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ASSESSMENT OF EFFECTIVENESS AND SAFETY OF MAINTAINING CENTRAL VENOUS CATHETER (CVC) IN PAEDIATRIC PATIENTS OUTSIDE AN INTENSIVE CARE UNIT

Ocena skuteczności i bezpieczeństwa utrzymania centralnego cewnika żylnego (CVC) u pacjentów pediatrycznych poza oddziałem intensywnej terapii

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A - Koncepcja i projekt badania, B - Gromadzenie i/lub zestawianie danych, C - Analiza i interpretacja danych, D - Napisanie artykułu, E - Krytyczne zrecenzowanie artykułu, F - Zatwierdzenie ostatecznej wersji artykułu

Abstract (in Polish):

Cel pracy

Celem badania była ocena skuteczności i bezpieczeństwa podtrzymywania centralny cewnik żylny u pacjentów pediatrycznych z zaburzeniami układu nerwowego przebywających poza oddziałem intensywnej terapii.

Materiał i metody
Na potrzeby badań wykorzystano analizę dokumentacji medycznej. Przeanalizowano dokumentację 100 pacjentów centralnym cenikiem żylnym, za okres od 2016 do 2018 roku w grupie pacjentów pediatrycznych.

Wyniki
Głównymi wskazaniami do implantacji CVC są trudne żyły obwodowe i przedłużona farmakoterapia. Wielokrotne kaniulacje żył obwodowych są zarówno bolesne, jak i stresujące. Główną przyczyną hospitalizacji badanej grupy były zaburzenia ośrodkowego układu nerwowego wymagające leczenia operacyjnego. Wskazaniem do cewnikowania centralnego (CVC) są przededwszystkim trudne żyły obwodowe. Najczęstszym powikłaniem było zaczerwienienie w miejscu wprowadzenia. W wyniku badań wykazano korelację pomiędzy wiekiem pacjenta pediatrycznego a trudnymi żyłami u tyc dzieci oraz między schorzeniem dziecka a brakiem możliwości kaniulacji żył obwodowych. Czas trwania CVC nie był związany z długością hospitalizacji dziecka w szptalu

Wnioski
Ścisła kontrola i monitorowanie CVC pozwala na jego bezpieczne utrzymanie u pacjentów pediatrycznych wymagających długotrwałej farmakoterapii poza oddziałem intensywnej terapii. Dzięki codziennej ocenie miejsca wszczepienia linii centralnej można uniknąć groźnych powikłań infekcyjnych związanych z cewnikiem żylnym, które wydłużają hospitalizację. Wskazania do pozostawienia CVC powinny być precyzyjne, a linię centralną należy usunąć, gdy nie ma już wskazań do jej zastosowania.

Abstract (in English):
Aim
Assessment of the effectiveness and safety of CVC maintenance in pediatric patients with nervous system disorders outside the ICU in a pediatric hospital

Material and methods
Medical documentation analysis has been used for the purposes of this research. Documentation of 100 CVC patients has been analysed for the period from 2016 to 2018 in the paediatric patient group.

Results
The main indications for CVC implantation are difficult peripheral veins and prolonged drug therapy. Multiple peripheral venous cannulations are both painful and stressful. The main reason for the hospitalization of the study group was central nervous system disorders requiring surgery. An indication for CVC - difficult peripheral veins. The most common complication was redness at the insertion site. There was a correlation between the patient's age and difficult veins, and between the disease and the inability to cannulate peripheral veins. The duration of CVC was not related to the length of hospitalization.

Conclusions
Strict control and monitoring of CVC allows to maintain it safely in paediatric patients requiring lengthy pharmacotherapy outside an intensive care unit. Due to everyday assessment of the site of central line implantation it is possible to avoid dangerous infectious complications related to a venous catheter, which prolong hospitalisation. Indications for CVC to remain in place should be precise and the central line should be removed as soon as there are no longer any indications for its use.

Keywords (in Polish): pacjent pediatryczny, OIT, centralny cewnik żylny.

Keywords (in English): ICU, pediatric patients, central venous catheter.

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Short title
Utrzymania CVC u pacjentów pediatrycznych poza OIT

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Authors (short)
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We tend to associate short-term catheters in a central vain with intensive care unit patients, who all have them implanted. This is also where all the attention as to correct procedures and catheter-related infection prevention goes. However, it is important to remember that central venous catheter (CVC) is also used in patients outside the intensive care unit. Catheter implementation consists in placing the catheter in a central vein of the circulatory system. In case of a paediatric patient a catheter may be placed inside an internal jugular vein, a subclavian vein or a femoral vein. Indications for CVC implementation are such as lack of possibility to cannulate peripheral veins, delivery of medications from the catecholamine group, prolonged intravenous therapies, hemodynamic monitoring, and treatment of various traumas. [3,4,7,9] Implantation and maintaining of CVC may be related to various complications, especially septic ones.[9] In young patients accessing blood vessels is a real challenge. Nursing staff taking care of patients with implanted CVC should have extensive knowledge on CVC and blood vessels' care, especially in terms of following the rules of aseptic technique. They should also watch the patients closely for complications and be able to take the right decisions. Improving the results of central venous catheter care should be based on the rules of best practice which should be implemented in everyday care for CVC patients. Minimalization of complications and the time necessary to maintain the cannula depend on the high level of competence of nurses that directly care for the patients. In case of a trauma unit which does not meet the criteria of an intensive care unit, this is especially difficult. The unit at which the research has been held was newly opened and right from the beginning the so-called central line bundle has been introduced there, specifying the rules concerning maintenance of an implanted catheter. [8] These guidelines most of all emphasise the role of systematic staff training and periodical

check if the procedures are being followed [1,3,4,5,9]. The central line bundle includes 6 standards which describe correct procedures:

1. Appropriate hand hygiene
2. Maximum barrier precautions while implanting the venous access
3. Use of alcohol-based skin antisepsis
4. Optimal catheter site selection
5. Daily review of the catheter site and assessment of line necessity.
6. Documentation [1,3,4,5,6,9]

The purpose of the work

The aim of the research was to assess the effectiveness and safety of maintaining CVC in paediatric patients with nervous system disorders, who are staying outside the intensive care unit.

Research methods, techniques and tools

The research is based on a medical documentation review method and on a statistical analysis. The study includes a sample of 100 children, aged 0 to 18, with implanted CVC. The research was carried out from October 2016 to December 2018.

Statistical analysis

Statistical analyses of the results were conducted with the use of statistical and analytical software STATISTICA 10.0 PL (Dell Inc. (2016). Dell Statistica (data analysis software system), version 13. software.dell.com) and SPSS Statistics (Statistical Package for the Social Sciences Statistics) ver. 26, by IBM. For conducting statistical analysis Pearson's chi-squared test (χ^2) of independence was used when the variables were compared, and Cramér's V analysis was used for contingency tables and assessing the correlation. During the statistical verification of the collected material, the p-value for the significance of the results was $p<0.05$. In the tables with Pearson's chi-squared test results, apart from the frequency distribution, the test result was included, with the following meaning: *χ2* – test value; *df* – degrees of freedom; *p* – significance level for the above test value. In the tables with the results of Spearman's rank correlation coefficient, apart from frequency distribution, the results have the following meaning: *rho* – correlation coefficient value; *p* – significance level for the above coefficient value.

Results

The research was carried out on 100 paediatric patients with implanted CVC, which constituted 3.1% of all the patients hospitalised in that period in the unit. The studied group was divided according to age. The biggest group of CVC patients were patients aged 11-15 years (20%), then 7-12 months (17%) and over 15 years (15%). The least numerous were patients under 28 days of age (7%).

When it comes to the reasons for hospitalisation of patients in the studied group, a substantial majority were patients with central nervous system disorders (35%), followed by patients with congenital defects (32%), and traumatic brain injuries (25%).

A vast majority of all the patients required surgical treatment (Fig.3).

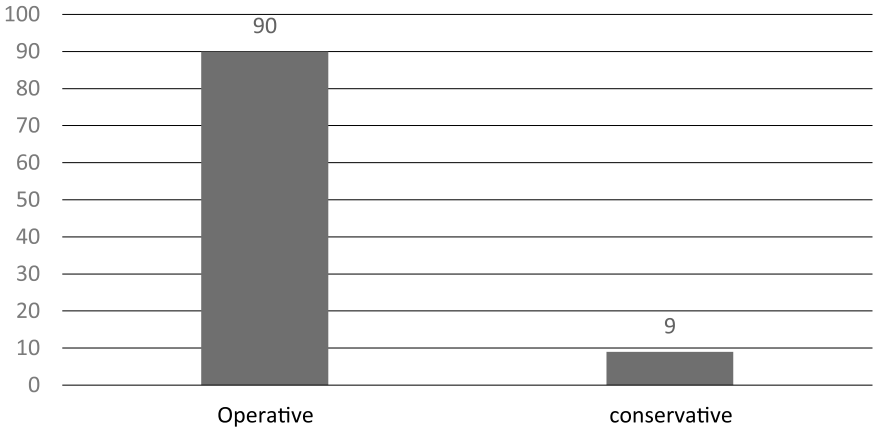

Fig. 1. Type of treatment

The length of patients' stay in the hospital ranged from several days to a dozen or so weeks (Fig. 4). The largest group of patients spent 14-30 days (41%) in the hospital, then the duration of stay was 7-14 days (23%), 30-45 days (14%), up to 7 days (5%). In the studied group 8% of patients stayed in the hospital for over 45 days.

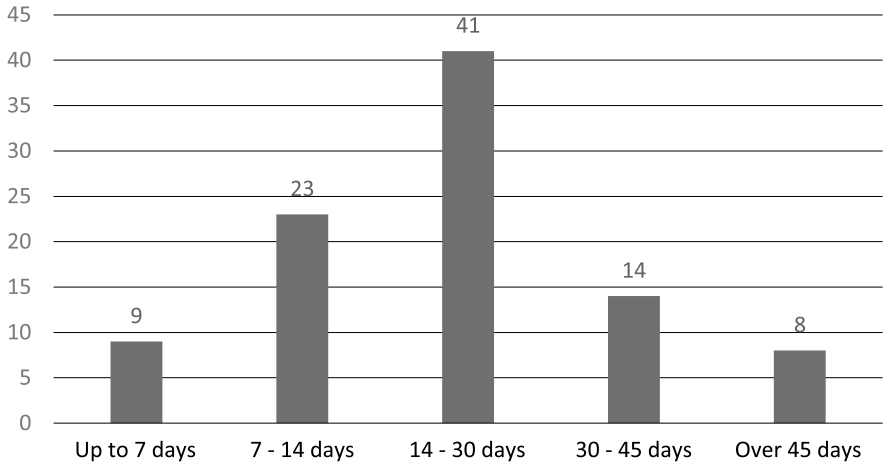

Fig. 2. Length of hospital day

An indication for CVC implantation in the studied paediatric patients' group is long-term pharmacotherapy (99%). In majority of patients (61%) the reason for CVC implantation was difficult access to peripheral veins, and thus no possibility of using a peripheral cannula. The indications for CVC placement are presented in Fig. 5.

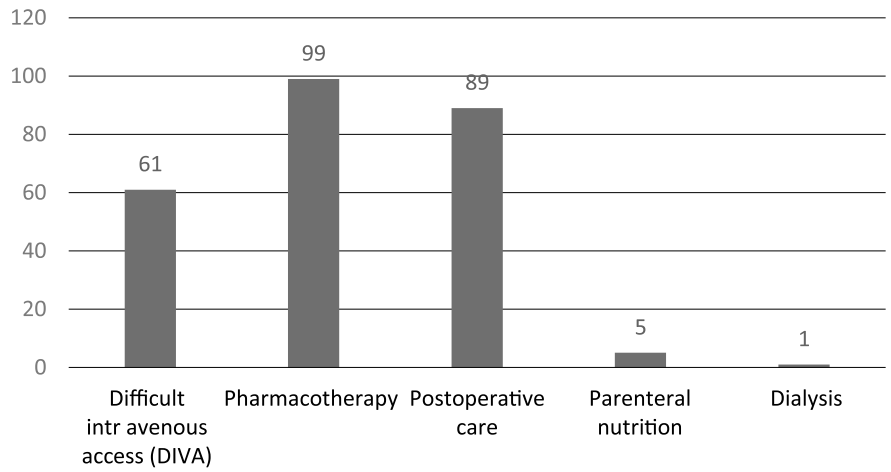

Fig. 3. Indications for CVC placement

The duration of CVC is presented in Fig.6. In most cases central lines remained in place up to 14 days (41%), then up to 7 days (38%). In 15% of patients the central line was used for up to 21 days, while 7% of patients had indications for keeping the central line for over 21 days.

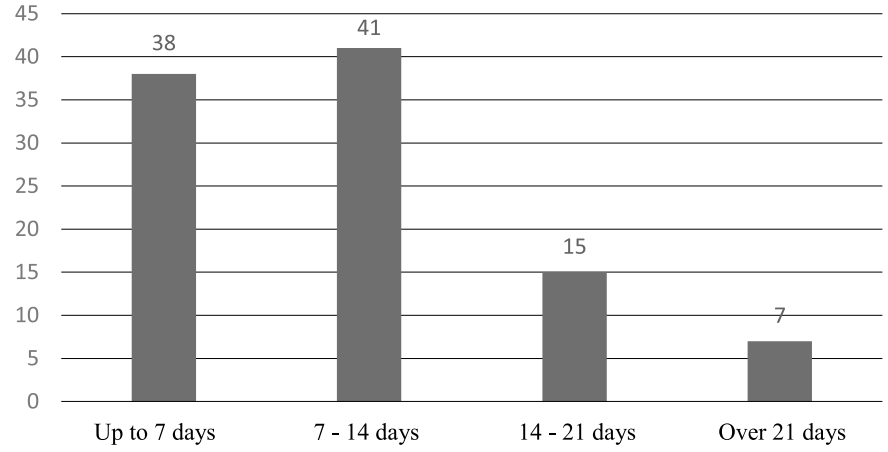

Fig. 4. Duration of CVC

The time for which a central line remains in place should be strictly monitored and the central line should be removed as soon as possible, upon considering clinical indications.

82% of central lines were removed when there were no more indications for CVC to remain in place, 11% were removed due to the necessity to replace a central line with a new one. Due to local inflammatory response – redness – 8% of CVC's had to be removed, while 6% were removed due to a blockage, and 2% - due to displacement.

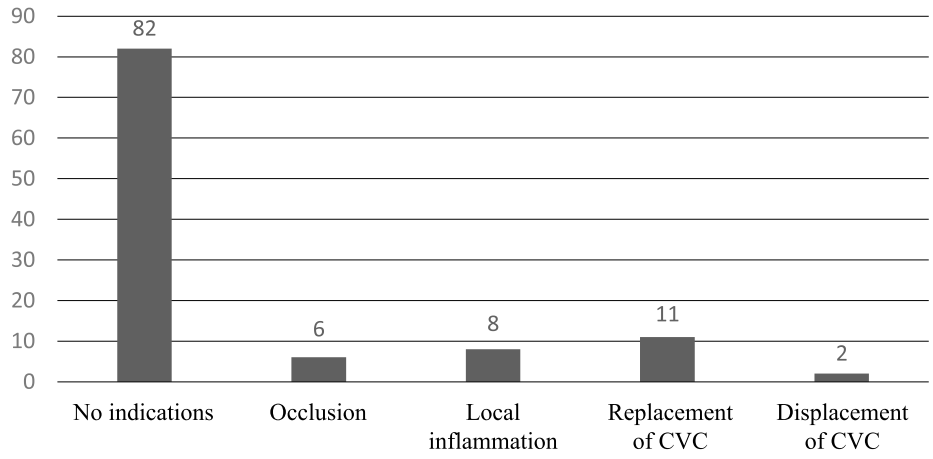

Fig. 5. Reasons for CVC removal

In a detailed statistical analysis correlations between the diagnosis and the type of treatment were shown, between the duration of CVC and the appearance of redness at the site of cannulation (local inflammatory response), between the age of a patient with difficult peripheral vines and the reason for hospitalisation, as well as between the length of stay and the duration of CVC. In order to verify the correlations, Cramér's V analysis was performed for contingency tables. A significant chi-squared test result was noticed, which means that the observed frequencies differ from expected frequencies. The significance level adopted for the results was $p<0.05$. The results are presented in Tables 1- 8.

Table 1. A correlation between the diagnosis and the type of treatment

		Type of treatment			Total
		No data available	Surgical	Conservative	
Diagnosis	No data available	1	5	0	6
		1.0%	5.0%	0.0%	6.0%
	Defects	0	32	1	33
		0.0%	32.0%	1.0%	33.0%
	Disorders	0	35	0	35
		0.0%	35.0%	0.0%	35.0%
	Trauma	0	18	8	26
		0.0%	18.0%	8.0%	26.0%
Total		1	90	9	100
		1.0%	90.0%	9.0%	100.0%
		Cramer's V	df	p	
		0.43	6	<0.001	

In order to verify correlations between the duration of CVC and the day during which redness was observed at the catheter site, four Cramér's V analyses were performed for contingency tables. The results were presented in tables form 2 to 5.

Table 2. A correlation between duration of CVC up to 7 days and redness.

		Redness		Total
		No	Yes	
Up to 7 days	No	37	25	62
		37.0%	25.0%	62.0%
	Yes	34	4	38
		34.0%	4.0%	38.0%
Total		71	29	100
		71.0%	29.0%	100.0%
		chi - square	df	p
		10.16	1	0.001

Table 3. A correlation between CVC duration from 7 to 14 days and redness

		Redness		Total
		No	Yes	
7-14 days	No	43	15	58
		43.0%	15.0%	58.0%
	Yes	28	14	42
		28.0%	14.0%	42.0%
Total		71	29	100
		71.0%	29.0%	100.0%
		chi - square	df	p
		0.66	1	0.416

In the period of between 7 and 14 days of CVC duration an insignificant chi-squared test result was observed

Table 4. A correlation between CVC duration from 14 to 21 days and redness

		Redness		Total
		No	Yes	
14 - 21 days	No	64	21	85
		64.0%	21.0%	85.0%
	Yes	7	8	15
		7.0%	8.0%	15.0%
Total		71	29	100
		71.0%	29.0%	100.0%
		chi - square	df	p
		5.07	1	0.024

Table 5. A correlation between CVC duration of over 21 days and redness

No		Redness		Total
		No	Yes	
Over 21 days	No	69	24	93
		69.0%	24.0%	93.0%
	Yes	2	5	7
		2.0%	5.0%	7.0%
Total		71	29	100
		71.0%	29.0%	100.0%
		chi - square	df	p
		6.58	1	0.010

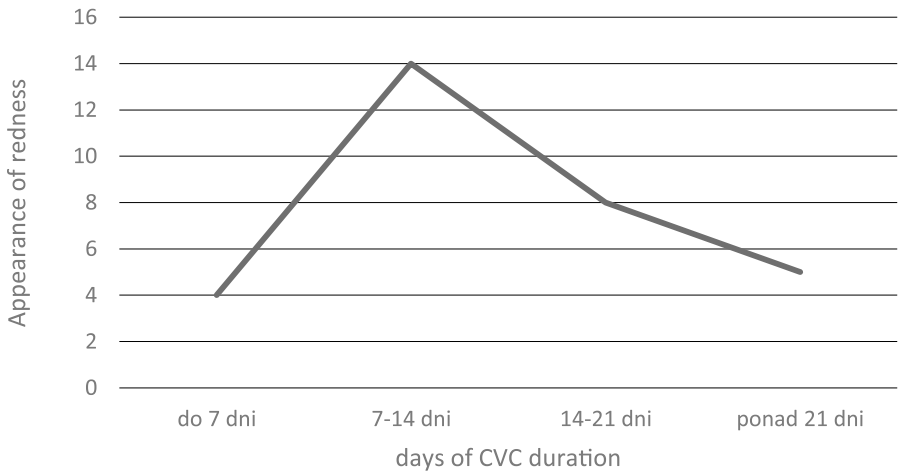

Fig. 6. CV duration vs. redness

In order to verify correlations between age and difficult blood vessels, Cramér's V analysis was performed for contingency tables. The results of the analysis are presented in Table 6.

Table 6. A correlation between age and difficult blood vessels

		Difficult blood vessels		Total
		No	Yes	
Age	No available data	0	6	6
		0.0%	6.0%	6.0%
	Up to 28 days	0	7	7
		0.0%	7.0%	7.0%
	16 months	1	10	11
		1.0%	10.0%	11.0%
	7-12 months	4	13	17
		4.0%	13.0%	17.0%
	1-4 years	4	7	11
		4.0%	7.0%	11.0%
	5-10 years	9	4	13
		9.0%	4.0%	13.0%
	11-15 years	12	8	20
		12.0%	8.0%	20.0%
	Over 15 years	9	6	15
		9.0%	6.0%	15.0%
Total		39	61	100
		39.0%	61.0%	100.0%
		Cramér's V	df	p
		0.51	7	0.001

In order to verify correlations between difficult blood vessels and the diagnosis, Cramér's V analysis was performed for contingency tables. The results are shown in table 7.

Table 7. A correlation between difficult blood vessels and the diagnosis

		Diagnosis				Total
		No available data	Defects	Disorders	Trauma	
Difficult vessels	No	0	3	24	12	39
		0.0%	3.0%	24.0%	12.0%	39.0%
	Yes	6	30	11	14	61
		6.0%	30.0%	11.0%	14.0%	61.0%
Total		6	33	35	26	100
		6.0%	33.0%	35.0%	26.0%	100.0%
		Cramér's V	df	p		
		0.55	3	<0.001		

In order to verify correlations between the length of hospital stay and CVC duration, four Cramér's V analyses were performed for contingency tables. The analyses' results shown that the duration of the central line is not correlated to the duration of hospital treatment. The results are presented in Table 8

Table 8. A correlation between the duration of CVC and the length of hospital stay

		CVC duration		Total
		No	Yes	
Length of stay	No available data	4	5	9
		4.0%	5.0%	9.0%
	Up to 7 days	5	0	5
		5.0%	0.0%	5.0%
	7-14 days	22	1	23
		22.0%	1.0%	23.0%
	14-30 days	39	2	41
		39.0%	2.0%	41.0%
	30-45 days	11	3	14
		11.0%	3.0%	14.0%
	Over 45 days	4	4	8
		4.0%	4.0%	8.0%
Total		85	15	100
		85.0%	15.0%	100.0%
		Cramér's V	df	p
		0.51	5	<0.001

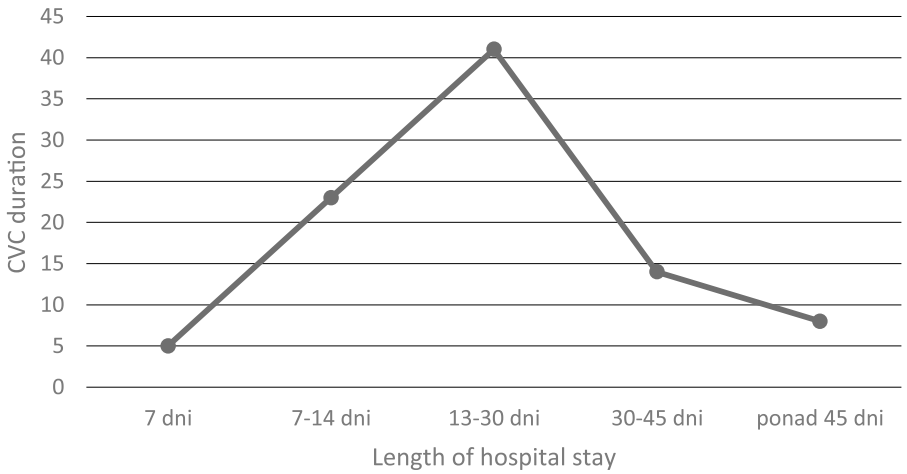

Fig. 7. CVC duration vs. lenght of hospitalisation

Discussion

Central venous catheters are often indispensable in the paediatric patients' population. They are connected with numerous complications, but proper care allows for their safer maintenance. Similar conclusions were drawn by Dinging l, Flowley J, and Wagner A. [2]. What is lacking are separate guidelines for children, yet it seems that implementation of general guidelines is rather effective. The research shown that 61% of the studied group had a catheter implanted due to difficult peripheral vessels and a necessity to use long-term intravenous pharmacotherapy. Similar results were obtained by Wiegering V, Schmid S, Andres O [8]. Analysis of the documentation shown that everyday assessment of the catheter implantation site as well as assessment of indications for the CVC to remain implemented

allowed for removal of the central line in 82% of patients as soon as there were no further indications for keeping it, which goes in line with the central line bundle. [1,9]

Conclusions

Strict control of CVC duration and indications for keeping it allow for its removal as soon as it is possible, that is when there are no more indications for its use.

Due to careful observation and its documentation it is possible to minimize complications and notice their appearance early, so as to act accordingly.

The most common complication observed in relation to central line care was redness at the site of cannulation, which signifies local inflammatory reaction. It may appear on any day of CVC duration. This requires careful observation and an immediate reaction, yet this is not always an indication for removal of the cannula. The longer the cannula remains in place, the greater the probability of an inflammatory reaction.

Paediatric patients at any age typically have peripheral vessels that are difficult to access. Despite numerous care-related and epidemiological problems the challenge is worth addressing, since central line implementation allows for maintaining long-term intravenous pharmacology without an additional stress or pain related to multiple peripheral venipunctures.

If correctly implemented, central line does not affect the total length of hospitalization.

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