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INTERVENTIONS TO DECREASE CATHETER-ASSOCIATED BLOODSTREAM INFECTIONS IN NEWBORNS: AN INTEGRATIVE REVIEW

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ABSTRACT

Objective: to perform an integrative review of strategies presented in care bundles to decrease central catheter-associated bloodstream infection among newborns.

Method: a search was conducted of the Cochrane Library, IBECS, PubMed, Lilacs, Medline and Scielo catalogues, using the terms "bundle", "catheter-related infection", "infection control", "prevention", "evidence-based nursing"," evidence-based medicine" and" central venous catheter". Inclusion criteria were: papers published from 2009 to April 2014; written in Portuguese, English or Spanish; addressing both neonatal and pediatric populations or just neonatal populations; describing the use and/or assessing care bundles or protocols to control central catheter-associated infection.

Results: fifteen studies published between 2009 and 2013 were selected. The main information extracted from the studies was systematized as: 1) measures adopted to prevent central catheter-associated bloodstream infection according to level of scientific evidence, and 2) strategies used to implement evidence into health practice.

Conclusion: there was a variety of practices adopted, some of which are consistent with scientific evidence and some of which are not. Systematization conducted in this study is expected to contribute to practice, facilitating the use of the best evidence in each context, and research indicating gaps in knowledge to be explored in future studies.

DESCRIPTORS: Catheter-related infections. Evidence-based nursing. Neonatal nursing. Patient care bundles. Catheters.

MEDIDAS PARA REDUÇÃO DE INFECÇÃO ASSOCIADA A CATETER CENTRAL EM RECÉM-NASCIDOS: REVISÃO INTEGRATIVA

RESUMO

Objetivo: realizar uma revisão integrativa sobre as estratégias presentes em *bundles* para redução de infecção de corrente sanguínea por cateter central em recém-nascidos.

Método: a busca foi realizada nas bases Biblioteca Cochrane, IBECS, PubMed, Lilacs, Medline e SciELO, utilizando-se os termos "*bundle*", "infecção associada a cateter", "controle de infecção", "prevenção", "enfermagem baseada em evidências", "medicina baseada em evidências" e "cateter venoso central". Os critérios de inclusão foram: publicações de 2009 a abril de 2014; apresentação nos idiomas português, inglês ou espanhol; estudos realizados com populações neonatais ou pediátricas e neonatais que descrevessem o uso e/ou avaliação de *bundles* ou protocolos para controle de infecção associada a cateter central.

Resultados: foram selecionados 15 estudos publicados entre 2009 e 2013. As principais informações extraídas dos estudos foram sistematizadas em 1) medidas adotadas para prevenção de infecção de corrente sanguínea por cateter central de acordo com o nível de evidência científica, e 2) estratégias utilizadas para a implementação das evidências na prática assistencial.

Conclusão: observou-se uma diversidade de práticas adotadas, tanto concordantes com as evidências científicas quanto discordantes. A sistematização realizada neste estudo pode contribuir com a prática, facilitando o emprego da melhor evidência para cada contexto, e com a pesquisa, apontando as lacunas de conhecimento para nortear futuras pesquisas.

DESCRITORES: infecções relacionadas a cateter. Enfermagem baseada em evidências. Enfermagem neonatal. Pacotes de assistência ao paciente. Cateteres.

MEDIDAS PARA LA REDUCCIÓN DE INFECCIÓN ASOCIADA A CATÉTER CENTRAL EN RECIÉN NACIDOS: REVISIÓN INTEGRATIVA

RESUMEN

Objetivo: realizar una revisión integrativa sobre las estrategias presentes en los *bundles* para la reducción de infección de corriente sanguínea por catéter central en los recién nacidos.

Método: se realizó una búsqueda en la base Cochrane Library, IBECS, PubMed, Lilacs, Medline y Scielo, el uso de los términos "*bundle*", "infección asociada a catéter", "control de infecciones", "prevención", "enfermería basada en evidencia", "medicina basada en la evidencia" y "catéter venoso central". Los criterios de inclusión fueron: publicaciones de 2009 abril de 2014; presentación en portugués, Inglés o Español; estudios en poblaciones neonatales o pediátricos y neonatales que describen el uso y/o evaluación de *bundles* o protocolos para controlar la infección asociada a catéter central.

Resultados: 15 estudios publicados fueron seleccionados entre 2009 y 2013. La principal información extraída de los estudios se sistematizaron en 1) las medidas adoptadas para la prevención de la infección del torrente sanguíneo catéter central de acuerdo con el nivel de evidencia científica, y 2) las estrategias utilizadas para la ejecución de pruebas en la práctica asistencial.

Conclusión: se observó una gran variedad de prácticas adoptadas, tanto concordantes con la evidencia científica como discordante. La sistematización en este estudio puede contribuir a la práctica, lo que facilita el uso de la mejor evidencia para cada contexto, y con la investigación, señalando las lagunas de conocimiento para guiar investigaciones futuras.

DESCRIPTORES: infecciones relacionadas con catéteres. Enfermería basada en la evidencia. Enfermería neonatal., Paquetes de atención al paciente. Catéteres.

INTRODUCTION

Primary bloodstream infections (BSI) are among the most common healthcare-associated infections. Approximately 60% of bacteremia existing in hospital settings are estimated to be associated with some intravascular device.[1] Even though central venous catheters (CVC) are an essential resource to enable necessary therapy, they are also known to be one of the primary risk factors for BSI.[1]

Central venous catheter-associated blood stream infections (CVC-BSI) occur when a microorganism that is present in the site of insertion reaches the blood stream, resulting in bacteremia, which when not contained, causes infection with sepsis, severely compromising a patient's clinical state.[1] The etiology of infection should be attributed to the catheter when there is no apparent primary infectious focus and when cultures of blood and the catheter tip, collected after 48 hours of hospitalization, result in the growth of the same infectious agent.[1] If association between catheter and blood infection is not confirmed by laboratorial tests, but a CVC is the most probable cause of infection, it is defined as CVC-BSI.[1]

CVCs are an integral part of the care provided in Neonatal Intensive Care Units (NICU), as they enable hemodynamic monitoring, hydration, and the administration of medication. Central lines, however, break the skin's integrity so that there is the risk of infections caused by bacteria and/or fungi.[2]

Healthcare-associated infections are one of the primary problems faced among newborns under intensive care – a population with characteristics that are not observed in any group of patients in the different periods of life. The increased susceptibility of newborns to infection is related to the immunological system's deficiencies and fragile skin and mucosa barriers.[1]

Studies report that mortality caused by BSI range from 15% to 35% in both ill adults and newborns, from 24% in the pre-surfactant era and 11% in the post-surfactant era.[3]

Given the negative impact of mortality and morbidity related to these infections and the cost caused by them, the clinical and scientific community has sought strategies to change this context by developing and disseminating protocols, guidelines and, more recently, care bundles in order to systematize the best-known practices to prevent CVC-BSI. The Institute for Healthcare Improvement developed the concept of care bundles, a package composed of a small set of practices that arguably improved the outcomes of healthcare, considering that, these practices lead to better outcomes when concomitantly implemented than when implemented individually.[4]

Even though the efficacy of care bundles is increasingly supported by various studies[4-17] and by the Centers for Disease Control and Prevention (CDC),[2] it is important to stress that the involvement of the entire multi-disciplinary team is key for successful actions and improved quality of care delivery. In this sense, the successful implementation of these actions, as well as the process of quality improvement as a whole, requires the entire staff to be engaged.[4]

Given the particularities of the neonatal population and the specific care required by those using CVCs, this study's aim was to perform an

integrative literature review concerning the strategies presented in care bundles to decrease CVC-BSI among newborns.

METHOD

This is an integrative literature review, a design that permits bringing scientific evidence to clinical practice and includes studies with different designs.[18] The following stages were adopted: identification of topic; establishment of guiding question; establishment of inclusion and exclusion criteria; definition of information to be extracted from the selected studies; critical assessment of studies; and interpretation of results.[18]

The search was conducted from March to April 2014, in the Cochrane Library, IBECS, PubMed, Lilacs, Medline and SciELO databases, using the terms "bundle", "catheter-related infections", "infection control", "prevention", evidence-based nursing", "evidence-based medicine" and "central venous catheter".

In the first stage, we adopted the strategy of using each descriptor in isolation, associating each to filters available in the Virtual Health Library, such as year of publication and language. The titles of papers, respective abstracts and keywords were read in order to select the ones that indicated the use and/or assessment of strategies to control CVC-BSI. The following exclusion criteria were adopted: diagnostic studies; studies addressing adults; experiments with skin antisepsis agents; and studies addressing hemodialysis catheters. Papers that were unavailable otherwise were requested from the authors and, after accessing the initially unavailable papers, the snowball method was used, through which another five papers that met inclusion criteria were selected. After this first selection, papers that did not address neonatal populations, that is, those papers that exclusively assessed pediatric patients, were excluded.

Finally, inclusion criteria were: papers published from 2009 to April 2014; available online or provided by authors after request; written in Portuguese, English or Spanish; studies addressing neonatal population or both pediatric and neonatal populations; describing the use and/or assessing care bundles or protocols to control CVC-BSI and evidencing it in the title, abstract and/or descriptors; regardless of study design.

The flowchart (Figure 1) presents the search stages and number of selected papers.

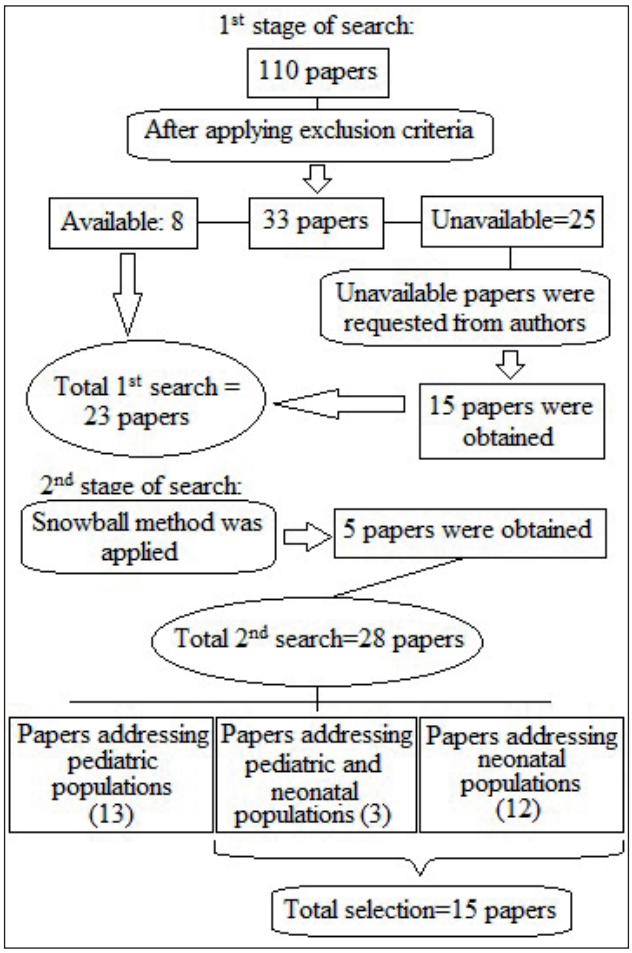

Figure 1 – Flowchart concerning the selection of papers

Evidence found in the studies categorized according to the CDC's guidelines:[2]

- Category IA: strongly recommended for implementation and strongly supported by well-designed experiments, clinical or epidemiological studies.

- Category IB: strongly recommended for implementation and supported by experiments, clinical or epidemiological studies with strong theoretical foundation; or accepted practice, though supported by limited evidence.

- Category IC: required by state or federal regulation, rules or standards.

- Category II: suggested for implementation supported by the clinical experience of experts in the field, epidemiological studies or theoretical foundation.

RESULTS

Fourteen of the 15 papers selected were written in English[9-11,19-29] (93.3%); only one was in Spanish;[30] none were written in Portuguese. In regard to the year of publication, the papers were mainly published in 2011,[9,19-20,24,26-27] 40% of the total, followed by 26.6% of the papers published in 2009.[22-23,28,30] In regard to the papers' specific fields, three (20%) addressed catheters both in pediatric and neonatal populations,[11,20,30] and the other 12[9-10,19,21-27-29] (80%) papers included only neonatal populations. Papers that only included pediatric populations were excluded in the final selection.

In terms of design, before and after interventions[19,24,29-30] (26.6%) and reviews[21-23,28] (26.6%) predominated, representing 53.2% of the sample. There were also three cohort studies,[9-10,27] two time-series studies,[11,26] one retrospective intervention study,[20] and one exploratory study.[25]

The main information extracted from the studies is distributed between: 1) measures adopted to prevent CVC-BSI according to level of evidence (Tables 1 and 2); and 2) strategies used to implement evidence into care practice (Table 3).

Table 1 – Scientific evidence to prevent central venous catheter-associated blood stream infections in children and newborns, published between 2009 and 2013. Londrina, Paraná, Brazil, 2014

Scientific evidence	Level
Placement of Central Venous Catheter	
Hand hygiene[9-10,19-20,22-24,26-27,29]	IA*
Maximal barriers during central venous catheter insertion[9,19-20,22-24,26, 29]	IA*
Skin cleansing with chlorhexidine at 0.2% and air drying[9-10,21,24, 29]	IA*
Keep preassembled insertion kits [9-10,20,23,26]	IB†
Establish a team with special training to exclusively provide care for the placement and maintenance of central lines[10,21,23,25]	IB†
Central Venous Catheter Maintenance	
Hand hygiene [9-10,19-20,22-24,26-27, 29]	IA*
Using sterile transparent semipermeable dressing or sterile gauze[9,22-23,27]	IA*
Dressing: rubbing the catheter site with chlorhexidine, alcohol at 70% or povidone-iodine and letting it air dry[9,23,26]	IA*
Rubbing the infusion system with alcohol or clorexidine[9,23,30]	IA*
Minimize infusions and multiple access routes[21-22]	IA*
Add 0.5ml of heparin in the total parenteral nutrition[21]	IA*
Change infusion systems after 96 hours or before if there is blood or suspicion of infection[25]	IA*
Daily assess the need to keep catheter[9,19-20,22-23,26,29]	IB†
Daily observe signs of infection on the catheter site and the aspect of dressing[9-10,23,26]	IB†
Change dressing if dirty, wet, loose or constricting[10,21,25]	IB†
Standardize aseptic placement and change of infusion systems[9,22- 24,30]	IB†
Use a sponge impregnated with chlorhexidine on the insertion site at every change of dressing[20,22]	IB†
Dressing: change gauze every two days or before if dirty, wet or loose[20,25]	II‡
Keep the infusion system closed/use closed infusion system[10,23,25,27,30]	II‡

*Strongly recommended for implementation and strongly supported by well-designed experiments, clinical or epidemiological studies; †Strongly recommended for implementation and supported by experiments, clinical or epidemiological studies with strong theoretical foundation; or accepted practice, though supported by limited evidence; ‡Suggested for implementation supported by the clinical experience of experts in the field, epidemiological studies or theoretical foundation.

Table 2 – Non-evidence-based recommendations to prevent central venous catheter-associated blood stream infections among children and newborns published between 2009 and 2013. Londrina, Paraná, Brazil. 2014

Intervention	Level
Rub the injector with chlorhexidine for different durations established for rubbing and drying[22,24-25]	--
Use of glove procedure every time catheter is manipulated[20,23]	--
Use sterile glove and mask to change sterile dressing[23-24]	--
Use double or three-lumen catheters to ensure there is one that is exclusive to parenteral nutrition[24]	--
Promote enteral nutrition to remove the central venous catheter early on[27]	--
Avoid the use of dyed/colored solutions on stumps that may received a catheter later[10]	--
Insert umbilical catheters in pairs to checklist the catheter insertion[10]	--
Not placing patients with umbilical catheter in the prone positon[10]	--
Changes of fluids and infusions of umbilical catheters made by a medical staff[10]	--
Dressings: use preassembled dressing kits[20]	--
Flush syringes are single use only[23]	--
Use clean gloves to check the system if not using a closed system[26]	--
Use sterile gloves to setup a closed system and at least clean gloves to install it[26]	--
Use flush syringes previously aspired by the manufacturer or in the pharmacy using sterile technique[26]	--
Comply with diagnostic criteria and measurement standards for nosocomial infections[27]	--
Identify the catheter with date of insertion and infusion system and connections with the date they were changed[30]	--
Avoid femoral site if possible/standardize the insertion sites[10,19, 29]	≠
Clean the stump or site of the peripherally inserted central catheter with iodine-based solution[10]	≠
Dressing: change transparent dressings every seven days or before if dirty, wet or loose[22]	≠
Change infusion systems within an interval between 72 and 96 hours, or before if there is blood or suspicion of infection[30]	≠

--: Non-evidence-based intervention; ≠: Intervention disagrees with evidence-based recommendation.

Table 3 – Strategies to implement evidence into central venous catheter-associated blood stream infections prevention among children and newborns published between 2009 and 2014. Londrina, Paraná, Brazil, 2014

Strategies
Education/training/workshops on the central venous catheter-associated blood stream infections concept[9-10,19,23-24,26-27-29]
Meetings with the staff/teleconferences[9,19-20,23,26,28-29]
Discussing infection rates in the unit[19-20,24,26, 28-29]
Daily checklists to verify bundles compliance[9 -10,20,23,28]
Feedback to the team concerning performance of bundles[19-20,23-24,28-29]
Use of posters/reminders[19-20,23-24,28-29]
Establish one or more leaders to prevent central venous catheter-associated blood stream infections[19,23-24,29]
Goals to decrease infection rates and improve adherence to bundles[20,26]
Autonomy to interrupt the insertion procedure if the team fails to observe any of a bundle's items[11,26]
Anonymous and random nursing auditing[24]
Applying tests or quizzes for the team[20]
Provide training to workers[20]
Ensure there is one antisepsis dispenser in every bed[24]
Prohibit accessories below elbow, including sleeves and long nails[24]
Establish a competition among employees to encourage their participation in the process[24]
Promote commemorative celebrations on the project's aniversaries[24]
Update practices by email and provide printed copies to staff[24]
Visit facilities with good practices and rates[23]
Involve other sectors that also use catheters (e.g., anesthesiology and radiology) [23]
Disseminate guidelines and tools[27]

DISCUSSION

The use of evidence-based practice can be encouraged. Up to 70% of the four million children who die every year who are still in the neonatal period could be saved if evidence-based practice were used, especially in the delivery of nursing care.[31]

In theory, care bundles intended to improve care delivery propose the adoption of the best evidence-based practices. In this review, however, even though most of the interventions employing care bundles were based on evidence-based practices, non-evidence-based recommendations were also found, while some of these recommendations diverge from already established evidence.

The 20 recommendations identified in care bundles not categorized with any level of evidence, presented in Table 2, in general represent particular measures adopted to decrease infection rates in diverse services. When not diverging from the already scientifically established evidence, they are not inappropriate *per se*, however they do not fit the bundle concept, i.e., a package of measures, the efficiency of which in improving practice is related to the rigor with which evidence was selected.[4]

Already established care procedures concerning the insertion of catheters were: hand hygiene; the use of maximal sterile barriers; cleansing skin with chlorhexidine at 0.2% and letting it air dry; keeping preassembled insertion kits; and having staff with special training based on evidence levels between IA and IB, used in various studies, exclusively regarding inserting and maintaining central lines.[9,19-27]

Fourteen examples of evidence were included in the bundles presented in the papers in regard to the maintenance of catheters, the most frequent being: hand hygiene; the use of sterile, transparent and semipermeable dressing or sterile gauze; daily assessing the need to the keep the catheter; daily examining for signs of infection at the site of insertion and also the aspect of the dressing; changing the dressing if dirty, wet or loose; standardizing the aseptic insertion and change infusion systems; and using a closed infusion system.

The recommendation to use a sponge impregnated with chlorhexidine on the insertion site whenever dressings are changed is classified by CDC as evidence level IB[2] and was observed in two studies.[20,22] It is, however, a procedure to be implemented in patients older than two months of age, if CVC-BSI is not receding with the adoption of basic preventive measures.[2] One of the two studies reporting adherence to this recommendation[20] was correct because care bundles were implemented both in neonatal and pediatric units. The other study,[22] however, recommended this procedure only in NICUs, which is inappropriate for this population.

In terms of gaps in knowledge, the time necessary for letting antisepsis agents dry on the skin has not yet been investigated, therefore, recommendations establishing such an interval of time, which in the studies ranged between 15 seconds and 1 minute, were considered as having "no level of evidence".[10,20]

Likewise, there is no scientific evidence establishing what length of time spent rubbing is sufficient or ideal to sterilize catheters' lateral injectors or connections, though the recommendation to rub with alcohol at 70% or alcoholic chlorhexidine, without an established period of time, is acknowledged as evidence level IA.[2]

Another gap is the type of chlorhexidine solution to be used with extremely preterm newborns, a population vulnerable to skin lesions, especially when alcoholic solutions are used. Since 2012, the Food and Drug Administration (FDA) reported increased chlorhexidine experience and safety concerns and recommends caution when using it on infants younger than two months of age,[13] but does not mention whether alcoholic or aqueous means would be recommended.

There were four recommendations diverging from what have been already scientifically established. One study[10] recommended cleaning stumps or the site of peripherally inserted central catheter (PICC) with an iodine-based solution, but there is a recommendation that has already been established to use chlorhexidine at 0.2%, especially with newborns.[2,9,19,22-23,26] Two studies[10,19] adopted the recommendation that is valid for adults, that of avoiding the femoral site, while there is evidence of level II that in children, both upper and lower limbs or the scalp can be used to insert a CVC.[2] Another study[22] recommended in a bundle that transparent dressings should be changed every seven days or before if dirty, wet or loose, when there is recommendation recognized to be level IB that changes in newborns not be performed at pre-established intervals.[2,9-10,23,25] Finally, another disagreement was found in regard to the frequency with which infusion systems should be changed. The standardized recommendation is 96 hours,[2,15,25] but one of the studies[30] established an "interval between 72 and 96 hours".

Much effort has been expended to encourage health workers to commit to evidence-based practice, with the acknowledgement that the de-

velopment and mere dissemination of systematic reviews and guidelines is not sufficient to ensure its implementation.

In view of this, another factor observed in these studies were the strategies described to implement these care bundles. According to the science of implementation, verifying the effectiveness of each type of strategy is essential[28] to supporting efforts to improve care practices. Twenty different strategies to implement and maintain care bundles were mentioned in the studies under analysis. The ones most frequently mentioned were educational interventions and trainings, meetings with the staff/teleconferences, discussing infection rates in the unit, daily use of checklists, feedback to the staff concerning compliance with bundles, and the use of posters and reminders.

The various different practices related to the prevention of CVC-BSI became apparent. Some bundles even proposed measures that diverged from recommendations, the efficacy of which had already been established and acknowledged by the scientific community. Hence, institutions need to appropriate better evidence, standardizing their practices according to what has been established as efficacious in CVC-BSI prevention.

There is a large number of terms used in the literature to name the process of applying knowledge to practice, including "use of knowledge", "knowledge transfer", "evidence-based practice", and "diffusion of innovation".[31] Some factors seem to favor this process, such as: facilitating roles that actively promote the use of research in an institution; establishing bonds with researchers and trendsetters outside of the organization; developing a technical infrastructure that enables access to scientific evidence, such as databases and libraries; and maintaining training programs to promote the staff's constant improvement and the updating of their training.[32] The fact is that, even though there are many and different interventions for implementation, there are no evidence-based recommendations regarding the use of a specific intervention to support implementation in a given setting.[31]

Besides the selection of high-level evidence to compose bundles and the adoption of implementation strategies that are efficacious and appropriate for each context of care delivery, there is a need to carefully assess results. The use of clinical indicators of quality in CVC care protocols favors the identification not only of indices concerning compliance and performance of such care, but also the identification of concrete situations interfering in the results, enabling direct and specific interventions to improve them.[30,33] Even though clinical indicators of performance related to CVCs were not the object of analysis in this study, they should be considered an important tool to assess and support the use of care bundles to prevent CVC-BSI.

CONCLUSION

This review's results present the existence of strong evidence to base care related to the insertion and maintenance of CVCs in newborns. On the other hand, the findings also reveal different practices that have been adopted in bundles and protocols, some of which even disagree with established scientific evidence.

There are a large number of strategies intended to engage and ensure collective participation of the staff, but a considerable gap of knowledge still persists regarding what is the most efficient and best strategy for each context, considering that it is a very complex task. Filling in the gap between what scientific research has proven to be efficacious and what care practice has actually provided to patients seems to be a considerable challenge.

This integrative review indicates gaps of knowledge to be explored in future studies and is also expected to contribute to the systematization of evidence and facilitate the use of the best evidence for each context.

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