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**Research Article**

# Implementation of a Package of Treatments for Peripheral Venous Catheters: An Improvement Project in Cardiac Intensive Care Unit

Serena FRASSINI[1*] Donatella GIOVANNINI[2] Ylenia ASTOLFI[3] Cindy Dolores FRASCIONE[3] Stefania RASORI[4] Nicola NARDELLA[5] Maria CAPALBO[6]

[1]Research Nurse Department of Health Professions, Ospedali Riuniti Marche Nord Piazzale Cinelli 4 zip code 61121 Pesaro (Italy)
[2]Nurse Coordinator Department of Health Professions, Ospedali Riuniti Marche Nord Piazzale Cinelli 4 zip code 61121 Pesaro (Italy)
[3]Student Nurse Università Politecnica delle Marche via Tronto, 10/a zip code 60020 Torrette di Ancona (Italy)
[4]Director of Nursing Ospedali Riuniti Marche Nord Piazzale Cinelli 4 zip code 61121 Pesaro (Italy)
[5]Medical Director-Risk Manager Ospedali Riuniti Marche Nord Piazzale Cinelli 4 zip code 61121 Pesaro (Italy)
[6]General Manager Ospedali Riuniti Marche Nord Piazzale Cinelli 4 zip code 61121 Pesaro (Italy)

*Corresponding Author
Serena FRASSINI

**Abstract:** Care bundles are cost-effective and improve performance and clinical outcomes. To improve the adherence to good practices, a bundle of peripheral venous catheter (PVC) was tested. A pilot project was carried out within an Italian public hospital. PVC bundle and a "kit" consisting of table of phlebitic medications, posters, reminder and tabs were implemented. After two months, a follow up survey was repeated. Overall 214 devices were monitored. After implementation significantly increased in both the number of PVCs used every day (56.5% vs 37.3% p = 0.005), and of those removed due to non-utilization (23.4% vs 12.1% p = 0.03). PVCs remained longer in site (Mean 3.9 vs 3.1 days p = 0.12) and phlebitic infusions decreased (12.2% vs 17.4% p = 0.28). The use of a care bundle, reminders and ad hoc nursing documentation significantly improves traceability and management of PVCs.

**Keywords:** "Patient Care Bundles"[MeSH], "Catheterization, Peripheral"[Mesh], "Quality Improvement"[Mesh].

## INTRODUCTION

Peripheral venous catheters are often considered low risk devices compared to power plants: however, their use can lead to the emersion of local systemic thrombotic and infectious events, consequently increasing morbidity and longer hospital stays. The literature reports incidence rates of PLABSI (peripheral bloodstream associated infections) ranging from 0.02 to 0.2 per 1,000 patient days (Maki, D.G. *et al.*, 2006), 0.5 per 1,000 catheter days (Mermel, L.A. 2017) and 0.18 cases / 1000 days / patient (Health Protection Surveillance Centre. 2014). Also the incidence rate of correlated CVP phlebitis varies, with data ranging from 61.2% to 1.3% (High Impact Intervention. 2011). The systematic updating of "bundles" can improve the care outcomes: the quality and quantity of scientific works produced on the subject is vast that their application must be updated today by "best practice". The phrase, “It is better than the sum of the single parts,” perfectly explains the concept of a care bundle, developed since 2001 by the Institute for Healthcare Improvement (IHI): the package is a set of evidence-based content practices generally 4-5 sets explicitly delineated are applied jointly and adequately, improve the quality and outcome of the processes, with a greater effect than if implemented separately (Pujol, M. *et al.*, 2007; Urbanetto, JDS. *et al.*, 2016). The care bundle has a great value for its innovative approach to reduce infections associated with central venous access in the intensive care units. It has gained recognition by the most important international scientific societies, such as the Society for Healthcare Epidemiology of America (SHEA), Infectious Diseases Society of America (IDSA), American Hospital Association (AHA) and Association for Professionals in Infection Control and Epidemiology (APIC) (Yokoe, D. S. *et al.*, 2014). In the United Kingdom the Agency for the modernization of the NHS (governmental body for innovation in the English Health System) strongly supports the imposition of the beams in clinical and welfare practice. Nowadays England has been at the forefront of implementing care bundles to uphold a high

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standard of good care practice (Bertoglio, S. *et al.*, 2017). A recent observational study (Duncan, M. *et al.*, 2018), conducted by a team of agents from the Misericordia Hospital in St. Louis, Missouri (USA) and published in the Journal of the Association for Vascular Access in March 2018, reports that the implementation of a bundle for the management of PVCs decreased the incidence of PLABSI (from 0.57 to 0.11 cases of infection per 1000 patient days, p <0.001). The purpose of this pilot study was to develop, introduce and implement the care bundles for the management of PVCs in an intensive care unit of the cardiology department. Our objective was to evaluate the efficiency and adherence in the application of good practices to improve performance.

**Experimental Section**

The QI pilot study was conducted by the nursing team of the Cardiac Intensive Care Unit of AORMN - Azienda Ospedali Riuniti Marche Nord in the period February-October 2018. During phase 1 (from February to July), an initial survey of CVP was carried out in use (baseline) with prospective data collection, in order to monitor the management methods and the incidence of any infectious and thrombotic complications; with the methodological support of the Research Unit belonging to the Health Professions Department, the working group found the most authoritative guidelines (Intravenous Nursing 2012; Loveday, H. P. *et al.*, 2014; & O'Grady, N.P. *et al.*, 2011), based on strong recommendations and other evidence-based secondary sources (Walaa, N.O., & Shaimaa, A.A. 2017), the bundle for the management of the PVCs (Figure 1), the other tools ("kit") were prepared and the staff had been trained for their correct use. During phase two (from August to December) the use of the tools was implemented and a second survey was carried out to assess the short-term impact on adherence to good practices. The details of the different phases is shown in Figure 2.

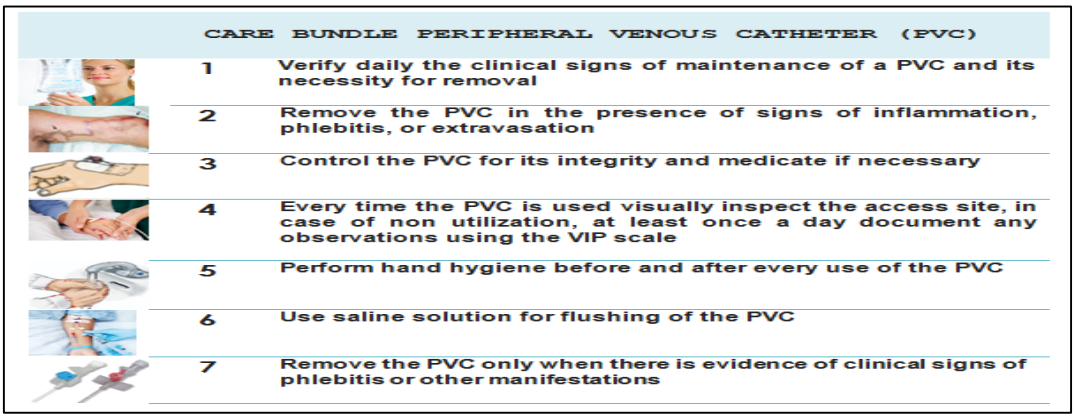



**Figure1. Care bundle**

| Time / Activity | Feb 2018 | Mar 2018 | Apr 2018 | May 2018 | Jun 2018 | Jul 2018 | Aug 2018 | Sep 2018 | Oct 2018 | Nov 2018 | Dec 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Project Review for Improvement | | | | | | | | | | | |
| Project Presentation | | | | | | | | | | | |
| Write-up of Project Monitoring | | | | | | | | | | | |
| 1st Data Collection Report | | | | | | | | | | | |
| Data Processing | | | | | | | | | | | |
| Research on Literature Reviews | | | | | | | | | | | |
| Processing on data of care bundles e "kit" | | | | | | | | | | | |
| Education on care bundle and "kit" | | | | | | | | | | | |
| Training of proper "kit" use | | | | | | | | | | | |
| Implementation of care bundle e "kit" | | | | | | | | | | | |
| 2nd Data Collection Report | | | | | | | | | | | |
| Data Processing and Discussion | | | | | | | | | | | |
| Data sharing of the results | | | | | | | | | | | |
| Defining areas of improvement | | | | | | | | | | | |

*KIT= table of phlebetic medications, "bundle" flyer, "VIP scale, reminder, nurses PVC sheet*

**Figure2. Chronogram of the project**

**DESCRIPTION OF MATERIALS**

**1. "PVC Monitoring" Report For Data Collection**. The format prepared for the pre and post- test implementation of the bundle to document, at every shift, the expiration of each device from the time of insertion to its removal: frequency, mode and solution used for flushing (saline or heparinized solution), active ingredients infused , use of the PVC for blood sampling, frequency of replacement, medication, reason for removal, and VIP score. Data collection was carried out by operating ICU nurses for all devices utilized in March (convenience sampling) and repeated in October 2018 applying the same methods.

**2. A Table of Phlebetic Active Ingredients**. List of active ingredients with pH> 600 mOsm / i pH with pH <5 or > 9 most frequently used in the ICU of Cardiology (whose peripheral infusion is strongly discouraged due to risk of phlebitis occurrence), drawn up through a research of literature and comparison with the AORMN Pharmacy Service.

**3.Vip Scale -Visual Infusion Phlebitis (Gallant, J. 2006)**. Scale also validated in Italian for the early detection of possible complications and the indication to replace or remove PVCs. The Infusion Nurses Society (INS) 15 recommends its use for the determination of the degree of phlebitis and any treatments to be implemented.

**4. Illustrative Poster Of The "Care Bundle Of The Peripheral Venous Catheter"** consisting of 7 strategies, solid in terms of scientific evidence, applicable in a systematic and contextual way: daily verification of the clinical signs of in situ maintenance of PVCs, removal of the PVC in the presence of signs of inflammation, phlebitis or extravasation, medication control, visual inspection of the insertion site, the execution of hand hygiene before and after each access to the site, the use of saline solution for flushing and finally, PVC replacement only when clinically signs were presented.

**5.PVC Documentation** sheet to track management modes at every shift (device features and insertion site, flushing frequency and mode, presence or absence of needle free connector, VIP score, substitution of the infusion line, and reason for removal) .

**6.Reminder.** Short guide to use the VIP scale and on the correct record of the nursing documentation.

The table of phlebitis, the VIP scale and the care bundle had been placed on posters in clearly visible locations such as on medication carts and in the nurses' station to serve as a prompt for continuous professional consultation.

**Statistical Analysis**

The pre-post monitoring report data was inserted into an Excel spreadsheet and statistically processed using the MedCalc statistical software (https://www.medcalc.org). Missing data have not been uploaded. The results were returned as absolute frequencies, averages, range and standard deviation, percentage values and percentage points. For the calculation of statistical significance (p value $\leq 0.05$), the Fisher Test was applied to compare the percentages and the student's t–test for the comparison between means.

**RESULTS AND DISCUSSION**

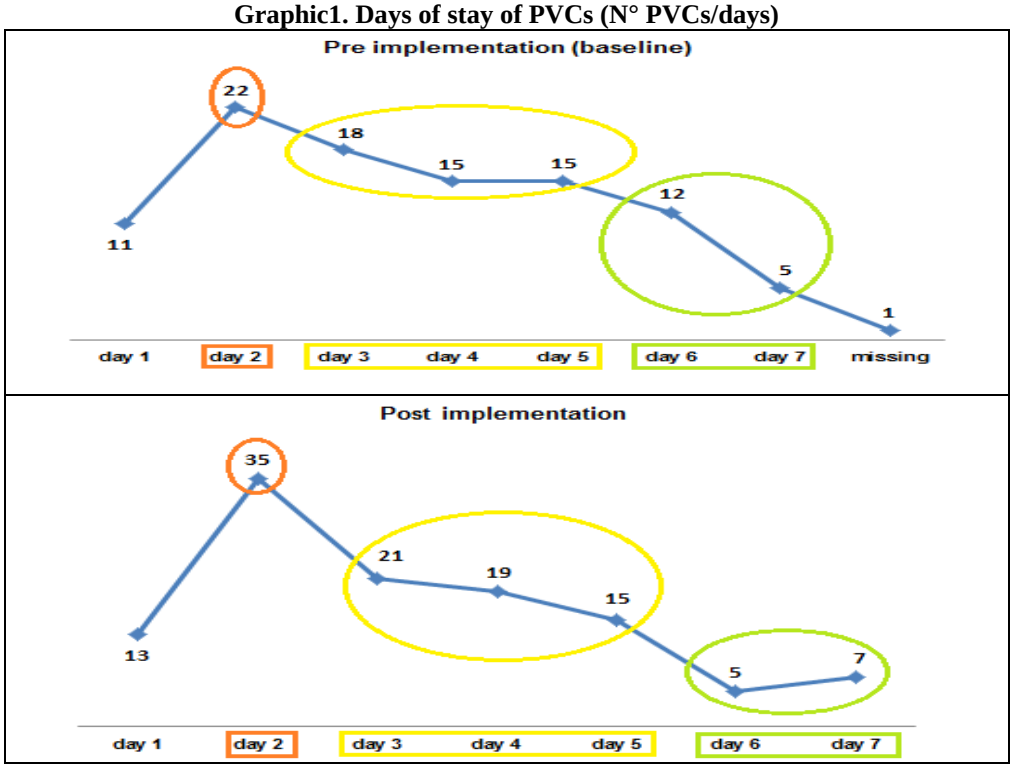
A total of 214 CVPs per 100 patients were monitored. The “pre” (baseline) survey was performed for 99 CVP and 48 patients, and the follow–up “post” survey for 115 PVC and 52 patients. Table 1 summarizes the descriptive data relating to both surveys.

**Table 1. Descriptive data on PVC surveying on the pre-posttest implementation of the care bundle**

| | | PVC pre-test (n=99) | PVC post-test (n=115) |
|---|---|---|---|
| N° of patients with a PVC n | | 48 | 52 |
| N° attempts in positioning a PVC/patient | Mean | 1.8 | 1.2 |
| N°PVC/patient Range | Mean±St.Dev., | 2.1 ±1, 1-5 | 3.3 ±1.6, 1-7 |
| N° patients /n°PVCs (%) | n | | |
| *1 PVCs* | | 11 (23%) | 19 (37%) |
| *2 PVCs* | | 23 (48%) | 20 (38%) |
| *3 PVCs* | | 11 (23%) | 7 (13%) |
| *>3 PVCs* | | 3 (6%) | 6 (12%) |

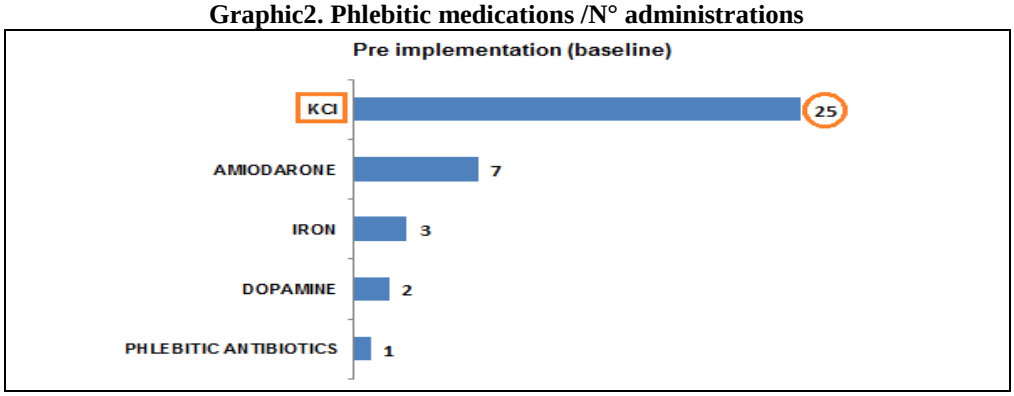
The data of the second survey showed an increase in the percentage of PVCs used daily, both for continuous and intermittent infusion therapy (65/115): 37/99 devices (37.3%) vs 65/115 (56.5%) with a statistically significant result (p = 0.005). Compared to the baseline, in the "post" the percentage of PVCs in place for a time of 4 and more days increases (22% vs 18.2%, p = 0.49). The days of stay show a similar trend in the two surveys (Graphic 1), with the peak in both for the duration of 2 days; starting from the 3rd day, the duration decreases in a superimposable way.

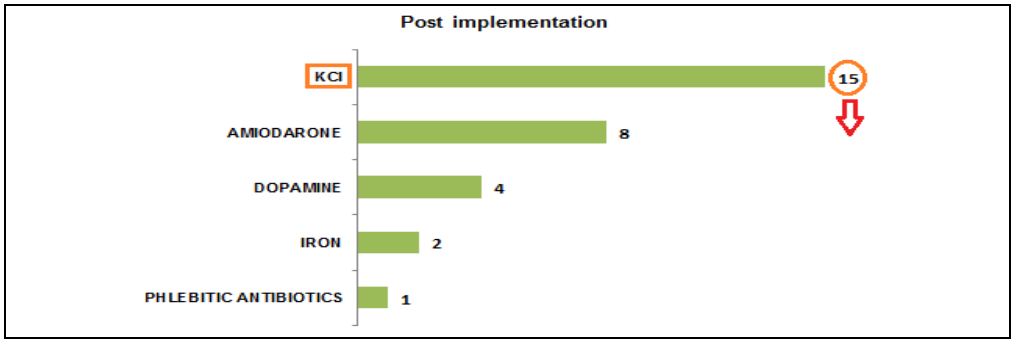
**Graphic1. Days of stay of PVCs (N° PVCs/days)**




The data of the "post" survey compared with those from baseline show a significant decrease in the percentage of potassium chloride infusions (KCl) (13% vs 25.2%, p = 0.02). See Graphic 2. The percentage data relative to the other phlebetic medications were substantially unchanged (amiodarone 6.9% vs 7.1%, dopamine 3.4% vs 2%). The percentage of administrations of phlebetic medications calculated on the total number of days of monitoring the PVCs used demonstrated a decreasing trend, despite of the short time period 12.2% vs 17.4% (p = 0.28), therefore a diminishment was obtained, albeit the time constraint.

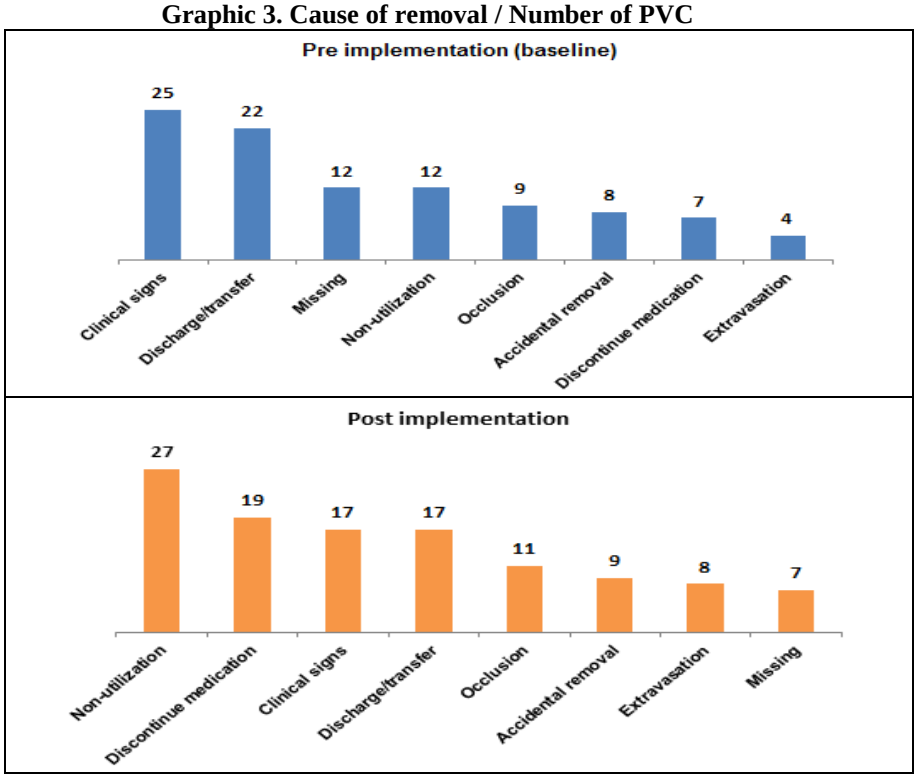
**Graphic2. Phlebitic medications /N° administrations**






The number of PVCs used at least once for blood drawing decreased (7.8% vs 10.1%, p = 0.55). In comparison to the flushing method, adherence to the bundle demonstrated maximum compliance: in the total 376 days per catheter, data shows no flushing with heparinized solution instead as replacements saline solutions were administered (baseline data: at least 1 flushing per day with a heparinized solution 32/ of 351 days of the catheter.) Regarding the removal of devices (Graphic 3), in the "post" test seventeen PVCs were removed based on "clinical signs" (VIP score ≠ 0), their survival time was in average of 3.9 days ± SD 1.9 (range 2-7) of these, 5/17 (29.4%) were infusions that contained phlebetic physicochemical properties, and the survival time of the PVCs increased for those removed with a VIP score ≠ 0, (an average 3.9 vs 3.1 days p = 0.12) but these results do not meet statistical significance. Regarding the PVCs removed for occlusion (n = 11), five (45.5%) had infused phlebetic medications; in total, eight PVCs had been used to infuse amiodarone and five were removed for VIP score between 1 and 2, values that indicate the presence of phlebitis. The study also showed an increase of the percentage of catheters removed for non-utilization is statistically significant (23.4% vs 12.1% p = 0.03), compared to baseline data.

**Graphic 3. Cause of removal / Number of PVC**




The results of the study have demonstrated the effectiveness of the bundle and other tools contained in the" kit ": the devices frequently in used increased significantly (+ 19.2 percentage points), although a modest change, survival times (+ 3.8 percentage points) resulted also positive in number for PVCs in place for a period of four days or longer. In regards to the appropriateness of their use in relation to the infused medications, a significant reduction in the administration of phlebetic physicochemical properties

through the peripheral route was discontinued, particularly potassium chloride and amiodarone: the number of infusions of phlebitis, calculated on the total of days in which the PVCs were used (- 5.2 percentage points), a default in not obtaining statistical significance for this result. The project seems to have improved the nursing team's adherence to the guidelines also for the execution of blood sampling from the peripheral route (-2.3 percentage points), (a highly discouraged practice except in the case in which it is carried out immediately after the insertion of the device) as supported by literature, it creates high rates of haemolysis). Data shows we were able to obtain discontinue use of flushing with heparin solution and have it replaced with saline, defined as "good practice" recognized by international guidelines but not yet uniformly adopted in all care contexts. The results obtained must be interpreted bearing in mind the peculiarities of the setting: patients of the Cardiac Intensive Care Unit can be carriers of two simultaneous peripheral catheters or have only one in place even in the absence of intravenous therapy, and served in case of emergency situations: hence the high number of PVCs insertions in place and its non-utilization. The main limitation of the project was the short time for implementation of the " kit ", in testing the bundle and related tools: the "post" test was conducted at a short time distance and, in all probability, the time to assimilate perfectly the indications to use the "kit" optimally was not enough for all nurses. On the other hand, the great motivation for change and the strong involvement of the nurses team allowed to bring the project to an end, despite the restricted time frame. The number of monitored PVCs made it possible to obtain statistical significance only for a fraction of the results obtained.

## CONCLUSIONS

The implementation of the Care Bundle and related tools has brought improvements both for the management and for the traceability of peripheral venous devices. By implementing multimodal strategies, which include training sessions, frequent feedback on the results obtained and user involvement through educational interventions and materials can further improve adherence to bundles and, in general, to good care practices. The pilot project provided the basis for the complete revision of our policy concerning the management of venous accesses; to complete the "kit", it could be very useful to adopt an "information sheet", or illustrated brochure, which describes the operation and care of the PVCs and fulfills the education requisite offered to patients and caregivers regarding precautions on hygiene. This has shown to provide greater control of the insertion site and the prompt reporting of any malfunctions and problems such as edema, redness or pain along the course of the vein.

**Key Points**

- Effectiveness of reminders to improve PVCs management and traceability
- The importance of raising awareness amongst medical and nursing staff to systematically avoid the infusion of potentially flebogenic active ingredients through PVCs
- Promotion and dissemination of "care bundle culture"

**Reflective Questions**

- Did we use the right criteria to judge success of our QI project? What alternatives were there?
- Could we have dealt with the situation any better in terms of organization?
- How would we conduct our QI project differently next time?

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**Declarations of Interest**:

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