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Sibling Screening in Suspected Abusive Head Trauma: A Proposed Guideline

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Abstract

Abusive head trauma (AHT) is the leading cause of death from child abuse in children under the age of 5 years. It is well documented that the contacts of children presenting with suspected AHT are at an increased risk of abuse when compared to the general infant population. Despite this association, there is a paucity of literature stratifying this risk and translating it to the clinic such that this high-risk group is stringently screened for abusive injuries. In this light, the authors propose a standardised screening method for all contact children of the index case and call for further consensus on the subject.

Introduction

Abusive head trauma (AHT) as a term represents a constellation of craniospinal injuries precipitated by a forceful insult to the head, whether by shaking, impaction, or a combination of these. It is a disturbingly common entity (prevalence 20-30/100,000 children) and the predominant cause of morbidity and mortality in children under 2 years of age with traumatic brain injury [1]. As such, it weighs a heavy personal and financial burden on society.

Siblings of abused children under 2 years of age, in particular those of multiple birth, are themselves at an increased risk of abuse in comparison to the general population. Despite this recognised association, there is a paucity of literature outlining the degree to which these children are at risk and how they should be assessed by the physician [2]. Campbell et al. report a survey of 93 respondent child abuse physicians in the United States, of whom 40% reported routine conflict surrounding the assessment of contact children [3]. This lack of unanimity, in addition to the poor outcomes associated with missed cases of AHT, furthers the need for the stringent evaluation of these children [4]. In this light, the authors propose a guideline for the assessment of the siblings of children with suspected AHT and call for further consensus on the subject.

Siblings and Risk: What is The Evidence?

Several observational studies note the increased prevalence of AHT and wider domestic physical abuse in the siblings of abused children. Hamilton-Giachritsis and Browne studied 795 siblings of 400 index cases of abused children and identified that, in 37%, abuse was not focused but directed towards all children whilst, in 20%, abuse was specifically directed towards one or more children. Importantly, no paternal or infantile risk factors were characterised that distinguished perpetrators who abused all children from perpetrators who abused specific children [5]. A better understanding of these influencing factors and the motives of the perpetrator may permit further risk stratification and improve the identification of high-risk siblings.

Recognised risk factors for abuse related to the child include age, multiple birth siblings, and chronic disease. Lindberg et al. conducted a study of 134 contacts of abused children who underwent skeletal survey and found at least 1 abusive fracture in 16 (11.9%) of these contact cases. None of these fractures were evident on external

clinical examination and so these data support the use of skeletal survey in all potentially abused children under the age of 1 year independent of clinical findings. Importantly, twins of abused children were more likely to be abused than non-twin siblings; odds ratio 20.1, 95% confidence interval 5.8-69.9 [6]. This notion of twins being at a relatively increased risk of abuse is furthered in the wider literature [7, 8]. Children with chronic disease are additionally predisposed to abuse and so particular care should be taken in screening these individuals [9, 10].

Parental vulnerabilities – notably mental health disorders, intellectual disability, substance abuse, and financial difficulties – have also been documented as risk factors for abuse of both the index case and other children being cared for in the same environment [11, 12].

Current and Proposed Imaging Guidelines

Despite the well described increased risk of abusive injuries in contacts of abused children, the screening of these contacts is relatively infrequent and is not risk appropriate. Indeed, a study of 1918 contacts identified abusive injuries in 9.4% and found that one or more recommended imaging modalities were omitted in greater than 20% of cases [8].

The United Kingdom's Royal College of Radiology (RCR) offers the most comprehensive guidance for the assessment of contact cases, recommending that all multiple birth siblings under the age of 2 years should have the same indicated imaging as the index case and that age-appropriate imaging should be considered on a case-by-case basis for all siblings and children under the age of 2 years who are cared for by the suspected perpetrator, whether in the same household or elsewhere [13]. The RCR also advise that, if these guidelines are not followed, senior clinicians should document reasons for this in the patient's medical record. The Royal College for Paediatrics and Child Health (RCPCH) echoes this guidance and recommends imaging siblings under the age of 2 years who have external evidence of physical abuse and to consider imaging siblings if there is any suspicion of abuse for other reasons [14].

Though otherwise comprehensive, the American College of Radiology's Appropriateness Criteria for Suspected Physical Abuse of The Child lacks consideration of the siblings of children presenting with suspected AHT [15]. Other guidelines and statements similarly lack recommendations for children other than the index case [16–18].

The assessment guideline proposed by the authors is presented in **Figure 1**.

In addition to a comprehensive clinical examination of all siblings as per the child protection protocol, we propose a skeletal survey for all contacts under the age of 2 years. Children over the age of 2 years with evidence or suspicion of trauma should have targeted imaging as indicated by their clinical findings. Skeletal survey is not indicated in this age group due to its relatively low yield detection of undiagnosed fractures in light of the considerable dose of additional radiation [19, 20]. The authors do, however, note that full skeletal survey may be of benefit in select children over 2 years of age, for example children with communication difficulties unable to give an accurate history. The potency of skeletal surveys for detecting abusive fractures is well proven in the literature. A retrospective study of 2036 children under the age of 60 months with skeletal surveys performed to evaluate for suspected abuse identified fractures in 18% of children [20]. A similar study of 703 skeletal surveys of suspected child abuse victims identified fractures in 10.8% of children, with those under 6 months of age with suspected AHT having the highest rates of positive skeletal surveys [21]. These data corroborate the use of skeletal survey in the detection of acute and healing fractures in children. If the child is to have a CT head (see below), then skull radiographs may be omitted from the skeletal survey though this an emerging view and future studies on this area are warranted [22]. Follow-up skeletal survey is a similarly powerful though not invariably used tool. In a study of 1470 children, Singh et al. found that only 169 underwent a follow-up skeletal survey but that, when performed, previously unrecognised abusive fractures were detected in 14% of cases [23].

We additionally recommend a computed tomography (CT) scan and magnetic resonance imaging (MRI) of the brain and whole spine, as per the AHT protocol, in all contacts where there is evidence or suspicion of trauma including neurological symptomatology. Contrastingly, even in the absence of neurological signs or symptoms, children under the age of 1 year in whom abuse is suspected should have a CT scan of the head and a subsequent MRI if the CT raises concerns. The use of neuraxial MRI in children with likely abuse is advised as it is the most sensitive modality for the detection of extra-axial (subdural) collections, parenchymal injuries, cerebral oedema, and the evolving neuroimaging features of acute or preceding AHT [24]. CT scans of the head are not as specific but they are a faster and less resource intensive modality which permits unrivalled assessment of the calvarium for potential skull fractures [25, 26]. Due to this, they are best suited to a screening role.

Children over the age of 2 years with no evidence or suspicion of trauma require no skeletal survey or neuroimaging.

Ongoing Challenges

The challenges of imaging siblings will vary across institutions depending on how they currently manage the index child with suspected abuse. This is a particular challenge in the setting of a patient presenting after routine working hours, when the resources of child abuse paediatricians, sedation providers, or radiological expertise may not be readily available. Points of contention include:

1. In the scenario of a patient presenting after routine working hours, who is admitted for further workup (including advanced imaging on the next working day), what should be the management and workup of appropriately aged siblings?
2. If the skeletal survey and/or CT head is performed to exclude abuse at presentation in the emergency department, but these are negative, and the patient is sent home, when and what should be the workup of the patient's siblings?
3. The expense of additional imaging, the cost and risk of sedation if required, and the diagnostic yield of imaging the siblings: physicians are able to recruit resources for the index patient but, for asymptomatic siblings, asking for additional resources can prove difficult.

There is preliminary and anecdotal data which suggest there has been an increase in the incidence of AHT during the prolonged lockdown period enforced in many nations during the severe respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic [27]. This phenomenon is historically reflected in other tumultuous periods with heavy associated psychosocial and socioeconomic burdens, for example following severe natural disasters [28]. Whether this is substantiated in more rigorous analyses remains to be seen but these data highlight the importance of having a protocol for assessing siblings as clinical evaluation may be more problematic if there is a delay in the presentation of children with suspected AHT.

Conclusion

The involvement of a multidisciplinary team and clear communication with child protection services is imperative. In this schema, the radiologist plays a central role in identifying the hallmarks of potential abuse and in conveying this opinion, as well as the degree of certainty with which this position is held.

The assessment of contact children should be performed with the same care and rigour as that given to the index case. It is our hope that this proposed guideline will aid the evaluation of these children. A consensus driven best practice approach for siblings of an abused infant will help child abuse paediatricians and radiologists deliver optimum care and justify the demand for extra resources. We have established the framework and begun the dialogue upon which this consensus may be built upon.

References

1. Parks S, Sugerman D, Xu L, et al (2012) Characteristics of non-fatal abusive head trauma among children in the USA, 2003-2008: application of the CDC operational case definition to national hospital inpatient data HHS Public Access. Inj Prev 18(6):392–398. https://doi.org/10.1136/injuryprev-2011-040234
2. Campbell KA, Squires J, Cook LJ, et al (2009) Disparities in the medical examination of children in the home of a child with suspected physical abuse. Child Abuse Negl 33(9):612–617. https://doi.org/10.1016/j.chiabu.2009.02.008
3. Campbell KA, Bogen DL, Berger RP (2006) The other children: A survey of child abuse physicians on the medical evaluation of children living with a physically abused child. JAMA Pediatr 160(12):1241–1246. https://doi.org/10.1001/archpedi.160.12.1241
4. Jenny C, Hymel KP, Ritzen A, et al (1999) Analysis of Missed Cases of Abusive Head Trauma. JAMA 282(7):621-627. https://doi.org/10.1001/jama.281.7.621
5. Hamilton-Giachritsis CE, Browne KD (2005) A Retrospective Study of Risk to Siblings in Abusing Families. J Fam Psychol 19(4):619–624. https://content.apa.org/doi/10.1037/0893-3200.19.4.619
6. Lindberg DM, Shapiro RA, Laskey AL, et al (2012) Prevalence of Abusive Injuries in Siblings and Household Contacts of Physically Abused Children. Pediatrics 130(2):193–201. https://doi.org/10.1542/peds.2012-0085
7. Becker JC, Liersch R, Tautz C, et al (1998) Shaken Baby Syndrome: Report on Four Pairs of Twins. Child Abuse Negl 22(9):931–937. https://doi.org/10.1016/s0145-2134(98)00069-6
8. Lindberg DM, Blood EA, Campbell KA, et al (2013) Predictors of Screening and Injury in Contacts of Physically Abused Children. J Pediatr 163(3):730–735. https://doi.org/10.1016/j.jpeds.2013.02.051
9. Krug EG, Dahlberg LL, Mercy JA, et al (2002) World report on violence and health. World Health Organization, Geneva. https://www.who.int/violence_injury_prevention/violence/world_report/en/. Accessed 2 September, 2020
10. Paddock M, Sprigg A, Offiah AC (2017) Imaging and reporting considerations for suspected physical abuse (non-accidental injury) in infants and young children. Part 1: initial considerations and appendicular skeleton. Clin Radiol 72(3):179–188. https://doi.org/10.1016/j.crad.2016.11.016
11. Schnitzer PG, Ewigman BG (2005) Child Deaths Resulting From Inflicted Injuries: Household Risk Factors and Perpetrator Characteristics. Pediatrics 116(5):e687–e693. https://doi.org/10.1542/peds.2005-0296
12. Department for Education (2019) Characteristics of children in need: 2018 to 2019 England. London. https://www.gov.uk/government/statistics/characteristics-of-children-in-need-2018-to-2019. Accessed 2 September, 2020
13. Society and College of Radiographers and The Royal College of Radiologists (2018) The radiological investigation of suspected physical abuse in children. SCoR & RCR, London. https://www.rcr.ac.uk/system/files/publication/field_publication_files/bfcr174_suspected_physical_abuse.pdf. Accessed 2 September, 2020
14. Royal College of Paediatrics and Child Health (2019) Recognition of Physical Abuse. In: Child Protection Companion. RCPCH, London. https://childprotection.rcpch.ac.uk/child-protection-companion/. Accessed 2 September, 2020
15. Wootton-Gorges SL, Soares BP, Alazraki AL, et al (2017) ACR Appropriateness Criteria Suspected Physical Abuse - Child. J Am Coll Radiol 14(5S):338–349. https://doi.org/10.1016/j.jacr.2017.01.036
16. Government of Western Australia (2014) Diagnostic Imaging Pathways - Paediatric, Injury (Non-Accidental). Perth. http://www.imagingpathways.health.wa.gov.au/index.php/imaging-pathways/paediatrics/non-accidental-injury#pathway. Accessed 2 September, 2020
17. Choudhary AK, Servaes S, Slovis TL, et al (2018) Consensus statement on abusive head trauma in infants and young children. Pediatr Radiol 48(8):1048–1065. https://doi.org/10.1007/s00247-018-4149-1
18. Narang SK, Fingarson A, Lukefahr J, et al (2020) Abusive Head Trauma in Infants and Children. Pediatrics 145(4):e20200203. https://doi.org/10.1542/peds.2020-0203
19. Paine CW, Wood JN (2018) Skeletal Surveys in Young, Injured Children: A Systematic Review. Child Abus Negl 76:237–249. https://doi.org/10.1016/j.chiabu.2017.11.004
20. Lindberg DM, Berger RP, Reynolds MS, et al (2014) Yield of Skeletal Survey by Age in Children Referred to Abuse Specialists. J Pediatr 164(6):1268–1273. https://doi.org/10.1016/j.jpeds.2014.01.068
21. Duffy SO, Squires J, Fromkin JB, et al (2011) Use of Skeletal Surveys to Evaluate for Physical Abuse: Analysis of 703 Consecutive Skeletal Surveys. Pediatrics 127(1):e47-e52. https://doi.org/10.1542/peds.2010-0298
22. Martin A, Paddock M, Johns CS, et al (2020) Avoiding skull radiographs in infants with suspected

inflicted injury who also undergo head CT: “a no-brainer?” Eur Radiol 30(3):1480–1487. https://doi.org/10.1007/s00330-019-06579-w
23. Singh R, Squires J, Fromkin JB, et al (2012) Assessing the use of follow-up skeletal surveys in children with suspected physical abuse. J Trauma Acute Care Surg 73(4):972–976. https://doi: 10.1097/TA.0b013e31825a773d
24. Kemp AM, Rajaram S, Mann M, et al (2009) What neuroimaging should be performed in children in whom inflicted brain injury (iBI) is suspected? A systematic review. Clin Radiol 64(5):473–483. https://doi.org/10.1016/j.crad.2008.11.011
25. Choudhary AK, Jha B, Boal DK, et al (2010) Occipital sutures and its variations: the value of 3D-CT and how to differentiate it from fractures using 3D-CT? Surg Radiol Anat 32(9):807–816. https://doi.org/10.1007/s00276-010-0633-5
26. Culotta PA, Crowe JE, Tran Q-A, et al (2017) Performance of computed tomography of the head to evaluate for skull fractures in infants with suspected non-accidental trauma. Pediatr Radiol 47(1):74–81. https://doi.org/10.1007/s00247-016-3707-7
27. Sidpra J, Abomeli D, Hameed B, et al (2020) Rise in the incidence of abusive head trauma during the COVID-19 pandemic. Arch Dis Child Published Online First: 2 July 2020. https://doi.org/10.1136/archdischild-2020-319872
28. Campbell AM (2020) An Increasing Risk of Family Violence during the Covid-19 Pandemic: Strengthening Community Collaborations to Save Lives. Forensic Sci Int Reports 2:100089. https://doi.org/10.1016/j.fsir.2020.100089