Turk Neurosurg 32(5):819-825, 2022

Original Investigation

DOI: 10.5137/1019-5149.JTN.37155-21.1

Received: 22.11.2021
Accepted: 06.01.2022

Published Online: 04.07.2022

How to Secure CSF External Drainage to the Skin: Hints from an International Survey and the Current Literature

Carolina NOYA[1,2], Anna Maria AURICCHIO[1,2], Luca MASSIMI[1,2], Federico BIANCHI[1,2], Gianpiero TAMBURRINI[1,2], Paolo FRASSANITO[1]

[1]Fondazione Policlinico Universitario A. Gemelli IRCCS,, Department of Pediatric Neurosurgery, Rome, Italy
[2]Università Cattolica del Sacro Cuore, Rome, Italy

Corresponding author: Paolo FRASSANITO ✉ paolo.frassanito@gmail.com

ABSTRACT

AIM: To investigate the current practice of neurosurgeons and their perception of complications related to the securement of external drainage (ED) to the skin.

MATERIAL and METHODS: We created a 24-points English language questionnaire on Google Forms covering the five main domains of care. The survey was distributed among members of the European Society for Pediatric Neurosurgery (ESPN) in April 2020.

RESULTS: The results were entirely self-reported, without any independent validation. Fifty-one neurosurgeons practising in different centres worldwide participated in this survey. Despite well-known complications and drawbacks, sutures are still the most commonly used method to secure cerebrospinal fluid (CSF) ventricular ED (49 out of 51 respondents) and spinal ED (37 out of 51) to the skin. Perception of the risk of pullout is estimated as <1% by 25.5% of the respondents, 1-5% by 39.2%, 5-10% by 17.6% and 10% by 11.8%>. Twenty out of fifty-one respondents acknowledge that their method of securement has drawbacks, and 49% believe that it may also affect the risk of infection. Factors eventually affecting the risk of pullout are young age (62.7%), aetiology (25.5%), neurological status (90.2%), occipital exit site (37.3%), inadequate length of the subcutaneous tunnel (58%), the duration of ED (70.6%), and hospital stay in service (84.3%). 39.2% of respondents agree that the paediatric population deserves a different device or technique to secure ED to the skin. 21.6% of respondents underestimate the risk of accidental pullout. 86.3% of respondents have never read about the 'sutureless subcutaneous anchoring device'.

CONCLUSION: Complications associated with the securement method, such as the risk of pullout and infection, are most likely underestimated. More research is needed to implement effective guidelines in this field.

KEYWORDS: Anchoring, External drainage, Pullout, Securement, Ventricular catheter

ABBREVIATIONS: CSF: Cerebrospinal Fluid, **ESPN:** European Society for Pediatric Neurosurgery, **EDs:** External drainages

INTRODUCTION

The use of cerebrospinal fluid (CSF) external drainages (EDs), either ventricular or spinal, represents a universal practice in neurosurgery. Although several bundles aiming to standardise their management have been issued (3,5,7) so far, insufficient attention has been paid to the methods used to secure EDs to the skin and their related complications (1,11,13).

The present international survey seeks to investigate the common practice of neurosurgeons on this issue.

Carolina NOYA : 0000-0001-6913-8129
Anna Maria AURICCHIO : 0000-0002-4186-4476
Luca MASSIMI : 0000-0003-3088-0822
Federico BIANCHI : 0000-0002-8216-8581
Gianpiero TAMBURRINI : 0000-0002-7139-5711
Paolo FRASSANITO : 0000-0003-0071-3126

MATERIAL and METHODS

We created a 24-points English language questionnaire on Google Forms defining the five domains of care (Figure 1).

The survey was sent out via email to members of the European Society of Pediatric Neurosurgery (ESPN) in April 2020 and was completed voluntarily by the participants. The responses were kept anonymous and were entirely self-reported with no independent validation.

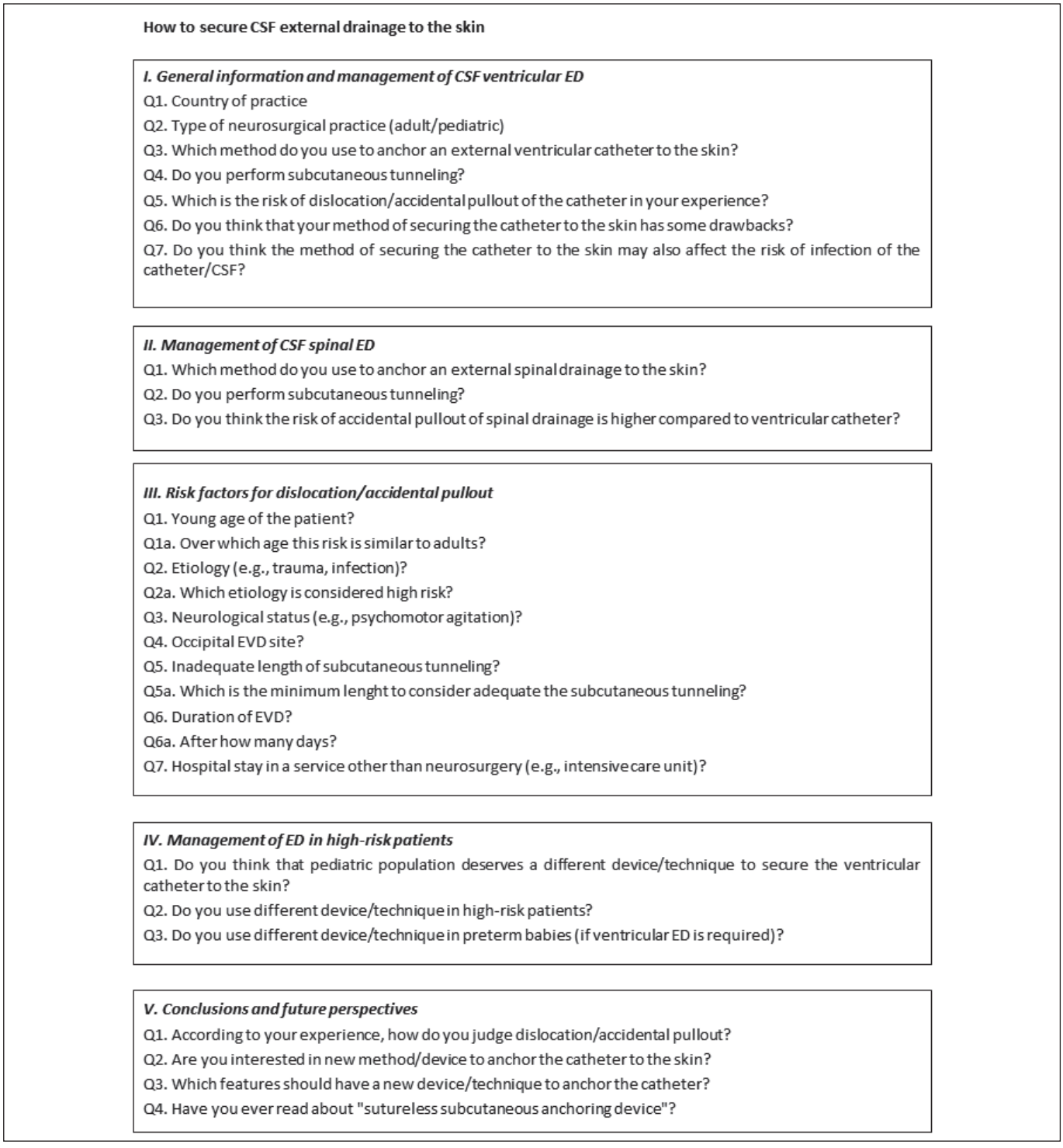


Figure 1: Online questionnaire.

RESULTS

The responses from fifty-one neurosurgeons, practising in fifty-one different centres around the world (France, Germany, Spain, Turkey, United Kingdom, Poland, Switzerland, Austria, Israel, Italy, Croatia, Bulgaria, Argentina, Brazil, Canada, Netherlands, United States of America, Belgium, Slovakia, Hungary, Egypt, Portugal, Greece and Russia) were collected and compiled, without investigating the levels of experience or years of training of the participants. Half of the participants stated that they only practised paediatric neurosurgery, while the other half practised both paediatric and adult neurosurgery.

General Information and Management of CSF Ventricular ED

Forty-nine neurosurgeons use sutures to secure ED to the skin, eventually combined with soft flange or technical variants exploiting 2-point fixation. Only four neurosurgeons use surgical staples to secure the catheter to the skin. One surgeon uses staples in addition to sutures to secure the catheter at the exit site. One surgeon relies on additional adhesive dressing sticking on the ED. One surgeon enhances the securement by closing the catheter in two layers of colloid, as already described in the literature (17).

Forty-nine out of fifty-one neurosurgeons (96%) always perform subcutaneous tunnelling.

The perceived risk of pullout is highly variable, with 25.5% of respondents estimating it to be 1%, 39.2% estimating it to be 1-5%, 17.6% estimating it to be 5-10%, and 11.8% estimating it to be 10%. Two neurosurgeons never experienced this complication; one does not know the incidence of this risk.

Despite this, 61% of neurosurgeons rely on their own method for securing the catheter and believe it has no drawbacks. On the other hand, twenty out of fifty-one neurosurgeons acknowledge that the method has drawbacks, most notably accidental pullout (6), followed by skin complication (5), kinking (3), infection (3), and CSF leak (1).

Interestingly, half of the neurosurgeons (49%) think that the method of securement may also affect the risk of infection when overtly asked.

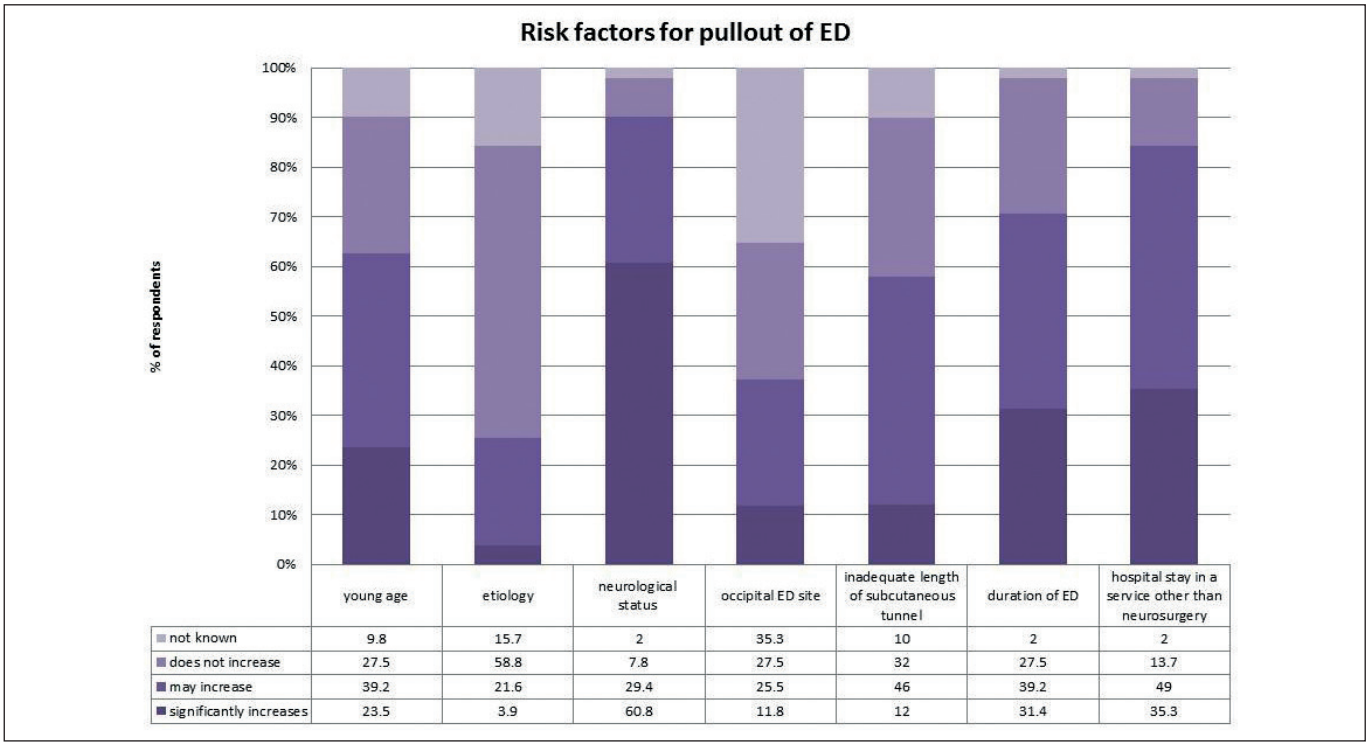
Management of CSF Spinal ED

Considering the securement of CSF spinal ED, 72.4% of neurosurgeons use sutures (37 respondents), combined with soft flange in almost two-thirds of the cases (22 out of 37 respondents), while 15.7% rely only on dressing. On the other hand, 12% of neurosurgeons use sutures with adhesive or colloid dressing in various ways.

Thirty-seven out of fifty-one neurosurgeons (72.5%) perform subcutaneous tunnelling, though only thirty-two respondents always use it. Quite surprisingly, a quarter of respondents never perform subcutaneous tunnelling. Finally, 58.8% of the interviewed surgeons think that the risk of accidental pullout of spinal ED is higher than that of ventricular ED.

Risk Factors for Dislocation or Accidental Pullout

Figure 2 summarizes the data on factors that may influence the risk of dislocation or accidental pullout of ED. Young age significantly increases this risk by 23.5% and may increase it for 39.2% of the respondents. Around a quarter of respondents (27.5%) do not consider it a risk factor, while



	young age	etiology	neurological status	occipital ED site	inadequate length of subcutaneous tunnel	duration of ED	hospital stay in a service other than neurosurgery
not known	9.8	15.7	2	35.3	10	2	2
does not increase	27.5	58.8	7.8	27.5	32	27.5	13.7
may increase	39.2	21.6	29.4	25.5	46	39.2	49
significantly increases	23.5	3.9	60.8	11.8	12	31.4	35.3

Figure 2: Risk factors for pullout of ED.

9.8% are unaware of this. Among respondents who view young age as a risk factor (62.7%), the age threshold above which this risk is comparable to an adult counterpart is debatable. Ten respondents indicated that it is up to five years of age, fourteen respondents said it is up to twelve years, and the remaining three respondents indicated an age up to twenty years.

Concerning aetiology (i.e., trauma, infection), 58.8% of the neurosurgeons do not perceive it as a potential risk factor, and 15.7% are unaware. Aetiology significantly increases the risk of pullout for only 3.9% and it may increase the risk for 21.6%. Among the 25.5% who consider aetiology a risk factor, six respondents attribute it to trauma, four to infections, one to subarachnoid haemorrhage, and one to any condition causing a frontal syndrome. In general, neurosurgeons specified that the increased risk of pullout might depend on conditions that affect the cognitive status or require long treatments.

Neurological status (e.g. psychomotor agitation) significantly increases the risk according to 60.8% of respondents and it may increase the risk for 29.4%. A minority (7.8%) do not associate this factor with the risk of pullout, and 2% do not know if it is related.

Moving on to technical issues, the occipital site of ED may significantly increase the risk for 25.5% of respondents by 11.8%; a consistent portion of respondents do not consider this a risk factor (27.5%) or do not know (35.3%).

The inadequate length of the subcutaneous tunnelling significantly increases the risk by 12% for 46% of the respondents; almost one-third of the respondents (32%) do not consider it a risk factor, and 10% do not know about it. The adequate length of the subcutaneous tunnelling varies greatly among neurosurgeons who identify this as a risk factor (58%). The majority of respondents (18 out of 23) indicated a length ranging from 3 to 6 centimetres, while other answers were: 7 cm (3 respondents) and 10 cm (2 respondents). According to one respondent, the length of tunnelling may affect the risk of infection but not the pullout risk.

The duration of ED significantly increases the risk of pullout by 39.2% for 31.4% of the respondents, while 27.5% do not consider it a risk factor and 2% do not know. Among the respondents who consider the duration of the ED as a risk factor (70.6%), the majority (16 out of 32 respondents) indicated a value of 7-10 days as critical. Interestingly, two respondents consider every day of ED as an additional risk of pullout.

Hospital stay in a service other than neurosurgery (e.g., intensive care unit) significantly increases the risk by 35.3% for 49% of the respondents; a minority of respondents (13.7%) do not consider it a risk factor or do not know (2%).

Management of ED in High-Risk Patients

Twenty out of fifty-one neurosurgeons agree that the paediatric population deserves a different device or technique to secure ED to the skin; nine respondents are unsure, and twenty-two respondents do not agree.

25% of respondents use different devices or techniques in high-risk patients. The majority (62%) use multiple sutures, eventually combined with the anti-tension loop of the catheter and adhesive dressing. Other options include a straight connector at the skin exit site warranting a more stable securement by suture, a Rickham catheter, a skin glue, or a long subcutaneous tunnelling with the exit site in the clavicle region.

In preterm babies, 19.6% of respondents use different devices or techniques. However, the description of these alternative techniques does not differ significantly in terms of the type of securement to the skin, which primarily consists of sutures, adhesive dressings or both. In general, smaller catheters and smaller sutures are preferred, with increased attention when handling the catheter. However, subcutaneous tunnelling is shorter and is not performed by some of the respondents.

Conclusions and future perspectives

Finally, based on their prior experience, participants were asked to rate the risk of dislocation or accidental pullout. 21.6% said it is not so rare and is likely underestimated, 60.8% said it is a rare complication, but precautions should be taken to avoid it, and a minority said it is extremely rare and the risk is acceptable.

As a result, the majority of the respondents (80.4%) are interested in new methods or devices to anchor the catheter to the skin.

According to the respondents, the principal characteristics of a new device/technique should be effectiveness (92.2%), easiness of use (78.4%), easiness of removal (64.7%), low price (54.9%), and other (7.8%). Another desired feature is the ability to effectively prevent CSF leaks and infections.

In conclusion, the majority of respondents (86.3%) have never read about ‘sutureless subcutaneous anchoring device’.

DISCUSSION

Sutures remain the most common method to secure CSF ventricular ED to the skin, mainly due to availability and low cost (9). Despite the introduction of several technical variants with multiple points of fixation aimed at reducing tension on the catheter and the skin, there is still a risk of accidental pullout and other complications (1,18). Because the pullout risk has received little attention in the literature, it is difficult to estimate the true incidence of this complication. According to the current survey, 3.9% of respondents believe the risk is nil, while only a quarter believe it is less than 1%. For the majority of respondents, the pullout risk ranges between 1-10%. Conversely, the proportion of respondents (11.8%) who believe the risk is greater than 10% is also significant.

In general, a consistent proportion of respondents (39.2%) identify the drawbacks of the method used to secure ED; nearly three-quarters of respondents believe that those methods may also affect the risk of infection of the catheter, CSF or both. The difficulty in cleansing the exit site and the risk of skin erosion by the sutures may clearly explain this relationship.

Additionally, the literary data shows that the replacement of ED after accidental pullout raises the risk of infection to 29%, compared to 6% in patients who had no replacement (2).

58.8% of respondents believe the risk of accidental pullout is even higher in spinal ED. This could be partly explained by the fact that subcutaneous tunnelling is used less frequently than ventricular ED.

Indeed, subcutaneous tunnelling is routinely performed for ventricular ED by almost all the respondents to the survey. The literary data clearly explains its role in preventing infections and CSF leaks (4,12,19). It may contribute to stabilising the catheter and reducing the risk of pullout, though, despite its use, a rate of complication as high as 8% has been reported in preterm babies (14). On the other hand, spinal ED is not routinely placed under sedation, and tunnelling is avoided to reduce the pain of the procedure. However, this does not dissuade neurosurgeons from using sutures to anchor the catheter.

Although there is no consensus about factors increasing the risk of pullout, most neurosurgeons acknowledge the role of some of these factors. Surprisingly, almost three-quarters of respondents (74.5%) do not use different devices or techniques in high-risk patients.

Dealing with risk factors, the majority of the respondents to the survey agree that young age represents one of them. Accordingly, more than half of the respondents (50.8%) think that paediatric patients deserve or may deserve a different technique or device to anchor ED. On the other hand, more than 80% of the respondents do not use a different device or technique when dealing with preterm babies.

The role of aetiology is less clear compared to neurological status, that is accepted a risk factor by almost 90% of respondents. The role of technical issues is even more debatable. Indeed, only 58% of respondents identify the inadequate length of subcutaneous tunnel as a risk factor and this percentage drops to 37.3% for the occipital site of ED. The adequate length of the subcutaneous tunnel is difficult to define (14). Some papers compare short versus long tunnels. However, because a long tunnel is sometimes associated with the use of a subcutaneous reservoir, which further stabilises the ED, the length of the tunnel cannot be evaluated exclusively. Furthermore, while this policy may reduce the risk of pullout, the main disadvantage is the need for additional surgical procedures to remove ED (4).

The duration of ED as a risk factor has garnered the most agreement (70.6%). This becomes even more significant by the fact that the majority of neurosurgeons believe the risk of pullout increases after 7-10 days of ED. This is partly due to the loss of tension of sutures and the risk of skin erosion. Accordingly, the necessity of a different method of securement is particularly prominent for medium to long-term indwell ED, as required for CSF infection or post-hemorrhagic hydrocephalus.

Hospital stay in a service other than neurosurgery represents a risk factor for the majority of neurosurgeons (84.3%). This highlights the need for careful training and education on the management of ED for the medical and nursing staff of intensive care units and other services dealing with neurosurgical patients harbouring ED.

Finally, the majority of the respondents appear dissatisfied with the method used to secure ED and are thus interested in new methods or devices. The characteristics of an ideal innovative solution are the same as those of all newly introduced devices in surgical practice, with a particular emphasis on increased effectiveness.

On these grounds, a sutureless subcutaneous anchoring device could represent a safe and effective option. Indeed, it represents the standard of care for medium- to long-term indwelling catheters (>5 days) in the vascular setting, leading to the complete abandonment of sutures. Furthermore, a preliminary experience published in 2016 demonstrated its effectiveness in securing CSF ED (9,10).

Quite surprisingly, although the preliminary experience with this device was published in a high impact neurosurgical journal (10) and the interest in new solutions to secure ED is significant, as confirmed by the present survey, the large majority of respondents (86.3%) have never read about it.

This raises questions about the methods currently used to spread neurosurgical knowledge. On the one hand, the abundance of journals and other online resources seems to favour the possibility of publishing and diffusing data. Conversely, the visibility of this content is significantly reduced and almost diluted by the proliferation of those same sources (8).

Furthermore, despite the fact that the results of the sutureless subcutaneous device were recently confirmed by larger data published after the acquisition of the current survey results (9), the two most recent papers with a focus on the method to anchor ED do not cite or discuss the results of this innovative solution (6,15).

On these grounds, we hope that this survey highlights the need for additional research and standardisation of the method to secure ED, and increases the visibility of this solution in the neurosurgical world.

Indeed, the outcomes of the various solutions for securing ED to the skin should be critically compared to the new benchmark represented by the sutureless subcutaneous anchoring device, which has proven to be a reliable method even in children and preterm babies (9,10).

Some neurosurgeons also stated that the ideal solution for securing ED should prevent CSF leaks. This is not usually accomplished by the securement method alone. Some technical variants involving sutures may be performed to seal the subcutaneous tunnel (16). However, care should be taken to avoid any kinking of the catheter. To achieve these results, the sutureless anchoring device may be combined with skin glue at the exit site.

CONCLUSION

The current study has inherent limitations that are common to any survey. Indeed, recall bias and observer bias are serious concerns. Additionally, it is difficult to evaluate the data with statistical methods. Thus, the results can be only used as a broad overview of the variability of practice on this specific issue and provide some valuable insight into the management of patients with ED.

However, the participation of fifty-one neurosurgeons from fifty-one different international centres depicts a reliable scenario of similar practices in the securement of CSF EDs worldwide.

This may represent an additional step in promoting the culture of ED safety. There is a need for global awareness of the issues surrounding ED management, which should favour formal training as well as continued medical and surgical education on the subject. The potential impact of ED securement on patient outcomes necessities further examination to hopefully implement effective guidelines in this field.

ACKNOWLEDGEMENTS

The authors kindly thank all the respondents: M Vinchon, UW Thomale, J Hinojosa, M Messing Junger, AO Borcek, J Goodden, T Roujeau, S Kwiatowski, K Kothbauer, T Beez, T Hauser, J Roth, F Sala, J Marquez-Rivas, C. Giussani, M. Gjurasin, E. Gimbert, J. Surchev, M Mandera, W. Brennan, AR Silva Neto, G Kahiloğullari, S de Ribaubierre, L Valentini, ML Van Veelen, F Giordano, A Ammar, T de Paiva Cavalcante, P. De Vloo, F Horn, A Peraud, N Laszlo, D Benderbous. V Baro, MJ Machado, K Apostolopoulou, WJR van Ouwerkerk, R Zorzi, M Shopov, M Schuhmann, EJ van Lindert, D Rodrigues, B Goker, D Narayanappa, MB Sürme, G Markogiannakis, N Togarepi, R Chrenko, S Chandrasekaran, I Mavridis, VE Danilin

AUTHORSHIP CONTRIBUTION

Study conception and design: PF

Data collection: CN, PF

Analysis and interpretation of results: FB, LM, GT

Draft manuscript preparation: CN, AMA

All authors (CN, AMA, LM, FB, GT, PF) reviewed the results and approved the final version of the manuscript.

REFERENCES

1. Akarca D, Durnford AJ, Ewbank FG, Hempenstall J, Sadek AR, Gould AER, Bulters DO: An evaluation of commonly used external ventricular drain securement methods in a porcine model: Recommendations to improve practice. World Neurosurgery 110: e197-e202, 2018
2. Aten Q, Killeffer J, Seaver C, Reier L: Causes, complications, and costs associated with external ventricular drainage catheter obstruction. World Neurosurgery 134:501-506, 2020
3. Cinibulak Z, Aschoff A, Apedjinou A, Kaminsky J, Trost HA, Krauss JK: Current practice of external ventricular drainage: A survey among neurosurgical departments in Germany. Acta Neurochir 158:847-853, 2016
4. Collins CDE, Hartley JC, Chakraborty A, Thompson DNP: Long subcutaneous tunnelling reduces infection rates in paediatric external ventricular drains. Childs Nerv Syst 30:1671-1678, 2014
5. Cui Z, Wang B, Zhong Z, Sun Y, Sun Q, Yang G, Bian L: Impact of antibiotic- and silver-impregnated external ventricular drains on the risk of infections: A systematic review and meta-analysis. Am J Infect Control 43:e23-e32, 2015
6. De Angelis LC, Parodi A, Sebastiani M, Consales A, Ravegnani GM, Severino M, Tortora D, Rossi A, Malova M, Minghetti D, Cama A, Piatelli G, Ramenghi LA: External ventricular drainage for posthemorrhagic ventricular dilatation in preterm infants: Insights on efficacy and failure. J Neurosurg Pediatr 28(5):563-571, 2021
7. Flint AC, Rao VA, Renda NC, Faigeles BS, Lasman TE, Sheridan W: A simple protocol to prevent external ventricular drain infections. Neurosurgery 72:993-999, 2013
8. Fontanella MM: The cobra effect: A venomous snake in the neurosurgical field. J Neurosurg Sci 62(4):381-382, 2018
9. Frassanito P, Auricchio AM, Antonucci J, Massimi L, Bianchi F, Tamburrini G: Securing CSF catheters to the skin: From sutures and bolt system to subcutaneous anchoring device towards zero complications. Childs Nerv Syst 36:2749-2755, 2020
10. Frassanito P, Massimi L, Tamburrini G, Pittiruti M, Doglietto F, Nucci CG, Caldarelli M: A new subcutaneously anchored device for securing external cerebrospinal fluid catheters: Our preliminary experience. World Neurosurgery 93:1-5, 2016
11. Fried HI, Nathan BR, Rowe AS, Zabramski JM, Andaluz N, Bhimraj A, Guanci MM, Seder DB, Singh JM: The insertion and management of external ventricular drains: An evidence-based consensus statement: A statement for healthcare professionals from the neurocritical care society. Neurocrit Care 24:61-81, 2016
12. George T, Moorthy RK, Rajshekhar V: Long tunnel external ventricular drain: An adjunct in the management of patients with infection associated hydrocephalus. Br J Neurosurg 33: 659-663, 2019
13. Hepburn-Smith M, Dynkevich I, Spektor M, Lord A, Czeisler B, Lewis A: Establishment of an external ventricular drain best practice guideline: The quest for a comprehensive, universal standard for external ventricular drain care. J Neuroscience Nursing 48:54-65, 2016
14. Leung GKK, Ng KB, Taw BBT, Fan YW: Extended subcutaneous tunnelling technique for external ventricular drainage. Br J Neurosurg 21:359-364, 2007
15. Salem MM, Ascanio LC, Enriquez-Marulanda A, Gomez-Paz S, Mackel CE, Kamel S, Moore JM, Ogilvy CS, Thomas AJ: The use of staples for external ventricular drain catheter fixation: A single-institution experience. Clin Neurol Neurosurg 207:106761, 2021
16. Tailor JK, Kulkarni AV: Stopping CSF leaks at external ventricular drain exit sites: A technical note. Childs Nerv Syst 36:2841-2844, 2020

17. Velásquez C, Rivero-Garvía M, Mayorga-Buiza MJ, Cañizares-Méndez M de los Á, Jiménez-Mejías ME, Márquez-Rivas J: Avoiding pullout complications in external ventricular drains: Technical note. JNS 126:1003-1005, 2017
18. Whitney NL, Selden NR: Pullout-proofing external ventricular drains: Technical note. PED 10:320-323, 2012
19. Zhou YJ, Wu JN, Chen LJ, Zhao HY: Comparison of infection rate with tunneled vs standard external ventricular drainage: A prospective, randomized controlled trial. Clin Neurol Neurosurg 184:105416, 2019