educational efforts regarding proper use of the devices to be unrewarding [4].

Although speculative, we believe that the design of the connector valve introduced in our hospital in March 2005 may have promoted microbial contamination and colonization. Upon close inspection of the valve (figure 2), one can observe a shallow depression and rim between the diaphragm and the plastic housing. It is possible that microbes and debris could collect in this area, which would be relatively resistant to cleansing or disinfection. The internal mechanism of the valve contains moving parts, which introduces irregularities in the fluid flow and may promote areas of stagnation and create potential reservoirs for microbial growth. Also, the plastic housing is opaque, which prohibits visual inspection of the connector valve. Therefore, it is possible that blood or infusion products could collect within the valve and, because of its opaque nature, go unnoticed by health care workers. Last, because of stiffness or "memory" of plastic intravenous tubing, if the luer connection mechanism is not fully engaged, the tubing can untwist, resulting in disconnection and possible contamination.