Evaluation of a Child Abuse Screen Performed by Nurses Among Young Children with Fractures Seen in a Pediatric Emergency Department

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ABSTRACT

AIMS: To assess institutional compliance with, and test characteristics of, a child abuse screen performed by emergency department (ED) nurses for children <5 years old who were diagnosed with fractures.

METHODS: A secondary analysis of a retrospective observational study of children 0–5 years old with fractures seen at a pediatric ED between January 2018 and April 2023 was performed. We analyzed demographics, ED visit data, and results of the nurse-completed abuse screen. Screen results were compared to ED clinician concern for abuse to calculate test characteristics.

RESULTS: The mean age of the 2,705 children identified was 38.4 months (SD 19.8). Out of the total patient cohort, 2,449 (90.5%) had a nurse-completed screen. Among these, 65 patients (2.4%) screened positive for possible abuse. We found no statistically significant difference in screen completion by age group, race, ethnicity, language, or insurance type. Of 312 (11.5%) encounters with clinician concern for abuse, 17.6% screened positive, 76.0% screened negative, and 6.4% had an incomplete screen. The sensitivity and specificity among screened children aged 0–5 were 19.2% [95% CI 14.7–23.8%] and 99.5% [95% CI 99.3–99.8%]. The PPV and NPV were 84.6% [95% CI 75.8–93.4%] and 90.3% [95% CI 89.1–91.5%]. Comparatively, among children <12 months, the sensitivity was 24.4% [95% CI 18.0–30.8%], specificity was 98.1% [95% CI 95.4–100%], PPV was 95.5% [95% CI 89.3–100%], and NPV was 43.7% [95% CI 37.3–50.1%].

CONCLUSIONS: Although there was high compliance with this nurse-completed abuse screen, it is an inadequate sole modality for screening young children with fractures, with a low probability of a positive screen given clinician concern for potential abuse for the entire cohort *and* among high-risk infants.

KEYWORDS: Child abuse screen, electronic health record, pediatric emergency department

INTRODUCTION

Child abuse is a public health issue with severe short- and long-term consequences. Approximately 25% of children are abused or neglected in their lifetimes, with an estimated 18% experiencing physical child abuse.[1,2] After bruising, fractures are the most common childhood injury from physical abuse.[3] It is estimated that 25–56% of abusive fractures occur among children <12 months,[4] up to 80% among children <18 months,[5] and the vast majority among children <5 years,[4] underscoring the importance of optimizing screening for this high-risk group.

The emergency department (ED) is an entry point into the healthcare system for many abused children. Children who have been abused are known to visit the ED more often than non-abused children, and ED providers may be their first and only medical contact.[6-8] While early detection presents ED providers with a critical opportunity to reduce morbidity and mortality, healthcare providers either miss or misdiagnose abusive fractures in young children up to 20% of the time.[9] Although the American Academy of Pediatrics (AAP) has developed evidence-based guidelines for evaluating physical child abuse, validated and universal child abuse screening tools remain lacking.[10]

To date, several screening tools have been published and validated, including injury-specific clinical decision rules and more general screens.[11-15] However, because no comprehensive gold standard to screen for all forms of child abuse exists, many hospitals implement their own screens, which can be active (provider-completed), passive (utilize information embedded in the electronic health record (EHR)), universal (for all children irrespective of presenting complaint) and/or targeted (limited to certain age groups and/or complaints).[4,16] Inconsistent screening compliance, insufficient clinician knowledge, and clinician biases, among other barriers, remain significant obstacles to accurate detection.[8,13,17] As such, hospitals must critically review their screening protocols to ensure that there is high compliance, identify potential institution-based barriers, and evaluate screening test characteristics.

In 2018, the study site, Hasbro Children's Hospital, implemented a mandatory abuse screen performed by ED nurses, similar to previously published screening questions.[13] To date, no formal evaluation of this screen has been completed.

The aims of our study were to assess institutional screening compliance and test characteristics (sensitivity, specificity, negative and positive predictive values) compared to ED clinician concern for abuse and discussion with a child abuse pediatrician (CAP), among children <5 years who were diagnosed with a fracture.

METHODS

Study design and population

A secondary analysis of a larger retrospective observational study of children aged 0–5 years old who visited a regional tertiary pediatric ED between March 2015 and April 2023 was performed. All patients included in the primary study had at least one diagnosed fracture, identified by the International Classification of Disease 10th revision (ICD-10) codes (See **Box**). Full-text ED encounter notes and discrete data were provided by research information services in Microsoft Excel™ (Microsoft, Redmond, WA, USA). The institutional abuse screen became embedded in the EHR in January 2018; as such, encounters between January 2018 and April 2023 were included. The study was approved by the institutional review board.

Box. ICD10 Codes for Fractures

Skull: S02.0*, S02.1*, S02.7*, S02.8*, S02.9*
Nasal bone, orbital floor, maxilla, mandible: S02.2, S02.3*, S02.4*, S02.6*; dental fractures (S02.5) were excluded
Pelvis and spine: S12*, S32*
Rib: S22.3*, S22.4*, S22.5*
Shoulder and humerus: S42*
Radius and ulna: S52*
Wrist, hand, and fingers: S62*
Femur: S72*
Tibia and fibula: S82*
Ankle, foot, and toes: S92*

Hasbro Children's Hospital is the only level-one pediatric trauma center in Rhode Island with a catchment area also including parts of Connecticut and Massachusetts. Annually, an average of 55–60,000 patients are seen in this pediatric ED, of which approximately 52% are male, 47% White, and 14% Black. Nearly 40% of patients identify as Hispanic. More than 45% of patients have public insurance. Any ED clinician concern about potential abuse and/or neglect can be reviewed directly with a consultant child abuse pediatrician (CAP) 24 hours a day, 7 days a week.

Measures

Demographic features including sex, age, race, ethnicity, insurance payor, and primary language were collected. Sex, race, and ethnicity categories were self-reported by the patient/caregiver or assigned by hospital registration in accordance with the institution's practices. We included race and ethnicity data because of previously described disparities in the screening and reporting of potential child abuse.[10,18-20]

Encounter-level characteristics included date and time of visit and ED disposition (e.g., admit, discharge). Derived variables based on the date and time of ED presentation were day of the week, month of the year, and shift. The three shift periods corresponded to the institution's standard nursing shifts (07:00–14:59, 15:00–22:59, and 23:00–06:59).

Child Abuse Screen

The four-question universal screen was to be completed by registered nurses for all children, regardless of age or chief complaint, to identify those who may have experienced abuse/neglect and potentially needed additional evaluation. Education regarding child abuse was provided in a lecture given by nurse educators or by an online educational module at the time of nursing onboarding. Education regarding the screening questions was provided during triage training by nurse educators.

Figure 1 shows the intended workflow of the screen. The screening questions are similar to the previously published Escape questionnaire.[13] A screen was considered positive for potential abuse if any of the four questions were answered "yes." A screen was considered negative if the first two questions were completed by the triage nurse and were answered "no" or if all four questions were completed by the room nurse and answered "no." Although screening was intended to be mandatory and universal, nurses were able to defer the questions in the EHR; a screen was considered incomplete if questions were left unanswered.

Emergency Department Clinician Concern for Abuse

If the ED clinician had concerns for potential abuse/neglect, independent of or based on the nursing screen, a CAP was called to review the case. Encounters reviewed with a CAP were identified in two ways. The first was the presence of a CAP consultation or plan of care note associated with the ED encounter. Second, keyword identification from the clinicians' notes for all encounters were identified through manual review of the dataset. Search terms included the child abuse pediatrics center eponym ("Aubin Center"), "child protect-" (-ion, -ive), "child safe," "abuse," "nonaccidental," "DCYF" and "DCF" (the local states' acronyms for departments of children (youth) and families), and "skeletal survey." Encounters with these terms were included if a clinician documented that there was a discussion with

Figure 1. Child Abuse Screen Workflow

- Nurses are prompted to answer questions 1 and 2 during the triage process.
- If the first two questions are answered "no" in triage, the screen is considered complete and negative.
- If at least one question is answered "yes" in triage, the screen is considered complete and positive, and the nurse is required to alert the attending physician. *Room nurses may additionally complete questions 3 and 4 at their discretion.
- Triage nurses can defer the initial two questions to room nurses, who are then prompted to answer all four questions. Questions may be deferred again, leaving the screen incomplete.
- If any one of the four questions is answered "yes" by the room nurse, the screen is positive; if all four questions are answered "no" by the room nurse, the screen is negative.
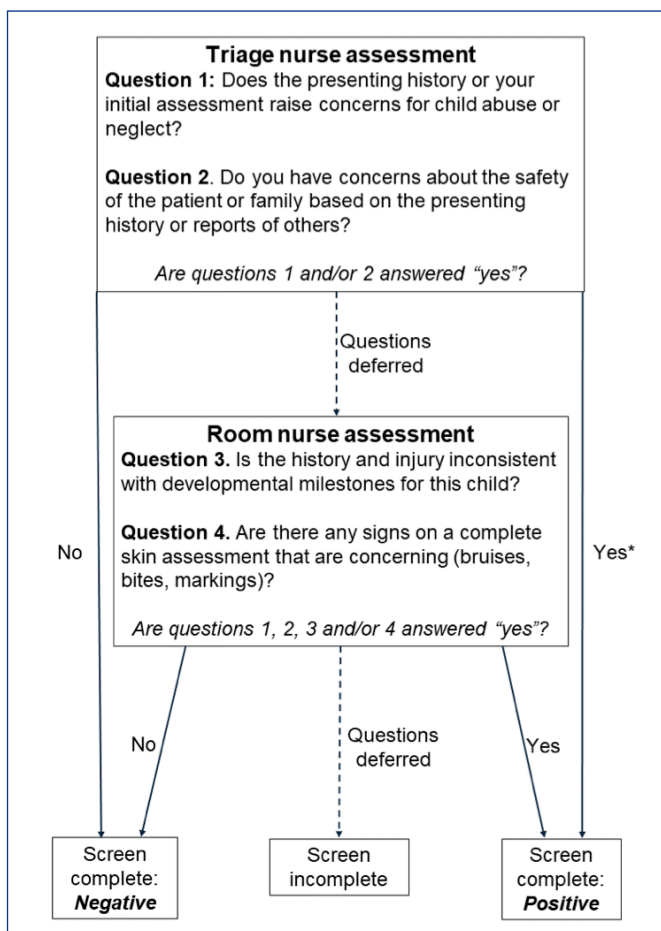
a CAP due to concerns of potential abuse/neglect related to the current encounter. Documentation of prior but not current abuse evaluation(s) or concerns, documentation of placement in child protective services custody prior to the time of the encounter but no concerns related to the current fracture visit, or explicit documentation of *lack* of concern, were coded as no concern.

Statistical Analysis

All data were exported into Microsoft Excel™ for coding and analyzed using SAS™ (version 9.4, SAS Institute, Inc., Cary, NC, USA). Descriptive analyses were performed to describe the study population and ED encounter characteristics, reporting results as frequencies and proportions, with mean and standard deviation when applicable. Bivariate analyses were conducted to determine associations between the patient and ED encounter characteristics by screening completion and results, with 95% confidence intervals reported. Chi-square tests were calculated for comparative analyses.

To calculate the test characteristics for the nursing screen, results were compared to the reference standard of ED clinician concern and discussion with a CAP. This reference standard was chosen rather than cases of confirmed abuse, as previously described,[3,13] given that the purpose of the screen is to recognize *potential or suspected* abuse/neglect, and not to diagnoses cases. Furthermore, the diagnosis of abuse is not commonly made in the ED setting, and concern for abuse is essential to its potential identification. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for the entire sample and stratified among children <12 months, 12 to <24 months, and 24 to <36 months, as younger children are at higher risk of sustaining and having missed abusive fractures.[9,20-22] Children with incomplete screens (N=256) were excluded from these analyses. There was a small proportion of patients with more than one encounter during the 8-year study period; because the screen was to be completed at every encounter and the opportunity for child maltreatment could arise between visits, all encounters were included in the analysis.

RESULTS

There were 2,705 children who presented to the ED with fractures during the study period. The mean age was 38.4 months (SD 19.8) and 45.7% were <3 years old. Most patients were female (55.3%), White (59.7%), non-Hispanic (72.2%), and publicly insured (35.4%) (**Table 1**). 69.6% of encounters occurred between Monday and Friday, 60.1% during the 15:00–22:59 shift, and 14.3% were admitted (**Table 2**). A combined 86.7% presented with a chief complaint related to an injury or pain. The most common fractures were radius and/or ulna (24.1%), humerus (23.3%), and tibia and/or fibula (17.0%) (**Table 2**).

Overall, 90.5% (N=2,449) of patients were screened, of which 65 (2.4%) screened positive for nursing concern for potential abuse/neglect, and 88.1% screened negative. There were 256 (9.4%) encounters with an incomplete screen. We found no statistically significant differences in screening completion by age group (p=0.14), race (p=0.66), ethnicity (p=0.89), primary language (p=0.92), or insurance type (p=0.56). Furthermore, screen completion was not

Table 1. Patient Demographics, N=2,705

	N (%)
Sex	
Male	1,497 (55.3%)
Female	1,208 (44.7%)
Mean age, months (SD)	38.42 (19.8)
Age group	
0 to <12 months	293 (10.8%)
12 months to <24 months	436 (16.1%)
24 to <36 months	506 (18.7%)
36 to <48 months	464 (17.2%)
48 to <60 months	480 (17.7%)
>60 months	526 (19.5%)
Race	
White or Caucasian	1,614 (59.7%)
Black or African American	211 (7.8%)
Other	859 (31.7%)
Unknown/patient refused	21 (0.8%)
Ethnicity	
Not Hispanic or Latino	1,953 (72.2%)
Hispanic or Latino	736 (27.2%)
Unknown/Patient Refused	16 (0.6%)
Language	
English	2,407 (89.0%)
Spanish	260 (9.6%)
Other	37 (1.4%)
Unknown	1 (0.0%)
Insurance	
Public	957 (35.4%)
Private	1686 (62.3%)
Self-pay	62 (2.3%)

Table 2. Emergency Department (ED) Encounter Characteristics, N=2,705

	N (%)
Day of week	
Monday	376 (13.9%)
Tuesday	360 (13.3%)
Wednesday	356 (13.2%)
Thursday	388 (14.3%)
Friday	401 (14.8%)
Saturday	401 (14.8%)
Sunday	423 (15.6%)
Shift[a]	
07:00-14:59	710 (26.3%)
15:00-22:59	1,625 (60.1%)
23:00-06:59	370 (13.7%)
Emergency Severity Index (ESI)	
1	3 (0.1%)
2	862 (31.8%)
3	1,441 (53.3%)
4	391 (14.5%)
5	3 (0.1%)
Missing	5 (0.2%)
ED disposition	
Discharge	2,311 (85.4%)
Admit	387 (14.3%)
Other/Unknown	7 (0.3%)
Mode of arrival	
Car/Walk-in	2,508 (92.8%)
Ambulance/Emergency Medical Services	182 (6.7%)
Helicopter/Other	13 (0.5%)
Missing	2 (0.1%)
Chief complaint[b]	
Injury	2,081 (76.9%)
Pain	265 (9.8%)
Medical	17 (0.6%)
Fussy	7 (0.3%)
Concern for abuse	1 (0.0%)
Other	323 (11.9%)
Missing	11 (0.4%)
Fracture type	
Forearm (radius and/or ulna)	653 (24.1%)
Humerus	629 (23.3%)
Tibia and/or fibula	459 (17.0%)
Clavicle	265 (9.8%)
Skull	198 (7.3%)
Fingers, metacarpals, and/or carpal bones	183 (6.8%)
Toes, metatarsals and/or tarsal bones	170 (6.3%)
Femur	79 (2.9%)
Orbital and/or nasal	31 (1.2%)
Multiple bones in disparate body regions	24 (0.9%)
Spine (cervical, thoracic, lumbar)	12 (0.4%)
Rib	2 (0.1%)

a Based on standard nursing shifts.
b Chief complaints categorized as "injury" specifically included the following terms: fall, "injury," known fracture, laceration, motor vehicle crash, trauma. Those categorized as "medical" included the terms: abdominal pain, cough, emesis, fever, hematemesis, joint swelling, "medical," mouth lesions, otalgia, seizures, shortness of breath, sore throat. Those categorized as "other" had a chief complaint specifically of "other."

statistically significant according to the day of the week (p=0.46), nursing shift (p=0.42), or triage acuity (p=0.36). The proportion of completed screens by sex was statistically significant (p=0.04), with a higher proportion of screens among males (54.7%). Screening by ED disposition was also statistically significant: 89.4% of discharged children were screened, versus 96.9% of admitted children (p<0.001). There was a significant difference in positive, negative, and incomplete screens by age group, with 15.0% of children <12 months screening positive compared to <2% positive in each of the other age groups (p<0.001).

There were 312 (11.5%) encounters that had ED clinician concern for abuse and/or neglect. Of those with clinician concern, 55 (17.6%) had a positive screen, 237 (76.0%) had a negative screen, and 20 (6.4%) had an incomplete screen. Among encounters with negative or incomplete screens and clinician concern, 139 (54.1%%) were <12 months, 44 (17.1%) were 12 to <24 months, and 31 (12.1%%) were 24 to <36 months. The racial distribution of patients for whom there was a positive screen and ED clinician concern (45.5% White, 12.7% Black) was similar to that of the general ED population (47% White, 14% Black), however there was an

Table 3. Test characteristics of nursing-completed abuse screen for the entire cohort ages 0–5 years, and stratified by age group[a]

	% [95 % CI]
1–5 years	
Sensitivity	19.2% [14.7%–23.8%]
Specificity	99.5% [99.3%–99.8%]
Positive predictive value	84.6% [75.8%–93.4%]
Negative predictive value	90.3% [89.1%–91.5%]
0–<12 months	
Sensitivity	24.4% [18%–30.8%]
Specificity	98.1% [95.4%–100%]
Positive predictive value	95.5% [89.3%–100%]
Negative predictive value	43.7% [37.3%–50.1%]
12–<24 months	
Sensitivity	11.1% [1.9%–20.3%]
Specificity	99.1% [98.2%–100%]
Positive predictive value	62.5% [29%–96.1%]
Negative predictive value	89.5% [86.4%–92.6%]
24–<36 months	
Sensitivity	12.1% [1%–23.3%]
Specificity	99.5% [98.9%–100%]
Positive predictive value	66.7% [29%–100%]
Negative predictive value	93.6% [91.3%–95.8%]

a Age was stratified up to age 36 months given the higher risk of abuse among infants and toddlers, and the estimate that up to one in five abusive fractures are missed among children under the age of 3 years.[9]

overrepresentation of White children (70%) compared to Black children (0%) for whom there was a positive screen and the ED clinician was *not* concerned.

The overall cohort admission rate was 14.3%. Over three-quarters (76.9%) of the 65 children with a positive screen were admitted, while 54.3% of the 312 children with ED clinician concerns were admitted. Clinicians raised concern for 56.1% of patients ultimately diagnosed with skull fractures and 32.9% with femur fractures who screened negative.

The test characteristics of the nursing screen among children <5 with completed screens as well as among children when stratified by age can be seen in **Table 3.** Overall, the sensitivity of the nurse-completed screen is poor (19.2%, 95% CI 14.7–23.8%), with a specificity of 99.5% (95% CI 99.3–99.8), PPV of 84.6% (95% CI 75.8–93.4%), and NPV of 90.3% (95% CI 89.1–91.5%). When stratified by age, there are notable differences in test characteristics. Among the highest risk children < 12 months, the sensitivity is slightly higher at 24.4% (95% CI 18–30.8%), with a specificity of 98.1% (95% CI 95.4–100%), and PPV of 95.5% (95% CI 89.3–100%), however the NPV is markedly lower at 43.7% (95% CI 37.3–50.1%).

DISCUSSION

We sought to assess compliance with and test characteristics of an institution-specific child abuse screening among children aged 0–5 diagnosed with a fracture(s). The overall compliance rate of 90.5% was comparable to other findings on universal child abuse screening in EDs.[23-24] Moreover, the proportion of children who screened positive (2.4%) is also comparable to other studies of universal screening.[13,25-26] We found no differences in the proportion of patients screened based on sociodemographics, with the exception of sex. While this may be due to the expectation of universal rather than targeted screening, evidence regarding the relationship between universal screening and human biases is still inconclusive.[16] We found the screen's overall sensitivity to be poor among children <5 who ultimately were diagnosed with fractures, markedly lower than that of previously published screens,[12,13,28-30] and signifying that few encounters raising clinician concern for potential abuse would be identified with a positive screen.

This institutional screen has similar questions to the Escape questionnaire,[13] yet the specific language and complete set of questions were not used. Studies assessing the diagnostic accuracy of Escape found its sensitivity, specificity, PPV, and NPV to be 80–100%, 98.3–99%, 10–25.5%, and 99–100% respectively when using reference standards of confirmed[12] and suspected[13] child abuse. However, these study populations included children who were up to age 18 years[12,13] and overall, at lower risk of abuse than just infants and toddlers, possibly impacting the test characteristics. As previously described,[3,13] clinician concern for potential abuse was intentionally chosen as the reference standard over confirmed abuse, as the goal of the screen is to identify high-risk cases that warrant further consideration, and not to diagnose abuse. The prevalence of abusive fractures among infants and toddlers is high,[4-5] and fracture identification should prompt consideration of abuse, particularly among infants <1 year. Thus, we chose to err on the side of including encounters that ultimately may not have been determined to be abuse as to minimize the potential for missed cases.

Our findings revealed a large discrepancy between clinician and nurse concerns, as 76.0% of children for whom clinicians were concerned for abuse had a negative screen. There were notable differences in test characteristics when stratified by the youngest and highest-risk patients. One possible explanation for these findings is that nurses may have suspected abuse to be more likely among children <12 months, thus increasing sensitivity and PPV compared to the entire cohort of children 0–5 years; however, 54.1% of cases with clinician concern but a negative nurse screen occurred in this age group. Although screening nurses were not aware of the final diagnosis, 86.7% of chief complaints were related to pain and/or injury, which should have prompted consideration of abuse, particularly among infants. Conversely, potential abuse among ambulatory

children 12 to <36 months could have been misinterpreted as a developmentally appropriate unintentional injury, resulting in lower screening sensitivity in this age group.[27,28] These discrepancies were likely influenced, at least in part, by a combination of limited child abuse training for nurses at the study institution, the use of a modified screen that has not been validated, and a suboptimal workflow. Questions 1 and 2 of the screen, typically completed in triage, relied on nurse assessment when 1) the history and exam were brief and limited; 2) the child was typically dressed and in the presence of a caregiver; and 3) multiple other assessments were required, which may have reduced screening accuracy.

Despite the lack of a gold standard screen, hospitals have been increasingly integrating clinical decision support systems into their EHRs to comply with AAP guidelines.[16,31,32] Child abuse pediatricians and researchers have agreed that these systems should layer active and passive approaches, incorporate real-time data on clinical characteristics, integrate into the clinical workflow, mitigate disparities, and be accompanied by ED staff training.[16,33,34] Although the screen in this study was brief and integrated into the EHR, workarounds allowed for nearly 10% of screens to remain incomplete, undermining the goal of universal screening. The sole reliance on nursing assessment as well as verbal communication of results to the responsible clinician limits its impact and value, and it is clear that this screen is not optimal for identifying the most vulnerable patients presenting with fractures. While our findings are not generalizable to hospitals with different screening tools, these findings support the need for institutions to assess their screens and utilize evidence-based validated methods, when possible, rather than institution-specific tools.

Limitations

Although a keyword search for common terms and phrases related to concern for child abuse, cases with ED clinician concern may have been overlooked if documentation did not include the identified keyword terms. Additionally, we designated clinician concern for abuse as the reference standard in lieu of having confirmed child abuse cases. This could have introduced misclassification bias into our test characteristics and limits comparability to other validated screens. Finally, we did not review all cases *without* the presence of the keywords, which may have introduced partial verification bias.

CONCLUSION

This study corroborates existing evidence on child abuse screening limitations and further emphasizes the need for institutions to perform ongoing assessment and validation of screening tools used to identify children who may have been abused across the pediatric age spectrum *and* in high-risk subgroups. Although the screen used in this study demonstrated high compliance, test characteristics varied by age, and there were notable differences compared to clinician concerns, highlighting potential knowledge gaps, biases, and opportunities for screening improvements. Based on our findings, we recommend implementation of automated multidimensional screening systems that incorporate evidence-based, objective, and discrete data elements and validated tools (e.g., TEN-4 FACESp),[15] and more robust nursing education about child maltreatment. Universal screening with special attention to high-risk groups (e.g., an infant presenting with an injury) is critical to improve the identification of potentially abused patients.

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