Reducing the degree of colonisation of venous access catheters by continuous passive disinfection

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Received 20 July 2015

Revised 31 August 2015

Accepted 25 September 2015

Published Online First

12 October 2015

ABSTRACT

Introduction The advent of Luer-type needleless venous access catheters has been accompanied by a growing number of catheter-related bloodstream infections. Our main objective was to compare rates of colonisation and phlebitis between our standard of care and the new passive disinfection system, using a Luer SwabCap bearing a sponge impregnated with 70% isopropyl alcohol.

Methods We performed a prospective experimental study involving patients attending our day hospital oncology unit, with central venous (CV) or peripheral venous (PV) access lines with needleless connectors for antineoplastic treatment delivery. We assessed the colonisation rate by culture of the inside of the hubs (qualitative culture) and also assessed the possible appearance of phlebitis and the extra cost of introducing the new system in our oncology day hospital; nurse satisfaction was evaluated by a questionnaire. The effectiveness of the isopropyl alcohol disinfection cap was evaluated by analysing rates of catheter colonisation and phlebitis between two groups: group 1 comprised of patients receiving the standard disinfection method and group 2 comprised of patients receiving SwabCaps on any venous access connectors. Samples were taken from the catheter lumen through a sterile swab seeded in Luria Bertani-rich broth and cultivated for at least 48 h at 37°C. We also assessed the extra cost of introducing the new system in our oncology day hospital, and nurse satisfaction was evaluated by a questionnaire.

Results 29 patients were included (13 in group 1 and 16 in group 2). In group 1, 56% of the samples were taken from CV access connectors versus 40% in group 2. Bacterial growth was detected in 43.7% of group 1 samples versus 0% in group 2 ($p=0.006$). No differences in the degree of contamination were found between CV and PV access connectors. No cases of phlebitis were observed. Nurse satisfaction with the new system was 9.2 out of a maximum score of 10. The incremental cost of incorporating the new system in our oncology unit was estimated at €1.87 836.

Conclusion Passive disinfection systems help reduce colonisation of venous access catheters without requiring large economic investment or special training of health personnel.

to the point where catheter-related bloodstream infection (CRBSI) is a major cause of morbidity and mortality in hospitalised patients.²

The incidence of CRBSI reported in the literature varies from 9% to 80%, depending on the catheter type and patient risk factors and on the definition of CRBSI or CABS that is used.³

CRBSI in hospitals is mainly due to intraluminal contamination (mainly in catheters of >7 days of use by manipulation of the hub; the infusion of contaminated solutions is a rare and extraordinary event) and extraluminal contamination (mainly in catheters of <7 days of use by migration of micro-organisms of the skin).^{4–8} In these cases, bloodstream access catheters facilitate infection.⁸ This can be reduced with the use of disinfectant agents for the preparation of the skin prior to catheter insertion and, once positioned, the use of dressings or sponges impregnated with such agents that are placed on the area of insertion.^{9–10} All these recommendations on handwashing, skin preparation, catheter manipulation and insertion are outlined in the Guidelines for the Prevention of Intravascular Catheter-Related Infections.¹¹ They also describe that the highest level of evidence (IA) corresponds to the education, training and staffing of those responsible for handling these catheters. Adherence to the guidelines is not always optimal. Thus, the incorporation of passive disinfection systems may be effective in routine hospital practice.

Certain patients such as oncology patients bear long-term catheters, and the most probable contamination route is intraluminal. That is why preventive measures such as passive disinfection to avoid contamination by manipulation are required.

Of the different passive disinfection systems on the market with these characteristics, we used the SwabCap (Excelsior Medical, BRAUN). The device contains a sponge pad saturated with 70% isopropyl alcohol. On connecting the protective cap to a mechanical valve, a minimal amount of friction is created at the top of the mechanical valve as the pad is compressed. Alcohol is released, bathing the top and threads of the valve. In order to reduce occupational accidents in healthcare, particularly those caused by needle puncture, needleless connector systems were introduced some years ago. However, since their appearance there has been a growing number of reports of CRBSI.^{12–13}

The main objective of this work, conducted in a day hospital oncology unit (DHOU), was to assess the effectiveness of a Luer cap system for needleless connectors of intravenous catheters, bearing a

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To cite: Gutiérrez Nicolás F, Nazco Casariego GJ, Viña Romero M M, et al. *Eur J Hosp Pharm* 2016;**23**:131–133.

INTRODUCTION

The use of catheters for access to the bloodstream generally presents two fundamental problems: mechanical, associated with a tendency to the development of thromboembolism,¹ and infection,

sponge impregnated with 70% isopropyl alcohol, for the prevention of bacterial colonisation, as well as to record the occurrence of phlebitis at peripheral bloodstream insertion sites. As secondary objectives, we evaluated the degree of nursing staff satisfaction with the new system and the extra costs involved.

MATERIALS AND METHODS

We performed a prospective single-centre pilot study during the month of June 2014, which included patients attending the DHOU who needed central venous (CV) or peripheral venous (PV) lines for their cancer treatment.

The number of patients was estimated from the percentage of patients who developed catheter infection in the HDO unit (2%) in 2013 (own data).

In the first 2 weeks of the study, the maintenance of catheters was carried out as usual (group 1). During the second half of the study, the new system using SwabCap (Excelsior Medical, BRAUN) was introduced in the HDO unit (group 2).

All patients were given appointments for blood extraction early in the morning, and each patient received a Luer access reservoir system.

After blood extraction, each patient left the DHOU and proceeded to consultation with their attending physician later during the morning and then, in the afternoon, they received chemotherapy treatment delivered via the Luer access reservoir system.

In group 1, where the standard method performed by the attending nurse was used after morning blood extraction: for PV access lines, the nurse covered the system with gauze prior to treatment delivery; for CV access lines, a conventional cap was applied after sealing with sodium heparin.

In group 2, where the new method was used after morning blood extraction: for both PV and CV access lines, a SwabCap was placed over the catheter. The single-use cap is packaged in a sterile plastic container incorporating a sponge impregnated with 70% isopropyl alcohol. Once in place, it is designed so that the sponge is in direct contact with and surrounds the Luer connector. The device remains in place on the catheter lumen and acts as a physical barrier and a chemical barrier against microbial infection. The Luer SwabCap remained in place until the administration of chemotherapy, which in 92% of cases took place on the same day, and in 8% of cases this was within 24 h.

For patients in both treatment groups, the nurse applied routine hygiene measures for catheter handling, including hand-wash and the use of sterile gloves.

The effectiveness of the system was assessed by analysing intraluminal catheter contamination by qualitative cultures of the sterile swabs. After scraping the lumen of the catheter, the swab was seeded directly into solid Luria Bertani-rich broth medium and cultivated for at least 48 h at 37°C. The primary outcome measure was positive or negative growth on the plate.

To assess nursing staff acceptance of the new SwabCap system, we used a questionnaire comprising the following items: (1) ease of using the new system (easy vs difficult); (2) additional time required (in minutes); (3) opinion on whether the new system benefits the patients (Yes vs No) and (4) overall satisfaction on a scale from 0 to 10, where 0=no satisfaction and 10=maximum satisfaction.

Statistical analysis was performed using χ^2 test using Yates correction and one-factor analysis of variance.

We estimated the economic impact of applying the new disinfection system taking into account the number of times it would be used to deliver antineoplastic treatment in 1 year (based on

DHOU data for the year 2013). We also took into account the fact that some neoplastic regimens would only require one SwabCap for delivery up to 5 consecutive days, although each one can be reused during 7 days.

RESULTS

During the study period, 29 patients were included (13 in group 1 and 16 in group 2). In group 1, 54% of the samples were taken from CV access connectors versus 50% in group 2. Samples were taken and cultivated as described in the Materials and methods section; after 96 h of incubation at 37°C, bacterial growth was present in 43.7% of group 1 samples versus 0% in group 2 ($p=0.006$) (table 1). No differences in the degree of contamination were found between CV and PV access connectors. No cases of phlebitis were observed.

Acceptance of the new SwabCap system by nurses working in the DHOU ($n=6$) was high, with a mean score of 9.2 (maximum 10). No nurse identified drawbacks in the use of the cap, or difficulty in use or additional time required for use.

The additional cost involved in applying the new disinfection system was estimated as follows: the unit cost of each SwabCap (€0.23) was multiplied by the number of times one would be used to deliver antineoplastic treatment in 1 year ($n=14\,336$ based on our DHOU data for the year 2013), totalling €2867.20. However, if we take into account the cost of alcohol-impregnated gauzes that would be needed every time a catheter is manipulated (€98 880), the incremental cost of incorporating the new system would be €187 836.

DISCUSSION

The advent of needleless systems in hospitals has been accompanied by an increase in the incidence of CRBSI. This is mainly due to extraluminal contamination by skin flora and intraluminal contamination by manipulation, but these causes are modifiable.¹⁴ The present study showed that it is possible to really reduce the rate of venous access catheter colonisation. The results indicate a significant reduction of connector contamination from 43.7% to 0% ($p=0.006$) with the use of the SwabCap. One of the limitations of the study is that we did not assess the incidence of CRBSI, but it seems reasonable to assume that a reduction in the degree of catheter colonisation correlates directly with decreased infection rates, as previously described by other authors.^{15 16}

Passive disinfection systems, such as the SwabCap, could represent an effective strategy; they require no extra training of health personnel¹⁵ and are readily accepted (as shown by our satisfaction survey), only requiring a slight modification of routine practice.

A limitation of the present study is that we did not perform a cost-benefit analysis, since that would have required analysis of the potential reduction in infections, implying the use of antibiotics, hospitalisation and/or removal of reservoirs. The estimated additional cost of incorporating this system seems

Table 1 Method 1: standard disinfection without SwabCap; Method 2: passive disinfection with SwabCap

	+Growth	–Growth
Method 1	6	7
Method 2	0	16
$p=0.006$.		

affordable in the context of the annual DHOU budget. Other limitations of the present study include the fact that the colonisation rate of the catheter hub was assessed using qualitative cultures, not semiquantitative cultures as recommended by the guidelines, and for the control group we did not assess nurse adherence to recommendations on the use of alcohol-impregnated gauze when manipulating catheters. So, future studies are needed to compare the colonisation rates between the new system and the conventional hub disinfection with alcohol wipes.

In summary, we believe that the implementation of passive disinfection systems could effectively reduce the colonisation of venous access catheters without requiring large economic investment or special training of health personnel, which, according to O'Grady *et al*, is the main factor involved in the prevention of intravenous catheter-related infection.

Key messages

What is already known on this subject?

- Central line-associated bloodstream infections are a significant cause of morbidity and mortality in hospitalised patients.
- Catheter hub decontamination requires a thorough scrub and compliance varies.
- The use of continuous passive disinfection of catheter hubs reduces their contamination.

What this study adds?

- We analysed the effectiveness of a passive catheter disinfection system used in a day hospital oncology unit (DHOU) by comparing colonisation rates with our standard of care.
- We analysed the economic impact of using this new system in a DHOU.
- We assessed the degree of nursing staff satisfaction with the new system.

Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

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