Management of Paediatric Head Injuries in Sweden: A 5 National Cross-Sectional Survey

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Abstract

Background

Previous studies have shown varying management of children with traumatic brain injury (TBI) in Sweden. Recently, new guidelines have been introduced which may have affected management of these patients.

Methods

Cross-sectional structured survey, containing different management domains, in Sweden during 2020, using an on-line survey system aiming to describe initial (first 24 hours) management of TBI in children. Data presented as descriptive analysis and comparisons with Fisher exact test when applicable.

Results

56 hospitals of differing size were included in the analysis (response rate 93%). 76% used established guidelines. Children with TBI are predominately managed by inexperienced doctors (84%), primarily from non-paediatric specialities (75%). Most hospitals (75%) have the possibility to observe children with TBI and almost all have complete access to CT scans. In larger hospitals, it was more common for nurses to discharge patients without doctor assessment ($p<0.001$). Use of established guidelines and written observation routines has increased significantly since 2006 ($p<0.001$).

Conclusions

Management of children with TBI still varies in Sweden, although many aspects have significantly improved over the last 15 years. Most hospitals use established guidelines,

utilise dose-reduction protocols for CT, use written observation routines and provide adequate information to patients/guardians at discharge.

Keywords

mTBI; TBI; children; guidelines; initial management; Sweden; descriptive

Background

Traumatic brain injury (TBI) is recognized as a common cause of death and disability among children worldwide [1]. The incidence varies; a recent review on global epidemiology of TBI in children and adolescents showed that 691/100 000 children per year were treated in emergency departments (ED´s), 74/100 000 was admitted to hospital and median mortality rate was 9/100 000 children and year [2]. Most patients (70-98%) are classified as having minimal or mild traumatic brain injury (mTBI) primarily from their initial level of consciousness (Glasgow Coma Scale, GCS) with or without specific risk factors [3-6]. Two thirds of these patients will swiftly recover without suffering from any persisting sequelae [7,8]. However, a minority will suffer life-threatening intracranial haemorrhages in need of urgent attention and often rapid surgical intervention [9]. The task of effectively identifying these patients is a clinical challenge.

Computed tomography (CT) is the gold standard used to detect intracranial complications after TBI, such as intracranial haemorrhages. CT is readily available in the western world and relatively inexpensive and simple to use. However, as CT utilizes ionizing radiation, a scan

increases the patient's lifetime risk of cancer; a risk even more pronounced in the paediatric population which [10] warrant careful consideration when subjecting children to CT scans [11,12].

In-hospital observation is an alternative management approach to detect complications after mTBI [5]. Evolving data support in-hospital observation as an equally valid strategy in terms of clinical outcome [13]. Evaluation of risks and benefits, regarding aspects such as costs, practicality and radiation issues, need to be performed in decision making for every individual case. In 2006, a national survey regarding management of paediatric mTBI revealed inconsistencies in the care of this patient group [14]. According to this study, only 27% of hospitals in Sweden used any sort of guideline for management of paediatric TBI. Initial assessment in emergency departments was primarily performed by non-specialists (assistant residents and/or residents) in 96% of cases [14]. This aspect is important, as attributes of the treating doctor has shown to influence the frequency of diagnostic imaging, with more risk –intolerant physicians more likely to order a CT scan, compared to colleges with greater risk tolerance [15]. Decisions concerning diagnostic tests are also influenced by concerns about patient satisfaction and malpractice issues, with substantiation knowledge and decision support frequently requested [16,17].

Differences in management routines and lack of established guidelines may negatively affect patient safety. The use of clinical decision rules (CDR´s) for management of mTBI has been shown to decrease the number of CT scans without an elevated risk of missing potentially dangerous intracranial haemorrhages [11,18]. Several evidence-based guidelines for management of mTBI in children have been derived to provide decision-making support regarding the utilization of head CT scans. Among the most commonly cited are the Paediatric Emergency Care Applied Research Network (PECARN) head CT rule [9], the

Canadian Assessment of Tomography of Childhood Head Injury-rule (CATCH) [19] and Children's Head injury Algorithm for the prediction of Important Clinical Events-rule (CHALICE) [20]. However, none of these CDRs are developed with the Scandinavian health care system in consideration. Also, concerns regarding a potential increase in CT scanning in children with the use of these guidelines have been raised [5]. An existing Scandinavian guideline, published in 2000, was primarily designed for management of adults [21]. Therefore, a new guideline (SNC16) was developed and published by the Scandinavian Neurotrauma Committee in 2016 [5] with the Scandinavian health care system in mind. The guideline was produced through a rigorous process of evidence analysis and includes consensus aspects to bridge evidence gaps. This guideline has a somewhat different approach than PECARN, CATCH and CHALICE. It is developed to detect intracranial complications after TBI in need of neurosurgery or medical intervention, and risk stratifies patients in five groups with accompanying recommendations concerning need for CT and/or observation. It also includes recommendations regarding observation time and quality, discharge advice and criteria for later CT scanning. External validation has shown encouraging results [22] and internal, national validation is currently in progress. Recently, another evidence- and consensus-based guideline for mild and moderate head injuries was published by the PREDICT collaborative, specifically developed for usage in Australia and New Zeeland [23], very much in line with the SNC16. How publication of these CDRs has influenced management of children with head injuries in Sweden is unknown.

Studies have shown that introducing new guidelines can be difficult [24]. One factor associated with successful implementation is that the guideline is well adapted and applicable in the clinical setting [25]. Prior to introducing the SNC16 nationally in Sweden, knowledge about current practice is of great important in order to optimize the implementation strategy

and achieve a high level of compliance. A previous national survey study [14], which showed considerable variations in management, allows analysis of changes in management over time. Also, although the SNC16 has not been officially implemented, the guideline may be in clinical use due to the lack of accepted alternative options.

The aim of this study is therefore to describe current management of these children in Sweden. Secondary aims are to analyse differences in management over time, to assess the implementation of the SNC16 and to analysis possible variations in care.

Methods

This is a descriptive cross-sectional study including all emergency departments at hospitals with the possibility of in-hospital care. Data was collected using a web-based survey designed in collaboration with members of the Scandinavian Neurotrauma Committee (SNC). The survey was designed to answer the most crucial questions regarding the current management of children with TBI in Sweden. The questions were structured into 5 different sections (table 1), exemplifying questions from each part. The questionnaire was completed using the program esMaker (Entergate AB). A primary pilot version was sent to 6 hospitals and after minor details adjusted the complete form was finished and sent.

Table 1. The questionnaire – sections and exemplified main questions

Section 1: Background information
● Name of hospital ● Presence of written guidelines concerning initial management of mTBI in children within 24 hours of trauma

Section 2: Initial treatment in the emergency department
● What clinic is responsible for paediatric patients with mTBI? ● Are these patients cared for by specialists or non-specialists?
Section 3: Radiology
● What primary radiology modality is used? ● Access to anaesthesiologist and diagnostic radiology
Section 4: In-hospital observation
● What department are patients admitted to in need of in-hospital observation? ● What parameters are being monitored during hospitalization?
Section 5: Discharge and follow-up
● Are patients and guardians provided with discharge information? ● Does your hospital arrange follow up?

The survey was answered once per participating hospital. Initial contact was established by phone to ensure that a suitable responder, able to provide valid information and an overall view, was reached. When appropriate recipients had been identified, the questionnaire was distributed by e-mail. Data was collected continuously from June 2020 to March 2021. Reminders were sent by e-mail twice to non-responders until >90% response rate was reached.

Data is summarized and presented using descriptive statistics. A cross-comparison was performed between four categories depending on the size of the hospital; local, regional, university and children´s hospital. Further statistical analysis was performed using Fisher's

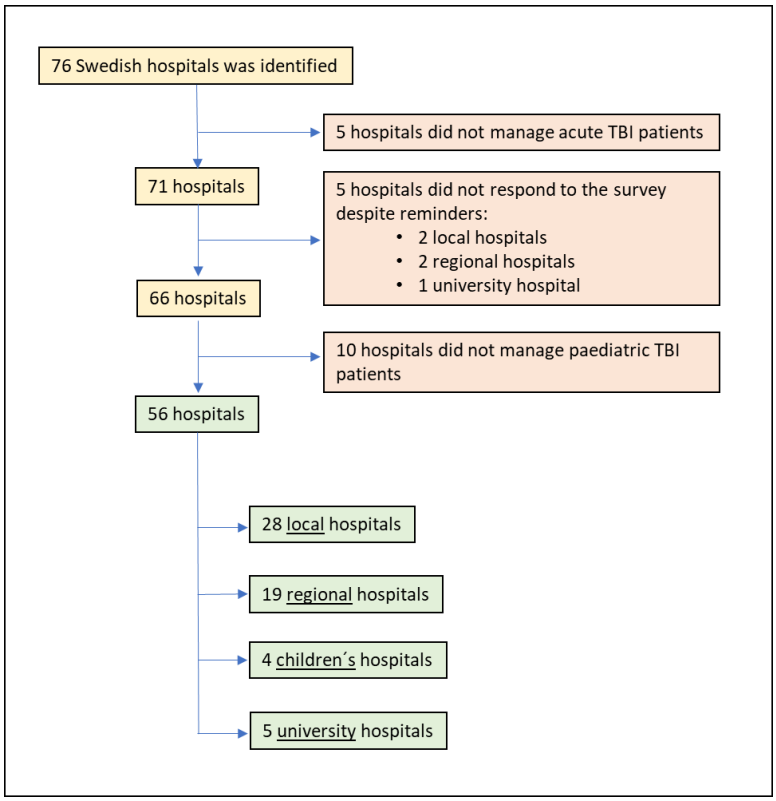
exact test to detect differences between groups, when indicated. A two-tailed p-value of <0.05 was considered significant. Due to known small numbers in the last two groups, the categories were *a priori* dichotomised to smaller hospitals (local and regional) and larger hospitals (university and children´s hospitals). As answers for a certain question were not always 100% complete, the total number of responses is given with each question.

Only the overall management of children with mild head injury was collected in this study. Neither personal data nor individual patient records were obtained. An ethical advisory opinion was granted by the Swedish Ethical Review Authority, *Dnr 2020-02693*.

Results

Initial contact was established with 76 hospitals in Sweden; 5 hospitals did not manage acute TBI at all. Of the remaining 71 hospitals, responses were returned from 66 hospitals (overall response rate 93%). 56 of these hospitals managed paediatric patients with TBI (10 only managing adult TBI) and form the base of this study. The size and type of the included hospitals (n = 56) varied; 28 local hospitals, 19 regional hospitals, 4 dedicated children´s hospitals and 5 university hospitals. Of the 5 non-responding hospitals, 2 were local hospitals, 2 were regional hospitals and one was a university hospital (figure 1).

Figure 1. Flowchart describing participating and non-participating Swedish hospitals



The age span which was used by participating units to define the patients as paediatric differed. Most common span at the non-paediatric hospitals were 0-18 years of age. In contrast, children´s hospitals had a different definition, with the upper limit differing between 14-16 years of age.

Nine (16%) hospitals reported limited access to a neurosurgical unit, with a transfer time of > 2 hours to the closest neurosurgical service.

In total, 76% (42/55) of the respondents reported use of an established guideline for the management of paediatric TBI at their hospital (Table 2). When comparing smaller hospitals (local and regional) to larger ones (university and children´s), there was no statistically significant difference in presence of guidelines (p=0.18). The most commonly used guideline was the SNC16 guideline (n=31, 55%). Following this, the most commonly described was a

local modification of pre-existing validated guidelines (such as PECARN) or local guidelines based on local expert opinion.

Table 2. Use of guideline for management of paediatric TBI

	Local Hospital n (%)	Regional Hospital n (%)	Children´s Hospital n (%)	University Hospital n (%)	Total n (%)
Established guideline	20 (71)	13 (68)	4 (100)	5 (100)	42 (76)
No guideline	7 (25)	4 (21)	0	0	11 (20)
Unknown	0	2 (11)	0	0	2 (4)
Total	27 (96)	19 (100)	4 (100)	5 (100)	55 (98)

Numbers presented for respective hospital category and all hospital categories in total. Respondent from one (n=1) local hospital did not respond to this question (response rate 55/56, 98%).

Children with TBI were predominantly managed by non-specialists (Table 3). There was no statistical difference in the presence of specialists between small (local and regional) and large (university and children´s) hospitals (p=0.17). Apart from dedicated children's hospitals, children with TBI were rarely treated by a doctor with a paediatric speciality (Table 4). Large (university and children´s) hospitals had significantly higher presence of paediatric specialities than small (local and regional) hospitals (p<0.001).

Table 3. Level of experience of responsible clinician.

	Local Hospital n (%)	Regional Hospital n (%)	Children´s Hospital n (%)	University Hospital n (%)	Total n (%)
Non-specialist *"assistant physician, dependent", "assistant physician, independent", "intern" and "resident" are merged*	22 (79)	18 (95)	3 (75)	4 (80)	47 (84)
Specialist	10 (36)	3 (16)	3 (75)	3 (60)	19 (34)

Most common experience level for clinicians manging children with TBI. Respondent were asked to rate how often a child with TBI in their ED was managed by a physician with experience level corresponding to "assistant physician, dependent", "assistant physician, independent", "intern", "resident" and "specialist". For each "category" (experience level) of physician the respondent rated on a 5-grade scale (always; often; sometimes; rarely; never) how frequent this category manage children with head trauma at their emergency department. A dichotomisation of the experience levels to "specialist" and "non-specialist level" (in which categories: "assistant physician, dependent", "assistant physician, independent", "intern" and "resident" were merged) was done for the analysis. To further simplify presentation, grade "always" and "often" was merged (implying the "most common" experience level for clinicians manging children with TBI) and presented for respective hospital size. This means that if grade "sometimes", "rarely" or "never" was chosen for a category (experience level) of physician it won´t be presented in the table. Merging of experience levels and response options means that the aggregated total response rate won´t be 100%. Percentages are calculated as number of responses per total hospitals in each category. Example: There was in total 22 responses in the non-specialist category deriving from local hospitals, implying that in 22 of the 28 local hospitals (79%) it is common ("often" or "always") that non-specialists are managing children with TBI.

Table 4. Responsible clinic: Paediatric vs non-paediatric specialities

	Local Hospital n (%)	Regional Hospital n (%)	Children´s Hospital n (%)	University Hospital n (%)	Total n (%)
Paediatric speciality	0	1 (5)	4 (100)	2 (40)	7 (13)
Non-paediatric speciality	22 (79)	18 (95)	0	2 (40)	42 (75)
Emergency medicine	10 (36)	6 (32)	0	3 (60)	19 (34)

Departments responsible for initial management of paediatric head trauma patients displayed for each hospital size and total. Responsible clinic (speciality of the clinic) is categorized as paediatric (paediatric surgery; paediatrics; paediatric neurology; paediatric orthopaedics), non-paediatric (neurology; general surgery; internal medicine; orthopaedics or other speciality) or emergency medicine. For each type of clinic, respondent was asked to rate on a 5-grade scale (always; often; sometimes; rarely; never) how frequent this speciality manages children with head trauma at their emergency department. To further simplify presentation, grade "always" and "often" was merged (implying the "most common" clinic/speciality manging children with TBI) and presented for respective hospital size. This means that if grade "sometimes", "rarely" or "never" was chosen for a clinic/speciality it won´t be presented in the table. Merging of clinics/specialities and response options means that the aggregated total response rate won´t be 100%. Percentages are calculated as number of responses per total hospitals in each category. Example: There was in total 10 responses in the emergency medicine category deriving from local hospitals, implying that in 10 of the 28 local hospitals (36%) it is common ("often" or "always") that emergency medicine physicians are managing children with TBI.

As shown in table 4, most of the patients are managed by physicians in non-paediatric specialities (75%), of which general surgery represents 71% (n=40). In 34% (n=19) of the hospitals, emergency medicine physicians often or always manage paediatric patients with TBI. It was uncommon (5%) that initial assessment always or often was done by a doctor specialising in neurology (Table 5).

Table 5. Responsible clinic: Neurology vs non-neurology specialities

	Local Hospital n (%)	Regional Hospital n (%)	Children´s Hospital n (%)	University Hospital n (%)	Total n (%)
Neurology speciality	0	0	1 (25)	2 (40)	3 (5)
Emergency medicine	10 (36)	6 (32)	0	3 (60)	19 (34)
Non-neurology speciality	20 (71)	18 (95)	3 (75)	2 (40)	43 (77)

Departments responsible for initial management of paediatric head trauma patients for each hospital size and total. Responsible speciality is categorized as neurology speciality (paediatrics; paediatric neurology; neurology; internal medicine), non-neurology (paediatric and general surgery; orthopaedics) or emergency

medicine. For respective type of speciality, respondent was asked to rate on a 5-grade scale (always; often; sometimes; rarely; never) how frequent this speciality manages children with head trauma at their emergency department. To further simplify presentation, grade "always" and "often" was merged (implying the "most common" clinic/speciality manging children with TBI) and presented for respective hospital size. This means that if grade "sometimes", "rarely" or "never" was chosen for a speciality it won´t be presented in the table. Merging of specialities and response options means that the aggregated total response rate won´t be 100%. Percentages are calculated as number of responses per total hospitals in each category. Example: There was in total 20 responses in the non-neurology category deriving from local hospitals, implying that in 20 of the 28 local hospitals (71%) it is common ("often" or "always") that non-neurology physicians are managing children with TBI.

15 hospitals (27%) reported that these patients are occasionally discharged by a nurse at triage without any doctor assessment. This management was more common ($p<0.001$) in university and children´s hospitals (n = 6/9) when compared to local and regional hospitals (n = 9/47). 8 of these units had written guidelines concerning this procedure; 6 of these used the SNC16 guidelines.

Almost all hospitals (n = 54) use CT as the primary choice of radiology modality to exclude intracranial complications. 96 % of hospitals (54/56) reported full accessibility to a CT scan irrespective of time or day. 48 % of hospitals (27/56) reported routine use of dose-reduction programs. However, many respondents (23/56, 41%) were not aware of any dose-reduction protocol, with only a few hospitals (2/56, 4%) reporting that a dose-reduction protocol was not routinely used and 3 respondents (5%) did not answer the question at all. If needed during the head CT scan, 50% of the respondents reported occasional use of sedation in some form. All hospitals had access to anaesthesiologists irrespective of time or day.

In 75 % of the hospitals (42/56), it was possible to admit patients for in-hospital observation. Most commonly (64%), these children were admitted to a general ward. In 46% (13/28) of smaller, local hospitals, children could not be admitted in-house and needed to be transferred to another hospital if admission was necessary, see Table 6 for details. In local hospitals, 50% (7/14) of children were observed in a non-paediatric ward. In larger hospitals, most children were admitted to paediatric wards (96%, 25/26). In one hospital, the Intensive Care Unit (ICU) was used for observation.

Table 6. Possibility of in-hospital observation

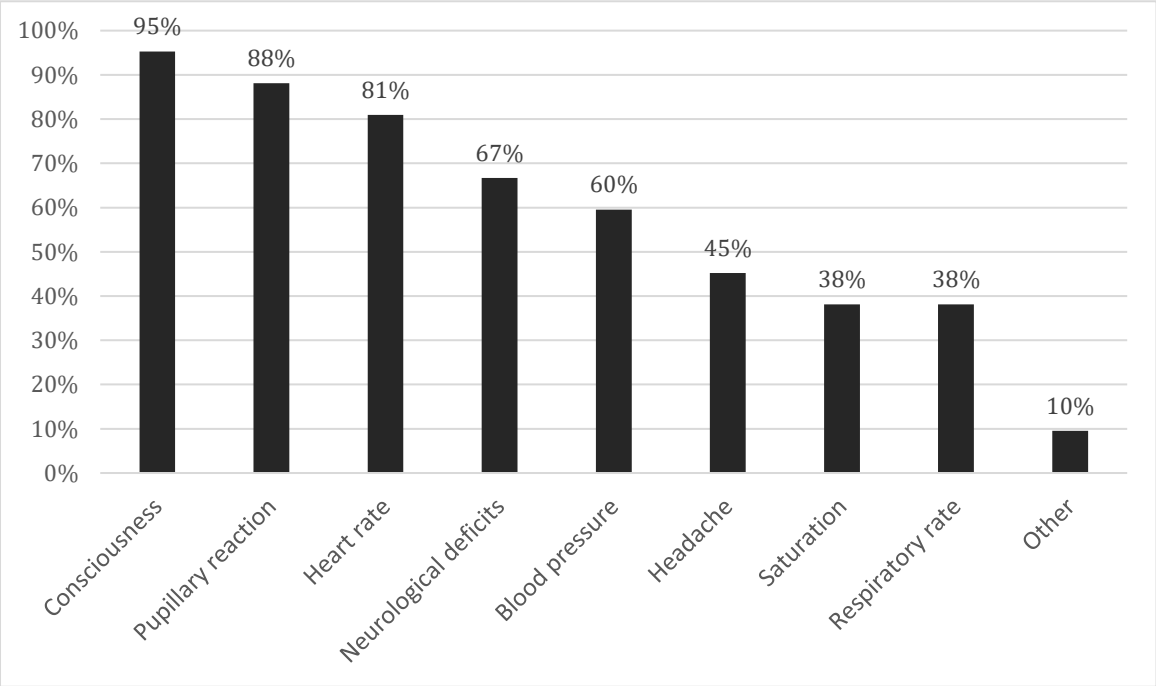
	Local Hospital n (%)	Regional Hospital n (%)	Children´s Hospital n (%)	University Hospital n (%)	Total n (%)
Possibility of in-hospital observation	15 (54)	18 (95)	4 (100)	5 (100)	42 (75)
No possibility of in-hospital observation	13 (46)	1 (5)	0	0	14 (25)

Numbers presented for respective hospital category and all hospital categories in total.

During the observation period, level of consciousness was the most frequently evaluated parameter (95%), followed by pupillary reaction, heart rate and neurological deficits (see figure 2).

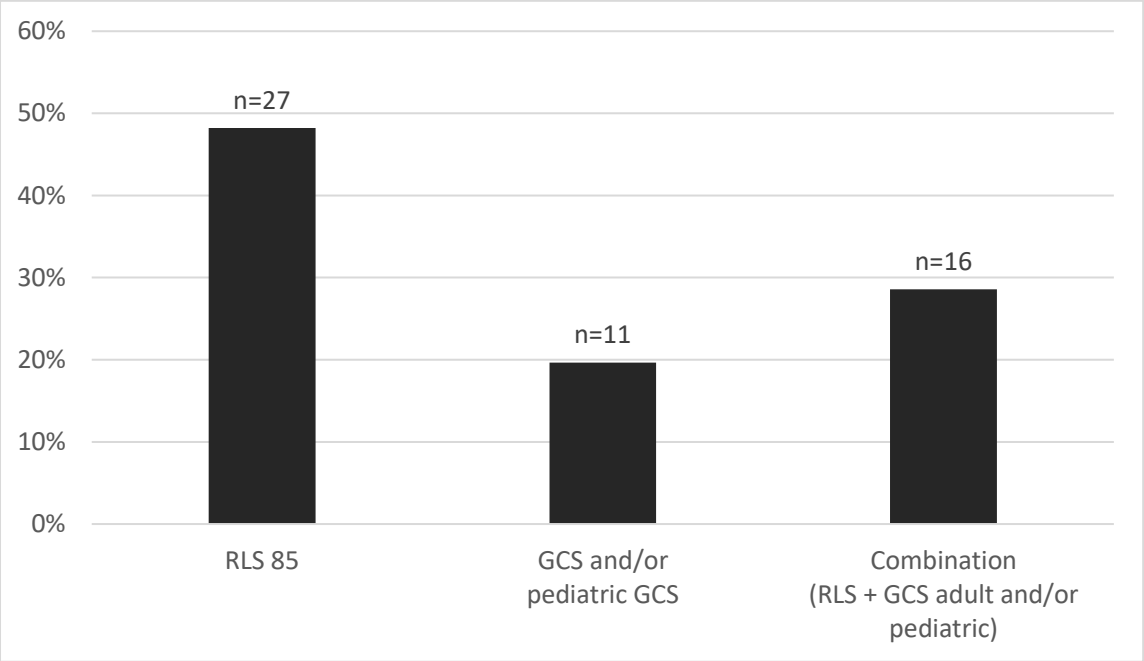
Different scales were used for evaluating the level of consciousness; the Reaction Level Scale (RLS 85) [26], Glasgow Coma Scale (GCS) or its paediatric version, and the Alert-Verbal-Pain-Unresponsive-scale (AVPU). RLS 85 was the most frequently reported answer, either alone (48%) or in combination with other assessment scales (29%) (Figure 3).

Figure 2. Parameters evaluated during in-hospital observation due to paediatric head trauma



Respondents could choose more than one alternative (n_{tot}=42)

Figure 3. Scale used for assessment of level of consciousness



Respondents were asked to report which scale(s) that was used at their hospital for assessment of level of

consciousness. Mmore than one alternative could be marked. RLS-85, GCS (adult version) and GCS (paediatric version) was prespecified options. Three (n =3) respondents reported use of AVPU-scale in addition to GCS or RLS-85.

97% of hospitals with capacity for in-hospital admittance (41/42) reported their observation routines. In 46% (19/41) elements of the SNC 16 routines were used regarding type, frequency and/or duration of observation and in 32% (13/41) the SNC16 was the sole guiding routine for in-hospital management. 44% (18/41) of the hospitals allowed individual doctor prescription of observation criteria, and in 27% (11/41) no other routines other than doctor prescribed observation was used. None of the responding hospitals reported a complete lack of routines for observation.

Routines for CT scanning in admitted children were mostly (solely or in combination with other written routine) based upon doctor discretion (65%, 27/41). In 49% (20/41) of the hospitals a written routine in some form guided CT scanning in admitted children, mainly the SNC16 (31%, 13/41).

56% (23/41) of hospitals reported lack of discharge-criteria following observation for TBI. Concerning information to patients/guardians at discharge, 15% (8/55) provided only written information, 9% (5/55) provided only oral information and 71% (39/55) provided both, with only 5% (3/55) not providing discharge information at all.
38% (21/56) of all hospitals could arrange a follow up assessment if needed, which was relatively more common at large hospitals (7/9, 78% vs 14/47, 30%) and usually either at a paediatric outpatient clinic (52%) and/or in the primary care sector (48%). 46% (26/56) did not provide or plan follow-up in children following TBI; this was more common in small

hospitals (25/26). There was a significant difference in follow-up routines between small (local and regional) and larger (university and children´s) hospitals (p=0.015).

In the 2006 survey, 51 hospitals were identified that managed children with TBI. Of these, only 27% (14/51) used management guidelines. In the current study, significantly more (76%, 42/55) of the hospitals used guidelines (p<0.001). In the present study, only one hospital (2%) used an ICU for observation, compared to 10 hospitals (20%) in 2006 (p=0.020). The presence of written observation routines (defined as presence of a local written routine regarding in-hospital observation and/or use of the SNC16 recommendation for in-hospital observation) is more common today when compared to 2006 (69% compared to 31%, p<0.001). Finally, the possibility of follow-up after discharge did not differ between 2006 and the current study (p=0.22). See table 7 below for details.

Table 7. TBI management in Swedish hospitals, comparison between 2006 [14] *and the present study*

	2006 survey *Åstrand et al* n (%)	**Current survey n (%)**	**p-value**
Using established guidelines	14/51 (27%)	42/55 (76%)	*p < 0.001*
ICU as observation unit	10/51 (20%)	1/42 (2%)	*p = 0.02*
Written observation routines	16/51 (31%)	29/42 (69%)	*p < 0.001*
Possibility of follow-up after discharge	13/51 (25%)	21/56 (38%)	p = 0.22

Discussion

This national cross-sectional survey aims to describe and analyse the current management of children with TBI in Sweden. With a high response rate (>90%) we have been able to efficiently collect data concerning different aspects of mTBI management. Most hospitals (76%) use an established guideline to aid in management and we did not observe a difference of guideline use between sizes of hospital. Most use the SNC16 guideline and the majority of the remaining hospitals use a locally constructed guideline, either a modification of an established guideline, such as PECARN, or one based on expert opinion.

In 27 % of the hospitals, in particular larger hospitals, nurses can discharge children with mTBI without any assessment by a doctor. These patients reasonably represent the mildest of injuries and are in 53% (8/15) of the hospitals discharged using a guideline, mainly the SNC16. If children can reliably be assessed by a nurse and judged to be in the mildest risk group of TBI, this type of management may be efficient. Further studies could evaluate this issue.

Children with TBI were managed predominately by non-specialists and (outside of dedicated children´s hospitals) non-paediatricians. These findings reinforce the need of a nationally implemented and accepted guideline for these patients, as most children with TBI will be managed by inexperienced doctors from varying specialities, especially in smaller hospitals. The field of emergency medicine is relatively young in Sweden, but may be the primary group to manage TBI patients in the future.

Sweden is not a densely populated country with some concentrations of inhabitants in larger cities. Due to this fact, large university hospitals are generally located in areas where many inhabitants reside. Large parts of Sweden are therefore some distance from these hospitals which contain the neurosurgery departments. Indeed, 16% of hospitals reported having at least 2 hours transfer time to the nearest neurosurgical unit. This aspect is important, as the severe complications after mTBI, although uncommon [9,27], require immediate attention and often neurosurgical expertise.

In approximately half (13/28, 46%) of local hospitals, there was no possibility of in-hospital observation of children with mTBI. These children are instead sent to adjacent, larger hospitals, indicating a practical and logistical hurdle for guideline development. The most common parameter evaluated during observation is level of consciousness, followed by simple measures of neurological function, such as pupillary reaction. Concerning observation routines, most hospitals had written routines for which parameters should be measured, including how often and for how long, and approximately half of these used the SNC16 observation routines.

Due to the potential risk of ionizing radiation in children, the aspect of dose-reduction protocols is highly relevant. Although approximately half of hospitals stated that routine reduction of radiation dose was used, many respondents could not reliably answer this question. In addition to the radiology departments, the referring party must also be made aware of the radiation issues related to CT scans [17]. In order to fully investigate this issue, a survey directed at the radiological department of the hospitals is warranted.

Following TBI, children may be manged (with CT, in-hospital observation, or both) in order to detect possible severe complications. In the absence of these, these children may be

discharged. The criteria for discharge may vary between hospitals but usually include the absence of worrying signs and symptoms. More than half of hospitals did not have specific discharge criteria for these patients. Although evidence is lacking in this area, written discharge criteria may facilitate management and promote equality in patient management. Discharge from the hospital, be that after initial assessment in the ED or after in-hospital observation, should be accompanied with information regarding the injury, what to expect and when to seek health care. Pleasingly, most hospitals provided this with only 3 hospitals (5%) stating that they do not provide such information.

A similar survey was conducted 2004 - 2005 and published 2006 [14] by our group and one major aim of this study was to analyse any change of management over time. During this time period, several high-quality CDR´s and guidelines have been published [9,19,20]. A guideline of special interest in the Swedish context is the Scandinavian guideline [5] published in 2016, with a published summary in Swedish in Läkartidningen [28] in 2017. This CDR was developed to give more precise recommendations on observation as an option to head CT, with a stepwise increase in the duration of observation based on a risk stratification in five groups. It also suggests an absolute or relative need for a head CT secondary to the risk stratification, recommendations for in-hospital observation routines and discharge information.

A significant increase in guideline use has occurred since 2006 (76% vs 27%), where more than half of these hospitals use the SNC16 guideline. The use of formal, written observation routines are more common today than in 2006, although almost a third of the hospitals still haven´t formalised this part of paediatric TBI management. The widespread use of elements in the SNC16 guideline, including other aspects than the risk criteria, such as observation

routines, in Sweden is gratifying as it implies introduction of a sound evidence-based approach in the management of head injuries in children. As these guidelines are still to be internally validated in the Scandinavian setting a certain amount of vigilance is still required, although external validation has shown encouraging results [22].

The strengths of this study lie in the high response rate and the on-line survey system which increases response accuracy and minimises ambiguous answers. As this group did a similar survey in 2006, most questions are similar which allows a comparison over time. This study has several limitations. Despite our best efforts to ensure that the respondent was fully aware of all aspects of TBI management at their respective hospital, inaccuracies may still have occurred. Also, the questions response rate was not always 100% within the same hospital which may also account for some errors. However, these issues were minimal and have little effect of the overall results.

In a survey such as this, there is always a balance between the complexity of the survey material and response compliance. Some areas, such as the questions concerning dose-reduction of CT scans, warrant further investigation in a new, separate survey to a new set of respondents more likely to have local knowledge concerning this aspect. Concerning the results of this study, there seems to be a widespread adoption and use of the SNC16 guideline. However, many hospitals still use management methods based upon weaker scientific methods, such as management based upon local expert opinion. Strategies and further research aiming to facilitate implementation of new evidence in emergency departments is important and needed. However, today's management was generally better when compared to management derived from the 2006 survey. Finally, validation of a

guideline should be encouraged before widespread clinical use. Efforts to increase participation in an ongoing Nordic validation study are warranted.

Conclusions

Management of children with TBI varies in Sweden, although many aspects have improved over the last 15 years. Most hospitals use established guidelines, utilise dose-reduction protocols for CT, use written observation routines and provide adequate information to patients/guardians at discharge. A minority of hospitals use management routines not based upon scientific evidence.

Declarations

Ethics approval and consent to participate

The study does not include individual patient data. Ethics approval by the Swedish Ethical Review Authority, Dnr 2020-02693

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

None of the authors have any financial competing interests. JU is a member of the SNC committee, a non-profit organisation independent from financial company support, who are responsible for the SNC16 guidelines.

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Authors' contributions

JU och FW conceived and planned the study. LP made the survey and contacted respondents. LP summarised the results and wrote the first draft together with FW and JU. All authors have read the manuscript.

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