

BMJ Open Quality Reducing unnecessary CT scan of the head for minor paediatric head injuries at the emergency department

Amr Elmoheen , Waleed Salem , Khalid Bashir 

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ABSTRACT

The CT scan is a determining imaging study in the diagnosis and treatment of head trauma; however, its indiscriminate application can have serious consequences for patients and the health system. More than 45% of CT scans of the head requested for minor head injuries in the paediatric age group in the emergency department were not correctly indicated according to international guidelines. The root of such a high percentage was misinformation and lack of knowledge about the ideal parameters for requesting a CT scan for minor head injuries. To achieve this, survey-based interventions and educational programmes were conducted to improve understanding of international guidelines and access to this information, which was the most important parameter during this project. A decreasing rate of CT scans for paediatric minor head injuries was demonstrated at the rate of 17%, achieving a reduction by more than 47% after the implementation of the interventions. Besides, misinformation and documentation deficits improved by more than 30%. Quality improvement methods decreased misinformation and improved access to information, which reduced errors in the indication of CT scans of the head in the paediatric age group and increased efficiency of patient care.

INTRODUCTION

Head trauma is an emergency that requires immediate medical evaluation, especially in paediatric patients. However, the misuse of available diagnostic tests for this type of injury brings counterproductive complications, ranging from alterations in the health of patients (due to unnecessary exposure to radiation) to the poor performance of health institutions (CT saturation, extended waiting time and deficits in the patient care).¹

The recent systematic review conducted by Cnossen *et al*² illustrated the necessity of evidence-based guidelines to improve staff adherence. According to the National Institute for Health and Care Excellence (NICE)³ and the Pediatric Emergency Care Applied Research Network (PECARN)⁴ guidelines and studies such as the Canadian Assessment

of Tomography for Childhood Head injury (CATCH),⁵ not all paediatric patients with minor traumatic head injuries require a CT scan.⁵ Studies show that only 1 in 500 children will have an intracranial complication that requires intervention or extra measures.⁶ The healthcare providers in the facility where this project was conducted came from different backgrounds, which resulted in ordering CT scans of the head in minor head injury based on various guidelines. Reviewing their practice at the emergency department (ED) showed that more than 45% of the CT scans requested in this population were not well indicated when referring to the agreed guidelines by the quality and guidelines committees and there was a noticeable lack of documentation (more than 36% in some cases).

This health institution is a tertiary care hospital that serves most of the community. According to estimates, more than 40 000 patients are treated. Considering that more than 1000 paediatric patients (more than 2.5%) come to this hospital for head trauma, we can highlight the importance of early and timely intervention on the correct management of imaging studies for these cases. It is necessary to optimise the process from the beginning, both the indication (based on the appropriate assessment of the patient) and the implementation and maintenance of the standards within the institution if they adhere to international protocols instead of the previous poor practice; almost CT scan of the head for every head injury. The institute hires emergency physicians from different regions all over the world who have different backgrounds. For minor paediatric head injury, they requested CT scans of the head according to their usual practice and did not adhere to one of the validated international guidelines. For example, they used to order CT scan of the head for any child with vomiting or scalp lacerations regardless of any other criteria. Documentation of the



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Emergency Medicine, Hamad Medical Corporation, Doha, Qatar

Correspondence to

Dr Amr Elmoheen;
aelmoheen@hamad.qa

physicians lacked the criteria of the decision-making (history and physical examination) of CT scan of the head.

This project aims to achieve sustained compliance with internationally acceptable standards for undertaking CT scanning of the brain for paediatric minor head trauma at the ED.

BACKGROUND

While CT scanning carries an important role in the identification of clinically significant intracranial injuries, there are associated risks of radiation.¹ Our initial audit of clinical notes and a survey of Emergency Medicine (EM) physicians revealed a rate of 45% CT scans for paediatric minor head injuries, with around half of requests not indicated. In 36% CT scans, there were issues with documentation.

BASELINE MEASUREMENTS

To adequately address the study, an initial audit was conducted to assess and provide an overview of the problem. Almost all the emergency care and paediatric care staff were included in this initial assessment. All indications for CT scan in paediatric head trauma patients were evaluated over 1 month, resulting in a sample of nearly 320 patients (63 children performed CT scan of the head). The patients' medical records were reviewed in conjunction with the various imaging studies performed.

After analysis of all available information, we determined that about 45% (29 patients) of the CT scans performed on paediatric head trauma patients had no clear indication for this study. The evidence tells us that CT scans were unnecessary. We also found that many of the cases were poorly documented or lacked information.

After doing the first audit, we decided to do a quick survey to find out the causes of the failure in the indication of CT scan. More than 200 physicians (residents, specialists, residents, fellows, consultants) took part in this diagnostic evaluation. Overall, 81% of the erroneous indications were directly related to difficulty in accessing information (the guidelines). The audit showed more than 45% of the CT scans requested in this population were not well indicated when referring to the agreed guidelines by the quality and guidelines committees and there was a noticeable lack of documentation (more than 36% in some cases).

Taking this as a basis, we decided to create several measures that could improve the use of CT scans in paediatric patients with head trauma. This project included evaluations every 3 months after the implementation of the standards and a global re-evaluation at the end of the project to determine the impact and significance of the criteria used. In both cases, surveys and the review of documentation related to patients admitted during that period were used.

Fishbone (Cause & Effect) Diagram

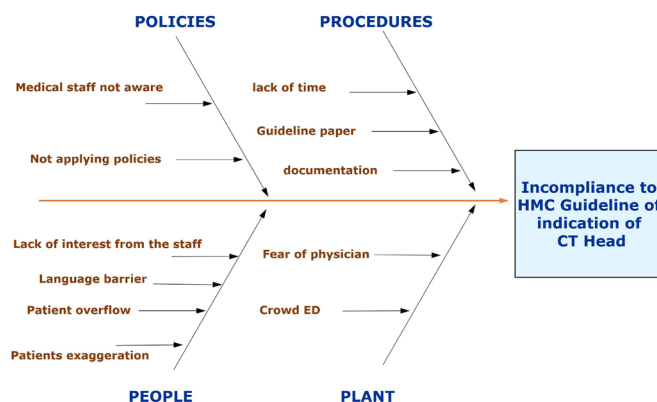


Figure 1 Fishbone analysis of the possible causes. ED, emergency department; HMC, Hamad Medical Corporation.

AIM

To reduce the unnecessary cranial CT scan for minor paediatric head injuries at the ED of Hamad Medical Corporation to reach 0% by 2020.

DESIGN

A large team was involved in carrying out the objectives (emergency medicine members, an EM consultant as a mentor, a senior radiology consultant, neurosurgery consultant, EM head of department). We investigated the possible causes and drivers shown in the fishbone analysis (figure 1) and the driver diagram (figure 2).

The project was based on creating a knowledge base of paediatric care personnel that could change the way indications were performed; however, this measure had to last over time and spread through employees and physicians who would be hired after the implementation period of this project. In principle, we considered that the best way to address the problem was with staff education through a weekly Continuous Medical Education programme, resident and fellowship activity, with an evidence-based clinical algorithm (EBCA) (figure 3) that was based on a compendium of international protocols, especially PECARN, which had a higher sensitivity for identifying clinically important traumatic brain injury in comparative studies.^{7 8} However, we consider positive aspects of other renowned studies such as the Children's Head injury ALgorithm for the prediction of Important Clinical Events (CHALICE)⁶ and the Canadian Assessment of Tomography for Childhood Head injury (CATCH)⁵ to maximise the efficacy of the indications. The central premise was facilitating access to quality information (the most crucial variable in our audits) to increase the correct indication of CT scan in paediatric patients with head trauma. The teaching was in the form of lectures, group workshops and one-to-one discussions. The education was conducted by senior emergency physicians and followed by a survey to measure staff satisfaction with the teaching.

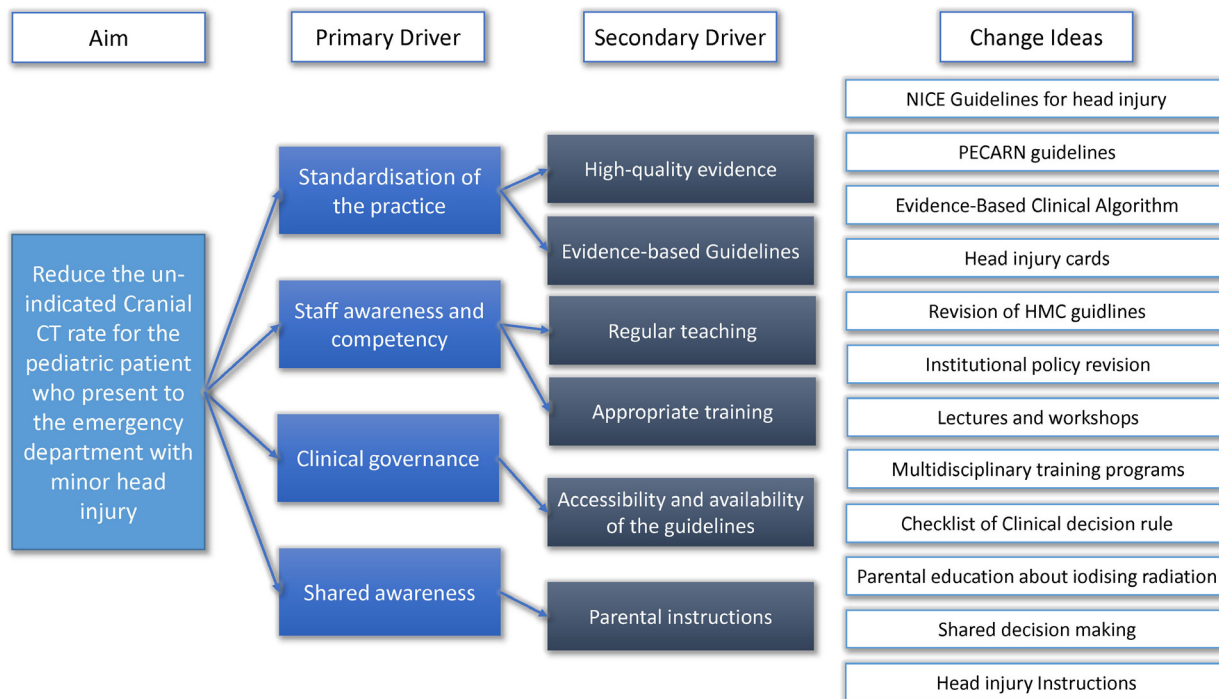


Figure 2 Driver diagram of the possible causes. HMC, Hamad Medical Corporation; NICE, National Institute for Health and Care Excellence; PECARN, Pediatric Emergency Care Applied Research Network.

For sustainability, we focused on creating regular teaching programmes that would be maintained despite the completion of the project, always providing information to the service providers. In addition, it was essential to keep a direct line to a source of updates to improve the system of indicating CT scan in paediatric patients if the guidelines were to change. Finally, we also made sure to create some posters that would remain in the service, this would be the fastest way to access information in case of emergency if staff were not yet trained to respond appropriately.

It was also necessary that staff were to be reassessed, so we proposed a short-term plan (reassessments every 3 months) and a long-term plan (every 6–12 months) by auditing the number of CT scans of the head for the paediatric minor head injuries requested to ensure the quality of the emergency care and the health of the paediatric patients while improving the service provided by the hospital.

STRATEGY

Our main goal was to achieve sustained compliance with internationally acceptable standards for undertaking CT scanning of the brain for paediatric minor head trauma at the ED. Thus, by the end of the project, there would be a decrease in the percentage of poor indications of CT scan of the head in paediatric patients. In the baseline, we found the percentage of the number of the total CT scans of the head requested for the paediatric minor head injury patients was 32%. We undertook three Plan-Do-Study-Act (PDSA) test cycles (figure 4).

PDSA Cycle 1: Our initial intervention was to teach our staff through study groups and oriented talks. For this, we had a group of trained medical consultants with knowledge of the PECARN and NICE guidelines. The percentage of CT scan of the head requested to total head injury cases decreased from 32% to 26% (figure 5) with the measures applied, however there was not good sustainability.

PDSA Cycle 2: In the second cycle, we improved the information programme with weekly lectures and workshops and with residency/fellowship programmes. In addition, we filled the information gap by promoting free information content on the PECARN and NICE guidelines. We also used posters and handouts to make information available in the clinical areas (EM EBCA). The percentage decreased to almost 20% during this period; however, there were still cases where the CT scan of the head was indicated outside the parameters of the guidelines mentioned above.

PDSA Cycle 3: In this last cycle, we hypothesised that our idea would be more effective if we indirectly forced staff to evaluate the paediatric patient according to the PECARN and NICE guidelines. While maintaining the rest of the measures carried out, we thought about how we could integrate the various points in the protocols of these guidelines into the general assessment of the head trauma patient. We devised a checklist to be attached to every patient's file and thus improved the documentation and memorisation of the algorithms. With these measures, we decreased the percentage to 17%, which corresponded to the final findings of our study.

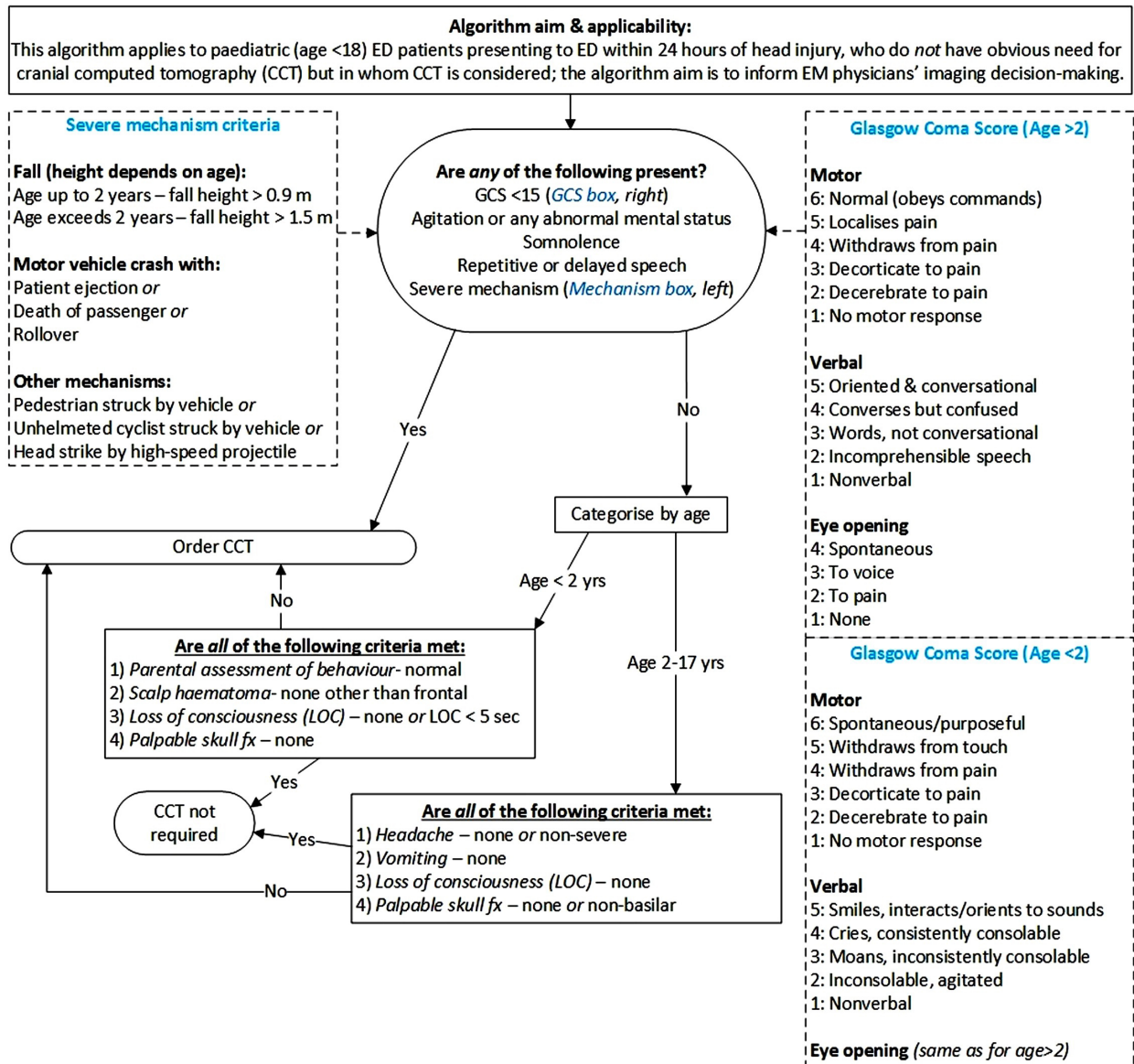


Figure 3 An evidence-based clinical algorithm of paediatric cranial CT after trauma. ED, emergency department; GCS, Glasgow Coma Score; EM, Emergency Medicine.

RESULTS

The most important finding was the decrease in misdiagnoses of CT scan of the head in paediatric patients with head trauma, as we determined with the use of audits. During the project, the percentage remained declined despite several limitations. We went from almost 32%

(our baseline) to less than 20%, which had a significant impact on patient’s health and ED’s performance.

Another point to note is the decrease in misinformation and the lack of access to the most up-to-date guidelines. Almost 100% of the doctors and health personnel included in the project had the necessary information to implement the guidelines and, in addition, acted correctly according to the signs and symptoms presented by the patient and there was a significant improvement in the documentation (figure 6)

With the various sustainability interventions we implemented—not only with educational measures, such as the various scientific programmes and readings/workshops, but also with the introduction of the posters and the checklist attached to the patient’s file—we were able to ensure the continued decrease of unindicated CT scan of the head in paediatric patients.

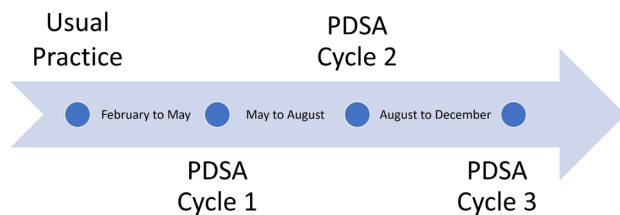


Figure 4 Timeline diagram of the Plan-Do-Study-Act (PDSA) cycles.

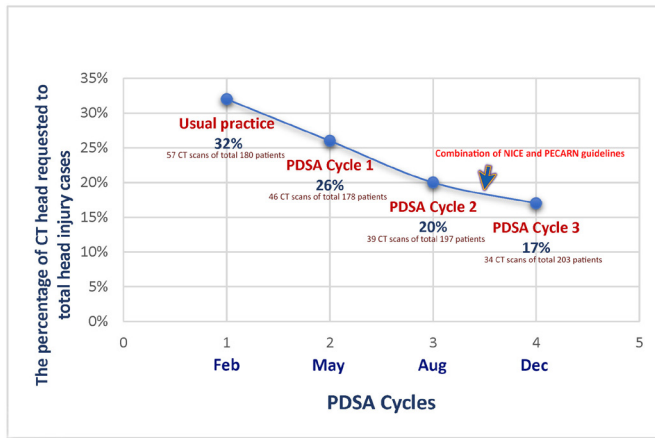


Figure 5 The results of the Plan-Do-Study-Act (PDSA) cycles comparing the percentages of cranial CT scan requested to total minor paediatric head injury cases. NICE, National Institute for Health and Care Excellence; PECARN, Pediatric Emergency Care Applied Research Network.

LESSONS AND LIMITATIONS

The key focus of this project was implementing a sustainable solution rather than a short-term intervention. The impact of the measures promised to be very beneficial both economically and functionally, so we wanted to leave a solution that could last and be continuously updated, rather than effecting a temporary intervention that would only improve the quality of the service based on the doctors present. To achieve this, we had to redesign the project several times from the beginning.

The PECARN and NICE guidelines are not the only ones that exist when talking about CT scan of the head in paediatric patients—there are thousands. In principle, we used the corporation guidelines as our basis for applying and changing the current system of the medical emergency. However, before the project, we realised that these guidelines were not sufficiently updated and did not fit well with the functioning of the emergency area, so we had to discard them quickly. After research and discussion with our team of medical specialists, we concluded

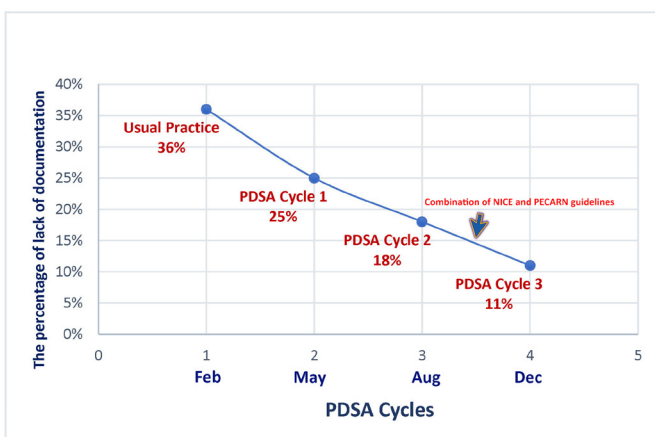


Figure 6 The results of the Plan-Do-Study-Act (PDSA) cycles comparing the lack of documentation.

that the PECARN and NICE guidelines would be the best option.

Additionally, data acquisition was a crucial problem. The lack of information became even more apparent as we further investigated during the first audit. However, there were many folders and histories to review and we were short-staffed soon after. We had to analyse many files in order to obtain the background information that would make sense with our interventions. To maintain the project, we recruited and hired more members for our team to be able to analyse the necessary information.

The authors related the residual 17% of CT scan requests that did not adhere to guideline indications to the high rate of doctors' turnover during the study time. Also, the intervention was directed in higher proportion to the doctors, people of limited time, so it was challenging to ensure that they remained attached to the educational sessions and the diverse protocols that we were applying to foment the knowledge of the guidelines. The project was based on the performance of the doctors, so it was essential to overcome this limitation. To this end, we sought to increase the doctors' understanding by sensitising them and reaching internal agreements with the directors of the institution so that they would have the necessary time to attend the educational events—all this without affecting the functioning of the institution during the research period.

This project undoubtedly highlighted the barrier of convincing long-term staff to accept a new data collection method and the new PECARN and NICE guidelines. Despite being a positive and necessary change, it was challenging to implement.

CONCLUSION

The project team was able to identify errors made during indications of CT scan of the head in paediatric patients through audits and surveys and developed effective measures to decrease unindicated CT scan. Besides, this project reduced the risk for some paediatric patients undergoing a CT scan of the head and the economic and functional impact of the service, based on strategic measures that improved the performance of physicians in the area.

Despite the various limitations, we managed to create a series of measures to ensure the sustainability of the project. In addition to the interventions related to the educational part of the doctors of the service, the integration of a special sheet to each patient's file represents insurance that the parameters of the different guidelines will be fulfilled.

This project also makes it clear that it is necessary to study the indications of the CT scan of the head in other scenarios, such as headache or prior to a lumbar puncture, in order to have the same benefits that we find in this case. In general, it is necessary to subject the staff of the institution to programmed performance evaluations that include compliance with the various protocols established



for any disease, based on the analysis of patient's file and other available resources.

Twitter Amr Elmoheen @amamiro2000

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Collaborators Saleem Farouk and Stephen Thomas.

Contributors AE planned and conducted the project, designed the management algorithm, did the literature review and wrote the manuscript. WS conducted a survey, delivered staff education, performed data collection and reviewed the manuscript. KB reviewed the manuscript and supervised the project.

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ORCID iDs

Amr Elmoheen <http://orcid.org/0000-0002-5079-5353>

Waleed Salem <http://orcid.org/0000-0003-0076-0088>

Khalid Bashir <http://orcid.org/0000-0003-4213-4667>

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