Efficacy of the implementation of the National Emergency X-Radiography Utilization Study II decision rule to clinical practice for paediatric head injury patients

Hautala, Maria

2021-07

Hautala , M , Koskela , U , Pokka , T , Rantala , H , Uhari , M , Serlo , W & Mikkonen , K 2021 , ' Efficacy of the implementation of the National Emergency X-Radiography Utilization Study II decision rule to clinical practice for paediatric head injury patients ' , Acta Paediatrica , vol. 110 , no. 7 , pp. 2200-2205 . https://doi.org/10.1111/apa.15859

http://hdl.handle.net/10138/340430
https://doi.org/10.1111/apa.15859

Received: 1 December 2020 | Revised: 3 March 2021 | Accepted: 25 March 2021

DOI: 10.1111/apa.15859

ACTA PÆDIATRICA NURTURING THE CHILD WILEY

REGULAR ARTICLE

Efficacy of the implementation of the National Emergency X-Radiography Utilization Study II decision rule to clinical practice for paediatric head injury patients

Maria Hautala[1] | Ulla Koskela[1] | Tytti Pokka[1] | Heikki Rantala[1] | Matti Uhari[1] | Willy Serlo[1] | Kirsi Mikkonen[1,2]

[1]PEDEGO Research Unit (Research Unit for Pediatrics, Dermatology, Clinical Genetics, Obstetrics and Gynecology), Medical Research Center Oulu (MRC Oulu), Oulu University Hospital, University of Oulu, Oulu, Finland

[2]Epilepsia Helsinki, Division of Child Neurology, Children's Hospital, and Pediatric Research Center, Helsinki University Hospital and University of Helsinki, Helsinki, Finland

Correspondence
Maria Hautala, Department of Paediatrics and Adolescence, University Hospital of Oulu, P.O. Box 23, Oulu 90029, Finland.
Email: maria.hautala@ppshp.fi

Funding information
This study was supported by the Special State Grants for Health Research in the Department of Pediatrics and Adolescence, Oulu University Hospital, Finland.

Abstract

Aim: To investigate the usefulness of the National Emergency X-Radiography Utilization Study (NEXUS) II head trauma decision rule in clinical practice for paediatric patients in a tertiary university hospital serving as the only paediatric hospital in the area.

Methods: We compared how doctors evaluated and examined patients with head injury during two time periods, before and after the introduction of NEXUS II decision rule. Multiple implementation strategies were used as follows: education, tutoring and written instructions for the use of NEXUS II.

Results: Two hundred and forty-four head injury patients visited the hospital before and 385 after the introduction of the NEXUS II decision rule. The number of hospital admissions (56%) and the mean duration of hospitalisation (2.5 days) remained the same during the two periods. In the NEXUS II evaluated group, there was a decrease of 40% in the number of hospital admissions. NEXUS II was applied in only 62 (16%) cases. The number of head imaging procedures remained the same. No patients with a clinically significant head injury were missed with the NEXUS II evaluation.

Conclusion: NEXUS II was ineffective as our implementation failed. When used, NEXUS II reduced expenses in our study population by decreasing the number of hospital admissions.

KEYWORDS
brain injury, clinical decision rule, head trauma, implementation, National Emergency X-Radiography Utilization Study II

Key notes

- The acceptance of National Emergency X-Radiography Utilization Study (NEXUS) II decision rule was low despite of the multiple implementation strategies.
- When NEXUS II was used, it decreased the number of hospital admissions.
- NEXUS II seemed safe in our small sample of paediatric patients with head injuries.

Abbreviations: CI, confidence interval; CT, computed tomography; DAI, diffuse axonal injury; GCS, Glasgow Coma Scale; ER, emergency room; MRI, magnetic resonance imaging; NEXUS II, National Emergency X-Radiography Utilization Study II; RCT, randomised clinical trial; SD, standard deviation; SND, standardised normal deviation.

1 | INTRODUCTION

Clinical practice guidelines, including decision rules, are increasingly common in clinical care. Evidence-based guidelines are assumed to improve the quality of health care. However, there are numerous barriers to the implementation of a new guideline in clinical practice.[1–3] Most implementation interventions have induced modest to moderate improvements in health care in randomised clinical trials (RCTs).[4,5] Multiple strategies must be used to inform the physicians, and there must be sufficient peer and superior support.[6]

Head injury is a common reason for an emergency hospital visit and is one of the most common potentially harmful injuries in children. Paediatric patients sometimes develop intracranial bleeding following the injury and exhibit only mild symptoms in the beginning[7]; therefore, they are frequently admitted for observation and imaging.[8] Head imaging of these patients using computed tomography (CT) is more cost-effective than hospital admission[9]; nevertheless, CT scans also involve risks, such as exposure to ionising radiation,[10] and imaging may require the administration of procedural sedation.[11,12]

The National Emergency X-Radiography Utilization Study (NEXUS) II rule is a head injury clinical decision rule developed for all blunt head injuries in adults and children.[13] In our previous retrospective survey, its use would have resulted in 18% fewer hospitalisations, 14% fewer days of hospital stay and $30,600 annual savings, without compromising patient prognoses.[14] NEXUS II also appeared to be one of the most powerful predictors of intracranial injury in a meta-analysis with a sensitivity of 96%–99% and a specificity of 15%–21%.[8] We wanted to examine the efficacy of NEXUS II after introducing it for clinical practice on head injury. Further, we aimed to determine whether the use of the NEXUS II decision rule would be safe for our patients. True validation of the decision rules can only be obtained by evaluating them as a part of real-life decision-making by clinicians.

2 | MATERIALS AND METHODS

This study was a prospective comparative observational study; wherein, the researchers did not approach the patients. Written consent was waived because the ethics committee of the University of Oulu Medical Faculty concluded that it was not necessary to evaluate the study protocol, as Oulu University Hospital administration approved the introduction of the NEXUS II decision rule to clinical use. The study was conducted at the Department of Pediatrics and the Department of Surgery at Oulu University Hospital, Oulu, Finland from October 7 2010 to November 6 2014. Oulu University Hospital serves as a tertiary hospital for the Northern Finland and a primary hospital for our region. The hospital's primary catchment area has a population of 85,000 children, and the secondary catchment area has 148,000 children. The study included all paediatric patients (age 0–16 years) who visited the hospital for any head injury during the study period. Paediatric patients with high energy injuries and patients requiring surgical evaluation for their other injuries were triaged to the surgical emergency room (ER) serving patients of all ages, otherwise to the Paediatric ER. The ER staff consisted of paediatric and surgical trainees and specialists.

The study consisted of two periods (Figure 1). From October 7 2010 to October 31 2012, the physicians worked as usual and were not informed about any intervention (Period 1). The head injury patients were treated in accordance with the Finnish national guideline. We introduced the NEXUS II decision rule to the physicians and nurses of the Department of Pediatrics November first 2012 and to the surgeons of the Department of Surgery on May 7 2013 (Period 2). During the period 2 to November 6 2014, the physicians of the ERs were instructed to make all decisions regarding the diagnostic brain imaging and observation of head injury patients based on the NEXUS II clinical decision rule. The study personnel identified the patients from the hospital's

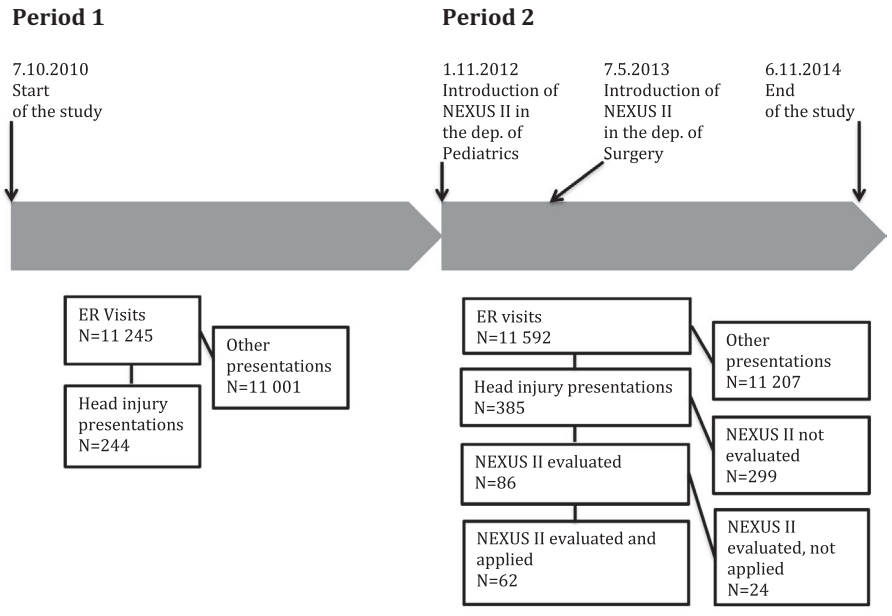

FIGURE 1 Flow chart of the study

electronic medical records regularly in 3-month intervals to gather patient data and documentation data by performing a search using the head injury diagnostic codes (International Classification of Diseases-10, S06.0 to S06.9).

We reminded the staff of the study regularly at least every 3 months in the Pediatric Department's meetings using a short PowerPoint slide show of the study protocol. In the Surgical Department, we gave the oral presentation only once. We provided the ERs and the wards with written instructions for the NEXUS II evaluation. In case of difficulties with the procedure, tutoring was offered. We did not monitor the staff's attendance to the information sessions.

If at least one of the seven NEXUS II criteria (evidence of significant skull fracture, altered level of alertness, neurological deficit, persistent vomiting, presence of scalp haematoma, abnormal behaviour, and coagulopathy) was fulfilled, brain imaging, preferably head CT or MRI, was recommended. Patients with no signs of traumatic brain injury on the scan could be discharged, depending on the need for hospital observation for other reasons or symptoms, such as persistent vomiting. If there were signs of traumatic brain injury, the patients were treated according to the hospital policy. A radiologist evaluated all the scans, and during the next office hours, also a radiologist trained to interpret brain images re-evaluated them. The physicians were instructed to document the NEXUS II evaluation in the electronic medical records. They were also instructed to document whether the rule was applied in the patient's medical care.

The patient data included the demographic features, injury date, detailed injury mechanism, posttraumatic symptoms (headache, vomiting, neurologic deficits, disorientation, confusion, dizziness, fatigue, seizure and urinary incontinence), length of loss of consciousness, pre- and posttraumatic amnesia duration, on-arrival physical examination results, Glasgow Coma Scale (GCS) score, NEXUS II evaluation results, brain imaging results, hospital admission and stay duration, neurosurgical procedures, revisits and control visits, neurologic disability and death. We classified the traumas into three groups according to the sequelae: patients with uncomplicated head trauma (no sequelae or a concussion), patients with complicated head trauma (a brain contusion, a skull base fracture, or a skull fracture) and those with severely complicated head trauma (patients who required neurosurgical intervention; those with an epidural haematoma, a subdural haematoma, a subarachnoidal haematoma, or an intracerebral haematoma; and patients who succumbed).

2.1 | Outcomes

The primary study outcome was the efficacy of the NEXUS II clinical decision rule, that is the difference in the number of hospital admissions and the length of stay between the two periods. The number of patients evaluated and treated according to the guideline was analysed to clarify the efficacy of the implementation. Secondary outcomes were the number of imaging studies conducted and whether any patients with a clinically important head injury were missed with this protocol.

2.2 | Data analyses

The main variables of the two study periods were compared. Continuous variables were tested using Student's *t*-test. Comparisons of the categorical variables were performed using standardised normal deviation (SND) tests. The main results were expressed as means or proportions with 95% confidence interval (CI) of the difference between means or proportions. Statistical analyses were conducted using IBM SPSS Statistics version 22 (IBM Corp.).

3 | RESULTS

3.1 | Demographic data

In total, 629 paediatric patients visited the hospital because of a head injury; of these, 244 patients visited before (Period 1) and 385 after the introduction of the NEXUS II rule (Period 2) (Table 1). There were no significant differences in any of the baseline clinical characteristics of the patient groups during the two study periods. Majority of the patients were boys 364 (58%), and the mean age of the study population was 7.8 years (SD 4.9 years). The occurrence of uncomplicated, complicated and severely complicated trauma was 92% (n = 580), 3% (n = 22) and 4% (n = 27), respectively. The most common injury mechanism was falling 220 (35%) (Table 1). There were minor differences in the injury mechanisms of the patients who visited the Surgical and Pediatric ERs because of the triage policy of our hospital; however, there was no statistically significant difference in the severity of brain injury between the patients in the ERs.

3.2 | The efficacy of the NEXUS II clinical decision rule

The number of hospital admissions remained the same in period 1 [137 (56%)] and in period 2 [216 (56%)]. The mean duration of hospitalisation was 2.5 days [standard deviation (SD) 8.3 days] for both periods. The difference between the hospital admissions in the NEXUS II evaluated and not evaluated groups was statistically significant [decrease of 47%, confidence interval (CI) 95% 56–35, $p \leq 0.001$], as was the difference between NEXUS II evaluated patients and the patients in period 1 (decrease of 40%, CI 95% 50–27, $p \leq 0.001$) (Table 2). The minimal daily cost of hospitalisation in our hospital is $705 per patient. Assuming the duration

TABLE 1 Demographic characteristics of the patients with head injury in study period 1 (before the use of NEXUS II) and period 2 (after the introduction of NEXUS II)

	Period 1	Period 2		
			NEXUS evaluated	
	All	All	Yes	No
Characteristics	***N* = 244**	***N* = 385**	***N* = 62**	***N* = 323**
Age, years mean, (SD)	7.6 (4.9)	7.9 (5.0)	6.8 (4.7)	8.1 (5.0)
Male, *n* (%)	134 (55)	230 (60)	44 (71)	186 (58)
Injury mechanisms				
Falling, *n* (%)	87 (36)	133 (35)	26 (42)	107 (33)
Sports, *n* (%)	36 (15)	83(22)	8 (13)	75 (23)
Road Traffic, *n* (%)	29 (12)	35 (10)	1 (2)	34 (11)
Bicycle crash, *n* (%)	10 (4)	16 (4)	3 (5)	13 (4)
Violence, *n* (%)	4 (2)	15 (4)	2 (3)	13 (4)
Other, *n* (%)	78 (32)	99 (26)	22 (36)	77 (24)
Unknown, *n* (%)	0	4 (1)	0	4 (1)
Severity of brain injury[a]				
Uncomplicated, *n* (%)	220 (90)	360 (94)	59 (95)	301 (93)
Complicated, *n* (%)	9 (4)	13 (3)	2 (3)	11 (3)
Severely complicated, *n* (%)	15 (6)	12 (3)	1 (2)	11 (3)

Note: Uncomplicated head trauma: no sequelae or a concussion complicated head trauma: a brain contusion, a skull base fracture or a skull fracture severely complicated head trauma: patients who required neurosurgical intervention; patients who had an epidural haematoma, a subdural haematoma, a subarachnoidal haematoma, or an intracerebral haematoma; and patients who succumbed.

aSeverity of brain injury.

of unnecessary hospitalisation was 1 day and that the NEXUS II would have been used in period 1 leading in 40% less hospitalisations, the use of the rule would have enabled an annual saving of at least $35,000.

3.3 | The efficacy of the implementation of the NEXUS II clinical decision rule

The NEXUS II rule was evaluated and applied on arrival only for 62 (16.1%) patients. 55/156 (35%) of the patients from the Pediatric ER were correctly evaluated and reported in medical records by the means of NEXUS II. In the Surgical ER, only 7/225 (3%) patients were evaluated with the NEXUS II. Altogether, 71% of the patients evaluated were male compared with 58% in the not evaluated group. Other than that, there were no significant differences in the baseline characteristics of patients evaluated compared with the ones not evaluated (Table 1).

3.4 | The safety of the NEXUS II clinical decision rule

In the acute phase, brain imaging with CT was performed for 44 (18%) patients in period 1 and 69 (18%) patients in period 2. The head CT imaging number for the NEXUS II evaluated group was 15 (24%); this was not significantly different from that of the non-evaluated patients (Table 2). None of the patients with a clinically relevant head trauma were missed using the NEXUS II evaluation. Altogether, 12 patients were either returned or recalled (Table 2) but none of them required further actions. The number of revisits was low; therefore, an accurate and meaningful statistical comparison between separate groups was not possible. During the study period, one patient died due to multiple injuries sustained in a traffic accident; the NEXUS II evaluation was not performed for this patient.

4 | DISCUSSION

In our study, NEXUS II appeared ineffective. The number of hospital admissions and the mean duration of hospitalisation remained the same before and after implementation. The main reason for this was the low compliance for a new evidence-based decision rule; NEXUS II was evaluated and applied in only 62 (16%) cases. In our small sample of correctly evaluated patients, the NEXUS II guideline reduced hospital admissions and indirectly also the expenses, without compromising patient safety.

The end point of our study was that NEXUS II was ineffective when it was brought to real-life clinical work. This resulted from the complete failure in the implementation, which happened despite quite extensive efforts. We did extensive and regular reminders to the staff and provided the staff with simple written instructions that were always readily available. A study physician was available for tutoring in case of problems with the procedure, and we had complete support from the superiors. Most implementation interventions have indeed induced only modest to moderate improvements in health care in randomised clinical trials (RCTs).[4,5] According to meta-analyses, the most convincing evidence for effective implementation of clinical guidelines is for the use of multifaceted interventions, interactive education and clinical reminder systems. Didactic education and passive dissemination strategies such as providing the guideline to clinicians in printed form seem ineffective.[15]

In a study of Scandinavian guidelines of head injury, a compliance of 50% improved to 70% after communicating the previous results to the staff and creating a feed-back loop training programme.[1,16] Combining workflow-based implementation methods, for example computer reminders with the traditional

TABLE 2 The effect of the introduction of NEXUS II for clinical practice in paediatric head injury patients for hospitalisation and brain imaging in study period 1 (P1, before the use of NEXUS II) and study period 2 (P2, after the introduction of NEXUS II). P2yes refers to the Nexus evaluated patients and P2no to the non-evaluated patients

	Period 1	Period 2								
		NEXUS evaluated								
		All	Yes	No	P2 vs. P1		P2yes vs. P1		P2yes vs. P2no	
	N = 244	*N* = 385	*N* = 62	*N* = 323	Difference		Difference		Difference	
Characteristics	*n* (%)	*n* (%)	*n* (%)	*n* (%)	(95% CI)	*p*-value	(95% CI)	*p*-value	(95% CI)	*p*-value
Hospitalisation	137 (56)	216 (56)	10 (16)	206[a] (64)	0 (−7.9 to 7.9)	>0.999	−40 (−50 to −27)	<0.001	−48 (−57 to −35)	<0.001
Discharge, recall	1 (0.4)	3 (0.8)	2 (3.2)	1 (0.3)	0.4 (−1.6 to 1.9)	>0.999	2.9 (0.4 to 11)	0.045	2.9 (0.4 to 11)	0.036
Discharge, return	0	8 (2.1)	3 (4.8)	5 (1.5)	2.1 (−0.5 to 4)	0.013	4.8 (1.7 to 13)	0.004	3.3 (−0.4 to 12)	0.074
Brain imaging	73 (30)	119 (31)	20 (32)	99[a] (31)	1 (−6.5 to 8.2)	0.7907	2.0 (−10 to 1)	0.648	1 (−10 to 15)	0.767
CT	44 (18)	69 (18)	15 (24)	54 /17)	−0.1 (−6.5 to 5.9)	>0.999	6.2 (−4,3 to 19)	0.217	−0.1 (−0.2 to 0.03)	0.153
MRI	30 (12)	55 (14)	5 (8)	50 (16)	2 (−3.7 to 7.7)	0.476	−4.2 (−11 to 5.8)	0.382	0.1 (−0.03 to 0.14)	0.119

[a]One death included, time to death one day.

provider-based implementation methods can increase guideline compliance.[17]

The obvious difference in the efficacy of implementation of NEXUS II (37% vs. 3% documented evaluations in the Pediatric and Surgical ERs, respectively) shows the importance of continuously reminding the staff about the protocol. The staff of the Pediatric Department was regularly reminded about the NEXUS II evaluation, while the staff of the Surgical Department was informed about the protocol only once, without reminders. Despite our efforts, we failed to underline the usefulness and safety of our decision rule. The physicians' positive beliefs about the usefulness of a clinical decision aid benefits to patient outcome will enhance the use of a decision rule.[18] It also seems that physicians can be sceptical against a clinical decision rule if they think it questions their professional autonomy.[19]

Despite the low acceptance of a new decision rule, we found a significant change in the hospital admissions in the NEXUS II evaluated group. In period 1, hospital admissions were 3.5 times, and in period 2, without the NEXUS II evaluation, four times more common than with the NEXUS II evaluation. This is in line with our previous study.[14] The difference in the hospital admissions would have translated into an annual saving of $35,000.

There was no statistically significant increase in the numbers of head imaging studies conducted although the absolute number of CT scans increased in the NEXUS II evaluated group. A Norwegian study showed an increase in CT use and hospitalisations during the implementation of a Scandinavian decision rule for head injury patients.[1] It is hypothesised that further validation and adoption of paediatric head CT decision aids may increase patient safety and reduce the medical expense.[8,20] The use of magnetic resonance imaging (MRI) is becoming more common. The accuracy of MRI and safety of radiation exceed those of CT; further, important prognostic factors, such as diffuse axonal injury (DAI), cannot be detected using CT. However, in the acute phase, CT is sufficient to detect injuries that require immediate care, for example, intracranial arterial bleedings. Moreover, many hospitals that manage paediatric head injury patients in Finland only have CT available, especially during off-hours.

We concluded that the acceptance of a new decision rule for clinical practice was low despite the use of multiple implementation strategies that can be used in hospitals at low costs. When applied, the NEXUS II decision rule clearly reduced hospital admissions and indirectly also the expenses, without compromising patient safety. The use of the NEXUS II rule had no influence on the number of head imaging studies conducted; therefore, it did not reduce the exposure to ionising radiation of the paediatric head injury patients. Considering our present results, it appears worthwhile to apply this decision rule to clinical practice. Informing clinicians about the results of the present study might improve the low compliance observed in our study.

CONFLICT OF INTEREST

Authors have no conflicts of interest to disclose.

ORCID

Maria Hautala https://orcid.org/0000-0002-8386-1572

REFERENCES

1. Heskestad B, Baardsen R, Helseth E, Ingebrigtsen T. Guideline compliance in management of minimal, mild, and moderate head injury: high frequency of noncompliance among individual physicians despite strong guideline support from clinical leaders. J Trauma. 2008;65(6):1309-1313.
2. Celind J, Sodermark L, Hjalmarson O. Adherence to treatment guidelines for acute otitis media in children. The necessity of an effective strategy of guideline implementation. Int J Pediatr Otorhinolaryngol. 2014;78(7):1128-1132.
3. Stiell IG, Clement CM, Grimshaw JM, et al. A prospective cluster-randomized trial to implement the Canadian CT Head Rule in emergency departments. CMAJ. 2010;182(14):1527-1532.
4. Grimshaw JM, Thomas RE, MacLennan G, et al. Effectiveness and efficiency of guideline dissemination and implementation strategies. Health Technol Assess. 2004;8(6):iii-iv, 1-72.
5. Grimshaw JM, Eccles MP, Lavis JN, Hill SJ, Squires JE. Knowledge translation of research findings. Implement Sci. 2012;7:50.
6. Francke AL, Smit MC, de Veer AJ, Mistiaen P. Factors influencing the implementation of clinical guidelines for health care professionals: a systematic meta-review. BMC Med Inform Decis Mak. 2008;8:38. 6947-8-38.
7. Dunn LT, Fitzpatrick MO, Beard D, Henry JM. Patients with a head injury who "talk and die" in the 1990s. J Trauma. 2003;54(3):497-502.
8. Pandor A, Goodacre S, Harnan S, et al. Diagnostic management strategies for adults and children with minor head injury: a systematic review and an economic evaluation. Health Technol Assess. 2011;15(27):1-202.
9. Norlund A, Marke LA, af Geijerstam JL, Oredsson S, Britton M, OCTOPUS Study. Immediate computed tomography or admission for observation after mild head injury: cost comparison in randomised controlled trial. BMJ. 2006;333(7566):469.
10. Mathews JD, Forsythe AV, Brady Z, et al. Cancer risk in 680,000 people exposed to computed tomography scans in childhood or adolescence: data linkage study of 11 million Australians. BMJ. 2013;21(346):f2360.
11. Hoffman GM, Nowakowski R, Troshynski TJ, Berens RJ, Weisman SJ. Risk reduction in pediatric procedural sedation by application of an American Academy of Pediatrics/American Society of Anesthesiologists process model. Pediatrics. 2002;109(2):236-243.
12. Godwin SA, Burton JH, Gerardo CJ, et al. Clinical policy: procedural sedation and analgesia in the emergency department. Ann Emerg Med. 2014;63(2):247-258.e18.
13. Oman JA, Cooper RJ, Holmes JF, et al. NEXUS II investigators. Performance of a decision rule to predict need for computed tomography among children with blunt head trauma. Pediatrics. 2006;117(2):e238-e246.
14. Klemetti S, Uhari M, Pokka T, Rantala H. Evaluation of decision rules for identifying serious consequences of traumatic head injuries in pediatric patients. Pediatr Emerg Care. 2009;25(12):811-815.
15. Prior M, Guerin M, Grimmer-Somers K. The effectiveness of clinical guideline implementation strategies – a synthesis of systematic review findings. J Eval Clin Pract. 2008;14(5):888-897.
16. Heskestad B, Waterloo K, Ingebrigtsen T, Romner B, Harr ME, Helseth E. An observational study of compliance with the Scandinavian guidelines for management of minimal, mild and moderate head injury. Scand J Trauma Resusc Emerg Med. 2012;20:32.
17. Flanagan ME, Ramanujam R, Doebbeling BN. The effect of provider- and workflow-focused strategies for guideline implementation on provider acceptance. Implement Sci. 2009;4:71.
18. Kilsdonk E, Peute LW, Jaspers MW. Factors influencing implementation success of guideline-based clinical decision support systems: a systematic review and gaps analysis. Int J Med Inform. 2017;98:56-64.
19. McDermott L, Yardley L, Little P, Ashworth M, Gulliford M, eCRT Research Team. Developing a computer delivered, theory based intervention for guideline implementation in general practice. BMC Fam Pract. 2010;11:90.
20. Schachar JL, Zampolin RL, Miller TS, Farinhas JM, Freeman K, Taragin BH. External validation of the New Orleans Criteria (NOC), the Canadian CT Head Rule (CCHR) and the National Emergency X-Radiography Utilization Study II (NEXUS II) for CT scanning in pediatric patients with minor head injury in a non-trauma center. Pediatr Radiol. 2011;41(8):971-979.

How to cite this article: Hautala M, Koskela U, Pokka T, et al. Efficacy of the implementation of the National Emergency X-Radiography Utilization Study II decision rule to clinical practice for paediatric head injury patients. *Acta Paediatr.* 2021;00:1–6. https://doi.org/10.1111/apa.15859