Eur J Clin Microbiol Infect Dis (2000) 19:655–662

Article

Clinical Trial Evaluating a New Hub Device Designed to Prevent Catheter-Related Sepsis

J. Luna, G. Masdeu, M. Pérez, R. Claramonte, I. Forcadell, F. Barrachina, M. Panisello

Abstract A new commercial hub device designed to minimise catheter-related infections was evaluated in a prospective, randomised trial in the intensive care and surgical units of the Hospital de Tortosa Verge de la Cinta in patients in whom the central venous catheters were expected to remain indwelling for at least 7 days. The assessments conducted at catheter withdrawal included cultures of the skin at the catheter site and cultures of the catheter tip and the catheter hubs; moreover, in cases of suspected catheter-related sepsis, samples of peripheral blood and infusion solutions were also cultured. Of the 130 catheters evaluated, 26 (20%) were withdrawn because of suspected catheter-related sepsis; 10 (15%) were in the control group and 16 (24%) in the new product group. Catheter-related sepsis was diagnosed in nine patients, six of whom were in the new product group and three in the control group; all infections in the former group and only one in the latter group were caused by the catheter connection. The rates of catheter hub colonisation (10 cfu) and catheter colonisation (15 cfu in semiquantitative culture and/or >1000 cfu in quantitative culture) of hub origin were not significantly different between the groups (15 cases in the control group vs. 20 cases in the new product group, and 5 cases in the control group vs. 11 cases in the new product group, respectively). The data indicate that the use of the new catheter hub device is no more effective in preventing catheter-related infection than standard good clinical procedures.

Introduction

Intravascular access for the administration of fluids, blood products, medications and nutritional support as well as for haemodynamic monitoring is one of the essential techniques of current clinical practice. The frequency of iatrogenic disease during infusion therapy is high, and intravascular devices may be the origin of perhaps the least frequently recognised nosocomial infection, i.e. intravascular device-related bloodstream infection [1]. Prospective studies have demonstrated that every type of intravascular device carries some degree of risk of bloodstream infection and that the degree of risk varies greatly with the type of device used [1]. The device that poses the greatest risk of iatrogenic bloodstream infection is the central venous catheter [2, 3].

An intravascular catheter can become colonised extraluminally by organisms from the patient's skin microflora during the insertion of the catheter or shortly thereafter. Microorganisms can also contaminate the catheter hub, where the administration set attaches to the catheter (i.e. intraluminal colonisation), or gain access to the fluid column and be infused directly into the patient's bloodstream. Furthermore, the device can become contaminated via blood from remote sources of local infection. It is even possible for the device to be contaminated during its manufacture [1].

Intraluminal contamination of the catheter hub during manipulation of the junction between the catheter and

J. Luna (✉), G. Masdeu, R. Claramonte, I. Forcadell, F. Barrachina
Intensive Care Unit, Servei de Medicina Intensiva, Hospital de Tortosa Verge de la Cinta, C/ Esplanetes 44, 43500 Tortosa, Spain
e-mail: htvcumi@tinet.fut.es

M. Pérez, M. Panisello
Department of Microbiology, Hospital de Tortosa Verge de la Cinta, Tortosa, Spain

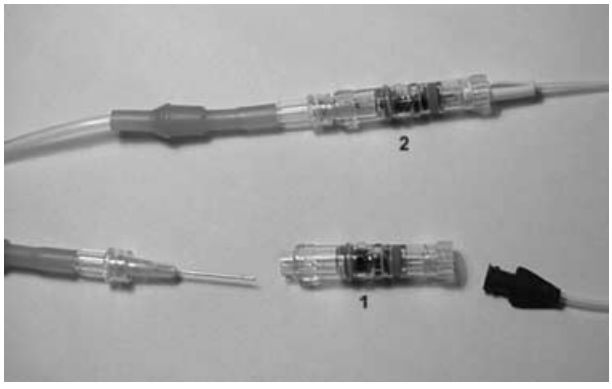

Figure 1 The new hub device has two parts. The female component, on the right, consists of a plastic chamber containing iodinated alcohol (1). The male component, which is contiguous with the infusion line, consists of a needle and a screw mechanism so that it can be attached firmly into the female component (2)

the tubing has been suggested as the most frequent cause of catheter-related bacteraemia in long-term central venous catheters [4, 5]. Strategies aimed at reducing hub-related bloodstream infection have been described. One of them involves a novel hub incorporating an iodine tincture reservoir (Figure 1) that, in a recent clinical trial, was reported to have reduced the incidence of bloodstream infection fourfold [6]. This reduction was obtained even without the use of standard barrier measures (gloves, masks and gown) in access-port manipulations and perfusion-line replacement. However, the trial excluded catheters used in antibiotic treatment schedules.

As part of an ongoing need to improve patient care in our hospital, we conducted a prospective, randomised study to assess whether this new model of hub, together with the modifications recommended for the maintenance and care of catheters, is indeed as effective as claimed in reducing the incidence of catheter-related infection.

Materials and Methods

Patient Population. Over a period of 16 months, all patients over 18 years of age who were not known to be allergic to iodine and who were scheduled to have a central venous catheter indwelling for more than 1 week were eligible to participate. There was no selection with respect to the type of therapy to be administered via the central venous catheter except that, in the case of parenteral nutrition, the lumen was used exclusively for this purpose. The patient was randomly assigned to a trial group or control group. A patient requiring multiple or consecutive catheters was retained in the same catheter-assignment group. The staff of the microbiology lab was blinded to the assignment of the catheters submitted to the laboratory. The study was approved by the Ethics Committee of the Tortosa Regional Hospital.

Protocol for Catheter Insertion. Catheters used in the study were noncuffed double- or triple-lumen central venous catheters of 20 or 30 cm, manufactured by Arrow International (models CS-16702 and CS-14703) or Abbott Laboratories (no. 41435-89-01). The new hub device (Segur-Lock) is manufactured by Inibsa Laboratorios, Barcelona, Spain. An experienced member of the ICU team inserted the catheters at bedside. Before insertion, the skin was disinfected with an antiseptic (10% povidone iodine) and allowed a 2 min contact time. The physician performed a thorough hand scrub, wore sterile gloves, gown, cap and mask, and used large sterile drapes. In the Segur-Lock catheter group, the connector was attached to all catheter lumens immediately after the insertion procedure. Aseptic conditions were maintained as described previously [6].

Description of the Trial Hub. The Segur-Lock connector has two pieces: a female part comprised of a plastic cylinder with an iodine-containing chamber, and a male part that consists of a 20G needle attached to the infusion line (Figure 1). The female part of the connector remains in place as long as the catheter is in use. Manipulations and replacements affect only the male part. When both pieces are connected, the needle passes through the iodine chamber, thus decreasing the possibility of contamination induced by manipulation. The risk of the patient receiving iodine intravenously is clinically nonsignificant.

Care and Maintenance of Catheters. In the control group, the catheter hub attached to the parenteral nutrition system was protected with povidone-impregnated sterile gauze immediately after catheter insertion and always at perfusion line changes. A povidone ointment was applied to the insertion site, which was covered with sterile gauze and tape. No antimicrobial ointment or transparent dressings were used.

Dressings and delivery systems were routinely replaced three times a week. Each time the skin was cleaned, povidone ointment was applied and the gauze and tape were changed. The catheter hubs were therefore manipulated at least three times a week when the delivery systems were replaced and more often when technically necessary. In the control group, these procedures were carried out in accordance with our hospital's guidelines, i.e. use of sterile gloves (and gown and mask as well in the case of parenteral nutrition). In the Segur-Lock group, and in accordance with the manufacturer's recommendations, sterile gloves were used only when a parenteral nutrition line was being replaced. In the replacement and manipulation of the other delivery systems using the Segur-Lock connections, the usual hygienic measures were followed (thorough hand washing), but in accordance with the recommendations of the manufacturer, no sterile gowns, masks or other external protection measures were employed.

A member of the investigation team evaluated each catheter at least once daily. The insertion site and any systemic effects that may have been caused by the catheter were assessed.

Microbiological Methods. Catheters were removed when their clinical indication was completed or when a catheter-related bloodstream infection was suspected. All catheters were assessed immediately upon transfer to the microbiology laboratory. Specimens included the catheter tip, swabs from skin around the insertion site and from catheter hubs and, if catheter-related sepsis was suspected, venous blood samples as well as samples of the parenteral nutrition solution.

After removing the gauze and tape, the skin culture was obtained. A sterile premoistened swab (Eurotubo; Industrias Aulabor, Spain) was rolled over an area of skin 2 cm in diameter around the puncture site. The skin was then disinfected with povidone iodine and a contact time of 2 min allowed. The catheter was then removed and a 5 cm segment of the tip of the catheter delivered to the microbiology laboratory in a sterile container. The catheter tip was cultured using the semiquantitative method described by Maki et al. [7] and the quantitative method described by Cleri et al. [8] as modified by Liñares et al. [9]. The Maki technique assesses the extraluminal colonisation of the catheter tip and

consists of the segment tip being rolled over a blood agar plate that is then incubated for 72 h at 35 °C. The Cleri technique consists of irrigating the lumen of the segment tip with 2 ml of tryptose broth and then streaking 0.1 ml of this broth onto agar plates that are then incubated for 72 h at 35 °C under aerobic conditions. Cultures were considered positive if >15 cfu were isolated using the Maki technique or >1000 cfu when using the modified Cleri technique.

The infusion devices were removed and the catheter hubs were cultured using sterile premoistened cotton swabs (Venturi Transystem; Nirco, Spain) that were inserted into the hub and gently rubbed against the inner surface of the catheter hub. In the Segur-Lock group, the connector was removed and then the catheter hub culture obtained. Cultures of skin and catheter hubs were sent in sterile transport medium to the laboratory, where they were inoculated onto blood agar plates and incubated for 72 h at 35 °C under aerobic conditions. The cultures from skin and catheter hubs were considered positive whenever bacterial growth was observed, irrespective of the number of colonies. The catheter hub or skin was considered contaminated if the culture contained >10 cfu as a cutoff. Whenever confluent growth was observed, the result was recorded as >100 cfu.

When catheter-related bacteraemia was suspected, two blood samples (30 min apart) of at least 20 ml were drawn from peripheral veins. Blood samples were never obtained through the catheter. Each sample (10 ml) was inoculated into aerobic and anaerobic media (ESP 80A Aerobic Broth; Difco, USA) and incubated at 35 °C in a continuous-monitoring, noninvasive, automatic system (ESP Unit; Difco) for 7 days. Parenteral nutrition samples of 10 ml were taken for culture by aseptically puncturing the delivery bag. The samples were then inoculated into aerobic media (ESP 80A Aerobic Broth; Difco).

All instrument-positive vials were subcultured onto solid media plates (Chocolate-PVX and blood agar). Any microorganisms that could be recovered in sufficient numbers were identified and the in vitro susceptibility to antibiotics established by standard methods.

Definitions of Infection. Using standard clinical definitions established prior to the start of the study, catheter-related bloodstream infection was clinically suspected when at least two of the following were noted: (i) body temperature >38 °C; (ii) leucocytosis >12,000/mm^3 or leucopaenia <2000/mm^3; and (iii) systolic pressure <80 mmHg. Based on the results of the microbiological assessments, catheter-related infections were defined as follows [10]: catheter-related bloodstream infection: concordant microbial growth between the catheter tip and percutaneously drawn blood cultures; primary hub catheter-related bloodstream infection: concordant growth from the catheter hub and the blood culture of peripheral veins, regardless of the results from the catheter tip; primary skin catheter-related bloodstream infection: concordant growth from the exit site and a percutaneously drawn blood culture; primary infusate catheter-related bloodstream infection: concordant growth from the infusate and a percutaneously drawn blood culture; catheter colonisation: significant growth of a microbial pathogen from the catheter tip; hub colonisation: significant growth (>10 cfu) of a microbial pathogen from the catheter hub; and exit-site colonisation: significant growth (>10 cfu) of a microbial pathogen from within 2 cm of the swabbed catheter insertion site.

Statistical Analysis. The estimated number of catheters to be assessed was calculated as 63 in each of the two groups of patients. This value was derived using a unilateral probability value of <0.05, a risk of 15% (power potency 85%) to detect a minimum relative difference of 90% between the two groups and an overall theoretical estimate rate of catheter-associated bloodstream infection of 12% and 1% in control group and study group, respectively.

Differences between the two groups were assessed using Student's *t* test or Wilcoxon rank-sum test for continuous variables with Fisher's exact test or chi-square test for categorical variables. Predictive values were estimated in terms of relative risk (95% confidence interval) for catheter sepsis and catheter contamination.

A probability value of $P<0.05$ was considered statistically significant for all tests used.

Results

Characteristics of Patients and Catheters. A total of 141 catheters (70 in the control group and 71 in the Segur-Lock group) were inserted in 108 patients. Of these, 11 catheters were excluded from the analyses, in five cases because of the short time they had remained inserted; in one case due to death of the patient; and in five cases because of catheter malfunction. Complete data were collected on 130 catheters (64 in the control group and 66 in the Segur-Lock group) inserted in 97 patients.

Clinical characteristics of patients were comparable in both groups (Table 1), except that there were more

Table 1 Baseline characteristics of patients and catheters

Characteristic	Control group	Segur-Lock group	*P* value
No. of catheters	64	66	
Percent male patients	56	60	0.72
Mean age in years (±SD)	65±13	64±14	0.68
No. (%) with underlying disease			
Cancer	21 (34)	23 (48)	0.11
Medical disease	12 (19)	11 (17)	0.81
Shock or MOF	7 (11)	9 (14)	0.52
No. (%) of patients in ICU	27 (42)	24 (36)	0.61
No. (%) with risk factors for infection			
Surgery	43 (67)	49 (74)	0.44
Contaminated surgery	29 (67)	28 (57)	0.40
Dirty surgery	12 (28)	14 (28)	1
Clean surgery	2 (5)	7 (14)	0.17
Parenteral nutrition	51 (80)	53 (80)	1
No. (%) with mechanical ventilation	23 (36)	20 (30)	0.57
No. (%) with urinary catheter	37 (58)	39 (59)	1
No. (%) with cirrhosis	1 (2)	4 (6)	0.36
No. (%) with diabetes mellitus	16 (25)	21 (31)	0.40
No. (%) with associated infection	17 (27)	26 (41)	0.13
No. (%) receiving systemic antibiotics	17 (27)	29 (45)	0.04
No. (%) with insertion site			
Subclavian vein	55 (86)	57 (86)	1
Jugular vein	3 (50)	3 (50)	1
Femoral vein	6 (9)	6 (9)	1
Admission duration pre-insertion (days±SD)	7±9	8±10	0.44
Duration of placement (days±SD)	13±9	14±6	0.96
No. (%) with reason for removal			
No longer needed	45 (70)	44 (65)	0.58
Local infection at insertion site	5 (8)	3 (4)	0.49
Malfunction	4 (6)	3 (4)	0.70
No. (%) with suspected CRS	10 (16)	16 (24)	0.24

MOF, multiple organ failure; CRS, catheter-related sepsis

Table 2 Catheter colonisation in the Segur-Lock group and the control group

	Total no. (%)	No. (%) of control patients	No. (%) of Segur-Lock patients	Relative risk (95% CI)	*P* value
Catheter withdrawn for suspected CRS	26 (20)	10 (15.6)	16 (24.2)	0.57 (0.24–1.39)	0.24
Catheter with colonised hub[a]	35 (26.9)	15 (23.4)	20 (30.3)	0.7 (0.32–1.54)	0.38
ICU[b]	11 (21.6)	8 (29.6)	3 (12.5)	2.94 (0.68–12.5)	0.14
Surgery unit[c]	24 (30.4)	7 (18.9)	17 (40.5)	0.34 (0.12–0.96)	0.04
Catheter colonised[d]	38 (29.2)	17 (26.6)	21 (31.8)	0.78 (0.34–1.67)	0.57
ICU[b]	14 (27.5)	7 (25.9)	7 (29.2)	0.85 (0.25–2.94)	0.80
Surgery unit[c]	24 (30.4)	10 (27)	14 (33.3)	0.74 (0.28–1.96)	0.54
Catheter with hub-origin colonisation	16 (12.3)	5 (7.8)	11 (16.7)	0.43 (0.14–1.3)	0.18
ICU[b]	3 (5.9)	2 (7.4)	1 (4.2)	1.85 (0.55–2.94)	1
Surgery unit[c]	13 (16.5)	3 (8.1)	10 (23.8)	0.28 (0.07–0.98)	0.05
Catheter-related sepsis	9 (6.9)	3 (4.7)	6 (9.1)	0.49 (0.12–2.04)	0.49
ICU[b]	1 (1.96)	1 (3.7)	0		1
Surgery unit[c]	8 (10.1)	2 (5.4)	6 (14.3)	0.34 (0.07–1.85)	0.27
CRS/1000 catheter-days	5.1	3.4	6.7		0.21
Hub-origin CRS	7 (5.4)	1 (1.6)	6 (9.1)	0.16 (0.03–1.35)	0.12
ICU[b]	1 (2)	1 (3.7)	0		1
Surgery unit[c]	6 (7.6)	0	6 (14.3)	1.17 (1.03–1.32)	0.03

[a] >10 cfu
[b] Results for catheters inserted in patients hospitalised in the ICU
[c] Results for catheters inserted in patients hospitalised in the surgery unit
[d] >15 cfu for semiquantitative technique and/or >1000 cfu for quantitative technique
CRS, catheter-related sepsis

patients in the Segur-Lock group who had received systemic antibiotic therapy. Seven patients in each group had had two catheters inserted, either simultaneously or consecutively. From among these patients, one patient from each group had catheter-associated bacteraemia, the cause of which had been the first of the two catheters inserted.

Catheter Hub Colonisation. We studied 291 catheter hubs (148 in the Segur-Lock group and 151 in the control group) and observed colonisation in 40 (14%). At least one hub became colonised in 35 (27%) catheters, and five catheters had more than one colonised hub. Although the rate of catheter-hub colonisation was higher in the Segur-Lock group (30%) than in the control group (23%), the difference was not statistically significant (Table 2). The risk of catheter hub colonisation was greater for catheters that had been indwelling for >10 days, a finding observed in both the control group (27% vs. 19%; relative risk 1.56; 95% CI = 0.48 to 5.06) and the Segur-Lock group (49% vs. 4%; relative risk 24.7; 95% CI = 3.04 to 200). The microorganisms isolated were similar in both groups, with a high incidence of colonisation by coagulase-negative staphylococci.

Catheter Colonisation. Colonisation was observed in 38 catheters (29% of all catheters). Segur-Lock catheters were associated with a higher rate of catheter-tip colonisation than control-group catheters (32% vs. 27%), but the difference was not statistically significant (Table 2). As with catheter hub colonisation, catheter tip colonisation was more likely to affect catheters inserted for more than 10 days. This was true for the control group (33% vs. 19%; relative risk 2.1, 95% CI = 0.67 to 6.57) as well as for the Segur-Lock group (49% vs. 7%; relative risk 11.8; 95% CI = 2.44 to 57.15).

Catheter colonisation resulted from a blood-borne spread from a biliary infection in one case, from skin colonisation in seven cases and from catheter hub colonisation in 16 cases. We were not able to identify with any certainty the origin of catheter colonisation in the remaining 14 cases, since in none of these cases were the organisms isolated from the skin and the connector the same as those isolated from the catheter tip. Hence, at a conservative estimate, 42% of catheter colonisations were due to hub colonisation, and 46% of the colonised hubs caused catheter colonisation (55% in Segur-Lock catheters and 33% in control catheters).

Catheter-Related Bloodstream Infection. A diagnosis of catheter-related bloodstream infection attributable to an indwelling catheter was established in nine cases (7% of all catheters); hence, 24% of catheter tip colonisations had caused catheter-related sepsis, at a calculated rate of 5.1 per 1000 catheter-days. No patient died from catheter-related bacteraemia.

Catheter-related bloodstream infection was more frequent in the Segur-Lock group. There were six cases of catheter-related bloodstream infection in this group (9% of all Segur-Lock catheters), all of which originated in the catheter hub. This compares with the three

Table 3 Risk factors for catheter-related sepsis (CRS)

Risk factor	CRS	H-CRS	HubC	H-TipC	TipC
Surgery	0.28	0.1	$P=0.008$ RR 4.32 CI (1.41–3.3)	$P=0.038$ RR 7.2 CI (0.92–56.7)	1
Parenteral nutrition	0.20	0.344	0.46	0.19	0.63
Antibiotic therapy	0.67	0.09	0.22	0.09	0.16
Concomitant infection	$P=0.017$ RR 6.73 CI (1.3–34.9)	$P=0.016$ RR 11.05 CI (1.25–97.87)	$P=0.021$ RR 2.62 CI (1.17–5.88)	$P=0.038$ RR 3.49 CI (1.15–10.56)	0.15
>10 days indwelling	P=0.29	0.13	$P=0.001$ RR 4.37 CI (1.74–11)	$P=0.032$ RR 4.04 CI (1.1–14.4)	$P=0.0005$ RR 4.46 CI (1.85–10.78)

H-CRS, catheter-related sepsis of hub origin; HubC, colonisation of catheter hub; H-TipC, colonisation of catheter tip, hub origin; TipC, colonisation of catheter tip; RR, relative risk; CI, 95% confidence interval

Table 4 Microbiological findings in nine episodes of catheter-related sepsis

Bacteria	Tip (SQ culture) (cfu)	Tip (Q culture) (cfu)	Hub (cfu)	Skin (cfu)
Control group				
1 *Staphylococcus hominis*	>100	>2000	neg.	neg.
2 *Staphylococcus epidermidis*	neg.	40	neg.	neg.
3 Viridans streptococci	40	20	20	neg.
Segur-Lock group				
4 *Staphylococcus aureus*	>100	640	>100	neg.
5 *Staphylococcus simulans*	>100	>2000	>100	neg.
6 *Staphylococcus haemolyticus*	>100	1600	>100[a]	neg.
7 *Staphylococcus epidermidis*	>100	neg.	>100	neg.
8 *Staphylococcus epidermidis*	>100	>2000	>100	neg.
9 *Staphylococcus epidermidis*	>100	>2000	>100	neg.

[a] The only related hub catheter-related sepsis not used for parenteral nutrition
SQ, semiquantitative; Q, quantitative; neg., negative with respect to microbiological growth

cases (1 of hub origin) observed in the control group (5% of control catheters). Thus, 6 of 20 catheter hub colonisations in the Segur-Lock group and 1 of 15 in the control group resulted in catheter-related bacteraemia (Table 2).

The main risk factors associated with infectious catheter-related complications were the duration of insertion, the presence of concomitant infectious diseases and the surgical procedures involved (Table 3). Catheter-related bloodstream infection occurred in catheters that had been in place for 17 ± 5.2 days. Seven of the nine cases occurred in catheters that had remained indwelling for more than 10 days. Although parenteral nutrition infusion per se could not be demonstrated as a significant risk factor, cultures of catheter hubs intended for nutritional perfusion were positive (>10 cfu) in six of seven catheter-related bloodstream infections originating in the hub.

Microorganisms identified in the nine cases of catheter-related bloodstream infection are shown in Table 4.

Analysis of stratified data indicated that the Segur-Lock catheters showed trends towards a reduced rate of catheter hub colonisation, catheter colonisation from the hub as source and catheter-related sepsis from hubs in patients hospitalised in the intensive care unit, while, in the surgery ward inpatients, these catheter-related complications were significantly less frequent in the control group. Although patients undergoing systemic antibiotic therapy were more common in the Segur-Lock group than in the control group, the results assessed separately for patients receiving antibiotics were quite similar to those obtained from the overall raw data (Table 2).

Side Effects and Technical Problems. We did not observe any side effects directly attributable to the new connection device. The new hub device needed to be changed on 13 occasions because of the loss of more than 50% of iodine content and on 20 occasions because of infusion leaks secondary to mechanical problems in the attachment device. Because of lumen reduction associated with the Segur-Lock, ten of the

new hub systems were withdrawn for short periods because of problems with fluid overload.

Discussion

Previous studies have shown that infections associated with catheters can be minimised by following established guidelines when the catheter is inserted or replaced, or when the administration sets and intravenous fluids are being replenished [11]. Strategies such as using the maximum barrier technique when the catheter is inserted [12], practising optimum catheter-site care [13] or replacing the administration set 72 h after initiation have been demonstrated to be not only safe but cost-effective as well [14]. If an aseptic technique is used when accessing ports, the number of catheter-related infections can be reduced [15, 16]. This is especially true in the case of parenteral nutrition.

Multilumen central venous catheters are usually inserted in critically ill patients, in those with life-threatening illnesses and in patients requiring frequent manipulation of access ports for the administration of fluids and drugs. In all of these situations there is a high risk of catheter-related infection.

Hub colonisation plays an important role in catheter-related bloodstream syndrome [4, 5, 9]. Protecting the catheter hub with gauze impregnated with povidone iodine solution and wrapped around the external surface of the hub has proved to be an effective way of preventing catheter-related bacteraemia [17]. Other protection systems such as daily flame-sterilisation of metallic catheter hubs have not been widely adopted despite their demonstrated efficacy [18].

We adopted the new hub system (Segur-Lock) because of its reported effectiveness in preventing catheter-related bloodstream infection. However, the results of our evaluation indicate that the Segur-Lock hub connection does not reduce the number of infections associated with central venous catheters.

The Segur-Lock barrier device was designed to protect catheter hubs from bacterial colonisation and, at the same time, reduce the workload of the nursing staff. Further, it was proposed that the use of the Segur-Lock system could make redundant other barrier measures such as the need for sterile gloves while replacing intravenous administration sets. Segur-Lock was demonstrated to be effective in decreasing the in vitro transfer of microorganisms from the delivery system to the catheter hub [19, 20], and a recent study by Segura et al. [6] demonstrated a significant reduction in infectious complications related to the use of central venous catheters. In this latter study, patients from three different hospitals were recruited, but only the initial central venous catheter of each patient was assessed, and antibiotic administration was specifically excluded from the assessments. Segura et al. [6] found three cases of catheter-related bloodstream infection in the Segur-Lock group and 12 cases in the control group, i.e. 16% of all control catheters.

The design of our study was very similar for the evaluation of the Segur-Lock connection except that all types of therapy/administrations via central venous catheters were included in the evaluation. This was done in order to mimic routine clinical practice as much as possible. Our results show no significant differences in the rate of catheter-hub colonisation, catheter-tip colonisation or catheter-related bloodstream infection between the control group and the Segur-Lock group. We have been unable, therefore, to demonstrate conclusively that the new hub device helps to prevent infectious complications, including bloodstream infections. On the contrary, patients in the Segur-Lock group tended to have a higher incidence of catheter-related infections than the control group.

In the Segur-Lock group, more patients had intercurrent infections, which is related to the increased risk of catheter-related bloodstream infection in cases of bacteraemia of different origin [21] or other severe infection processes [22] and, above all, in the absence of antibiotic treatment. In our study, surgical wound infections in the Segur-Lock group were triple that in the control group, although mild intercurrent infections have not been demonstrated to be risk factors for catheter infection [23]. Conversely, there was a greater use of parenteral antibiotic therapy in the Segur-Lock group. Antibiotic therapy has not been shown to have any clear effect on infectious complications related to catheters [21, 24]. Although microbial colonisation can be inhibited, the increased number of manipulations could result in an increased risk of contamination of the catheter, particularly at the connection site.

In two cases of catheter-related bloodstream infection in the control group, we could not establish whether the origin of the catheter infection was from the hub or from the skin. This applied to some cases of catheter-tip colonisation in both the control group and the Segur-Lock group. Previous studies, in which more rigorous methodologies were used, have indicated that this is not unusual [25, 26].

We were not able to establish any catheter-related bacteraemia of cutaneous origin. The two cases of catheter-related bloodstream infection of undefined origin became clinically evident on day 10 of catheter insertion. This early appearance of catheter-related sepsis has been reported as being of cutaneous origin [27]. It has been demonstrated, moreover, that the catheter tip can become infected with cutaneous flora at the time of insertion, even though no microorganisms are isolated from the insertion site at the time of

catheter withdrawal. In these cases, the microorganisms isolated from the insertion site shortly after catheter insertion were the same as those isolated from the catheter tip upon withdrawal, although there was no evidence of microorganisms at the insertion site at the time of catheter withdrawal [25, 28]. Another reason the origin of catheter infection may remain unknown is that a contaminated solution might not be assessed microbiologically if it was infused long before clinical signs became fully apparent.

The differences between our results and those of Segura et al. [6] are difficult to explain. The incidence of catheter-related bloodstream infection in our study was lower than that predicted for a catheter insertion time of more than 7 days [23, 24]. However, the most important difference was that the rate of bacteraemia in the control group was low (5% of control patients) in our study but high in the Segura et al. [6] study (16% of control patients).

A theoretical limitation in demonstrating a benefit from the new hub device could be the use of povidone-impregnated sterile gauze for externally protecting the catheter hub in control catheter hubs used for parenteral nutrition administration. This is an effective method of protection, as has been demonstrated previously [15–17], and its clinical indication has been incorporated into the guidelines of catheter care and maintenance in our hospital. This technique, in effect, is similar to protection proposed for the Segur-Lock device. In the study by Segura et al. [6], there were no data regarding the percentage of patients in the control group in whom this method of protection was applied. The option was left up to the individual participating centres and, as such, could explain the differences observed between the two studies. Other confounding factors could be the greater frequency of manipulation in the Segur-Lock system due to, for example, malfunction of the device or, perhaps, less strict nursing care due to the preconceived concept of its improved safety. Indeed, the latter could explain the differences observed in the infectious complications between patients hospitalised on general surgical wards and those in the specialist intensive care unit, where there is a much higher awareness of the need for a more rigorous control of infection sources. The data of the study of Segura et al. [6] do not clarify this point.

In conclusion, and bearing in mind that the power of the study may have been diminished by the lower-than-expected incidence of catheter-related bloodstream infection in the control group, we consider that a protective effect of the new Segur-Lock catheter hub device could be possible, provided that other barrier techniques (at least sterile gloves during all catheter manipulations) are also employed. Indeed, without these added precautions, the use of the Segur-Lock system may be counterproductive because of the laxity in standard good clinical practice induced by the perceived advantages of the system. A more definitive role for the Segur-Lock system awaits clarification in further controlled trials.

Acknowledgements Editorial assistance was provided by Dr. P.R. Turner of t-SciMed (Reus, Spain).

References

1. Maki DG, Mermel LA: Infections due to infusion therapy. In: Bennet JV, Bachman PS (eds): Hospital infections. Lippincott-Raven, Philadelphia (1998) pp 689–724
2. Trilla A, Gatell JM, Mensa J, Latorre X, Almela M, Soriano E, Jimenez de Anta MT, García San Miguel J: Risk factors for nosocomial bacteremia in a large Spanish teaching hospital: a case-control study. Infection Control and Hospital Epidemiology (1991) 12:150–156
3. Wey SB, Mori M, Pfaller MA, Woolson RF, Wenzel RP: Risk factors for hospital-acquired candidemia: a matched case-control study. Archives of Internal Medicine (1989) 149:2349–2353
4. Sitges-Serra A, Liñares J, Garau J: Catheter sepsis: the clue is the hub. Surgery (1985) 97:355–357
5. Salzman MB, Isenberg HD, Shapiro JF, Lipsitz J, Rubin G: A prospective study of the catheter-hub as the portal of entry for microorganisms causing catheter-related sepsis in neonates. Journal of Infectious Disease (1993) 167:487–490
6. Segura M, Alvarez-Lerma F, Tellado JM, Jimenez-Ferreres J, Oms L, Rello J, Baró T, Sanchez R, Morera A, Mariscal D, Marrugat J, Sitges-Serra A: A clinical trial on the prevention of catheter-related sepsis using a new hub model. Annals of Surgery (1996) 223:363–369
7. Maki DG, Weise CE, Sarafin HW: A semiquantitative method for identifying intravenous catheter related infection. New England Journal of Medicine (1977) 296:1305–1309
8. Cleri DJ, Corrado ML, Seligman SJ: Quantitative culture of intravenous catheters and other intravascular inserts. Journal of Infectious Diseases (1980) 141:781–786
9. Liñares J, Sitges-Serra A, Garau J, Pérez JL, Martín R: Pathogenesis of catheter sepsis: a prospective study with quantitative and semiquantitative cultures of catheter hub and segments. Journal of Clinical Microbiology (1985) 21:357–360
10. Mermel LA: Defining intravascular catheter-related infections: a plea for uniformity. Nutrition (1997) 13:1–3
11. Nelson DB, Kien CL, Frank S, Davis SD: Dressing changes by specialized personnel reduces infection rates in patients receiving central venous parenteral nutrition. Journal of Parenteral and Enteral Nutrition (1986) 10:220–222
12. Raad I, Hohn DC, Gilbreath BJ, Suleiman N, Hill LA, Bruso PA, Marts K, Mansfield PF, Bodey GP: Prevention of central venous catheter-related infection by using maximal sterile barrier precautions during insertion. Infection Control and Hospital Epidemiology (1994) 15:231–238
13. Conly JM, Grieves K, Peters B: A prospective, randomized study comparing transparent and dry gauze dressings for central venous catheters. Journal of Infectious Diseases (1989) 159:310–319
14. Snydman DR, Donnely-Reidy M, Perry LK, Martin WJ: Intravenous tubing containing burettes can be safely changed at 72-hour intervals. Infection Control (1987) 8:113–116
15. Sitges-Serra A, Liñares J, Pérez L, Jaurrieta E, Lorente L: A randomized trial on the effect of tubing changes on hub contamination and catheter sepsis during parenteral nutrition. Journal of Parenteral and Enteral Nutrition (1985) 9:322–325

16. Stotter AT, Ward H, Waterfield AM, Hilton J, Sim ASW: Junctional care: the key to prevention of catheter sepsis in intravenous feeding. Journal of Parenteral and Enteral Nutrition (1987) 11:159–162
17. Halpin DP, O'Bryne P, MaEntee G, Henesy TP, Stephens RB: Effect of a betadine connection shield on central venous catheter sepsis. Nutrition (1991) 7:33–34
18. Holm I: Parenteral nutrition in surgical and medical gastroenterology. Acta Chirurgica Scandinavica (1977) 143:297–305
19. Segura M, Alia C, Oms LL, Sancho JJ, Torres-Rodriguez JM, Sitges-Serra A: In vitro bacteriological study of a new hub model for intravascular catheters and infusion equipment. Journal of Clinical Microbiology (1989) 27:2656–2659
20. Segura M, Alia C, Valverde J, Franch G, Torres-Rodriguez JM, Sitges-Serra A: Assessment of a new hub design and the semiquantitative catheter culture method using an in vivo experimental model of catheter sepsis. Journal of Clinical Microbiology (1990) 28:2551–2554
21. Brun-Buisson C, Abrouk F, Legrand P, Huet Y, Larabi S, Rapin M: Diagnosis of central venous catheter-related sepsis. Critical level of quantitative tip cultures. Archives of Internal Medicine (1987) 147:873–877
22. Ena J, Cercenado E, Martinez D, Bouza E: Cross-sectional epidemiology of phlebitis and catheter-related infections. Infection Control and Hospital Epidemiology (1992) 13:15–20
23. Leon Regidor MA, Leon Gil C, Mateu Sola A, Olaechea P, Insausti JM, Martínez A, Gonzalez V, López V, Alvarez B: Estudio multicéntrico. Infecciones relacionadas con catéteres intravasculares en el paciente crítico. Medicina Intensiva (1993) 17:531–544
24. Tacconelli E, Tumbarello M, Pittiruti M, Leone F, Lucia MB, Cauda R, Ortona L: Central venous catheter-related sepsis in a cohort of 366 hospitalized patients. European Journal of Clinical Microbiology & Infectious Diseases (1997) 16:203–209
25. Atela I, Coll P, Rello J, Quintana E, Barrio J, March F, Sanchez F, Barraquer P, Ballús J, Cotura A, Prats G: Serial surveillance cultures of skin and catheter hub specimen from critically ill patients with central venous catheters: molecular epidemiology of infection and implications for clinical management and research. Journal of Clinical Microbiology (1997) 35:1784–1790
26. Moro ML, Vigano EF, Lepri AC: Risk factors for central venous catheter-related infections in surgical and intensive care. Infection Control and Hospital Epidemiology (1994) 15:253–264
27. Raad I, Costerton W, Sabharwal U, Sacilowski M, Anaissie E, Bodey GP: Ultrastructural analysis of indwelling vascular catheters: a quantitative relationship between luminal colonisation and duration of placement. Journal of Infectious Diseases (1993) 168:400–407
28. Elliott TSJ, Moss HA, Tebbs SE, Wilson IC, Bonser RS, Graham LP, Faroqui MH: Novel approach to investigate a source of microbial contamination of central venous catheters. European Journal of Clinical Microbiology & Infectious Diseases (1997) 16:210–213