Recognition of Abusive Head Trauma in Young Children by Emergency Physicians and Paediatricians: A Survey

Annelien Marcelis [a,*], Marjolein Mattheij [b,c,*], Sebastian Schnaubelt [b,d], Wouter Karst [a], Stijn Verhulst [a,e], Berten Ceulemans [a,e], Koenraad G. Monsieurs [b,c]

[*] These authors contributed equally and share first authorship
[a] University of Antwerp, Antwerp University Hospital, Department of Paediatrics, Edegem, Belgium
Dutch National Forensic Medical Expertise Center (LOEF), Leerbroek, The Netherlands"
[b] University of Antwerp, Antwerp University Hospital, Department of Emergency Medicine, Edegem, Belgium
[c] University of Antwerp, Antwerp Surgical Training, Anatomy and Research Centre (ASTARC), Wilrijk, Belgium
[d] Medical University of Vienna, Department of Emergency Medicine, Austria
[e] University of Antwerp, Faculty of Medicine and Health Sciences, Laboratory of Experimental Medicine and Paediatrics, Wilrijk, Belgium

annelienmarcelis@gmail.com ; marjolein.mattheij@uza.be

Keywords

Abusive head trauma ; inflicted injury.

Abstract

Objective

The aim of our study was to determine the physicians' accuracy in evaluating fictitious cases of young children with high, moderate and low probability of abusive head trauma (AHT), their behaviour in reporting cases to child protection services or legal institutions, and the estimation of their own competence in interpreting injuries in children.

Methods

Six hypothetical cases (high, moderate and low probability of AHT, with and without risk factors for abuse) were presented to physicians in a survey. The assigned probability score for AHT was compared with the calculated probability of AHT according to the PediBIRN-7 prediction tool.

Results

The majority of physicians underestimated the probability of AHT in the cases with high probability of AHT (especially in the absence of risk factors for abuse), and overestimated the probability of AHT in cases with low probability of AHT (especially in the presence of multiple risk factors for abuse). In cases with high probability of AHT without multiple risk factors for abuse, the majority of physicians would not have reported the case.

Conclusions

Our survey showed that the presence or absence of risk factors for abuse seemed to play a more important role in physician's assessment of the aetiology of head injury in young children than the presence of injuries with a high specificity for AHT or accidental head injury. Unawareness of physicians´ lack of competence in evaluating injuries is a potential threat.

Introduction

Abusive head trauma (AHT) is an injury to the skull or intracranial contents of a child, caused by inflicted blunt impact, shaking, or both (1). AHT is the leading cause of fatal head injuries in children younger than two years (2-4). Survivors show considerable associated morbidity (1). A missed diagnosis leads to an increased risk of further injury or death. A 2016 study found that 25% of the infants with AHT had at least one earlier opportunity to identify abuse (5). However, recognizing AHT is a major challenge, predominantly because of the heterogenous and non-specific clinical findings (vomiting, irritability, feeding difficulties, altered mental status, seizures, increasing head circumference and apnoea) and of further investigations (subdural hematoma, cerebral oedema, skull fracture, spinal changes, complex retinal haemorrhages and rib or other fractures) (1, 2, 6, 7). Although there are known risk factors for abuse such as a low socioeconomical status, a household with unmarried parents or unrelated adults, parental alcohol or substance abuse, or excessive crying of the child, their absence does not rule out abuse: literature shows that AHT was more likely to be unrecognized in white children from intact families (8-12).

Laskey et al found that in 50% of the cases, pathologists and paediatricians did not agree on their categorization (unintentional, undetermined, or inflicted) of hypothetical cases of traumatic brain injury (13). The aim of our study was to determine (a) the accuracy of physicians evaluating fictitious cases of young children with high, moderate and low probability of AHT, (b) to what extent physicians were guided by certain physical injuries and the presence or absence of risk factors for abuse, (c) the behaviour in reporting the cases to child protection services or legal institutions, and (d) if physicians had an accurate idea of their own competence in the interpretation of injuries. Our hypothesis was that the presence or absence of risk factors for abuse would significantly contribute to whether a case would be deemed suspicious and reported to child protection services or legal institutions.

Methods

The PediBIRN-7 tool is a clinical prediction rule that predicts the likelihood of AHT, based on the presence or absence of seven different clinical variables, being (a) respiratory compromise, (b) bruising involving ear, neck or torso, (c) bilateral or intrahemispheric subdural haemorrhage or fluid collection, (d) a complex skull fracture, (e) fractures on skeletal survey that are suspicious for abuse, (f) moderate to extensive retinal haemorrhages or retinoschisis and (g) brain hypoxia, ischaemia or swelling (14). The tool was designed using prospectively captured data of 500 children aged zero to three years with acute head injury who were admitted to a paediatric intensive care unit. Children with motor vehicle collisions were excluded. Applying a mean probability threshold

of > 0.5 to classify patients as abused, the tool has a sensitivity of 0.73 (95% CI: 0.66-0.79) and a specificity of 0.87 (95% CI: 0.82-0.90). To prevent circular reasoning, the study used definitions of AHT and accidental head trauma without inclusion of the seven variables. Within the group of children with three present variables of the PediBIRN-7 tool, there are three subgroups with a statistical significant different probability of AHT: (a) children with bruising of ear, neck or torso, bilateral or interhemispheric subdural haemorrhage and a suspicious fracture on skeletal survey, with a calculated probability of AHT of 0.91 (CI 0.79-0.97, in our study defined as "high probability of AHT"), (b) children with respiratory compromise, bilateral or interhemispheric subdural haemorrhage and moderate to extensive retinal haemorrhages, with a calculated probability of AHT of 0.55 (CI 0.38-0.70, in our study defined as "moderate probability of AHT") and (c) children with a complex skull fracture, moderate to extensive retinal haemorrhages and brain hypoxia, ischaemia, or swelling with a probability of AHT of 0,17 (CI 0.07-0.37, in our study defined as "low probability of AHT") (14). We incorporated each combination of variables in two hypothetical cases of a young child with traumatic brain injury, one with risk factors for abuse and one without risk factors for abuse. The PediBIRN-7 tool variables and risk factors for abuse that were integrated in the cases can be found in Table 1. Except for the variables that are mentioned above, the content of the hypothetical cases was written by the authors. This strategy led to the development of six cases (high, moderate and low probability of AHT, all with and without risk factors for abuse). We developed an online questionnaire, with introductory questions concerning the education and the employment of the respondent, and a self-evaluation of their competence to interpret injuries in children. After the presentation of each case, the physicians were asked to rate the probability of AHT on a 6-point scale and their decision to report the case.

As emergency physicians, paediatricians and forensic physicians have the highest probability of encountering children with traumatic brain injury, and thus recognition of AHT by these physicians is of great importance, they were the focus of our study. Between February and July 2022 the departments of their specialities at the Antwerp University Hospital and their Flemish professional associations were contacted with a link to the survey, which was forwarded to their members, with a subsequent reminder email. A link was also shared on their social media groups. Participation in the survey was anonymous and voluntary. The Ethics Committee of the Antwerp University Hospital granted a waiver for this study (EC reference number 2023-5426).

An important goal of our study was to evaluate whether the physician´s assigned probability score of abuse was congruent with the calculated probability by the PediBIRN-7 tool (14). In our survey only round numbers from 0 to 5 could be chosen as response options for the probability score for inflicted skull-brain injury ("how likely do you think the option of inflicted skull-brain injury is in this case?" 0 almost non-existent - 1 very unlikely - 2 unlikely - 3 likely - 4 very likely - 5 almost certain). We considered a score of 4 or 5 in the cases with high probability, 2 or 3 in the cases with moderate probability and 0 or 1 in the cases with low probability of AHT as a "correct" assessment, hence a probability score that was congruent with the calculated probability by the PediBIRN-7 tool. Possible differences in correct assessment between the different physician subgroups were evaluated using the Mann-Whitney U-test. The influence of the presence of risk factors for abuse on the assigned probability score for abuse was evaluated using the Wilcoxon Signed Rank test. We assumed that the categories of the AHT probability score were equidistant and described the results as mean and 95% CI of the mean. We also investigated whether physicians who considered themselves more competent in diagnosing inflicted injuries scored better in terms of the total number of correctly assessed cases via the Spearman correlation coefficient.

Table 1: The PediBIRN-7 tool variables and risk factors for abuse integrated in the cases of our survey, the number and percentage of the total group of respondents that correctly estimated the probability of abusive head trauma (AHT) based on PediBIRN-7 tool, the elements that the respondents found suspicious for AHT, and information about whether or not the respondents would have reported the case.

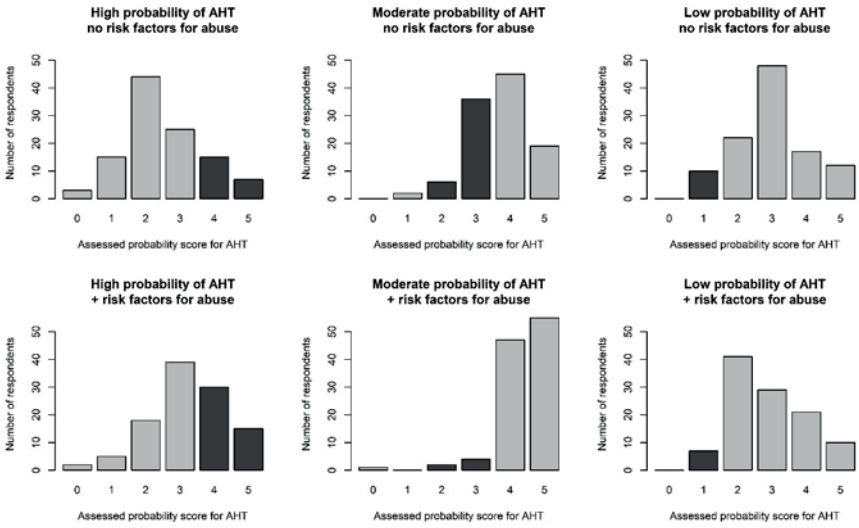
	PediBIRN-7 variables integrated in the case	Risk factors for abuse integrated in the case	Correct estimation of probability of AHT of total group (n=109) (number, (%))	Elements suspicious for abuse according to the respondents	Reporting to child protective services or legal institutions
Case with high probability of AHT, with risk factors	Haematoma on thorax Bilateral subdural haemorrhages Rib fracture	Large and reconstituted family Excessive crying	45 (41%)	Social situation 41% Crying baby 20% Rib fracture 40% Subdural haemorrhage 25%	No 6% Yes 94%
Case with high probability of AHT, without risk factors	Haematoma on scapula region Bilateral subdural haemorrhages Scapular fracture	None	22 (20%)	Subdural haemorrhage 27% Scapular fracture 21% Later arrival mother 23% Mother no injuries 13%	No 62% Yes 38%
Case with moderate probability of AHT, with risk factors	Intrahemispheric subdural haemorrhage Multiple retinal haemorrhages Respiratory compromise	Alcohol abuse parent Aggressive behaviour parent	5 (5%)	Alcohol and aggression 58% Retinal haemorrhages 76% Subdural haemorrhage 32% Severity of injuries not concomitant with story 42%	No 5% Yes 95%
Case with moderate probability of AHT, without risk factors	Bilateral subdural haemorrhages Multiple retinal haemorrhages Respiratory compromise	None	42 (39%)	Retinal haemorrhages 61% Subdural haematoma 31% Late communication fall in nursery 35% Story not congruent with age 11%	No 10% Yes 90%
Case with low probability of AHT, with risk factors	Frontal skull fracture Brain oedema Multiple retinal haemorrhages	Financial problems Large family	7 (6%)	Retinal haemorrhage 58% Social situation 18% Financial problems 14%	No 29% Yes 71%
Case with low probability of AHT, without risk factors	Bilateral parietal skull fracture Brain oedema Multiple retinal haemorrhages	History of prematurity*	10 (9%)	Skull fracture 17% Retinal haemorrhages 59% Less supervision 19%	No 31% Yes 69%

*This case was supposed to be a case without risk factors for abuse. The history of prematurity was accidently incorporated in the case, but is indeed a risk factor for abuse. Eight percent of the respondents mentioned the prematurity as a "suspicious element" for AHT in that case

Results

The survey was sent by email to 193 physicians, and shared through social media. The survey was initiated by 159 physicians. The results of forty-nine respondents who did not fully complete the survey were excluded. One questionnaire had to be excluded due to inconclusive demographical data of the participant, thus eventually 109 questionnaires were included. Participants were paediatricians (n=67; 61%), paediatric residents (n=20; 18%), emergency physicians (n=4; 4%), emergency medicine residents (n=17; 16%), and one forensic physician. Figure 1 shows the assigned probability score for AHT in the different cases. Most physicians underestimated the probability of AHT in the cases with high probability of AHT, and overestimated the probability of AHT in the cases with moderate and low probability of AHT.

Figure 1: The assigned probability score for abusive head trauma (AHT) per case. The black columns represent the probability scores that were congruent with the calculated probability according to the PediBIRN-7 study [15] (see section methods for more information).



In the cases with a high probability of inflicted injury, the assigned probability score for AHT in the case with risk factors was significantly higher than in the case without risk factors (with risk factors: mean probability score of 3.24 [95% CI 3.02 - 3.46] vs. without risk factors: mean probability score of 2.48 [95% CI 2.26 - 2.70], p<0.001). For the two cases with the "moderate" probability of AHT, we saw the same effect of the presence of risk factors: the assigned probability score for AHT in the case with risk factors was significantly higher than in the case without risk factors (with risk factors: mean probability score 4.40 [95% CI 4.25-4.55] vs. without risk factors: mean probability score 3.7 [95% CI 3.53-3.86], p<0.001). There was no significant difference in the assigned AHT probability scores between the two cases with "low" probability of abuse (with risk factors: mean probability score 2.88 [2.67-3.09] vs. without risk factors: mean probability score 3.02 [95% CI 2.81-3.22], p 0.179).

The respondents assessed the abuse probability in the high probability case for AHT without risk factors for abuse lower than the abuse probability in all the moderate and low probability cases (p<0.001 for the cases with moderate probability of AHT with and without risk factors; p=0.001 for the case with low probability of AHT without risk factors; p=0.010 for the case with low probability of AHT with risk factors).

Table 2 shows, for each case, the number and percentage of physicians that correctly estimated the probability of AHT. Only 20% correctly

Table 2: Number and percentage of four subgroups of respondents (paediatricians, residents paediatrics, emergency physicians and residents emergency medicine) that correctly estimated the probability of AHT based on PediBIRN-7.

	Correct estimation of probability of AHT - subgroup paediatricians (n=67) (number, (%))*	Correct estimation of probability of AHT - subgroup paediatric residents (n=20) (number, (%))*	Correct estimation of probability of AHT - subgroup emergency medicine residents (n=17) (number, (%))*	Correct estimation of probability of AHT - subgroup emergency physicians (n=4) (number, (%))*
Case with high probability of AHT, with risk factors for abuse	30 (45%)	5 (25%)	7 (41%)	2 (50%)
Case with high probability of AHT, without risk factors for abuse	14 (21%)	4 (20%)	4 (24%)	0 (0%)
Case with moderate probability of AHT, with risk factors for abuse	1 (1%)	0 (0%)	4 (24%)	0 (0%)
Case with moderate probability of AHT, without risk factors for abuse	22 (33%)	15 (75%)	5 (29%)	0 (0%)
Case with low probability of AHT, with risk factors for abuse	5 (7%)	2 (10%)	0 (0%)	0 (0%)
Case with low probability of AHT, without risk factors for abuse	6 (9%)	0 (0%)	4 (24%)	0 (0%)

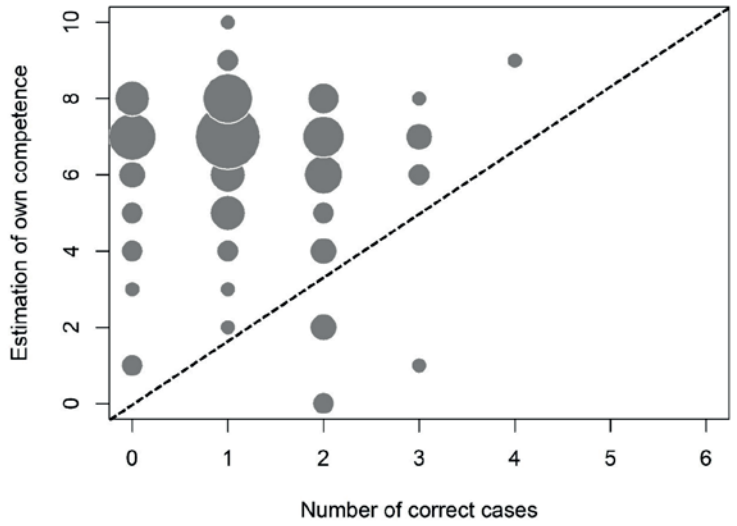
* There was no significant difference between the residents on one hand (paediatrics and emergency medicine, n=37) and the specialists on the other hand (paediatrics and emergency medicine, n=71) (mean number of correctly assessed cases 1.34 (95% CI 1.07-1.62) versus 1.12 (95% CI 0.88-1.35), p-value 0.619), or the paediatric residents and paediatricians on one hand (n=87) and the emergency medicine residents and emergency physicians on the other hand (n=21) (mean number of correctly assessed cases 1.18 (95% CI 0.98-1.39) versus 1.24 (95% CI 0.83-1.64), p-value 0.909).

Table 3: Comparison of the assigned probability score for AHT between physicians who would not report the case and physicians who would report the case.

	Mean probability score for AHT in group physicians that do not report the case (95% CI) (N = number of respondents*)	Mean probability score for AHT in group physicians that report the case (95% CI) (N = number of respondents*)	P-value
Case with high probability for AHT, with risk factors	1.79 (1.22 – 2.35) (N = 14*)	3.47 (3.27 – 3.68). (N = 93)	p < 0.001
Case with high probability for AHT, without risk factors	1.92 (1.70 – 2.15) (N = 66)	3.40 (3.11 – 3.70) (N = 42)	p < 0.001
Case with moderate probability for AHT, with risk factors	4.17 (2.94 – 5.39) (N = 6)	4.42 (4.27 – 4.57) (N = 102)	p = 0.75
Case with moderate probability for AHT, without risk factors	3.00 (2.33 – 3.67) (N = 11)	3.76 (3.58 – 3.93) (N = 95)	p = 0.010
Case with low probability for AHT, with risk factors	2.00 (1.77 – 2.23) (N = 31)	3.24 (3.00 – 3.48) (N = 75)	p < 0.001
Case with low probability for AHT, without risk factors	2.18 (1.94 – 2.42) (N = 33)	3.38 (3.14 – 3.62) (N = 74)	p < 0.001

* There was no significant difference between the residents on one hand (paediatrics and emergency medicine, n=37) and the specialists on the other hand (paediatrics and emergency medicine, n=71) (mean number of correctly assessed cases 1.34 (95% CI 1.07-1.62) versus 1.12 (95% CI 0.88-1.35), p-value 0.619), or the paediatric residents and paediatricians on one hand (n=87) and the emergency medicine residents and emergency physicians on the other hand (n=21) (mean number of correctly assessed cases 1.18 (95% CI 0.98-1.39) versus 1.24 (95% CI 0.83-1.64), p-value 0.909).

Figure 2: Bubble plot of the correlation between the number of correctly assessed cases of children with acute head injury and the estimation of own competence in child abuse (Spearman correlation 0.12, p = 0.55). The magnitude of the bullets represents the number of respondents. The dotted line in the figure shows the trend of the results if there were to be a correlation.



classified the case with the high probability of AHT without risk factors for abuse, which means that 80% of the respondents underestimated the probability of AHT in this case. When the total number of correctly assessed cases was compared between the four larger subgroups of respondents, we found no significant differences, see Table 2. Belgian law states that reporting cases suspicious of child abuse is not obligated, but that in case of severe and threatening danger professional secrecy can be overruled. In all cases except the case with moderate probability of AHT with risk factors, there was an association between the probability score for AHT and the reporting of the case to child protective services or legal institutions (see Table 3). In other words: when the physician deemed AHT more probable, the threshold to report the case became lower.

In our survey, the respondents were asked to rate their own competence regarding child abuse. Figure 2 shows that there was no correlation between the respondent's number of correctly assessed cases and the estimation of their own competence.

Discussion

The probability of AHT was underestimated by physicians in the cases with high probability of AHT, and overestimated in cases with moderate and low probability of AHT, when this probability was compared to the calculated probabilities of AHT based on the PediBIRN-7 tool (14). This means that the physicians in our survey tended to give moderate probability scores rather than extreme values. A reason behind these findings could be a lack of knowledge of intra- and extracranial injuries in children with AHT and accidental head trauma. However, it also possibly represents the difficulty for clinicians to handle the uncertainties and nuances of assessing histories, risk factors and concomitant injuries, and the potential risks of a conclusion at either end of the spectrum of accidental or abusive head injury. The four cases with moderate and low AHT probabilities all showed retinal haemorrhages (RH), while the two cases with high probability of AHT did not. It is possible that physicians overestimate the negative and positive predictive value of RH and falsely conclude that "without RH AHT can be ruled out", and "with RH AHT is present". This hypothesis is concomitant with the study by Laskey et al., which showed that the clinicians´ opinion of the aetiology of an injury was affected by the single additional finding of retinal haemorrhages, changing the majority response from undetermined to inflicted traumatic brain injury (13). In our cases with RH, 58-76% of physicians reported the presence of RH as a suspicious factor for AHT. A meta-analysis in children less than three years old with intracranial injury showed that retinal haemorrhages are indeed suspicious for AHT, but that they can

also be the result of accidental trauma (6). The interpretation of the presence or absence of retinal haemorrhages should depend on other injuries or circumstances in the patient, as well as on the different degrees and descriptors of the retinal haemorrhages (6).

The presence of risk factors for abuse effectively increases the probability of abuse; this is of course the consequence of a risk factor. In our survey, the presence of risk factors for abuse increased the physician´s estimation of AHT probability in the cases with a high and moderate probability of AHT, but not in the cases with "low" probability of AHT. This was possibly due to the fact that a risk factor for abuse (prematurity) was accidently incorporated in the low probability case that was supposed to be without risk factors. Although the cases with risk factors had multiple risk factors, it is possible that the presence of the prematurity influenced the physicians: eight percent of the respondents indeed mentioned the prematurity as a "suspicious element" for AHT in that case.

In our survey, AHT was overestimated in cases with risk factors, and underestimated in cases without risk factors for abuse. The case with a high AHT probability without risk factors for abuse was found less suspicious for AHT than the case with moderate (and even low) probability of AHT with risk factors. In other words: the combination of high-risk injuries was not interpreted as high risk in the absence of risk factors. A remarkable finding in our study was that in the cases with a high probability of AHT only 38% of physicians reported the case without risk factors to official authorities, while 94% of physicians reported the case when there were multiple risk factors. This could mean that not only in the assessment of the probability of AHT, but also in the decision of reporting a case, the presence or absence of risk factors for abuse plays a more important role for the physician than the presence of injuries with a high specificity for AHT or accidental head trauma. A recent study indeed showed that biases based on socioeconomic status and social factors may impact the decision to refer to child protective services (15).

Our study has several limitations. The sample size was small. A recent study that was probably performed in the same time frame as our study, that presented four cases of head injury to physicians with interest in the subspecialty of child abuse showed both within and between subspecialty diagnostic variability (16). The original aim of our study to compare the diagnostic variability of paediatricians, emergency physicians, forensic physicians and their residents was not fully possible due to small numbers in certain subgroups. Our survey did not provide information about the training and experience of the respondents, which makes it impossible to examine the possible influence of duration of practice and experience of the physician on the recognition of abuse. Also, the respondents were self-selected, which could be a risk for bias. Furthermore, the artificial surrounding of a survey with fictitious cases and limited information makes its applicability to real life limited: even a slightly different design could yield different judgements. Although the cases were carefully developed and discussed with a co-author of the original PediBIRN-7 tool, they were not internally validated by a broader expert panel, which could have added value (14).

The unvalidated 6-point probability score, and the artificial categorization into a low, intermediate and high risk score for AHT that we used, has its drawbacks, including potential response bias, oversimplification of nuanced opinions, and difficulty in interpreting differences between adjacent score points. However, in a survey as ours, it seems impossible to work without an intuitive score.

Prediction rules such as the PediBIRN-7 tool are developed to provide an estimation of the probability of AHT, based on a certain combination of clinical findings. They should not be considered a sufficient foundation upon which to base expert medical opinion. The PediBIRN-7 tool does not account for the presenting history or familial psychosocial risk factors. History is very important in assessing abuse likelihood, and in our cases the histories varied. It is unknown if the types of trauma that we presented in our survey were representative for the history given in the 500 true cases of the PediBIRN-7 study. Also, different histories have different levels of credibility, and the judged credibility of the history will influence the judgement of the case. It is also unknown whether the social risk factors that we integrated in the cases were present in the PeriBIRN-7 cohort. However, the risk factors that we chose to integrate in our cases are widely present in the community (large and reconstituted family, excessive crying, financial problems, substance abuse, aggressive behaviour), which makes us assume that they were also present in the PediBIRN-7 cohort. Statistically, it was unfortunately impossible to examine which factor weighed heavier in the assessment of the physicians; the history and therefore a certain credibility of the case, the presence or absence of social risk factors, or the potential knowledge of the literature. While it would have been possible to create cases with partly overlapping histories, risk factors for abuse and injures, this would have required at least a doubling of the sample size, which would have presented a challenge.

Overall, our study shows that physicians consider both trauma history and social history while assessing AHT probability, and that the combination of these findings cause them to have substantially different assessments of abuse likelihood than the signs and symptoms considered alone. Paediatrics is a holistic specialty, and considering the social context of the child is crucial. However, we believe it is contributory to realize that the social context of a child with injuries can potentially guide us towards an incorrect interpretation of the injuries. It is clear that both under- and overestimation of child abuse come with risks. Under-estimation causes the risk of continued abuse and harm and delayed intervention, while overestimation leads to loss of the trust relationship between physician and parent, unwarranted investigations, and unnecessary psychological and emotional impact on the children and their families. The question is how to minimize the risk of over- and underestimating child abuse, and how to minimize the bias in the suspicion and reporting of child abuse. Additional training for physicians who could encounter inflicted injuries in children seems recommended. In the United States, there is a specific subspecialisation for paediatricians called Child Abuse Paediatrics. In the Netherlands the subspecialty of social paediatrics exists, where paediatricians focus on the bio-psycho-social determinants as either causes or consequences of health issues. Such trainings or subspecialties do not currently exist in Belgium, for neither paediatricians or emergency physicians.

The existence of a multidisciplinary child abuse team or child abuse paediatrician can also possibly help to minimalize the risk of over- and underestimation of child abuse: a previous study showed that multidisciplinary child abuse teams can reduce unwarranted referral to child protective services or police, or temporary out-of-home placements (17). However, it is not feasible to establish such multidisciplinary teams in every hospital in Belgium. Similar to the Sexual Assault Centres in our country, we would like to advocate for the establishment of a national reference centre for the interpretation of injuries in children in our country, where cases can be presented to a multidisciplinary team with experience regarding child abuse. In the Netherlands the Dutch expertise centre for child abuse prove to be of significant added value in the accurate assessment of inflicted injuries in children (18).

Conclusion

In cases of young children with brain injury, most paediatricians and emergency physicians underestimated the probability of AHT in cases with a high probability of AHT, especially in the absence of risk factors for abuse, and overestimated the probability of AHT in cases with a moderate or low probability of AHT, especially in the presence of risk factors for abuse. Our survey showed that the presence or absence of risk factors seemed to play a more important role in the assessment of the aetiology of head injury, and possibly also in the referral of possible child abuse cases, than the presence of injuries that have a high specificity for AHT or accidental head injury. We recommend routine child abuse evaluation of all young children with acute brain injury, not only cases that are found suspicious. We believe the results of our study contribute to the need to develop a national reference centre for the interpretation of injuries in children.

Acknowledgements

We thank K. Wouters, statistician of the University Hospital of Antwerp, for statistical support and for help in designing the figures.

Funding and competing interests

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript. The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript. There are no relevant financial or non-financial interests to disclose.

REFERENCES

1. Greeley CS. Abusive head trauma: a review of the evidence base. AJR Am J Roentgenol. 2015;204(5):967-73.
2. Choudhary AK, Servaes S, Slovis TL, Palusci VJ, Hedlund GL, Narang SK, et al. Consensus statement on abusive head trauma in infants and young children. Pediatr Radiol. 2018;48(8):1048-65.
3. Overpeck MD, Brenner RA, Trumble AC, Trifiletti LB, Berendes HW. Risk factors for infant homicide in the United States. N Engl J Med. 1998;339(17):1211-6.
4. Joyce T, Gossman W, Huecker MR. Pediatric Abusive Head Trauma. StatPearls. Treasure Island (FL): StatPearls Publishing Copyright © 2024, StatPearls Publishing LLC.; 2024.
5. Letson MM, Cooper JN, Deans KJ, Scribano PV, Makoroff KL, Feldman KW, et al. Prior opportunities to identify abuse in children with abusive head trauma. Child Abuse Negl. 2016;60:36-45.
6. Maguire S, Pickerd N, Farewell D, Mann M, Tempest V, Kemp AM. Which clinical features distinguish inflicted from non-inflicted brain injury? A systematic review. Arch Dis Child. 2009;94(11):860-7.
7. Tiyyagura G, Gawel M, Koziel JR, Asnes A, Bechtel K. Barriers and Facilitators to Detecting Child Abuse and Neglect in General Emergency Departments. Ann Emerg Med. 2015;66(5):447-54.
8. Rebbe R, Mienko JA, Martinson ML. Incidence and Risk Factors for Abusive Head Trauma: A Population-Based Study. Child Abuse Rev. 2020;29(3):195-207.
9. Rosenfeld EH, Johnson B, Wesson DE, Shah SR, Vogel AM, Naik-Mathuria B. Understanding non-accidental trauma in the United States: A national trauma databank study. J Pediatr Surg. 2020;55(4):693-7.
10. Hurme T, Alanko S, Anttila P, Juven T, Svedström E. Risk factors for physical child abuse in infants and toddlers. Eur J Pediatr Surg. 2008;18(6):387-91.
11. Hymel KP, Laskey AL, Crowell KR, Wang M, Armijo-Garcia V, Frazier TN, et al. Racial and Ethnic Disparities and Bias in the Evaluation and Reporting of Abusive Head Trauma. J Pediatr. 2018;198:137-43.e1.
12. Jenny C, Hymel KP, Ritzen A, Reinert SE, Hay TC. Analysis of missed cases of abusive head trauma. Jama. 1999;281(7):621-6.
13. Laskey AL, Sheridan MJ, Hymel KP. Physicians' initial forensic impressions of hypothetical cases of pediatric traumatic brain injury. Child Abuse Negl. 2007;31(4):329-42.
14. Hymel KP, Wang M, Chinchilli VM, Karst WA, Willson DF, Dias MS, et al. Estimating the probability of abusive head trauma after abuse evaluation. Child Abuse Negl. 2019;88:266-74.
15. Zamalin D, Hamlin I, Shults J, Katherine Henry M, Campbell KA, Anderst JD, et al. Predictors of Making a Referral to Child Protective Services Prior to Expert Consultation. Acad Pediatr. 2024;24(1):78-86.
16. Doswell A, Killough E, Zinkus TP, Sherman A, Anderst J. Examining diagnostic variability among pediatric subspecialists using case examples of infant head injury. Child Abuse Negl. 2023;144:106371.
17. Wallace GH, Makoroff KL, Malott HA, Shapiro RA. Hospital-based multidisciplinary teams can prevent unnecessary child abuse reports and out-of-home placements. Child Abuse Negl. 2007;31(6):623-9.
18. van Rijn RR, Affourtit MJ, Karst WA, Kamphuis M, de Bock LC, van de Putte E. Implementation of the Dutch expertise centre for child abuse: descriptive data from the first 4 years. BMJ Open. 2019;9(8):e031008.