Clinical Response to Child Abuse

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The pediatric medical provider is confronted frequently with patients in whom child abuse is a possible concern. It goes without saying that the accurate and timely diagnosis of child maltreatment has the potential to seriously and permanently affect the well being of these children.

Role of the medical provider

Child abuse is a complex phenomenon. Unlike many other conditions evaluated by pediatric practitioners, the diagnosis of child maltreatment requires significant input from nonmedical community sources. The medical provider must form an alliance with community members responsible for the investigation, management, and adjudication of child abuse cases. It is only by collaborating with these team members that a complete clinical picture can be elucidated and diagnosed definitively. Measurements, photographs, and careful descriptions of the scene are often critical to an accurate diagnosis. Likewise, a history from child protection services of previous multiple injuries, previous termination of parental rights, or familial substance abuse may be critical in the assessment of a child's safety and the development of a treatment plan.

The ability to share information with family members may be limited by the possibility that such information could actually put the child at risk for further

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injury. The "family centered care" model may have to be adapted in cases of suspected maltreatment. The role of a medical practitioner in possible child abuse cases requires a keen awareness of the necessity for a team approach, a level of caution in the exchange of information with the family that is not required in other cases, and most of all, a willingness ensure that the diagnosis of child maltreatment is appropriately included in the differential diagnosis.

Abusive head trauma

An association has long been recognized between closed head injury and child abuse. In 1946, an article by Caffey [1] described the association between long bone fractures and chronic subdural hematomas. In this early article, Caffey suggested a whiplash-type mechanism. However, it was not until the 1970s when landmark articles clearly identifying violent acceleration and deceleration as the postulated mechanism were published in refereed medical journals, first in 1971 by Guthkelch and then in 1972 by Caffey [2,3]. From slightly different perspectives, both of these articles noted the relationship among intracranial hemorrhage, child battering, and the lack of evidence of external head trauma. Both authors postulated a mechanism of violent acceleration and deceleration causing a derangement of brain tissue and an injury to cerebral vasculature. From this early research, the concept of the "shaken baby syndrome" (SBS) evolved. Clinicians and scientists alike noted a recurrent constellation of symptoms in victims of abusive head trauma, including intracranial and retinal hemorrhage, evidence of brain injury, and often, characteristic fractures of the ribs and the long bone metaphyses. Over the ensuing decades, this constellation of symptoms became reified into SBS. Recently, many child abuse clinicians and researchers have become somewhat uneasy with the "syndrome" designation and have preferred to describe nonaccidental head injury of infants as abusive head trauma (AHT) or inflicted traumatic brain injury (ie, iTBI). These designations acknowledge the lack of specific observational data and the impracticality of human study. These semantic distinctions in no way diminish the clinical or scientific certainty that this form of abuse does exist.

The incidence of AHT is understandably difficult to measure. Two prospective population-based studies, one in Scotland and one in North Carolina, estimate the incidence at, respectively, 24.6 per 100,000 and 29.7 per 100,000 infants less than 1 year of age. Both studies are well designed, and both face the pitfalls of unidentified and wrongly identified abusive head trauma [4,5]. It is clear from several studies that the risk of abusive head trauma is the highest in children less than 1 year of age. It is important to note that ethnicity has not been shown to be a significant predictor of abusive versus accidental head trauma [6,7].

Four primary pathologic and diagnostic features will be discussed: traumatic injury to the brain substance; causes of intracranial hemorrhage and its diagnos-

tic significance; retinal hemorrhage and its diagnostic significance; and an approach to the evaluation of AHT in the clinical setting.

The precise mechanism of injury to the brain in abusive head trauma has yet to be elucidated clearly. There is general agreement among mainstream clinicians and researchers that the abuse creates shearing forces in the developing infant brain, which cause injury to the axonal system. Symptoms depend on the severity and often include a loss of consciousness, apnea, and cerebral edema. It is this brain substance injury that accounts for the primary symptoms and clinical course of the injured child. This traumatic axonal injury is the key pathologic feature in AHT.

Readily identifiable on radiographic imaging and autopsy, the presence of intracranial blood has long been a central diagnostic feature of AHT. Although axonal injury is the key pathologic feature, the identification of intracranial hemorrhage is certainly important both diagnostically and with respect to medical management. Although subdural hemorrhage is certainly the intracranial pathology most commonly identified in cases of AHT, subarachnoid and epidural hemorrhage have been reported.

Subdural hemorrhage presents typically in one of two forms. First and much more commonly in accidental head trauma is the subdural hemorrhage associated with the translational forces of impact. These contact-type injuries present with clear evidence of impact in the form of soft tissue swelling or actual skull fracture. These are high-force injuries, but a history of accidental impact such as the motor vehicle crash or a fall from a significant height onto a hard surface can be reassuring. The second form is the more diffuse form of subdural hemorrhage resulting from rotational and shearing forces on the bridging veins of the brain surface. Evidence of impact may be present, but there will be diffuse areas of hemorrhage that are often intrahemispheric, all or perifalcial. This form is much less common in infants and suggests AHT.

There is good evidence that accidental subdural hemorrhage in small children is rare. Feldman and colleagues [6] examined a series of children under the age of 3 years and were able to identify nearly 60% who were abused. Interestingly, in Feldman and colleague's study, abuse was much more common in children in whom there was a history of a short fall or no history at all. Delay in seeking care and evidence of other trauma were also significant predictors of abuse. It should be noted that there are multiple studies that have examined the possibility of significant intracranial injury from short and medium distance falls in children. Overwhelmingly, the data reveal that severe injuries resulting from such falls are exceedingly rare and need to be scrutinized carefully [8–12].

Retinal hemorrhages (RH) are frequently noted in abusive head trauma. It is fair to estimate that approximately 80% of children who have suffered abusive head trauma have retinal hemorrhages [13]. There is also good evidence that RH is found more commonly at autopsy than in intact survivors. This certainly suggests that retinal hemorrhaging is a marker of severity [14]. There are case reports of retinal hemorrhages that occur in severe accidental trauma and those

that are possibly associated with severe intracranial hypertension [15,16]. In these cases, however, the hemorrhages have been confined to the posterior pole of the retina and have usually been few in number. With increasing knowledge about the variability and pathology RH, it is critically important that a skilled ophthalmologist carefully document the character and location of the hemorrhage. Markers of severity such as vitreous hemorrhage or retinoschisis should be noted.

The recognition of abusive head trauma is not always straightforward. A 1999 study by Jenny and colleagues [17] has noted that nearly one of three AHT cases were seen by a physician after the abusive episode and were not diagnosed. Reasons for these misdiagnoses included nonspecific presentation by a small infant, absence of external signs of trauma, radiologist error, and the child coming from a white, intact, family. This study is not, as it may seem to some, a global indictment of our profession. It is instead a call to strengthen our diagnostic armamentarium and to encourage all of us to keep child abuse on our differential diagnoses.

The diagnostic approach to abusive head trauma begins with a careful and well-documented history. Quoted remarks should be used whenever possible, and the child's caregiver should be asked to carefully describe the mechanism of injury. The medical provider or child abuse consultant should include in the differential diagnosis any possible medical or accidental causes of the child's symptoms. It is not the physician's role to accuse or confront family members. The medical provider should also refrain from suggesting mechanisms of injury to the family. Finally, it is critically important that the medical care team involve community members of the child abuse team in planning for the safety of the child.

Early consultation with a child abuse pediatrician is critical in planning a diagnostic strategy and providing liaison with community professionals. Decisions can be made at that time about other consultations (eg, neurosurgery or ophthalmology or other treatments). Imaging strategies can also be developed in concert with the child abuse consultant. This type of collaboration between hospital and community teams will most likely result in the most accurate diagnosis and will minimize trauma to the patient and the patient's family.

Also required for accurate diagnosis is an imaging strategy that addresses the specific radiologic features of AHT, encompassing three primary areas. For head imaging, an initial CT scan is a reasonable place to begin. Although it is not as sensitive as MRI, CT can be obtained quickly and without sedation. CT scanning, however, may miss small extradural blood collections. If there is a high index of suspicion, early MRI may be necessary; otherwise, an MRI study performed during the first 72 hours can be a helpful diagnostic adjunct. This strategy of course should be coordinated with the treatment team. Second, a complete skeletal survey should be undertaken. Using protocols guided by the American College of Radiology, this survey should always be repeated in 2 weeks, when there has been an acute presentation. A nuclear bone scan may be helpful in the first days to identify occult bony injury, but this will not obviate the need for the repeat survey. Special attention should be paid to the ribs and the long bone

metaphyses because these fractures are associated commonly with AHT. Finally, with respect to imaging, occult abdominal trauma should be considered. Children with elevated liver function tests or those most likely to have suffered abdominal trauma, toddlers and older infants, should undergo an abdominal CT with contrast if renal function is adequate.

Skeletal injury

Any skeletal injury can be the result of abuse. A careful history evaluated in the context of the patient's developmental stage is the key to differentiating abusive from nonabusive injury. An understanding of the literature surrounding short falls is invaluable. Additionally, some fractures, particularly in infants, should always raise suspicion for abuse.

Household falls in infants are common and usually harmless. A study of more than 11,000 infants less than 6 months of age has revealed that approximately 22% of the infants were involved in a household fall. Less than 1% of these falls resulted in any serious injury (defined as concussion or fracture). There were more than 1700 falls from beds or settees, and only one fracture, a clavicle, was reported [18]. In a second well-designed study, 207 falls ranging in height from 25 to 54 inches occurring in hospitalized children less than 6 years of age resulted in only two fractures, a simple skull fracture and a clavicle fracture [9]. Hennrikus and colleagues [19] report that fractures resulting from falls in children less than 1 year of age were uncommon compared with older children and were injuries of concern for physical abuse in 50% of cases. Even in this study reporting frequent injuries from household falls, the authors urge caution and suggest a careful investigation for nonaccidental trauma when children less than 1 year old present with fractures after a fall from a bed or couch.

Fractures in very young children, particularly nonmobile infants, are often the result of abuse [20,21]. Additionally, there are a few fractures in young children that warrant special attention because of their high specificity for abuse. High-specificity fractures include classic metaphyseal lesions (CML) and rib fractures. Scapular fractures, spinous process fractures, and sternal fractures are also highly specific.

The classic metaphyseal lesion (the corner or "bucket handle" fracture), regardless of history, should be viewed as highly specific for abuse. Until the mid 1980s the CML was believed to be an avulsion fracture at the point of insertion of the periosteum. Kleinman and colleagues [22] studied radiologic and histologic features of these fractures in abused infants at autopsy. Rather than an avulsion fracture, they discovered that the CML is actually a planar series of microfractures through the metaphyseal primary spongiosa. When the lesion is viewed tangentially, a corner fracture appearance is noted. When viewed at an angle, a bucket handle fracture is noted. Coned down views of the metaphyses may be helpful in the evaluation of suspected abuse. In the case of suspected

nonaccidental fatal trauma, a postmortem examination of the metaphyses may be indicated even in metaphyses with no radiologic evidence of fracture [23].

Rib fractures, particularly posterior rib fractures, are highly specific for abusive injury in young infants. Although rib fractures have long been known to be highly correlated with abuse, three recent independent case series studies reveal very similar results. In children less than 1, 2, and 3 years of age, 82% to 83% of rib fractures were attributed to abuse. The remaining rib fractures were the result of bone disease or accidental injury. Accidental fractures were rare and were the result of cardiac surgery, pedestrian versus car accidents, motor vehicle crashes, a birth injury, a stairway fall in the arms of the father, and an instance of an older sibling who fell on an infant. In contrast, the fractures attributed to abuse often presented with no history of trauma or a history of minor trauma [24–26]. In two of the studies, abused children were found to have significantly more rib fractures than children with noninflicted injuries, and in 20% to 29%, there were no associated injuries identified [25,26]. Additionally, Cadzow and Armstrong [25] report that one of three children who returned home after an inflicted rib fracture subsequently suffered a significant reinjury.

Cardiopulmonary resuscitation (CPR) is often cited as a cause for rib fractures in critically injured children. This explanation should be viewed with extreme skepticism. Based on the radiologic examination of 50 children who received CPR, Feldman and Brewer [27] report that rib fractures in children are rarely if ever the result of CPR. Spevak and colleagues [28] studied 91 infants who had no evidence of abuse but who had received CPR. These patients were examined both radiologically and on autopsy. No rib fractures were identified.

Posterior rib fractures are the result of unique mechanical forces and are highly suggestive of inflicted trauma. The posterior rib and the transverse process act as a lever mechanism. The transverse process is the fulcrum. As the chest is compressed, the posterior ribs move dorsally, causing excess levering over the transverse process. This injury is typically the result of an adult grasping the child around the chest and squeezing the chest, but it could result from an infant being slammed or hurled face-first into a solid object. This mechanism would also allow chest compression and dorsal migration of the posterior ribs and could be the result of abusive injury or forceful accidental injury such as a motor vehicle crash [29].

Although a discussion of radiologic dating of fractures is beyond the scope of this article, it should be noted that multiple fractures in various stages of healing is an indication of possible abuse.

A skeletal survey is the primary diagnostic tool to identify occult fractures in young children and is mandatory in any child less than 2 years old in whom physical abuse is suspected. A skeletal survey may also be indicated in children 2 to 5 years old based on the history. When abuse is suspected, the skeletal survey should be repeated in 2 weeks. A ''babygram'' is not acceptable. A skeletal survey should comply with the standards developed by the American College of Radiology. Radionuclide bone scanning may have a role as an adjunct to plain films [30]. Films should be reviewed by a pediatric radiologist.

Cutaneous manifestations of abuse

Bruises are common in children but may be a sign of child abuse. Three factors can assist the clinician in distinguishing inflicted bruises from accidentally acquired bruises: the age and developmental stage of the child, the bruise pattern, and the location.

As with skeletal injury, bruises in young children raise concern for abuse. Sugar and colleagues [31] performed a large prospective cross-sectional survey of children less than 3 years of age who were not suspected to be victims of abuse and had no known medical condition to account for bruises. Only 2.2% of precruisers had any bruises, whereas 17.8% of cruisers and 51.9% of walkers had bruises. Although few precruisers had any bruises, the majority of the bruises in this group were in children greater than 6 months of age. One lesson from this large study is simply stated in the report's title: "Those that don't cruise rarely bruise" [31]. Labbe and colleagues went a step further and examined recent skin injuries in children 0 to 17 years of age. Skin injuries, including bruises, abrasions, scratches, and other injuries, were extremely common in most children. Children 0 to 8 months old, however, had relatively few injuries, and the majority of injuries were scratches on the head and face. Again, bruises were rarely found in this age group (1.2%) [32].

Sometimes being struck with a hand or object results in a patterned bruise or injury. These patterned injuries are seldom the result of routine childhood activity. Some objects leave recognizable patterns. A slow-velocity impact such as a grab or a squeeze may bruise at the points of contact, such as beneath the pads of the assailant's fingers. In this case, capillary disruption occurs directly beneath the force. Conversely, in a high-velocity impact, such as a slap with an open hand, the outline of the fingers may be identifiable as a bruise or petechial injury. In this case, the injury outlines the points of contact, and there is sparing directly beneath the points of contact. A child struck with an object such as a belt may have parallel linear bruises. Again, the injury often outlines the object. A looped cord may leave a "closed loop" imprint on the child's skin. There may even be a laceration of the skin at the tip of the loop. Often, the implement that left the patterned injury cannot be identified by examination alone. Involvement of a multidisciplinary team may allow identification of the implement.

Some pattern injuries are the result of the child's anatomy rather than the implement with which they are struck. Spanking of the buttocks may leave a diagnostic patterned injury consisting of petechial injuries paralleling each side of the gluteal cleft with central sparing. When the child is struck, the buttocks are forced to comply with the shape of the object. As a result, the skin at the margin of the gluteal cleft is forced into an exaggerated fold. Petechial injury occurs along this fold. Bruising of the gluteal convexities may or may not be present. Similarly, an ear that is struck or pinched may have petechae on the edge of the helix, presumably from folding of the helix [33].

Bruise location can offer some insight to the cause. Accidental bruises in mobile children occur most frequently over bony prominences such as shins,

knees, and foreheads [31,34,35]. Bruises on the trunk, buttocks, and cheeks are unusual and warrant additional consideration.

Some texts suggest that the color of a bruise can be used to estimate the age of an injury. It is now clear that clinicians cannot accurately predict the age of bruises, and this practice should be avoided [36–38].

All bruises suspected to be inflicted should be photographically documented with a 35-mm format or high-quality digital photographs. Photographs should be taken with adequate lighting and include a measuring device. Multiple photos, including both tight and wide angle, should be obtained.

Inflicted burns are an important manifestation of child abuse. As with all forms of child abuse, an accurate and carefully obtained history is crucial. This history must then be evaluated in the context of the child's development. In scald burns, particular attention should be paid to identifying what the child was wearing at the time of the injury. Hot liquid soaked into clothing in contact with the skin may alter the pattern of a hot liquid burn. The initial physical examination and burn distribution should be carefully documented and photographed if possible. This allows a future review of the injury before medical intervention that may change the appearance of the injury.

Inflicted burns may be the result of contact with hot objects such as cigarettes or curling irons. Patterned burns should raise concern for an inflicted trauma. Inflicted cigarette burns tend to be round, 7 to 8 mm in diameter, and may be multiple, whereas accidental cigarette burns tend to be ill defined. Bilateral symmetric burns (stocking or glove distribution) should raise concern for a forced immersion. A lack of splash marks may indicate that a child was held still, and areas of sparing may give insight into the position of the child at the time of the injury. Spared areas may be the result of the skin being in contact with itself such as in joint flexion or may be the result of the skin being in contact with the fluid receptacle such as the bottom of the bathtub [39].

Abdominal injury

Inflicted abdominal injury is the second leading cause of child abuse fatalities. The fatality rate may be greater than 50% [40]. In young children, abuse is second only to motor vehicle crashes as a cause of abdominal trauma. Independent of comorbid injuries, inflicted abdominal trauma is associated with a sixfold increase in inhospital mortality. Inflicted abdominal injury is often difficult to diagnose. Unlike most cases of accidental abdominal injury, the history is often absent or deliberately falsified. Additionally, this unreliable history may be coupled with vague signs and symptoms. Children with associated fractures may in fact have a lower mortality rate than children without fractures. Presumably, the fractures alert caretakers and medical personnel to the unreported history of trauma [41].

Children with inflicted abdominal injury tend to be younger and present for medical care later than accidentally injured children. Toddlers and young children

appear to be at particular risk. Injuries may be the result of punches, kicks, or the child being hurled into other objects. Child abuse can result in either solid- or hollow-organ injury. Any abdominal injury in a toddler or young child without a history of severe trauma such as a motor vehicle crash warrants evaluation. Several studies demonstrate that hollow-organ injury in young children, particularly when reported to be the result of a fall, are injuries of high concern for abuse [40,42]. In fact, fatal blunt force abdominal injury from nonvehicular accidents appears to be so rare that it can almost be viewed as nonexistent [43].

Occult abdominal trauma should be considered in patients with nonspecific signs and symptoms and in patients with other signs of abuse. Abdominal bruising is an important sign, but the absence of bruising does not rule out internal injury because a significant number of patients do not have bruises [42]. Coant and colleagues [44] report a series of patients suspected to have been physically abused who did not have signs or symptoms of abdominal trauma. Four of 49 patients had elevated liver transaminase levels. Three of the four had liver injury documented on CT scan. This suggests that liver enzymes may be a reasonable screen in any patient who is suspected of being abused. In the stable patient, CT is usually the examination of choice and will best demonstrate many of the injuries resulting from abuse [30]. In the opinion of the present authors, the clinician should have a relatively low threshold for obtaining abdominal CT in a patient who has any significant inflicted injury such as AHT or multiple fractures.

Sexual abuse

Child sexual abuse remains a common and vexing problem. A recent study by Finkelhor and colleagues [45] suggests that the prevalence rates for sexual victimization were 96 per 1000 for girls and 67 per 1000 for boys between the ages of 2 and 17 years. Responding to child sexual abuse is often daunting for the pediatric provider. Invariably, the atmosphere is emotionally charged, and the practitioner is faced with a diagnostic and management challenge. In meeting this challenge, it is important to be mindful of the current literature regarding the examination of possible abuse victims as well as some basic principles and procedural guidelines.

It is important to remember that caring for a youngster who may have been sexually abused is, first and foremost, medical care. Although these cases seem unique and the legal aspects may be intimidating, the basic principles of medical care apply. Clinical decision making needs to use the same risk-benefit analysis that the practitioner uses customarily. There may be pressure to perform procedures to facilitate a legal resolution that pose a risk to the patient. Additionally, the emotional state of the child's caregivers, often ranging from terror to rage, may add a sense of urgency to the case.

Because the history and physical evaluation of these youngsters has become so specialized and the potential for emotional trauma so great, these evaluations

are best performed in a comfortable, child-friendly setting by practitioners specially trained and facilities specially equipped for such examinations. Therefore, it is critically important that communities develop procedural guidelines to determine what constitutes a true emergency and who will respond if necessary. However, the majority of child sexual abuse cases are not emergent and can be scheduled at a time that is optimum for the comfort of the child and therefore obviate the need for multiple evaluations.

There are times when an urgent evaluation is required. Reasons for emergency examinations include cases of

- Complaints of pain
- Evidence or complaint of bleeding or injury
- An alleged assault that has occurred within the previous 72 hours and the transfer of biologic material may have occurred
- Medical intervention that is needed emergently to assure the safety of the child

With prepubertal children, there is evidence to suggest that forensically significant biologic transfer material rarely lasts longer than 24 hours [46]. These data however, may be updated as modern DNA technology is used. There is still strong evidence, however, that the most likely location of biologic transfer material is in the clothing or bedding related to the assault. Therefore, when assessing the need for and performing an emergency acute sexual assault evaluation, it is critical that community resources be used to obtain clothing and bedding.

Because physical findings are rarely diagnostic in these cases, a well-documented and careful medical history is most often the sole or primary diagnostic evidence. For this reason, obtaining the medical history from an allegedly sexually abused child, sometimes referred to as forensic interviewing, has become a highly specialized practice. Although it is necessary to obtain sufficient information from the child victim to assure their medical well being and safety, it is recommended that the complete and definitive medical history be obtained by a specially trained individual.

In addition to a well-documented history, the alleged child sexual abuse victim needs a thorough physical examination, including a complete physical assessment, looking for other signs of maltreatment and other unrelated medical conditions. It should also include a gentle, well-documented genital examination. Like the history, this genital examination requires special competencies. The ability to provide photographic documentation through video colposcopy or photography is crucial. This documentation will potentially obviate the need for multiple examinations.

There is good evidence that, without specific training, even highly qualified pediatric practitioners are unable to accurately interpret genital findings. In a well-designed study, Makoroff and colleagues [47] note that of 46 nonacute sexual abuse examinations called abnormal by pediatric emergency room physicians, 79% of these examinations were found to be normal or nonspecific

by child abuse specialists. These data strongly argue for performing sexual abuse examinations or, at the very least, having the examinations reviewed by trained and experienced child abuse medical providers.

Importantly, the likelihood that nonacute genital examination findings are diagnostic for child sexual abuse is remarkably low. Studies by Berenson and colleagues [48] and Heger and colleagues [49] clearly place the likelihood of diagnostic findings in prepubertal girls, including those who have been penetrated, at less than 5%. Remarkably, an excellent study by Kellogg and colleagues [50] notes normal or nonspecific examinations in pregnant adolescents, a condition that most authors agree has been preceded by sexual contact. The reasons for the lack of clear and definitive findings in these cases are

- The broad range of normal demonstrated in multiple studies [51–53]
- Children's remarkable capacity to heal [54]
- The fact that many disclosures of sexual abuse occur long after the actual trauma
- That many episodes of child sexual abuse, even with penetration, may not be damaging

Finally, when considering child sexual abuse, the pediatric practitioner must be aware that the diagnosis of sexually transmitted infections (STI) has both legal and medical implications. This means that a practitioner must be aware of STI prevalence patterns in the community and region. There has been a shift of late in the probative significance of the various sexually transmitted infections. Children infected with syphilis, gonorrhea, or Chlamydia are still considered to have had sexual contact. However, infections with herpes simplex viruses or human papillomaviruses are increasingly ambiguous with respect to the possibility of a sexually acquired infection. Of course, testing for and, when indicated, prophylaxis against HIV and hepatitis remain critically important measures. A protocol for post-exposure prophylaxis should be available to the practitioner.

Summary

The medical evaluation of child abuse is challenging and requires a highly specialized response. The role of the pediatric medical provider is not significantly different than it is with other unusual or challenging health problems. The child's well being remains the primary concern, and consultation with a child abuse specialist will help to ensure the child's safety.

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