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Quality Improvement Project

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Improvement of Broviac catheter-related outcomes after the implementation of a quality management system: A before-and-after prospective observational study

Manel Kammoun, [1] **Anouar Jarraya,**[*1] **Saloua Ammar,** [2] **Kamel Kolsi,**[1]

1. Anesthesiology Department, Hedi Chaker University Hospital, University of Sfax, Tunisia

2. Pediatric Surgery Department, Hedi Chaker University Hospital, University of Sfax, Tunisia

Correspondence*: Dr. Anouar Jarraya, Anesthesiology Department, Hedi Chaker University Hospital, University of Sfax, Tunisia. **E-mail**: jarraya_anouar@medecinesfax.org

KEYWORDS

Broviac catheter, Quality process, Complications, Venous access

ABSTRACT

Background: Because of the high rates of Broviac catheter complications, we started an urgent quality process to reduce this morbidity. The aim is to assess the efficiency of the main actions we have taken in enhancing our practice and improving Broviac outcomes.

Methods: We included all neonates and young infants requiring surgical central venous access using a Broviac tunneled catheter. We compared the catheters' outcomes before and after the implementation of a quality program based on a nurse teaching program, patient selection, and catheter management multidisciplinary protocol. The significance threshold was set at $p<0.05$.

Results: We included 94 patients: 51 in the protocol group and 43 in the control group. The complication rate was reduced from 60.3% to 25.5% with p=0.001. The lifetime of the catheter was improved from 11.3 ± 4.3 days to 19.1 ± 9 days with p=0.007. The catheter infection was reduced from 65.3% to 46.1% with $p\leq0.001$.

Conclusion: This quality improvement project shows the utility of a quality assurance program based on careful indications and patient selection, a nursing teaching program, and a multidisciplinary catheter management protocol, in reducing Broviac catheter-related morbidity.

INTRODUCTION

The tunneled Hickman-Broviac® catheter is widely used for neonates and young infants having difficult central venous access and requiring prolonged intravenous therapy. [1] However, it needs surgical experience and nursing skills to prevent adverse outcomes. [2] In our institution, high rates of catheter-related complications were previously observed. [3] A quality process was established urgently to reduce catheter-related morbidity through the implementation of a new protocol for patient selection and catheter management. [4]

The aim of this study is to describe the new protocol of Broviac® catheters and to assess the efficacy of the main actions we have taken in enhancing our practice and improving the outcomes.

METHODS

Design and settings: This quality improvement project was prospectively performed from January 2020 to June 2021 and from January 2022 to November 2022. Participants were inpatients of the Pediatric Surgery department of the Hedi Chaker University Hospital in Sfax, Tunisia. The new Broviac® catheter protocol was approved and started in August 2021.

Participants: In this study, we included all patients who had successful Broviac® catheter surgical insertion in the operating room of the pediatric surgery department. Those with contraindications (hemostasis troubles, severe infection, cutaneous infections or burns, or risk of superior cava vein syndrome) were not even part of the population study, the same for those with failure of insertion. We also excluded patients who died before the removal of the catheter, when the death was not related to catheter complication.

We included 51 patients in the protocol group (after the protocol implementation) to be compared with 43 patients in the control group (before the protocol implementation). Seven patients were excluded as they died before the Broviac® catheter removal. Deaths were not related to the catheter complication.

New protocol: Guided by the risk factors for Broviac® catheter-related morbidity [3], several actions were taken. First, all neonatal and pediatric healthcare teams were informed about the outcomes of Broviac catheters in our institution and particularly in their departments. A vascular access team was created to monitor and assure our quality program. A nursing teaching program was started to improve the skills in managing Broviac® catheters and to enhance hygiene measures. A daily written nurse report was used for all catheters inserted to emphasize traceability. We also selected patients and indications according to a multidisciplinary approach. The Broviac® catheter was inserted only in neonates and/or young infants requiring intravenous therapy for more than 4 weeks, whose ages were under six months, and who did not have the possibility of having peripherally inserted central catheters (PICCs). PICCs were recommended mainly for premature neonates. We opted for the internal jugular or infraclavicular subclavian percutaneous central catheters in patients requiring prolonged intravenous therapy for less than two weeks (like antibacterial therapy) and for perioperative patients, instead of Broviac® catheters.

Variables and Data measurement: The variables included age, weight, sex, previous comorbidities, the department in which the patient was admitted, the circumstances of insertion, and the indications for the Broviac® catheter insertion. To assess catheter-related complications, the site was inspected and the nurses' report was reviewed daily. The main outcomes were the incidence of complications (infection, bleeding, mechanical complications like fracture, occlusion, accidental removal, or vein thrombosis), and the lifetime of the catheter, defined by the duration between insertions and removal. Early removal of the catheter was considered when the catheter was removed within the first ten days after its placement.

Bias: All Broviac® catheters were inserted under the same conditions (in the operation room with respect to aseptic conditions under general anesthesia with Sevoflurane inhalation anesthesia) by the same team in the internal jugular vein.

Study groups: To assess the efficacy of the main actions we have taken to enhance our practice and improve the Broviac catheter-related outcomes, we compared the outcomes in the protocol group with a control group.

Protocol group: included 51 patients who had a Broviac® catheter after the implementation of the quality process.

Control group: included 43 patients who had a Broviac® catheter before the implementation of the patient selection and catheter management protocol.

Sample size calculation: The sample size was calculated to be 86 (43 patients in each group) considering 60.3% the incidence of complications in a previous study in the same department [3], versus 23.03 % in the preliminary results from the data of the first 13 patients included in this study. A study sample of 43 patients in each group is required for a 95% confidence level and a 5% margin of error.

Statistical analysis: Statistical analyses were achieved using the SPSS 25.0 (SPSS, Chicago, IL, USA) statistical package. The Shapiro-Wilk test was used to determine whether the data were normally distributed. Continuous variables with normal distribution were presented as means value ±standard deviation. Otherwise, we used medians.

The comparison between groups was achieved by Student's t-test and Chi2 test for continuous variables and categorical variables, respectively. The Mann-Whitney U test was used for nonparametric variables. The significance threshold was set at $p<0.05$.

RESULTS

In this study, we included 94 patients: 51 in the protocol group and 43 in the control group. The patient's age, weight, and emergency context were reduced (Table 1). The sex ratio, comorbidities and ASA class were comparable in both groups. The catheter indications have changed with lower rates of prolonged IV therapy including prolonged antibacterial treatments, and higher rates of parenteral nutrition (Table 1). The departments requesting the placement of Broviac® catheters were the same before and after the implementation of the quality process.

The lifetime of the catheter was improved from 11.3 ± 4.3 days to 19.1 ± 9 days with $p=0.007$ and the incidence of early catheter removal was reduced from 41% to 7.8% with $p\leq0.001$. The complication rate was reduced from 60.3% to 25.5% with $p=0.001$. The catheter infection was reduced from 65.3% to 46.1% with $p\leq0.001$. However, we noted more mechanical complications in the protocol group (Table 2). No complication was noted while the removal of the Broviac® catheters.

DISCUSSION

This study shows the role of a quality process based on a multidisciplinary protocol in enhancing practice and improving Broviac® catheter-related outcomes. The implementation of a new protocol allowed lower rates of complications with longer catheter lifetime.

The clinical implication of this study is that it encourages healthcare providers to have regular feedback on their practice in order to detect deficiencies and improve their outcomes. [5]

In our quality process, we tried to select the patients and limit the indications of Broviac® catheters and we opted for other alternatives like subclavian percutaneous catheters, or peripherally inserted central catheters (PICCs) which could be applied effectively as traditional central venous devices in neonates allowing central venous access saving [7], with lower rates of morbidity. [8] However, PICC lines are not always available in our hospital, and the need for surgical Broviac® catheters still has expanded indications [9], even in an emergency context.

Table 1: Efficacy of the protocol in selecting patients.

	Control group N=43	**Protocol group N=51**	**P value**
Age (months)	3.16 ± 2.8	1.7 ± 0.9	**0.001**
age≤ 6 months	33	47	**0.036**
Weight (kg)	4.15 ± 3.2	3.13 ± 0.9	**0.007**
Weight ≤ 6kg	34	40	0.572
Sex: M/F	26 / 17	30 / 21	0.520
Emergency context	20	11	**0.009**
ASA class (I/II/III/IV)	8 / 19 / 14 / 2	11/ 22/ 16/ 2	0.986
Comorbidities:			
Prematurity	28	35	0.443
Cardiac diseases	3	4	0.595
Respiratory disease	11	10	0.328
Neurological disease	6	8	0.524
Oncology/hematology	3	3	0.577
Indications:			
Perioperative	10	8	0.594
Oncology	3	4	-
Prolonged IV therapy including antibiotherapy	22	15	**0.028**
Parenteral nutrition	8	24	**0.001**
Patient department			
Pediatric Surgery	5	6	0.723
Neonatal and pediatric Critical care	30	38	0.723
Medical departments	7	6	0.723
Oncology/hematology	1	1	0.723

Table 2: Improvement of Broviac catheter-related outcomes

Complications:	**Control group N=43**	**Protocol group N=51**	**P value**
Catheters' lifetime (days)	11.3 ± 4.3	19.1 ± 9	**0.007**
Duration ≥ 10 days	25 (58.1%)	47 (92.1%)	**≤ 0.001**
Early catheter removal	18 (41.8%)	4 (7.8%)	**≤ 0.001**
Complicated catheters	26 (60.4%)	13 (25.5%)	**0.001**
Type of Complications			
Infection	17 (65.3%)	6 (46.1%)	**≤0.001**
Bleeding	1 (3.8%)	0	-
Mechanical complication	7 (26.9%)	7 (53.8%)	**0.024**
Vein thrombosis	1 (3.8%)	0	**-**
Other	0	0	-

According to a recent study, the Broviac® catheter placement using an ultrasound-guided percutaneous approach in infants <5 kg was safe. [10] It is, however, a technically challenging procedure and requires special organization and technical skills that are not available in our context. [10] In developed countries, open venous cutdown in a tertiary children's hospital is no longer necessary for the insertion of tunneled central venous catheters.

In developing countries, changing the habits of all the healthcare teams (physicians, nurses, anesthetists) needs several teaching strategies to convince them to be more implicated in our healthcare quality improvement approach. [11,12] Even though it was reported that the multimodal learning approach and particularly simulation-based learning improves the central line maintenance skills of ICU Nurses, reduces the risk of complications, and prolongs the catheter's life [12, 13], the additional workload generated by our new protocol discourages nurses from joining our program. We suggest involving nurses in healthcare quality programs and hospital accreditation processes. [14] We also suggest regular simulation-based training programs for all healthcare providers implicated in pediatric venous access management. [13-16] Nevertheless, the clear improvement of the Broviac® catheter outcomes helped us to convince nurses, to adhere to our catheter maintenance protocols. In our institution, Broviac® catheters were requested by several different departments. This was the major difficulty to implement and approve our patient selection protocol and to enhance the catheter maintenance traceability using daily nurse reports. We have also created a vascular access team composed of doctors, anesthesiologists, and nurses to help different departments requesting central venous access by giving advice and required training for their healthcare teams. The major role of this venous access team was to monitor the outcomes of the actions and interventions taken. The establishment of a vascular access team is widely recommended to improve catheter-related outcomes. [17, 18]

The first limitation of the study is that it does not assess the difficulties and barriers to implementing such a protocol. [6] The second limitation is that we did not assess the satisfaction of either the healthcare team implicated in the application of the protocol or the patients and their parents.

CONCLUSION

This study shows the utility of a quality assurance program in improving Broviac® catheter-related outcomes. A nursing teaching program and a multidisciplinary catheter management protocol were very efficient in reducing Broviac® catheter-related morbidity. Although there were several barriers to improving our practice, we have achieved some advantages by changing habits and improving practitioners' skills, but there is still a big gap to a developed country and continuous monitoring for Broviac® catheter outcomes and continuous actions are required for further improvements.

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REFERENCES

1. Thomas JH, MacArthur RI, Pierce GE, Hermreck AS. Hickman-Broviac catheters. Indications and results. Am J Surg. 1980; 140:791-6.
2. Fritsch LM, Le M, Elrod J, Wössmann W, Vincent D, Reinshagen K, et al. Surgical experience affects the outcome of central venous access catheter implantation in children: A retrospective cohort study. J Pediatr Hematol Oncol. 2022; 10:97.
3. Kammoun M, Jarraya A, Ketata H, Ammar S, Zouari M, Regaieg C, et al. Risk factors for Hickman-Broviac catheter complications: An experience from a Tunisian hospital. J Neonatal Surg. 2022; 11:26.
4. Antonacci G, Reed JE, Lennox L, Barlow J. The use of process mapping in healthcare quality improvement projects. Heal Serv Manag Res. 2018; 31):74-84.
5. Van Loon M, Van der Mark W, Beukers N, De Bruin C, Blankestijn PJ, Huisman RM, et al. Implementation of a vascular access quality programme improves vascular access care. Nephrol Dialys Transplant. 2007; 22:1628-32.
6. Mosadeghrad AM. Obstacles to TQM success in health care systems. Int J Health Care Qual Assur. 2013; 26:147-73.
7. Gupta N, Gandhi D, Sharma S, Goyal P, Choudhary G, Li S. Tunneled and routine peripherally inserted central catheter placement in adult and pediatric population: review, technical feasibility, and troubleshooting. Quant Imaging Med Surg. 2021; 11:1619-27.
8. Bahoush G, Salajegheh P, Anari AM, Eshghi A, Aski BH. A review of peripherally inserted central catheters and various types of vascular access in very small children and pediatric patients and their potential complications. J Med Life. 2021; 14:298-309.
9. Ponsky JL, Gauderer MW. Expanded applications of Broviac catheter. Arch Surg. 1980; 115:324.
10. Reddy SM, Soccorso G, Lawrence L, Bennett J, Jester I, Pachl M, et al. Ultrasound-guided percutaneous insertion of Broviac lines in infants less than 5kg: Prospective study of 100 consecutive procedures. J Pediatr Surg. 2022; 57:534-7.

11. Lian A, Rippey JC, Carr PJ. Teaching medical students ultrasound-guided vascular access-which learning method is best? J Vasc Access. 2017; 18:255-8.
12. Barsuk JH, Cohen ER, Mikolajczak A, Seburn S, Slade M, Wayne DB. Simulation-based mastery learning improves central line maintenance skills of ICU nurses. J Nurs Adm. 2015; 45:511-7.
13. Sannoh S, Clones B, Munoz J, Montecalvo M, Parvez B. A multimodal approach to central venous catheter hub care can decrease catheter-related bloodstream infections. Am J Infect Control. 2010; 38:424-9.
14. Aiken LH, Sloane DM, Bruyneel L, Van den Heede K, Griffiths P, Busse R, et al. Nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study. Lancet. 2014; 383:1824-30.
15. Mu Y, Wang L. Standardized post-catheter nursing intervention reduces the incidence of catheter complications in the disabled elderly and improves their quality of life. Am J Transl Res. 2021; 13:12957-64.
16. Chopra V, Kuhn L, Ratz D, Shader S, Vaughn VM, Saint S, Krein SL. Vascular access specialist training, experience, and practice in the United States: Results from the National PICC1 Survey. J Infus Nurs. 2017; 40:15-25.
17. Mussa B, Pinelli F, Cortés Rey N, Caguioa J, Van Loon FHJ, Munoz Mozas G, et al. Qualitative interviews and supporting evidence to identify the positive impacts of multidisciplinary vascular access teams. Hosp Pract. 2021; 49:141-50.
18. Cortés Rey N, Pinelli F, van Loon FHJ, Caguioa J, Munoz Mozas G, Piriou V, et al. The state of vascular access teams: Results of a European survey. Int J Clin Pract. 2021; 75:e14849.