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Reduction of bacterial colonization at the exit site of peripherally inserted central catheters: A comparison between chlorhexidine-releasing sponge dressings and cyano-acrylate

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Abstract

Introduction: A serious complication associated with Central Venous Access Device (CVAD) is infection because of bacterial contamination, either by the extra-luminal or by the intra-luminal route.

We evaluated the efficacy, the safety, and the cost-effectiveness of two strategies for non-inferiority in controlling bacterial colonization of the exit-site of Peripherally-Inserted Central Catheters (PICC).

Methods: After PICC placement, a skin swab of the exit site was taken and cultured. In group A the exit site was sealed with N-butyl-cyanoacrylate glue, while in group B a chlorhexidine-releasing sponge dressing was applied. A second skin culture was taken at day 7.

Results: A total of 51 patients were enrolled in each group. In 42 patients the second skin culture was not performed because of 20 patients were lost at follow-up or deceased and in 22 patients the dressing needed to be changed early, because of local bleeding (13 cases, in group B) or because of dressing detachment (four in group A and five in group B). The microbiological study was completed in 36 patients in group A and 24 in group B. No microorganisms were isolated in any patient.

Conclusions: Both strategies were effective in controlling bacterial colonization. Glue was effective in reducing local bleeding, and it was more cost-effective than sponge dressing. During the first week, when local bleeding and bacterial colonization must be prevented, glue might be more appropriate than chlorhexidine-releasing dressing; after the first week chlorhexidine-releasing dressing might be preferable, considering that the safety of glue application on the skin for prolonged periods is still questionable.

Keywords

Biopatch, chlorhexidine-releasing sponge dressing, cyanoacrylate glue, extra-luminal colonization, Peripherally Inserted Central Catheters (PICC)

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Introduction

Central Venous Access Device (CVAD) are often required for high-flow infusion, for the administration of drugs that are not compatible with the peripheral route, for repeated daily blood sampling, and/or for hemodynamic monitoring (measurement of central venous pressure or of oxygen saturation in mixed venous blood). Regardless of the type of central line—peripherally inserted central catheters (PICC), centrally inserted central catheters (CICC) or femoral inserted central catheters (FICC)—catheter-related infection is one of the most relevant complications which may occur, and it is caused by bacterial colonization of the catheter during its use.

It is widely accepted[1–4] that the main routes of bacterial contamination of any venous access device are the extraluminal route (bacterial colonization of the exit site of the catheter) and the intra-luminal route (bacteria entering the infusion line through the hubs of the catheter). During the last decades, several strategies have been adopted to minimize extraluminal bacterial contamination: proper policies of hand hygiene; optimization of skin antisepsis (i.e. use of 2% chlorhexidine in 70% isopropyl alcohol); tunneling the catheter so to move the exit site far from the puncture site; use of semipermeable transparent membranes; consistent adoption of securement with sutureless device; chronic protection of the exit site with chlorhexidine-releasing sponge dressing or with cyanoacrylate glue.

Chlorhexidine-releasing sponge dressings ensure a persistent antiseptic environment all around the exit site, and they are known to be effective in reducing the bacterial colonization and thus the risk of catheter related infections. In case of oozing or bleeding from the exit site, these sponge dressings are able—to a certain extent—to absorb blood and secretions, but they are not able to stop them. Local oozing/bleeding is not uncommon and typically occurs in the first hours or days; it is particularly frequent with venous access devices inserted by the modified Seldinger technique (PICC and Midline catheters) and in patients with abnormal coagulation (thrombocytopenia, liver disease, treatment with antiaggregant or anticoagulant drugs, etc.).

Cyanoacrylate glue is commercially available for medical purpose as butyl-cyanoacrylate, octyl-cyanoacrylate or butyl-octyl-cyanoacrylate: preliminary clinical studies[5–6] suggests its efficacy both in reducing bacterial colonization of the exit site and in stopping the local bleeding. In our center, the adoption of cyanoacrylate glue for sealing the exit site of PICCs has had a relevant impact on our clinical practice. The standard clinical recommendations suggest covering the exit site of PICCs, soon after placement, with a gauze dressing, to be replaced after 24 h with a transparent membrane. This recommendation is based on the observation that some oozing or bleeding of the exit site may occur in 40% to 50% of cases in the first 24 h; since the local presence of blood may favor bacterial colonization, it is advisable to clean it and apply the transparent dressing only when the risk of bleeding has subsided. On the other hand, when cyanoacrylate glue is applied to seal the exit site soon after placement, the risk of local bleeding is nullified, and therefore it is possible to apply directly the transparent dressing and replace it only 7 days later. Though, until now, it has been uncertain whether this strategy would also be effective in reducing bacterial colonization, in addition to the benefits of preventing dressing change and further hospital evaluation or medication.

In short, both sponge dressing and glue appear to be effective in reducing bacterial colonization at the exit site, with two different mechanisms. Sponge dressings actively release chlorhexidine, maintaining a good degree of local skin antisepsis for a full week. Glue seals the breech of the skin where the catheter exits, so to block the entrance of bacteria; furthermore, it stops local bleeding and secretions, reducing the risk of bacterial growth and this effect also seems to last at least 1 week.

In our study we compared the safety and the effectiveness of chlorhexidine-releasing sponge dressing vs. butyl-cyanoacrylate glue on the bacterial colonization of the exit site during the first week after PICC placement.

Methods

We studied all PICCs inserted by our team in a 2-month period (October–November 2019).

We enrolled adult patients candidate to PICC placement, excluding only patients with known systemic dermatologic disease, which may represent a relative contraindication to the use of either chlorhexidine-releasing sponge dressings or glue.

Patients were randomized in two groups (A and B), according to a sequential 1:1 randomization scheme.

All catheters were power injectable, polyurethane, non-valved, 4Fr single lumen or 5Fr double lumen PICCs. All of them were inserted by venous access specialist (VAS), according to the PICC insertion bundle described by GAVeCeLT[7] and currently adopted by our institution: pre-procedural scan of the veins of both arms and of the infra/supra-clavicular area; proper hand hygiene, skin antisepsis with 2% chlorhexidine in 70% isopropyl alcohol, maximal barrier precautions; choice of a vein of proper caliber (at least three times the external caliber of the catheter); identification of median nerve and brachial artery before venipuncture; ultrasound guided venipuncture by the out of plane/short-axis technique; ultrasound-based tip navigation; tip location by intracavitary electrocardiography or by trans-thoracic echocardiography; sutureless securement; protection of the exit site with a semipermeable transparent membrane.

At the end of the maneuver of PICC placement, after the placement of the sutureless device, a cutaneous swab

of the exit site was taken and sent for microbiological analysis, in all patients. Immediately after the swab, in group A we sealed the exit site with a small amount (<0.5 ml) of sterile N-butyl-cyanoacrylate glue (Histoacryl, BBraun), while in group B we applied a chlorhexidine-releasing sponge dressing (Biopatch, Ethicon) all around the catheter at the exit site. After the placement of glue or sponge dressing, a semipermeable transparent dressing was applied in all patients. In both groups, a second swab was scheduled to be repeated on day 7, during the maneuver of dressing change, before skin antisepsis.

Technique of swab culture

The cutaneous swab was obtained by rubbing the swab on the exit-site and in the surrounding area for about 1 square cm, with centrifugal movements from the center to the periphery (to avoid causing any contamination of the exit-site).

Plates containing tryptic soy agar with 5% sheep blood, chocolate agar with Polivitex and MacConkey agar (all provided by bioMérieux) were inoculated with the swabs, then incubated aerobically in ambient air enriched with 5% CO2 at 35°C and examined 24 to 48 h later; plates containing colistin–nalidixic acid agar and Schaedler agar were incubated anaerobically and examined 48 to 72 h later, for evidence of pathogenic microorganisms.

In our laboratory, species identification is performed by the matrix-assisted laser desorption/ionization time-of-flight (MALDI) mass spectrometry using the MALDI Biotyper system (Bruker Daltonics). To assess antimicrobial susceptibilities of the isolates, we determine the MICs by the VITEK® 2 system using AST cards, and results are interpreted according to EUCAST breakpoints.

Endpoints of the study

The primary endpoint of the study was to assess the safety and the efficacy of two different strategies (glue vs sponge dressing) for reducing bacterial contamination at the exit site in the first 7 days after PICC placement.

The secondary endpoint was to evaluate the incidence of other complications in the two groups: unscheduled dressing change, local bleeding, inflammation/infection of the exit site, and other catheter-related complications.

Data collection

Follow up of the patients during the first week after placement included the collection of the following data: occurrence of intraprocedural complications related to the maneuver of insertion; daily visual inspection or palpation of the dressing and of the exit site, so to detect local problems (inflammation, bleeding, etc.); incidence of unscheduled dressing change; reason for unscheduled dressing change (local bleeding; detachment of the dressing; etc.); catheter related complications (infection of the exit site; catheter-related blood stream infection; catheter dislodgment; catheter malfunction; catheter-related thrombosis; etc.); any skin abnormalities potentially related to the sponge dressing, or to the glue, or to the transparent membrane (MARSI = medical adhesive-related skin injury).

Ethics committee

The study was approved by the Ethics Committee. Informed patient consent was expressed at the same time as informed consent for the placement of the PICC.

Results

In the study period, we enrolled 102 PICCs: 51 in Group A (glue) and 51 in Group B (sponge dressing). Patients were hospitalized in different units: oncology (54%), hematology (34%), internal medicine (7%), infectious diseases (5%).

There were no intraprocedural complications.

All 102 patients had the swab taken soon after placement.

In 42 patients we were not able to take the swab at day 7, for different reasons: nine patients were lost at follow up because discharged or transferred to long-term facilities; 11 patients deceased before day 7; in 22 patients, the dressing was changed before schedule, because of local bleeding (13 cases, all in group B) or dressing detachment (four in group A and five in group B). The patients in which we completed the microbiological study were, in the end, 60, 36 in group A and 24 in group B.

No patient had local signs of inflammation or infection at the exit site during the study period.

There were no cases of catheter-related bloodstream infection or catheter-related thrombosis or catheter dislodgment or catheter malfunction. We had only one case of MARSI: mild dermatitis apparently related to the transparent dressing, since the lesion was topographically correspondent to the area covered by the membrane. No skin changes potentially related to the glue or to the sponge dressing were detected.

In all patients, no microorganisms were isolated, either in the swab performed at placement or in the swab performed on day 7.

Discussion

Cyanoacrylates are a class of synthetic glues that quickly solidify on contact with weak bases such as water and blood. Many uses of these glues are described in the medical field, ranging from the suture of wounds or surgical incisions[8] to the securement of medical devices (epidural catheters, nephrostomies, orthopedic prostheses), to the treatment of bleeding gastric varices or corneal perforations.[9,10] Wilkinson

et al.[11] were the first to describe the use of glue on venous catheters as an alternative method of securement. More recently, other reasons for using glue on the exit site of venous catheters have been identified[12–16]: its hemostatic role, particularly important when some risk of local bleeding is anticipated,[6] and its antibacterial role, since sealing the exit site provides a mechanical obstacle to bacterial invasion.[17]

The possibility of glue-related skin damage has been suggested only in patients where large amounts of glue have been applied for a prolonged time (many weeks).[18] A recent experimental study has demonstrated that cyanoacrylate glue is not associated with any catheter damage even if applied to polyurethane PICCs for prolonged periods of time.[19]

Chlorhexidine-releasing polyurethane sponge dressings have been introduced in clinical practice since more than a decade, to reduce bacterial contamination around the exit site, and thus decreasing the risk of extraluminal colonization of the venous access device. The sponge dressing continuously releases chlorhexidine gluconate[20] for 7 days around the insertion site of the catheter; it is also capable of absorbing secretions and blood up to eight times its own weight. At least eight different randomized studies have documented the safety and efficacy of these sponge dressing: their systematic use reduces the risk of catheter-related bloodstream infections by 60% and the risk of local infections by 44% if compared to traditional dressing.[21,22]

Some skin changes - dermatitis and other kinds of local skin damage - has been reported in low-weight infants and in some patients with skin disease (Stevens-Johnson syndrome, epidermolysis bullosa, graft vs host disease, burns and anasarca); this could limit their use in these populations.[23–28]

The results of our study confirm that both cyanoacrylate glue and chlorhexidine-releasing sponge dressing are effective in minimizing the bacterial colonization of the exit site during the first week after PICC placement. Also, in our population of adult patients, both strategies were safe, since we did not observe any kind of skin changes potentially related to the glue or the sponge dressing for the first 7 days of usage, although studies exclusively on animal models have demonstrated the safety of the glue applied for 8 weeks.[29]

On the other hand, while the cyanoacrylate glue was 100% effective in reducing local bleeding, the incidence of significant oozing/bleeding - severe enough to demand a dressing change - was quite high (26%) in the sponge dressing group. This accounts for better cost-effectiveness of cyanoacrylate glue. While the cost of a 0.5 ml vial of Histoacryl (N-butyl-cyanoacrylate) is almost the same of one Biopatch (chlorhexidine-releasing sponge dressing), the need of unscheduled dressing change in one-fourth of the cases is an additional and relevant cost when the glue is not used. Considering that in our hospital approximately 6000 PICC are inserted every year, not using glue would imply at least 1500 unscheduled dressing changes during the first week, which corresponds to an additional cost of about €20,000 per year.

Limitations

This is an explorative and single-center study, with a limited sample of patients. Further multi-center studies, based on a larger sample and involving a greater number of VAS, are needed to reinforce our results.

Conclusions

Our study suggests that there is no difference between butyl-cyanoacrylate and chlorhexidine-releasing sponge dressing for 7 day usage, in terms of efficacy in minimizing the bacterial colonization of the exit site, even if a considerably larger sample would be needed to reinforce such data. Also, both are safe in the adult patient.

However, there seems to be a higher risk of bleeding of the exit site and unscheduled dressing change in patients with sponge dressing versus patients with glue, and this makes a relevant difference in terms of cost-effectiveness between the two products.

Based on these findings, and considering that the long term safety of glue on the skin is still uncertain, we suggest to protect the exit site of PICC with cyanoacrylate glue in the first week after placement, and after that use of the chlorhexidine-releasing sponge dressing in the following weeks, when the risk of local bleeding is not significant.

Declaration of conflicting interests

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