

RESEARCH ARTICLE (ORIGINAL) 

Quality index of nursing care provided to patients with central venous catheters undergoing hemodialysis

Índice de qualidade dos cuidados de enfermagem aos utentes com cateter venoso central em hemodiálise

Índice de calidad de los cuidados de enfermería a los pacientes con catéter venoso central en hemodiálisis

Telma Patrícia Machado Pedreiro ¹

 <https://orcid.org/0000-0001-9241-6086>

Matilde Delmina da Silva Martins ^{2,3}

 <https://orcid.org/0000-0003-2656-5897>

¹ Northeastern Local Health Unit, Hospital Unit of Bragança, Department of Hemodialysis, Bragança, Portugal

² Polytechnic Institute of Bragança, School of Health of Bragança, Bragança, Portugal

³ Health Sciences Research Unit: Nursing (UICISA: E), Nursing School of Coimbra (ESEnfC), Coimbra, Portugal

Abstract

Background: Infection is the second cause of mortality among patients with renal failure. The development of infections is often associated with the contamination of vascular access.

Objectives: To analyze the Quality Index (QI) of nursing procedures related to central venous catheter (CVC) handling and maintenance in patients undergoing hemodialysis and the associated factors.

Methodology: Cross-sectional analytical study conducted with a sample of 50 nurses in hemodialysis units in northern Portugal between June and September 2019. Nurses were directly observed and completed a questionnaire for socio-professional characterization. Data were entered into and analyzed using IBM SPSS Statistics, version 21.0.

Results: The mean QI for CVC-related procedures was 80%. The use of chlorhexidine for skin antiseptics had the lowest compliance rate.

Conclusion: There is an opportunity to improve the QI of CVC-related procedures for hemodialysis. Professional training was considered a predictor of best practices.

Keywords: catheterization, central venous; nursing care; nosocomial infection; hemodialysis

Resumo

Enquadramento: A infeção é a segunda causa de mortalidade nos insuficientes renais e o desenvolvimento de infeções está, muitas vezes, associado ao acesso vascular.

Objetivos: Analisar o Índice de Qualidade (IQ) dos cuidados de enfermagem realizados à pessoa em hemodiálise, na manutenção e manipulação do cateter venoso central (CVC), e os fatores associados.

Metodologia: Estudo transversal analítico realizado em unidades de hemodiálise do norte de Portugal, entre junho e setembro de 2019. Participaram no estudo 50 enfermeiros aos quais foi realizada uma observação direta e aplicado um questionário para caracterização socioprofissional. Os dados foram inseridos e analisados no programa informático IBM SPSS Statistics, versão 21.0.

Resultados: A média do IQ nos procedimentos realizados ao CVC foi de 80%. A utilização da clorexidina para antisepsia da pele foi o procedimento que registou menor cumprimento.

Conclusão: Os resultados indicam oportunidade de melhoria do IQ nos procedimentos realizados ao CVC em hemodiálise, apontando-se a formação dos profissionais como indicador preditivo de melhores práticas.

Palavras-chave: cateterismo venoso central; cuidados de enfermagem; infeção hospitalar; hemodiálise

Resumen

Marco contextual: La infección es la segunda causa de mortalidad en la insuficiencia renal y el desarrollo de infecciones suele estar asociado, muchas veces, al acceso vascular.

Objetivos: Analizar el Índice de Calidad (IC) de los cuidados de enfermería prestados a las personas sometidas a hemodiálisis, en el mantenimiento y la manipulación del catéter venoso central (CVC), y los factores asociados.

Metodología: Estudio transversal analítico realizado en unidades de hemodiálisis del norte de Portugal, entre el junio y septiembre 2019. En el estudio participaron 50 enfermeros, que fueron observados directamente y recibieron un cuestionario de caracterización socioprofessional. Los datos se introdujeron y analizaron en el programa informático IBM SPSS Statistics, versión 21.0.

Resultados: La media del IC en los procedimientos realizados al CVC fue del 80%. El uso de clorhexidina como medida antiséptica de la piel fue el procedimiento con menor cumplimiento.

Conclusión: Los resultados indican una oportunidad para mejorar el IC en los procedimientos realizados al CVC en hemodiálisis y apuntan a la formación de los profesionales como indicador preditivo de mejores prácticas.

Palabras clave: cateterismo venoso central; cuidados de enfermeira; infección nosocomial; hemodiálisis

Corresponding author

Telma Patrícia Machado Pedreiro

E-mail: telmapedreiro@gmail.com

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Introduction

Infection is the second leading cause of death among patients with end-stage renal disease. One of the risk factors for infections in these patients is the contamination of the vascular access required for treatment (Annual Dialysis Data Report, 2015). The nursing team should be capable of preventing complications related to healthcare-associated infections in patients undergoing dialysis, which will increase patients' trust in the team, given that catheter infection is closely associated with the lack of aseptic techniques and inadequate handling of these devices (Nogueira et al., 2016). This study aimed to analyze the Quality Index (QI) of the nursing procedures related to central venous catheter (CVC) handling and maintenance in patients undergoing hemodialysis (HD) in HD units in northern Portugal and the associated factors.

Background

According to the National Nephrology Hospital Specialty and Referral Network (*Rede Nacional de Especialidade Hospitalar e de Referência de Nefrologia* [RNEHRN], 2017), Portugal has one of the highest incidence and prevalence rates of stage 5 chronic kidney disease in Europe. Data from 2017 show that HD is the main renal replacement therapy (RRT) for 59.7% of patients with this disease (RNEHRN, 2017). HD requires a vascular access, which is a major risk factor for infection (Schaefer & Fernandes, 2021). It is estimated that the relative risk for hospitalization and death due to infection is 2-3 times higher in patients with a CVC than in patients with an arteriovenous fistula for HD (Böhlke et al., 2015). Therefore, safe CVC handling should be a priority of the nursing team, with technical rigor and surveillance to prevent and control the risk of infection and promote patient safety in HD (Guimarães et al., 2017). One of the strategies for reducing and preventing CVC-related infections is the use of bundles, which have proven to be effective in reducing incidence rates. In Portugal, the Directorate-General of Health (Direção-Geral da Saúde, DGS) issued standard no. 022/2015 entitled Bundle of Interventions for Prevention of CVC-related Infections, recommending the following procedures for CVC maintenance: review the need for CVC daily; wash hands with water and a pH-neutral soap followed by scrubbing with an alcohol-based antiseptic solution before CVC handling; disinfect connectors with 2% chlorhexidine in 70% alcohol before any local handling; disinfect access ports and extension tubing (needleless connectors, three-way stopcock, among others) by scrubbing with 2% chlorhexidine in 70% alcohol for 10 to 15 seconds and allow to dry before connecting any sterile device; and change dressings at appropriate intervals and using aseptic techniques (DGS, 2015).

Research question

What is the QI of the nursing procedures related to CVC handling and maintenance in patients undergoing

hemodialysis in HD units in Northern Portugal and the associated factors?

Methodology

This cross-sectional analytical study was carried out in HD units in Northern Portugal between June and September 2019. The sample consisted of 50 nurses who were directly observed during CVC handling and maintenance. The data collection tools were a questionnaire for the socio-professional characterization of the sample and an observation grid. A list of the nurses working at the HD units was compiled. Each of them was assigned a code number. Only the data collection team had access to this list, which was deleted immediately after the observation data were entered into the database. Each nurse was given a questionnaire in a closed envelope, corresponding to the randomly assigned number, with the instructions for completion and the purpose of the study. After completion, the questionnaire was returned to the observer who added the number in the observation grid during CVC care and sent it to the researcher without any identification. The informed consent form was placed in a single envelope, separated from the data collection tools. This grid was based on the bundle of interventions for the prevention of CVC-related infections adapted from DGS Standard 022/2015 of 16/12/2015. It consists of four items related to CVC connection and disconnection, including hand hygiene before catheter handling, use of personal protective equipment (PPE) when connecting and disconnecting the CVC, type of dressing, and frequency of dressing change (DGS, 2015). Some of these nursing interventions were adapted to the reality of patients undergoing HD, with the individualization of the monitoring of connection and disconnection practices because the CVC is handled in these two contexts. To this end, an item related to connection and disconnection was introduced to monitor nursing practices and procedures related to PPE, hand hygiene, and disinfection of lumens with appropriate solutions in both phases of the process. The observations were made at the beginning and end of the HD session by the researcher, with the collaboration of a member of each team from the HD units involved in this study, after a presentation of the study objectives and a detailed explanation of the data collection tool and the behaviors that would be observed and documented. Data were coded, entered into, and analyzed using IBM SPSS Statistics, version 21.0. The study was submitted for approval to the HD unit's boards of administration and obtained a favorable opinion from the Ethics Committee (no. 32/2019 of 04/26/2019 and no. 92/2019 of 03/21/2019).

Results

The sample consisted of 50 nurses, mostly women (72%), with a mean age of 49.84 years, an undergraduate degree (72%), and without a nursing specialization (82%; Table 1).



Table 1*Sample distribution according to sociodemographic characteristics (n = 50)*

Variables		n	%
Gender	Female	36	72.0
	Male	14	28.0
Age	Below 40	9	18.0
	41 – 50	17	34.0
	Above 50	24	48.0
Minimum=31 years; Maximum=66 years Mean=49.84 years; standard deviation=8.74 years			
Education level	Bacharelato (3-year degree)*	1	2.0
	Undergraduate degree (4-year degree)	36	72.0
	Postgraduate degree	11	22.0
	Master's degree	2	4.0
Specialization in Nursing	Yes	9	18.0
	No	41	82.0

Note. *No longer offered.

With regard to the length of professional experience, 80% of the nurses worked in dialysis for at least 20 years, 74% for at least 10 years, and most of them (62%) worked in a public unit. In this sample, 76% of the nurses had

training in the prevention of CVC-related infections and 62% were familiar with DGS standard no. 022/2015 (Table 2).

Table 2*Sample distribution according to professional characteristics and training in the prevention of CVC-related infections (n = 50)*

Professional and training variables		n	%
Length of professional experience	Less than 20 years	10	20.0
	20-29 years	24	48.0
	30 or more years	16	32.0
Xmin=6 years; Xmax=45 years Mean=25.70 years; standard deviation=8.36 years			
Length of professional experience in dialysis	Less than 10 years	13	26.0
	10-19 years	16	32.0
	20 or more years	21	42.0
Xmin=1 year; Xmax=30 years Mean=15.52 years; standard deviation=8.38 years			
Department of dialysis	Public	31	62.0
	Private	19	38.0
Training in the prevention of CVC-related infections	Yes	38	76.0
	No	12	24.0
Knowledge of DGS standard No. 022/2015	Yes	31	62.0
	No	19	38.0

CVC = central venous catheter; DGS = Directorate-General of Health.

Most procedures related to patient connection to the Extracorporeal Circuit (beginning of the HD session) and CVC disconnection (end of the HD session) were almost fully performed. The items with lower compliance

were: use of an gown at connection and disconnection); instruct the patient to turn the head to the opposite side of the CVC (at connection and disconnection); and use a catheter protection pouch at disconnection (Table 3).

Table 3

Sample distribution according to the procedures recommended for CVC handling/maintenance at connection and disconnection (n = 50)

		CVC connection		CVC disconnection	
		n	%	n	%
Use of a surgical mask	Yes	49	98.0	50	100.0
	No	1	2.0	0	0.0
Use of an gown	Yes	21	42.0	22	44.0
	No	29	58.0	28	56.0
Use of sterile gloves	Yes	49	98.0	50	100.0
	No	1	2.0	0	0.0
Use of surgical mask by the patient	Yes	50	100.0	50	100.0
	No	0	0.0	0	0.0
	No	22	44.0	23	46.0
Wash hands with water and a pH-neutral soap or scrub with an antiseptic solution before CVC handling	Yes	49	98.0	48	96.0
	No	1	2.0	2	4.0
Disinfect the lumens with 2% chlorhexidine or 70% alcohol for 10-15 seconds before connecting the patient to the ECC (connection)	Yes	47	94.0	45	90.0
	No	3	6.0	5	10.0
Protect the CVC with gauze swabs and sterile drape (connection)	Yes	50	100.0	Not applicable	
	No	0	0.0	Not applicable	
Disinfect the ECC connectors of the CVC bloodlines and lumens with 2% chlorhexidine or 70% alcohol for 10-15 seconds before attaching the sterile caps (disconnection)	Yes	Not applicable		45	90.0
	No	Not applicable		5	10.0
Place the CVC protection pouch	Yes	Not applicable		30	60.0
	No	Not applicable		20	40.0

Note. CVC = central venous catheter; ECC = Extracorporeal circuit.

With regard to CVC dressing procedures, nurses observed the characteristics of the insertion site and used a surgical mask and sterile gloves. The following items had a lower

level of compliance: use of a dressing kit (58%), use of 2% chlorhexidine for skin antiseptics (20%), and indicate the insertion data on the dressing (18%; Table 4).

Table 4

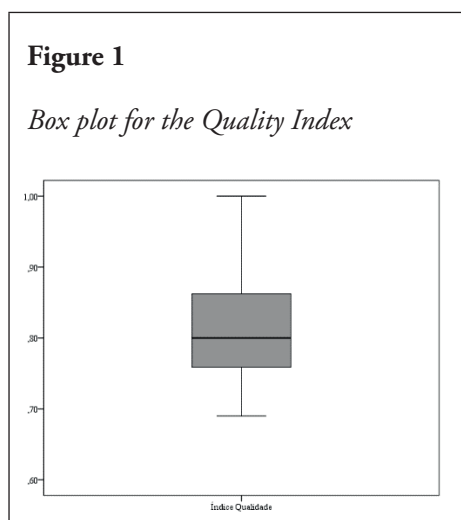
Sample distribution according to the procedures recommended for CVC dressing (n = 50)

CVC dressing		n	%
Observation of the characteristics of the insertion site	Yes	50	100.0
Use of a surgical mask	Yes	50	100.0
Use of sterile gloves	Yes	50	100.0
Use of a sterile drape to place the dressing material	Yes	32	64.0
	No	18	36.0
Use of a dressing kit	Yes	29	58.0
	No	21	42.0
Use of 2% chlorhexidine for skin antiseptics	Yes	10	20.0
	No	40	80.0
Indicate the insertion date on the dressing	Yes	9	18.0
	No	31	62.0
	Not applicable	10	20.0

Note. CVC = central venous catheter.

The QI ranged from a minimum of 0.6897 to a maximum of 1.000, with a mean value of 0.809. Thus, the nurses

obtained a QI of 80% in the procedures related to CVC handling/maintenance (Figure 1).



A statistically significant difference was found between the type of unit and CVC procedures, such as the use of an gown at connection and disconnection, the use of 2% chlorhexidine in alcohol for skin antisepsis when

placing a dressing over the insertion site, the placement of a catheter protection pouch at disconnection, the use of a sterile drape to place the dressing material, and the use of a dressing kit ($p < 0.005$; Table 5).

Table 5

Association between the type of unit and the procedures used for CVC handling/maintenance (n = 50)

Variables	Dialysis Units			χ^2 (p)	
	Public n(%column)	Private n(%column)	Total n(%column)		
Use of an gown at connection	Yes	21(67.7%)	0(0.0%)	21(42.0%)	22.191 (0.000)***
	No	10(32.3%)	19(100%)	29(58.0%)	
Use of an gown at disconnection	Yes	21(67.7%)	0(0.0%)	21(42.0%)	22.191 (0.000)***
	No	10(32.3%)	19(100%)	29(58.0%)	
Placement of a catheter protection pouch at disconnection	Yes	11(35.5%)	19(100%)	30(60.0%)	20.430 (0.000)***
	No	20(64.5%)	0(0.0%)	20(40.0%)	
Use of a sterile drape to place the dressing material	Yes	13(41.9%)	19(100%)	32(64.0%)	17.238 (0.000)***
	No	18(58.1%)	0(0.0%)	18(36.0%)	
Use of a dressing kit	Yes	10(32.3%)	19(100%)	29(58.2%)	22.191 (0.000)***
	No	21(67.7%)	0(0.0%)	21(42.0%)	
Use of 2% chlorhexidine in alcohol for skin antisepsis	Yes	10(32.3%)	0(0.0%)	10(20.0%)	7.661 (0.008)**
	No	21(67.7%)	19(100%)	40(80.0%)	

With regard to the QI for the several professional variables (Table 6), nurses from public institutions obtained, on average, a lower QI than those who worked in private institutions. Having attended training on the prevention

of CVC-related infections and having knowledge of the DGS standard No. 022/2015 did not significantly contribute to improving the QI.

Table 6*Association between the quality index and the professional variables (n = 50)*

Variable	QI		t(p)
	X	sd±	
Dialysis units	Public	0.795	-2.323 ^a (0.020)*
	Private	0.832	
Training in the prevention of CVC-related infections	Yes	0.806	-0.434 (0.666)
	No	0.817	
Knowledge of DGS standard no. 022/2015	Yes	0.799	-1.609 ^a (0.108)
	No	0.825	

Note. t = t-statistic; p = p-value; * = significant differences at 5%; ^a = Mann-Whitney test, the distribution was not normal; QI = quality index; DGS = Directorate-General of Health.

Discussion

The sample in this study consists of 50 nurses, mainly women (72%). These results align with the statistical data published by the Ordem dos Enfermeiros (Portuguese nursing regulator [OE], 2020), showing that 82.3% of the nurses working in Portugal are women. As for age, most participants were over 50 years (48%), with a mean age of 49.8 years. These results differ from those found by Lemos et al. (2015) with a sample of 84 nurses. In their exploratory quantitative cross-sectional study, the mean age was 35 years, which, according to the authors, shows maturity and experience, essential characteristics for working in HD units. Therefore, the mean age in this study (49.8 years) shows that the sample is experienced. With regard to academic qualifications, 72% of the nurses hold an undergraduate degree and 18% have a nursing specialization. The sample has a low level of advanced and specialized training, which is not in line with OE recommendations (2016, p. 14) that “given the specific context of nurses’ intervention in dialysis techniques, namely the high complexity, demands, and risks associated with dialysis treatment, the services/units should ensure that at least 50% of nurses have specific nursing skills for providing care to critically ill, chronic, and palliative patients”. The mean length of professional experience in dialysis is 15.52 years, with 74.0% of the nurses working in this area for at least 10 years, that is, with experience in dialysis. Therefore, it can be concluded that this sample consisted of experienced professionals. In this line of thought, Amaral and Ferreira (2014) advocate that nurses’ experience and expertise are essential for quality care and positive patient outcomes in a complex health-care environment. Most of these nurses work in a public dialysis unit (62%), which does not reflect the reality in Portugal. According to a DGS report on dialysis patient flows (2013), HD care is mainly provided by private healthcare providers. With regard to training in the prevention of CVC-related infections (76% of the sample) and knowledge of DGS standard no. 022/2015 (62% of the sample), the results are far from those expected. Regular training sessions for the professionals responsible

for CVC care improve the safety culture and increase adherence to strategies for reducing infection rates (Perin et al., 2016). The results regarding the knowledge of the DGS standard are similar to those found by Fernandes et al. (2019) in their cross-sectional quantitative study. These authors aimed to determine health professionals’ knowledge about the bundle to prevent CVC-related bloodstream infections (BSIs) and found that 53.6% of the sample was familiar with the bundle. However, the use of bundles as a strategy to prevent the incidence of infections has led to positive outcomes (DGS, 2017). Fortunatti (2017) emphasizes that the simultaneous use of insertion and maintenance bundles reduces the rate of CVC-related BSIs, representing an efficient alternative to improving the quality and safety of care. Concerning the use of PPE at the time of CVC connection and disconnection, a compliance rate of almost 100% was observed. The item with the lowest level of compliance was the use of an gown, which was only used by 42% of participants at connection and 46% at disconnection. The use of PPE is an essential component of infection prevention and control measures. Compliance with infection control measures and use of PPE are critical to prevent the transmission of pathogens (Hakim, Abouezz, & El Okda, 2016).

Moreover, this study found a high level of compliance with hand hygiene before CVC handling at connection and disconnection. Hand hygiene is one of the most relevant measures to prevent infections, ensuring safe care for patients and health professionals. Fortunatti (2017) found a reduction in the infection rate from 3.48 to 1.52 episodes per 1.000 CVC-days. Concerning CVC dressing, it should be noted that all nurses observed the characteristics of the insertion site and used a surgical mask and sterile gloves. This aspect is aligned with Silva and Oliveira (2016). These authors concluded that CVC insertion site should be observed to check for any skin changes that may suggest infection, such as the presence of exudate at the exit site and inflammatory signs (heat, pain, redness, edema). The following items had a low level of compliance: use of a dressing kit, use of 2% chlorhexidine for skin antiseptic, and indicate the insertion date on the

dressing. These results are far from those recommended in the standards for CVC dressings. The DGS (2015) recommends cleaning the insertion site, using a mask, sterile gloves, and sterile drape to place the dressing material, using a dressing kit, using 2% chlorhexidine in alcohol for skin antiseptics, and inserting a date on the dressing. It should be noted that 20% of the nurses in this study used 2% chlorhexidine in alcohol for skin antiseptics, with many authors advocating the use of this antiseptic solution at dressing changes. Cassia et al. (2021) concluded that the use of chlorhexidine at dressing changes has many benefits, particularly by reducing the number of microorganisms and possible colonization and preventing primary BSIs. The mean QI in CVC maintenance/handling procedures was 80%; however, this percentage falls short of the desired compliance of 100% (DGS, 2015). Thus, it should be noted that in DGS standard 022/2015 (2015, p. 9), CVC bundles “are a set of interventions (usually 3 to 5) that lead to better outcomes when grouped and implemented in an integrated way, with greater impact than the mere addition of the effect of each of the interventions individually”. In turn, Fortunatti (2017) found an overall compliance of 62.9% for the maintenance bundle. This level of compliance was low compared to other published studies, and it is important to achieve a level of compliance of approximately 95% for a substantial reduction in CVC-related BSIs. The results found in this study are also far from those reported by the previous author for catheter infection prevention. Concerning the attendance of training in the prevention of CVC-related infections and the knowledge of the DGS standard, this study concluded that these aspects did not significantly contribute to increasing the QI. This finding is not consistent with recent scientific research. Rodrigues (2019) found differences in nurses’ practices related to CVC optimization before and after structured training. After training, nurses’ practices improved, confirming the positive impact of training on nurses’ practices. Therefore, in view of the above, nurses’ training and knowledge of the bundle would be associated with the procedures related to CVC handling/maintenance. The statistically significant difference found between the QI of nurses from public units and those from private units should be highlighted. Nurses from private units obtained a higher QI in CVC handling/maintenance than those working in public units. This aspect can be explained by the fact that nurses from private units had a higher overall level of compliance with CVC handling/maintenance procedures. Data analysis showed that the professionals in private units did not comply with the use of a gown for connection and disconnection and the use of chlorhexidine for skin antiseptics (Table 5). In public units, there was a lower level of compliance with the items related to the placement of a catheter protection pouch, the use of a sterile drape to place dressing material, the use of a dressing kit, and the use of chlorhexidine. The nurses from private units complied with a higher number of items in the DGS standard, which translated into a higher QI in CVC handling/maintenance procedures. All interventions in the bundle are necessary and if any of them are not ap-

plied, the outcome will be different because the bundle is a cohesive set of measures that must be implemented together for a successful intervention (DGS, 2015).

Conclusion

This study revealed a mean QI of 80% in the procedures related to CVC handling/maintenance. A significant percentage of the sample had no training in the prevention of CVC-related infections or knowledge of DGS standard no. 022/2015. A significant percentage of nurses reported being unfamiliar with it, which reflects a lack of training to provide nursing care based on the best scientific evidence on the prevention of CVC-related infections. Thus, training health professionals is a key strategy for preventing and reducing the risk of infection. They should receive lifelong training to update their knowledge and provide safe and quality care. This study found a low use of 2% chlorhexidine in alcohol for skin antiseptics in CVC dressing care, so the authors suggest using it as the antiseptic of choice in this procedure. On-the-job training should be offered to convey the importance of knowing and complying with DGS standard no. 022/2015 in HD units for the prevention of CVC-related infections. Nurses from private units had a higher QI in CVC handling/maintenance procedures than those from public units. Future studies should increase the number of observations and use a larger sample to investigate associations and draw conclusions for the general population.

Author contributions

Conceptualization: Pedreiro, T. P. & Martins, M. D.
 Data curation: Pedreiro, T. P. & Martins, M. D.
 Formal analysis: Pedreiro, T. P. & Martins, M. D.
 Investigation: Pedreiro, T. P. & Martins, M. D.
 Methodology: Pedreiro, T. P. & Martins, M. D.
 Project administration: Martins, M. D.
 Resources: Pedreiro, T. P. & Martins, M. D.
 Supervision: Martins, M. D.
 Validation: Pedreiro, T. P. & Martins, M. D.
 Visualization: Pedreiro, T. P. & Martins, M. D.
 Writing – original draft: Pedreiro, T. P. & Martins, M. D.
 Writing – review and editing: Pedreiro, T. P. & Martins, M. D.

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