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Risk factors for unplanned readmissions in paediatric neurosurgery: a systematic review protocol

Lance Vincent Caburian Sese [1,2] Ma Celina Legaspi Guillermo [3]

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[1]Department for Continuing Education, University of Oxford, Oxford, UK
[2]Nuffield Department of Primary Care Health Sciences, University of Oxford, Oxford, UK
[3]Ateneo School of Medicine and Public Health, Ateneo de Manila University, Pasig City, Philippines

Correspondence to
Dr Lance Vincent Caburian Sese; lance.sese@kellogg.ox.ac.uk

ABSTRACT

Introduction Unplanned hospital readmission (UHR) following surgical procedures reflects patient outcomes. While adult readmission studies are abundant, limited research exists in paediatric populations, especially in the context of neurosurgery.

Methods and analysis This protocol outlines a systematic review aimed at identifying reasons for unplanned readmissions (30-day and 90-day readmissions) and risk factors following paediatric neurosurgical procedures. Narrative synthesis, sensitivity analyses, subgroup analyses, and meta-analysis, when appropriate, will be done.

Ethics and dissemination There are no primary data involved and no access to confidential patient information. The findings aim to contribute to refining clinical practice, enhance patient counselling, and optimise healthcare resource utilisation in paediatric neurosurgical care.

PROSPERO registration number CRD42023455779.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Unplanned hospital readmissions following paediatric neurosurgical procedures pose challenges, but literature in this domain remains limited. Current research primarily focuses on adult populations, leaving gaps in understanding the complexities and risk factors specific to paediatric neurosurgical cases, where complications frequently arise.

WHAT THIS STUDY HOPES TO ADD

⇒ We aim to do a comprehensive investigation into the causes and risk factors associated with unplanned readmissions after paediatric neurosurgical procedures. By analysing existing literature, we will provide evidence that can inform clinical practice and contribute to minimising unplanned readmission rates in this vulnerable population.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE, OR POLICY

⇒ Findings could lead to more effective resource allocation within healthcare systems. For instance, if the study highlights a correlation between unplanned readmissions and specific procedure types, hospitals might consider refining protocols for postoperative monitoring, discharge, and follow-up for patients undergoing those procedures.

INTRODUCTION

Unplanned hospital readmission (UHR) after undergoing a surgical procedure has increasingly been used as a success indicator and increasing trends tend to depict higher medical costs. This represents the instance when a patient must be admitted again in the hospital following initial discharge. While most readmission studies were done in adult populations, there remained a limited pool of studies being done in children. Children, in particular the younger age group, are at a higher risk of developing complications in the postoperative period.[1] Younger children are often more vulnerable to complications postoperatively.[2 3] Their developing bodies react differently to procedures, medications and postoperative care. This unique aspect adds complexity in understanding and managing unplanned readmissions following surgery. In a nationwide study done on children in the USA,[4] between 2013 and 2014, 5041 children (n=3.9%) underwent unplanned readmission after their index operation. Of these, readmission rates were seen to be the highest in neurosurgery (10.8%).[4]

Paediatric neurosurgery often deals with complex neurological conditions, some of which might also require multiple interventions over time, both planned and unplanned. This complexity increases the likelihood of potential complications and the subsequent need for readmission. In line with this, the study aims to answer the following question: in children who underwent a neurosurgical procedure, the presence of which factors increases the risk of having a 30-day and 90-day UHR post surgery?

Neurosurgical procedures done in children are complex interventions that often involve the skull, brain, vertebral column, spinal cord and peripheral nerves. UHRs occurring within 30 or 90 days represent instances where complications or other medical issues may have occurred prompting the patient to

return to the hospital and be readmitted. In two different studies by Cusimano *et al*,[5 6] they looked at readmission in patients after neurosurgery of the spine and cranial procedures respectively. They found that age and preoperational comorbidities to be significant predictors for spine procedures while complications arising during or after the index procedure were significant for cranial procedures. Furthermore, readmission after surgery was seen to be associated with postdischarge complications often relating to the index procedure.[7 8] With many neurosurgical procedures falling under craniotomy procedures, cerebrovascular procedures, and spinal procedures, complications during the perioperative stages remain high resulting in high mortality and morbidity.[9] Furthermore, neurosurgical complications within the first 30 days happening in children tend to be frequent, with reported complication rate as high as 20%.[10] Some examples include haemorrhage, neurological deficits, procedure-related complications such as shunt malfunction and cerebrospinal fluid leak.[10] However, complications can still be expected up until 90 days post discharge. Hospital-acquired and surgical site infections also pose a risk, especially for a vulnerable age group such as children.[11 12] Unplanned readmissions also pose a burden to the financial capability of the institution or the patient. Readmission costs can be as expensive as the index hospitalisation.[13]

The purpose of this study is to identify reasons for readmission, and systematically review risk factors associated with unplanned readmission or reoperation following a neurosurgical procedure. Specifically, the study has three objectives.

1. Determine the prevalence or incidence of unplanned readmissions in paediatric neurosurgical patients.
2. Identify risk factors and reasons for unplanned readmissions in paediatric neurosurgery.
3. Offer insights to improve paediatric neurosurgical care and reduce unplanned readmission rates to ultimately improve patient outcomes.

The findings of this study will provide insights into areas for improvement in neurosurgical care in children, aid in patient counselling, and help healthcare providers in better identifying high-risk patients. First, results from the study can help identify areas for improvement in hospital care and contribute to refining surgical protocols. By looking into these risk factors, healthcare practitioners can gain insights on specific complications that arise within 30 or 90 days and can develop strategies on how to mitigate them.[14–16] Protocols in hospitals, in particular postoperative pathways, can be improved where these risk factors play a significant role.[17 18] Second, identification of risk factors can help in patient counselling.[19] If certain procedures are deemed to have a high risk of readmission within a specific period, healthcare providers can inform patients and their families during the preoperative period. Lastly, by being able to pinpoint high-risk paediatric patients, healthcare providers transition from reactive responses to proactive measures.[20] For example, more vigilant postdischarge monitoring and close coordination with the patient's family can ensure adherence to postoperative guidelines for these high-risk patients. These targeted strategies can effectively mitigate the likelihood of unplanned readmissions.[20] Ultimately, conclusions drawn from the study can potentially lead to better patient outcomes and a more efficient use of healthcare resources.

METHODOLOGY AND ANALYSIS

The systematic review will adhere to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses checklist. The systematic review will be carried out according to the Cochrane Handbook for Systematic Reviews.[21] The following (table 1) will be used as the eligibility criteria for studies to be included.

Information sources

To ensure comprehensive coverage, various sources will be used such as medical databases and grey literature. After consultation with an information specialist, since the research question is surgical in nature, Medline, Embase and CINAHL are the high-yield databases that will be searched. These are medical and surgical databases that are likely to contain the studies on interest. Grey literature such as conference abstracts (Science Citation Index via Web of Science), theses (Proquest Dissertations & Thesis Global), reports (Overton), and preprints (medRxiv or Europe PMC) may also be considered. However, looking through all these can be time-consuming and inefficient. If articles found in grey literature are deemed relevant, another problem arises since assessing their quality is challenging. These articles possibly did not undergo a rigorous peer review process. Databases which include non-English literature such as Global Index Medicus, Fuente Academica and MedicLatina will also be considered. However, hand searching, which involves manual searching of articles in journals and websites, will not be done. This is particularly relevant in niche topics where electronic databases may not capture such studies.

The literature search for all the main databases will be done on the same day and results will be imported to a reference manager software such as EndNote. No language and publication date filters will be applied. For Non-English studies, translation software or online tools (such as Google Translate or DeepL) will be used to translate such studies to English.

Search strategy

The search strategy that will be used can be seen in online supplemental material 1. Support was sought through the university's research librarian regarding the validity of the search strategy. The Medline via Ovid search strategy will be adapted to the other databases.

Table 1 Eligibility criteria

Inclusion criteria	
Population	Paediatric patients (<18 years old) who underwent a neurosurgical procedure
Exposure	Type of neurosurgical procedure Number (or percentage) of patients readmitted with their characteristics Risk factors for readmission (ideally, factors that are known while patient is admitted)
Comparisons	None
Outcome of Interest	Readmission or reoperation within 30 days and 90 days after index neurosurgical procedure
Timing	Including all studies up to the present
Setting	Single and multicentre studies; hospital admissions Worldwide
Study designs	Expected to include observational studies but controlled trials may only be included if the intervention being studied is the index neurosurgical procedure. In this case, only data from the group which has undergone a neurosurgical procedure will be included.
Exclusion criteria	
Studies reporting planned readmission or reoperation such as second-look surgery Studies that reported readmission as a part of a composite outcome or an index Studies where the full text is not available despite extensive efforts in procuring Qualitative studies, case reports, case studies, case series, and commentaries	

Study variables

The main risk factor that will be investigated in the study is the type of neurosurgical procedure done on the central and peripheral nervous system in children, encompassing both the procedure itself and its underlying indication. Other risk factors such as (but not limited to) age group, type of surgery, length of hospital stay, presence of other comorbidities, and admission to critical care will also be examined.

The main outcome is UHR. It is defined as any unplanned readmission for any reason within 30 days and 90 days of the index or principal surgical procedure. The readmission must be classified as an 'inpatient' stay by the readmitting hospital or reported by the patient/family.[11 13 22]

Secondary outcomes include prevalence and/or incidence rates of different indications for readmission or reoperation. The study also aims to include adverse events reported within the studies that are included in the analysis.

Data extraction and selection process

A proposed timeline for the conduct of the study can be found in online supplemental material 2. Data will be extracted from included studies by two reviewers to ensure accuracy. The reviewers should ideally have some background knowledge in medicine and health research. The following information will be extracted whenever applicable: study description (author, year of publication, setting, study design, sample size), patient characteristics (age, sex, ethnicity), type of neurosurgical procedure, indication for the index neurosurgical procedure, number and reason for unplanned readmissions, mean or median length of stay in days in the hospital, percentage of patients who stayed in the intensive therapy unit, percentage of those who had postoperative complications, and risk factors (both unadjusted and adjusted) associated with unplanned readmissions. A data extraction form will be drafted and pilot tested for five articles. This will be done independently by two reviewers who will deliberate to see whether it captures the required data. This will be an iterative process until a consensus is reached where both reviewers agree that the form is ready to be used.

Search results will be tabulated using EndNote. Corresponding authors of respective studies will be contacted if any relevant data is missing. Multiple reports of the same study will be linked together. The Rayyan software will also be used for the purposes of data screening, collection and management in this study. This platform will facilitate systematic handling of numerous studies since it also allows collaborators to efficiently access the review.

Quality assessment

To assess the quality of the studies in this review, the Newcastle-Ottawa Scale (NOS) will be used for observational studies such as cross-sectional studies, case-control studies and cohort studies. It was created to evaluate the quality of non-randomised studies and was designed to be user-friendly for integrating quality assessments into meta-analyses.[23] NOS uses a 'star system' where it rates studies based on three main aspects: group selection, group comparability and exposure or outcome ascertainment in case-control or cohort studies, respectively.[23]

Whenever applicable, Quality in Prognostic Studies[24] and Risk of Bias (ROB) in Non-randomized Studies of Intervention[25 26] tools will be used to assess prognostic studies and intervention studies respectively.

The Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) approach will also be included into the quality assessment since this can provide a robust framework for evaluating the quality of

evidence. By applying GRADE's five domains for rating down confidence in effect estimates, including ROB, imprecision, inconsistency, indirectness and publication bias, as well as criteria for rating up quality, the systematic review will have standardised approach in determining confidence in estimates of overall prognosis based on risk factors[27] of children who underwent a neurosurgical procedure.

Any disagreements between the two reviewers will be resolved through discussion and consensus. If a consensus cannot be reached, a third senior reviewer with expertise in systematic reviews will be consulted to make the final decision. We will document any inter-rater discrepancies and their resolutions in the final manuscript.

Data synthesis

To synthesise qualitatively the findings of the included studies, a narrative synthesis will be conducted. It will provide a comprehensive and coherent understanding of the evidence base and will highlight similarities and differences in the findings across studies regarding unplanned readmissions in paediatric neurosurgery.

Risk factors will be also tabulated along with their respective odds ratios (ORs) or relative risks (RRs) and whether these were significant in their respective studies. This will offer a structured and quantitative representation of the factors contributing to unplanned readmissions.

Sensitivity analysis, subgroup analysis and meta-analysis

These analyses will be carried out where and when appropriate. Sensitivity analyses will be done by excluding studies with high ROB or studies with very small sample sizes. Subgroup analysis will be performed if included studies have data feasible for this. These will be done a priori to avoid misleading results. Proposed subgroups include the following:

1. Study design (cross-sectional, case-control, cohort studies).
2. Paediatric age group (newborn, infant, school age, adolescents).
3. Type of neurosurgical procedure.
4. Comorbidities.
5. Hospital admission characteristics (presence of health insurance, length of stay, admission to critical care).
6. Location characteristic (geographic, single or multicentred studies).
7. Duration of unplanned readmission (30-day, 90-day readmissions).

If applicable, a meta-analysis using Review Manager (RevMan) or Stata will be done once data extraction has been finished. ORs or RRs and their respective 95% confidence intervals will be pooled with a random-effects model. Heterogeneity will be assessed using i^2 statistics. A flow chart of the review and forest plots of included studies, if applicable, will be generated.

Patient and public involvement

Patients will not be involved in the conduct of the systematic review.

ETHICS AND DISSEMINATION

There is no ethical approval sought in the conduct of the study since there are no primary data involved, no human or animal participation involved, and no access to confidential patient information. The researchers also do not have any conflict of interest. If a conflict of interest will be identified, it will be managed by recusal from relevant decision-making processes, such as during screening, data extraction, and quality assessment. This will also be reported in the final manuscript. The protocol is also currently registered in PROSPERO with registration number CRD42023455779. Results will be disseminated through presentation in relevant conferences and publication in peer-reviewed paediatric and neurosurgical journals.

DISCUSSION

In this study, potential meta-biases include publication bias and selective reporting. Funnel plots will be generated if 10 or more studies meet the eligibility criteria. Afterwards, Egger's regression may be used to quantify publication bias. Authors may also be contacted to encourage full disclosure and request for additional data where findings may be questionable. If feasible, published study protocols and their corresponding final manuscripts will also be compared to detect any selective reporting discrepancies.

The conduct of this study is also not without limitations and challenges. We recognise that most of the studies that will be included are observational in nature. The variability in the definitions of the exposures and outcomes, measurements and reporting among different healthcare institutions across the world may lead to heterogeneity in data, impacting the comparability of study findings. This may also hinder the probability of doing a meta-analysis later. The possible paucity of studies in a specific field may also present as a challenge which restricts the pool of eligible research. Addressing these will require a well-thought search strategy and approach to data analysis.

Twitter Lance Vincent Caburian Sese @sirlancelot141

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ORCID iDs
Lance Vincent Caburian Sese http://orcid.org/0000-0002-4808-1810
Ma Celina Legaspi Guillermo http://orcid.org/0000-0001-6840-3023

REFERENCES

1 Miller R, Tumin D, Tobias JD, *et al*. Estimating surgical risk in younger and older children with congenital heart disease. *J Surg Res* 2018;232:298–307.
2 Edomwonyi NP, Ekwere IT, Egbekun R, *et al*. Anesthesia-related complications in children. *Middle East J Anaesthesiol* 2006;18:915–27.
3 Gobbo Braz L, Braz JRC, Módolo NSP, *et al*. Perioperative cardiac arrest and its mortality in children. A 9-year survey in a Brazilian tertiary teaching hospital. *Pediatric Anesthesia* 2006;16:860–6. 10.1111/j.1460-9592.2006.01876.x Available: https://onlinelibrary.wiley.com/toc/14609592/16/8
4 Kulaylat AN, Rocourt DV, Tsai AY, *et al*. Understanding Readmissions in children undergoing surgery: A pediatric NSQIP analysis. *J Pediatr Surg* 2018;53:1280–7.
5 Cusimano MD, Pshonyak I, Lee MY, *et al*. A systematic review of 30-day readmission after cranial Neurosurgery. *J Neurosurg* 2017;127:342–52.
6 Cusimano MD, Pshonyak I, Lee MY, *et al*. Causes of 30-day readmission after Neurosurgery of the spine. *J Neurosurg Spine* 2016;24:281–90.
7 Merkow RP, Ju MH, Chung JW, *et al*. Underlying reasons associated with hospital readmission following surgery in the United States. *JAMA* 2015;313:483–95.
8 Alsaigh SH, Airuwaili KR, Alsaleh LI, *et al*. Hospital readmission after surgery: rate and predisposing factors (retrospective study). *Int J Med Res Health Sci* 2020;9:1–7.
9 Sarwal A. Neurologic complications in the postoperative Neurosurgery patient. *Continuum (Minneap Minn)* 2021;27:1382–404.
10 van Lindert EJ, Delye H, Leonardo J. Prospective review of a single center's general pediatric neurosurgical intraoperative and postoperative complication rates. *J Neurosurg Pediatr* 2014;13:107–13.
11 Sherrod BA, Johnston JM, Rocque BG. Risk factors for unplanned readmission within 30 days after pediatric Neurosurgery: a nationwide analysis of 9799 procedures from the American college of Surgeons national surgical quality improvement program. *J Neurosurg Pediatr* 2016;18:350–62.
12 Sherrod B, Rocque B. Morbidity associated with 30-day surgical site infection following Nonshunt pediatric Neurosurgery. *J Neurosurg Pediatr* 2017;19:421–7.
13 Chotai S, Guidry BS, Chan EW, *et al*. Unplanned readmission within 90 days after pediatric Neurosurgery. *J Neurosurg Pediatr* 2017;20:542–8.
14 Kehlet H, Wilmore DW. Multimodal strategies to improve surgical outcome. *Am J Surg* 2002;183:630–41.
15 Zheng C, Zhou H, Zhu H, *et al*. Understanding unplanned Readmissions for children undergoing surgery in a single pediatric general surgical Department. *BMC Pediatr* 2019;19:340.
16 Lushaj EB, Hermsen J, Leverson G, *et al*. Beyond 30 days: analysis of unplanned Readmissions during the first year following congenital heart surgery. *World J Pediatr Congenit Heart Surg* 2020;11:177–82.
17 Jain A, Puvanesarajah V, Menga EN, *et al*. Unplanned hospital Readmissions and Reoperations after pediatric spinal fusion surgery. *Spine (Phila Pa 1976)* 2015;40:856–62.
18 Kato S, Dear T, Lewis SJ. Factors affecting length of stay following 3-column spinal Osteotomies in pediatric patients. *Global Spine J* 2021;11:154–60.
19 dosLR, Maksoud-Filho JG, Tannuri U, *et al*. Fatores Prognósticos E Sobrevida em Recém-Nascidos com Hérnia Diafragmática Congênita [Prognostic factors and survival in neonates with congenital diaphragmatic hernia]. *J Pediatr (Rio J)* 2003;79:81–6.
20 Drake JM, Riva-Cambrin J, Jea A, *et al*. Prospective surveillance of complications in a pediatric Neurosurgery unit. *J Neurosurg Pediatr* 2010;5:544–8.
21 Higgins JPT, Thomas J, Chandler J, *et al*. Cochrane Handbook for systematic reviews of interventions version. 2022. Available: www.training.cochrane.org/handbook
22 American College of Surgeons. *User Guide for the 2020 ACS NSQIP Pediatric Participant Use Data File*. Chicago: American College of Surgeons, 2021. Available: https://www.facs.org/media/ccfk0yok/peds_nsqip_userguide_2020.pdf
23 Wells G, O'Connell D, Peterson J, *et al*. The Newcastle-Ottawa scale (NOS) for assessing the quality of Nonrandomised studies in meta-analyses. 2021. Available: https://www.ohri.ca/programs/clinical_epidemiology/oxford.asp
24 Cochrane Methods. QUIPS tool. 2023. Available: http://methods.cochrane.org/sites/methods.cochrane.org.prognosis/files/uploads/QUIPS%20tool.pdf
25 Cochrane Methods. Robins-I tool. 2023. Available: https://methods.cochrane.org/robins-i
26 Risk of Bias. Robins-I tool. 2016. Available: https://www.riskofbias.info/welcome/home/current-version-of-robins-i/robins-i-tool-2016)
27 Iorio A, Spencer FA, Falavigna M, *et al*. Use of GRADE for assessment of evidence about prognosis: rating confidence in estimates of event rates in broad categories of patients. *BMJ* 2015;350:h870.