

## Original Article

# Comparing Safety and Colonization Rates Between Octyl-Isocyanacrylate Glue and Standard Gauze Sponge Dressings for Patients with PICC-PORTs: A Pilot Randomized Controlled Trial

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## Abstract

**Introduction:** Bacterial colonization in patients with peripherally-inserted implantable ports (PICC-PORTs) is a serious complication that has attributable morbidity and mortality.

**Methods:** We conducted a single center randomized controlled trial comparing safety and effectiveness of octyl-isocyanacrylate glue (GLUE) and standard gauze (SG) dressings for PICC PORT placement. Block randomization was used to allocate patients into the two groups. Swab cultures of the port site were obtained at the end of the procedure and five days after device placement. We assessed the safety of GLUE vs. SG dressings and measured the rate of skin colonization between the two groups. We also estimated the feasibility for conducting a full scale clinical trial.

**Results:** Twenty six patients were randomly allocated to the GLUE group and 25 to the SG dressing group. We observed one case of localized bleeding (GLUE group). We found no cases of localized inflammation or infection at the exit site, no unscheduled dressing changes were reported, and no skin irritation related to either group. There was no difference in the rate of skin colonization post procedure or after five days ( $p=0.28$ ). Feasibility analysis showed that 98.1% of patients screened were eligible and agreed to enroll in the study and all patients received allocated treatment. Only one patient denied his/her participation in the study. There were no losses to follow up.

**Conclusions:** No difference was found in skin colonization rates between the uses of GLUE or SG dressings for PICC-PORT placement. The high eligibility, recruitment and retention rate show that a larger clinical trial would be feasible.

**Keywords:** octyl-isocyanacrylate glue, PICC-PORTs, randomized trial, safety, feasibility study

## Introduction

PICC-PORT associated blood stream infection is a concerning complication and can be caused by microorganisms that colonize and migrate from the incision site to the blood stream through which the PICC-PORT was implanted (Chen & Liang, 2022; Gao et al., 2022). The intra-luminal and the extra-luminal route (bacteria colonization of the infusion line through the catheter hubs and bacterial colonization of the exit site of the catheters respectively) are the main routes of the infection of central venous access devices such as with peripherally inserted central catheters (PICCs) and PICC-PORTs (Maki et al., 2006; Sitges-Serra, 1999).

The use of cyanoacrylate glue has been shown to be safe and effective in several clinical scenarios such as for the treatment of variceal and non-variceal gastrointestinal bleeding, portal vein embolization, fixation in laparoscopic inguinal hernia repair, and more recently, the stabilization of peripherally and centrally inserted central venous catheters (Ali et al., 2021; Chevallier, Comby, et al., 2021; Chevallier, Guillen, et al., 2021; Tavares et al., 2020; Wilkinson et al., 2007). Moreover, octyl-isocyanacrylate glue is safe and effective for closing skin incisions, and may provide several advantages including control of localized bleeding, act as a physical barrier to microorganisms, and is cosmetically appealing compared to skin sutures (Auyong et al., 2017; Chalacheewa et al., 2021; Gurnaney et al., 2011; Pittiruti et al., 2022).

Several in-vitro studies have reported potential antibacterial activity with octyl-isocyanacrylate glue, especially against Gram-positive bacteria (Bhende et al., 2002; Narang et al., 2003; Wilkinson et al., 2008). A number of studies have reported the effectiveness of cyanoacrylate glue in patients with PICCs, including reduced bleeding from exit sites, reduced local adverse reactions, and high compliance of patients and nurses (Pittiruti et al., 2012, 2016; Scoppettuolo et al., 2013, 2015). A more recent study comparing chlorhexidine-releasing sponge dressings and cyano-acrylate glue in controlling bacterial colonization and bleeding in patients with PICCs, found no microorganisms isolated in either group, and the use of glue was associated with a greater cost benefit than chlorhexidine-releasing sponge dressings (Gilardi et al., 2021).

The aim of our study was to estimate the safety and the effectiveness of octyl-isocyanacrylate

glue (GLUE) vs. SG dressings in patients requiring PICC-PORTs and to assess the feasibility of conducting a larger scale study.

## Methods

**Study design:** We conducted a pilot prospective randomized controlled trial from May 2018 to June 2021 in a public oncological hospital in Athens, Greece. All participants were patients with malignancies. We included adults aged over 18 years requiring the insertion of a PICC-PORT for treatment. The exclusion criteria were patients with a medical contraindication to the use of either GLUE or SG dressings, the presence of skin lesions at the chosen insertion site, and patients incapable of understanding the information given to provide informed consent (Figure 1).

We used the block randomization method (block size of four) to randomize patients into the two groups (GLUE vs. SG) that result in equal sample sizes (Kim & Shin, 2014).

We obtained swab cultures of the exit site at the end of each PICC-PORT insertion procedure and five days after insertion in both groups. Care and maintenance of the devices was the same in both groups and based on local organizational policies.

All catheters were polyurethane, titanium power injectable ports (P.A.S. Port<sup>®</sup>, Smiths Medical, Minneapolis USA). A protocol based ultrasound assessment method (rapid assessment of peripheral veins - RAPEVA protocol) was employed prior to catheter insertion (Alexandrou, 2019). The tip of the catheter was terminated at the cavo atrial junction using the intra cavitory ECG method (Alexandrou et al., 2022). In all cases the closure of the port pocket was performed with dissolvable subcutaneous sutures.

We collected baseline characteristics for both groups that included demographics, type of malignancy, previous chemotherapies, previous infections or thromboses, hospitalization and or intensive care admission in the previous year, any previous surgeries, and any antibiotic treatment in the preceding month from catheter insertion.

**Technique of swab culture:** A site swab was taken and colonies were identified using an automated mass spectrometry microbial identification system (Vitek<sup>®</sup> MS, bioMérieux United Kingdom). The system detects phenotypes for most aerobic, anaerobic, and

fungal microorganisms. The colonies were counted in petri dishes and bacterial density was identified using the semi quantitative method.

**Study endpoints:** The primary endpoint of the study was to assess the safety of GLUE vs. SG dressings in patients receiving a PICC-PORT. We measured the following complications in the two groups: local bleeding, local signs of inflammation or infection at the exit site, unscheduled dressing change, skin changes due to the glue or to the sponge dressing, and other catheter-related complications.

The secondary endpoints were to (a) estimate the bacterial colonization rate at the exit site post procedure and after first five days of PICC-PORT placement (stratified by frequency of colonies in a five-point ordinal scale; rare, few, several, many, and plenty colonies) and to (b) estimate the feasibility for conducting a full scale clinical trial.

**Statistical analysis:** Categorical variables are presented as numbers (percentages), while continuous variables are presented as mean (standard deviation). We used the Kolmogorov-Smirnov test and normal Q-Q plots to test the normality of the distribution of the continuous variables. We used chi-square test, Fisher's exact test and independent samples t-test to assess differences between the GLUE group and SG dressing group for baseline characteristics. The chi-square trend test was used to estimate differences in the number of colonies between the two groups after five days of PICC-PORT placement. Our sample size was based on the approach suggested by Bell et al, who proposes when future trials are designed around a small effect, the number of patients per arm for the pilot study should be 25 for 90% power (Bell et al., 2018). All tests of statistical significance were two-tailed, and p-values of less than 0.05 were considered significant. Statistical analysis was performed with the Statistical Package for Social Sciences software (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.).

**Ethical issues:** The investigators informed the patients for the study protocol. Written informed patient consent was obtained for the PICC-PORT placement and the study participation. Ethical

approval of the trial was obtained from the Ethics Committee of Department of Nursing, National and Kapodistrian University of Athens (2018/1431) and the study was conducted in accordance with the Helsinki Declaration for conducting medical research involving human subjects (World Medical Association., 2001).

## Results

Study population included 26 patients in the GLUE group and 25 patients in the SG dressing group. Baseline characteristics of the study population are shown in Table 1. There were no differences according to the baseline characteristics between the two groups. In particular, mean age of the patients in the GLUE group was 59.2 years and mean age of the patients in the SG dressing group was 55.1 years. Among females, 53.1% belonged to the GLUE group and 46.9% belonged to the SG dressing group. Only four patients had previous thromboses (one patient in the GLUE group and three patients in the SG dressing group), while eight patients were admitted to an intensive care unit within the preceding year of study enrolment (four in each group).

We observed only one case of localized bleeding among all patients (GLUE group). There were no cases of local signs of inflammation or infection at the exit site, unscheduled dressing changes, no observed skin integrity changes, or any other catheter-related complications in the two groups.

The frequency of colonies at the exit site in the first five days after PICC-PORT placement in both groups are shown in Table 2. No difference in the frequency of colonies was observed between the two groups ( $p=0.28$ ). However, the bacterial load was lower in the GLUE group compared to the SG dressing group. In particular, frequency of colonies was rare in 80.8% of patients in the GLUE group, while the respective percentage in the SG dressing group was 68%.

Feasibility analysis showed that 98.1% of patients (51 out of 52) screened were eligible and agreed to enroll in the study and all patients received allocated treatment. Only one patient denied his/her participation in the study. There were no losses to follow up.

**Table 1. Baseline characteristics of the study population.**

	Standard gauze sponge dressings group (n=25)		Octyl-isocyanacrylate glue group (n=26)		P-value
	N	%	N	%	
Gender					0.45 <sup>a</sup>
Males	8	42.1	11	57.9	
Females	17	53.1	15	46.9	
Age <sup>b</sup>	59.2	8.6	55.1	10.5	0.14 <sup>c</sup>
Malignancy					0.48 <sup>a</sup>
Breast	5	62.5	3	37.5	
Colon	7	63.6	4	36.4	
Pancreas	4	44.4	5	55.6	
Other	9	39.1	14	60.9	
Previous chemotherapies					0.18 <sup>a</sup>
No	9	64.3	5	35.7	
Yes	16	43.2	21	56.8	
Previous infections					0.30 <sup>a</sup>
No	24	48	26	52	
Yes	1	100	0	0	
Previous thromboses					0.32 <sup>a</sup>
No	24	51.1	23	48.9	
Yes	1	25	3	75	
Hospitalization during the last year					0.11 <sup>a</sup>
No	19	44.2	24	55.8	
Yes	6	75	2	25	
Intensive care unit hospitalization during the last year					0.95 <sup>d</sup>
No	21	48.8	22	51.2	
Yes	4	50	4	50	
Previous surgeries					0.08 <sup>d</sup>
No	6	31.6	13	68.4	
Yes	19	59.4	13	40.6	
Antibiotic treatment during the last month					0.27 <sup>a</sup>
No	18	45	22	55	
Yes	7	63.6	4	36.4	

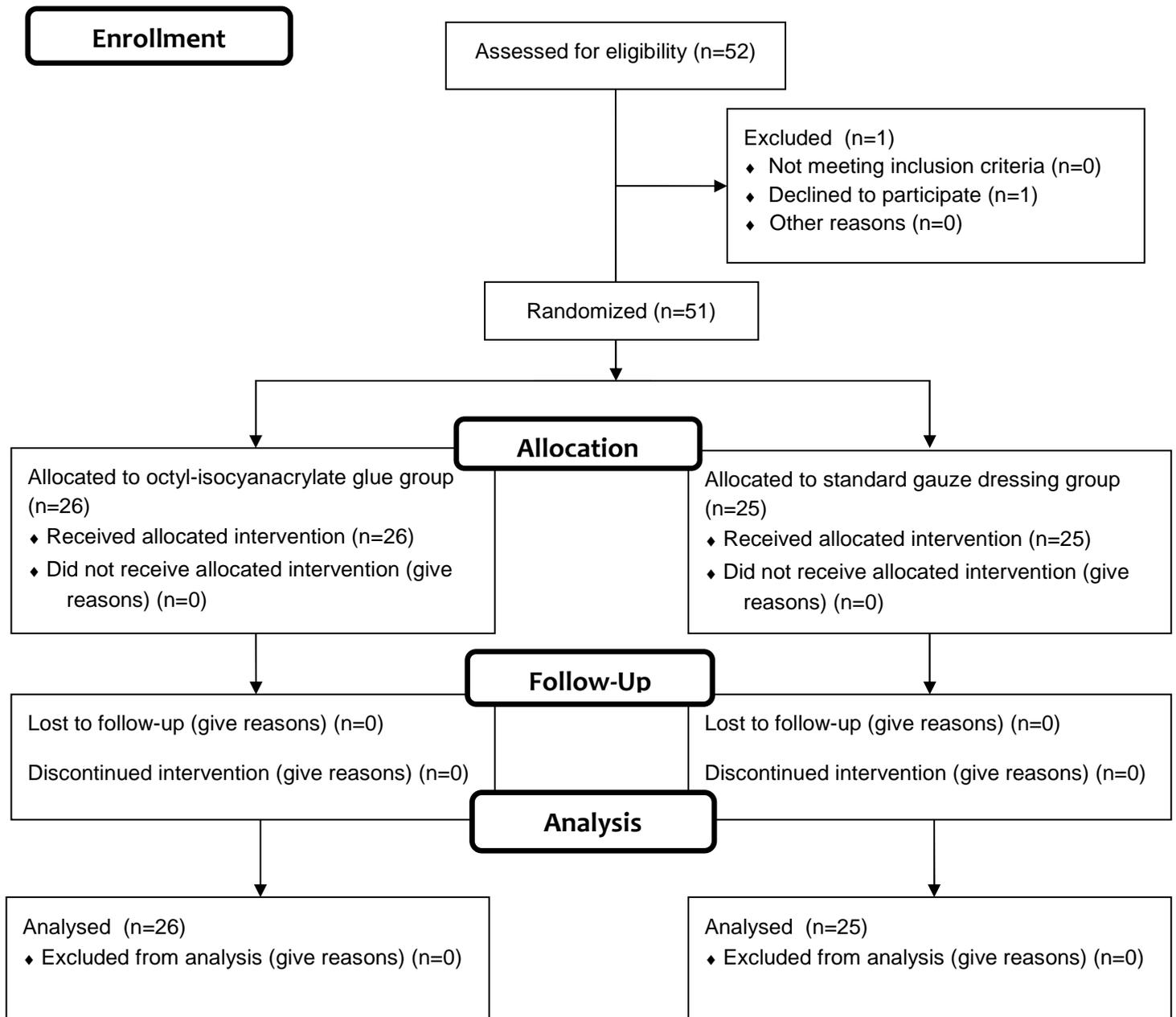
<sup>a</sup> chi-square test <sup>b</sup> mean, standard deviation <sup>c</sup> independent samples t-test <sup>d</sup> Fisher's exact test

**Table 2. Frequency of colonies at the exit site in the first five days after the PICC-PORT placement in the octyl-isocyanacrylate glue group and the standard gauze sponge dressings group.**

Group	Frequency of colonies										P-value <sup>a</sup>
	Rare		Few		Several		Many		Plenty		
	N	%	N	%	N	%	N	%	N	%	
Octyl-isocyanacrylate glue	21	80.8	0	0	3	11.5	1	3.8	1	3.8	0.28
Standard gauze sponge dressings	17	68	0	0	4	16	2	8	2	8	

<sup>a</sup> chi-square trend test

**Figure 1.** CONSORT flow diagram of the pilot randomized controlled trial.



## Discussion

We conducted a pilot randomized controlled trial to compare the safety and effectiveness of octyl-isocyanacrylate glue vs. standard gauze dressings in patients receiving a PICC-PORT. There were no differences between the two groups regarding catheter-related complications. We found no difference in the rate of skin colonization between the two groups after five days. The high eligibility, recruitment and retention rate showed that a larger clinical trial would be feasible.

Only one case of localized bleeding was observed in patients in the GLUE group. There were no cases of localized inflammation or infection at the exit site, no unscheduled dressing changes and no skin integrity changes or any other catheter-related complications in either group making the utility of GLUE feasible.

Our findings reflect and support current literature. A study with 124 PICCs in patients with malignancies found that an additional securement by cyanoacrylate glue and standard transparent dressing decreases the risk of catheter failure (Chan et al., 2017). Moreover, cyanoacrylate glue was more effective in reducing local bleeding and more cost-effective than the chlorhexidine-releasing sponge dressings in the first seven days after PICC placement (Gilardi et al., 2021). The hemostatic effect of the cyanoacrylate glue seems to be the main reason for the cost-effectiveness of glue, since it eliminates the need for dressing changes 24 hours after insertion in both peripheral and central venous catheters (Nicholson & Hill, 2019). Several other studies confirm further clinical benefits of cyanoacrylate glue in patients with PICC placement, such as reduced local adverse reactions, reduced inflammation and infection, and high compliance of patients and healthcare professionals (Pittiruti et al., 2012, 2016; Scoppettuolo et al., 2013, 2015). In general, cyanoacrylate glue is effective and cost-effective to close skin incisions, for all venous access procedures (Pittiruti et al., 2022).

Also, in our population of patients with malignancies, we did not observe any skin integrity changes due to cyanoacrylate glue or to standard gauze dressings. Gilardi et al. (Gilardi et al., 2021) support our finding in their study with a total of 102 patients (51 patients in each group) for the first week of usage. Studies on animal models also show the safety of the cyanoacrylate glue applied for eight weeks (Vanholder et al.,

1993). Moreover, an in-vitro study found that the long-term use of cyanoacrylate glue up to 12 weeks is not associated with any catheter damage (Di Puccio et al., 2018).

Overall, we found no difference in the frequency of colonies between the two groups with the density of colonies being lower in the GLUE group compared to the SG dressing group in all categories suggesting cyanoacrylate glue may have provided additional anti-microbial protection. This would support the work by Gilardi et al. (Gilardi et al., 2021) who found that both cyanoacrylate glue and was just as effective as chlorhexidine-releasing sponge dressings in controlling bacterial colonization. Several other experimental studies confirm the potential antimicrobial activity of cyanoacrylate glue (Bull et al., 2018; Prince et al., 2018; Waller et al., 2019).

**Limitations:** Our results need to be considered in the context of potential limitations, we performed a pilot, single-center study, with a limited number of patients. However, we were able to swab all 51 patients after 5 days of randomization (no loss to follow up) in our study, thus minimizing attrition bias. Further studies with larger samples should be considered to confirm our findings and a possible greater effect size. Our swabs were taken at day zero and day five after PICC-PORT placement, more studies with prolonged use of cyanoacrylate glue would also be beneficial to assess effectiveness and feasibility. Our study setting was an oncological hospital and our study population was limited to patients with malignancies, future studies comparing greater heterogeneous groups would also add value to the growing literature on this topic.

**Conclusions:** Our findings suggest that there is no difference between octyl-isocyanacrylate glue and standard gauze dressings after five days usage. Also, both strategies were proven to be safe in patients with PICC-PORT placement. Octyl-isocyanacrylate glue seems to be safe and effective but should be used in the first days after the PICC-PORT placement since the long term safety of glue on the skin is still uncertain.

## References

- Alexandrou, E. (2019). Right assessment and vein selection. In *Moureau NL. (ed) Vessel health and preservation: The right approach for vascular access* (pp. 9–22). Springer Cham.

- Alexandrou, E., Mifflin, N., McManus, C., Sou, V., Frost, S. A., Sanghavi, R., Doss, D., Pillay, S., Lawson, K., Aneman, A., Konstantinou, E., & Rickard, C. M. (2022). A randomised trial of intracavitary electrocardiography versus surface landmark measurement for central venous access device placement. *The Journal of Vascular Access*, 112972982210852. <https://doi.org/10.1177/11297298221085228>
- Ali, A., Ahle, M., Björnsson, B., & Sandström, P. (2021). Portal vein embolization with N-butyl cyanoacrylate glue is superior to other materials: A systematic review and meta-analysis. *European Radiology*, 31(8), 5464–5478. <https://doi.org/10.1007/s00330-020-07685-w>
- Auyong, D. B., Cantor, D. A., Green, C., & Hanson, N. A. (2017). The Effect of Fixation Technique on Continuous Interscalene Nerve Block Catheter Success: A Randomized, Double-Blind Trial. *Anesthesia & Analgesia*, 124(3), 959–965. <https://doi.org/10.1213/ANE.0000000000001811>
- Bell, M. L., Whitehead, A. L., & Julious, S. A. (2018). Guidance for using pilot studies to inform the design of intervention trials with continuous outcomes. *Clinical Epidemiology, Volume 10*, 153–157. <https://doi.org/10.2147/CLEP.S146397>
- Bhende, S., Rothenburger, S., Spangler, D. J., & Dito, M. (2002). In Vitro Assessment of Microbial Barrier Properties of Dermabond Topical Skin Adhesive. *Surgical Infections*, 3(3), 251–257. <https://doi.org/10.1089/109629602761624216>
- Bull, T., Corley, A., Smyth, D. J., McMillan, D. J., Dunster, K. R., & Fraser, J. F. (2018). Extracorporeal membrane oxygenation line-associated complications: In vitro testing of cyanoacrylate tissue adhesive and securement devices to prevent infection and dislodgement. *Intensive Care Medicine Experimental*, 6(1), 6. <https://doi.org/10.1186/s40635-018-0171-8>
- Chalacheewa, T., Arnuntasupakul, V., Sangkum, L., Buachai, R., & Chanvitayapongs, J. (2021). Decreasing leakage during continuous femoral nerve catheter fixation using 2-octyl cyanoacrylate glue (Dermabond®): A randomized controlled trial. *BMC Anesthesiology*, 21(1), 169. <https://doi.org/10.1186/s12871-021-01386-7>
- Chan, R. J., Northfield, S., Larsen, E., Mihala, G., Ullman, A., Hancock, P., Marsh, N., Gavin, N., Wyld, D., Allworth, A., Russell, E., Choudhury, M. A., Flynn, J., & Rickard, C. M. (2017). Central venous Access device SeCurement And Dressing Effectiveness for peripherally inserted central catheters in adult acute hospital patients (CASCADE): A pilot randomised controlled trial. *Trials*, 18(1), 458. <https://doi.org/10.1186/s13063-017-2207-x>
- Chen, X., & Liang, M. (2022). A Meta-Analysis of Incidence of Catheter-Related Bloodstream Infection with Midline Catheters and Peripherally Inserted Central Catheters. *Journal of Healthcare Engineering*, 2022, 1–8. <https://doi.org/10.1155/2022/6383777>
- Chevallier, O., Comby, P.-O., Guillen, K., Pellegrinelli, J., Mouillot, T., Falvo, N., Bardou, M., Midulla, M., Aho-Glélé, S., & Loffroy, R. (2021). Efficacy, safety and outcomes of transcatheter arterial embolization with N-butyl cyanoacrylate glue for non-variceal gastrointestinal bleeding: A systematic review and meta-analysis. *Diagnostic and Interventional Imaging*, 102(7–8), 479–487. <https://doi.org/10.1016/j.diii.2021.03.004>
- Chevallier, O., Guillen, K., Comby, P.-O., Mouillot, T., Falvo, N., Bardou, M., Midulla, M., Aho-Glélé, L.-S., & Loffroy, R. (2021). Safety, Efficacy, and Outcomes of N-Butyl Cyanoacrylate Glue Injection through the Endoscopic or Radiologic Route for Variceal Gastrointestinal Bleeding: A Systematic Review and Meta-Analysis. *Journal of Clinical Medicine*, 10(11), 2298. <https://doi.org/10.3390/jcm10112298>
- Di Puccio, F., Giacomarro, D., Mattei, L., Pittiruti, M., & Scoppettuolo, G. (2018). Experimental study on the chemico-physical interaction between a two-component cyanoacrylate glue and the material of PICCs. *The Journal of Vascular Access*, 19(1), 58–62. <https://doi.org/10.5301/jva.5000816>
- Gao, T., Zhu, X., Zeng, Q., Li, X., Luo, M., Yu, C., Hu, L., He, J., Li, Y., Yang, Z., Yang, H., Huang, X., Gu, X., & Liu, Z. (2022). Peripherally inserted central catheter-related bloodstream infections in patients with hematological malignancies: A retrospective 7-years single-center study. *American Journal of Infection Control*, S0196655322000578. <https://doi.org/10.1016/j.ajic.2022.01.016>
- Gilardi, E., Piano, A., Chellini, P., Fiori, B., Dolcetti, L., Pittiruti, M., & Scoppettuolo, G. (2021). Reduction of bacterial colonization at the exit site of peripherally inserted central catheters: A comparison between chlorhexidine-releasing sponge dressings and cyano-acrylate. *The Journal of Vascular Access*, 22(4), 597–601. <https://doi.org/10.1177/1129729820954743>
- Gurnaney, H., Kraemer, F. W., & Ganesh, A. (2011). Dermabond Decreases Pericatheter Local Anesthetic Leakage After Continuous Perineural Infusions. *Anesthesia & Analgesia*, 113(1), 206. <https://doi.org/10.1213/ANE.0b013e31821d38fb>
- Kim, J., & Shin, W. (2014). How to Do Random Allocation (Randomization). *Clinics in Orthopedic Surgery*, 6(1), 103. <https://doi.org/10.4055/cios.2014.6.1.103>
- Maki, D. G., Kluger, D. M., & Crnich, C. J. (2006). The Risk of Bloodstream Infection in Adults With Different Intravascular Devices: A Systematic Review of 200 Published Prospective Studies. *Mayo Clinic Proceedings*, 81(9), 1159–1171. <https://doi.org/10.4065/81.9.1159>

- Narang, U., Mainwaring, L., Spath, G., & Barefoot, J. (2003). In-vitro Analysis for Microbial Barrier Properties of 2-Octyl Cyanoacrylate-Derived Wound Treatment Films. *Journal of Cutaneous Medicine and Surgery*, 7(1), 13–19. <https://doi.org/10.1177/120347540300700103>
- Nicholson, J., & Hill, J. (2019). Cyanoacrylate tissue adhesive: A new tool for the vascular access toolbox. *British Journal of Nursing*, 28(19), S22–S28. <https://doi.org/10.12968/bjon.2019.28.19.S22>
- Pittiruti, M., Annetta, M. G., Marche, B., D'Andrea, V., & Scoppettuolo, G. (2022). Ten years of clinical experience with cyanoacrylate glue for venous access in a 1300-bed university hospital. *British Journal of Nursing*, 31(8), S4–S13. <https://doi.org/10.12968/bjon.2022.31.8.S4>
- Pittiruti, M., Emoli, A., & Scoppettuolo, G. (2012). Cyanoacrylate glue prevents early bleeding of the exit site after PICC placement. *The Journal of Vascular Access*, 13(2), 27A. <https://doi.org/10.5301/JVA.2012.9868>
- Pittiruti, M., Scoppettuolo, G., Emoli, A., Musarò, A., & Biasucci, D. (2016). Cyanoacrylate Glue and Central Venous Access Device Insertion. *Journal of the Association for Vascular Access*, 21(4), 249. <https://doi.org/10.1016/j.java.2016.10.026>
- Prince, D., Solanki, Z., Varughese, R., Mastej, J., & Prince, D. (2018). Antibacterial effect and proposed mechanism of action of a topical surgical adhesive. *American Journal of Infection Control*, 46(1), 26–29. <https://doi.org/10.1016/j.ajic.2017.07.008>
- Scoppettuolo, G., Annetta, M., Marano, C., Tanzarella, E., & Pittiruti, M. (2013). Cyanoacrylate glue prevents early bleeding of the exit site after CVC or PICC placement. *Critical Care*, 17(S2), P174, cc12112. <https://doi.org/10.1186/cc12112>
- Scoppettuolo, G., Dolcetti, L., Emoli, A., La Greca, A., Biasucci, D. G., & Pittiruti, M. (2015). Further benefits of cyanoacrylate glue for central venous catheterisation. *Anaesthesia*, 70(6), 758–758. <https://doi.org/10.1111/anae.13105>
- Sitges-Serra, A. (1999). *Strategies for prevention of catheter-related bloodstream infections*. 7(6), 391–395.
- Tavares, K., Mayo, J., Bogenberger, K., Davis, S. S., & Yheulon, C. (2020). Fibrin versus cyanoacrylate glue for fixation in laparoscopic inguinal hernia repair: A network meta-analysis and indirect comparison. *Hernia*, 24(5), 927–935. <https://doi.org/10.1007/s10029-019-02072-x>
- Vanholder, R., Misotten, A., Roels, H., & Matton, G. (1993). Cyanoacrylate tissue adhesive for closing skin wounds: A double blind randomized comparison with sutures. *Biomaterials*, 14(10), 737–742. [https://doi.org/10.1016/0142-9612\(93\)90037-3](https://doi.org/10.1016/0142-9612(93)90037-3)
- Waller, S. C., Anderson, D. W., Kane, B. J., & Clough, L. A. (2019). In Vitro Assessment of Microbial Barrier Properties of Cyanoacrylate Tissue Adhesives and Pressure-Sensitive Adhesives. *Surgical Infections*, 20(6), 449–452. <https://doi.org/10.1089/sur.2018.280>
- Wilkinson, J. N., Chikhani, M., Mortimer, K., & Gill, S. J. (2008). The antimicrobial effect of Histoacryl skin adhesive. *Anaesthesia*, 63(12), 1382–1384. <https://doi.org/10.1111/j.1365-2044.2008.05775.x>
- Wilkinson, J. N., Sheikh, N., & Jayamaha, J. (2007). Tissue adhesive as an alternative to sutures for securing central venous catheters. *Anaesthesia*, 62(9), 969–970. <https://doi.org/10.1111/j.1365-2044.2007.05240.x>
- World Medical Association. (2001). World Medical Association Declaration of Helsinki. Ethical principles for medical research involving human subjects. *Bulletin of the World Health Organization*, 79(4), 373–374.