

BMJ Open Quality Project to improve the management of the head injury patients presenting to the emergency department

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ABSTRACT

Introduction At Sandwell General Hospital, there was no risk stratification tool or pathway for head injury (HI) patients presenting to the emergency department (ED). This resulted in significant delays in the assessment of HI patients, compromising patient safety and quality of care.

Aims To employ quality improvement methodology to design an effective adult HI pathway that: ensured >90% of high-risk HI patients being assessed by ED clinicians within 15 min of arrival, reduce CT turnaround times, and aiming to keep the final decision making <4 hours.

Methods SWOT analysis was performed; driver diagrams were used to set out the aims and objectives. Plan-Do-Study-Act cycle was used to facilitate the change and monitor the outcomes. Process map was designed to identify the areas for improvement. A new HI pathway was introduced, imaging and transporting the patients was modified, and early decisions were made to meet the standards.

Results Data were collected and monitored following the interventions. The new pathway improved the proportion of patients assessed by the ED doctors within 15 min from 31% to 63%. The average time to CT head scan was decreased from 69 min to 53 min. Average CT scan reporting time also improved from 98 min to 71 min. Overall, the average time to decision for admission or discharge decreased from 6 hours 48 min to 4 hours 24 min.

Conclusions Following implementation of the new HI pathway, an improvement in the patient safety and quality of care was noted. High-risk HI patients were picked up earlier, assessed quicker and had CT head scans performed sooner. Decision time for admission/discharge was improved. The HI pathway continues to be used and will be reviewed and re-audited between 3 and 6 months to ensure the sustained improvement.

INTRODUCTION

Problem description

A man in his 60s presented to our emergency department (ED) with a head injury (HI) via ambulance after being found by a stranger on the road. After initial assessment using clinical risk assessment tool named Manchester triage system, patient was given a priority 3 which meant that the patient should be seen within 60 min of arrival.¹ As it was a busy day in emergency, the patient waited for 1 hour 43 min, until he started vomiting. At this point, he

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Even though we found studies related to serious head injury (HI) patients in intensive care versus as low impact HI patients in emergency. We were not able to identify any study which concentrates on risk stratification of HI patients in the emergency and providing care accordingly.

WHAT THIS STUDY ADDS

⇒ This study focuses on management of HI patients, risk stratify them early in their hospital attendance via emergency, provide lifesaving interventions and management in a timely and safe manner. There is minimal evidence available focusing on risk stratification of HI patients in emergency department (ED), this study targets this particular aspect and helps in early identification of high-risk patients.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study will help in focusing on optimal care provision in emergency using a risk stratification HI pathway. Further research on this topic will help in streamlining the measures to minimise patients stay in ED and quick decision-making for HI patients. Any delays in ED could impact the future outcome, morbidity and mortality for the HI patients.

was assessed by an emergency physician after being in the ED for 2 hours and 7 min, who then decided that the patient needs to be in the resuscitation area for further management.

A trauma alert call was made at this point to involve the trauma team. The patient was intubated and transported to the radiology department for trauma series CT scan of the body after 3 hours and 44 min of being in the ED. CT scan was reported to have a left sided subdural haematoma and bilateral sub-arachnoid haematomas. The CT report was available after 4 hours and 7 min. Final decision from the neurosurgical team at local trauma centre was made 2 hours later.

The patient was then transferred to the intensive therapy unit for further treatment after 6 hours and 7 min in the ED. He was



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later reviewed in intensive care and deemed not suitable for surgery and eventually died 3 days after initial presentation in emergency. This specific case highlighted the need to improve the quality of care in the management of HI patients at our ED.

Specific aims of the project

Decrease the ED clinician time to assess the high-risk HI patients, improve the CT turnaround times and to minimise the time spent in ED by the HI patients. This article will lay out the specific quality improvement methods employed to identify and improve the management of the HI patients, an analysis of the data and a reflection on how we might improve this process in the future. This study focuses on establishing a connection between utilisation of HI pathways in high-risk HI patients and impact of such utilisation in improving their quality of care and safety in EDs.

Available knowledge

HI is the most common cause of death and disability in people aged 1–40 years in the UK.² Each year, 1.4 million people attend EDs in England and Wales with a recent HI.² Annually, about 200 000 people are admitted to hospital with HI, one-fifth of these have features suggesting skull fracture or have evidence of brain damage.² An HI pathway should standardise the care and reduce the time span in the ED, there is evidence that it helps to improve the patient care, safety and reduce the cost.^{3–5} There is evidence to suggest that neurological observation of the HI patients helps in identifying the high-risk patients sooner.⁶

Looking for a published solution, we carried out a PubMed and Cochrane Library search with “high risk head injury” and “pathway” and “emergency department”. This revealed papers relevant to the minor HI patients, but no articles related to high-risk HI patients in ED. I did find some papers with high-risk HI patients management based for critical care.⁷ Adding key words “clinical pathways” and “head injury” on PubMed did reveal one study which discussed utilisation of a clinical pathway and improving the quality of care.⁸ Another study showed the effect of a clinical pathway for severe traumatic brain injury on resource utilisation.⁹ I was not able to find an ED-related study; however, these papers did help me to understand the impact of a clinical pathway and its utilisation in improving the care for patients with HI. When HI patients attend emergency, the early 4 hours are the most critical in their initial care, and such care decides about their long-term quality of life, morbidity and mortality. As we were not able to identify previous studies or established pathways in relation to high-risk HI patients in ED. It immediately meant that we need to conduct this study/quality improvement project and study its impact on patient care and safety in emergency.

In this project, our team used National Institute for Health and Care Excellence (NICE) best practice guidelines for management of HI as mentioned in [box 1](#). We

Box 1 National Institute for Health and Care Excellence (NICE) best practice criteria

1. All patients with head injury (HI) should be assessed by trained member of staff within 15 min of arrival at hospital.
2. In patients considered to be at high risk for clinically important brain injury and/or cervical spine injury, extend assessment to full clinical examination to establish the need to request CT imaging of the head and/or imaging of the cervical spine and other body areas.
3. Patients who, on initial assessment, are considered to be at low risk for clinically important brain injury and/or cervical spine injury should be re-examined within a further hour by an emergency department (ED) clinician.
4. Perform and record observations on a half-hourly basis until Glasgow Coma Scale (GCS) equal to 15 has been achieved. The minimum frequency of observations for patients with GCS equal to 15 should be as follows, starting after the initial assessment in the ED; half-hourly for 2 hours, then 1-hourly for 4 hours and then 2-hourly thereafter (2003).
5. For adults who have sustained an HI and have any of the risk factors as per NICE guideline 1.4.7, perform a CT head scan within 1 hour of the risk factor being identified. A provisional written radiology report should be made available within 1 hour of the scan being performed.
6. Give verbal and printed discharge advice to patients with any degree of HI who are discharged from an ED or observation ward, and their families and carers.

also used Royal College of Emergency Medicine (RCEM) best practice standards for management of HI patients in ED. NICE best practice guidelines recommend:

1. HI patients to be seen within 15 min of arrival in emergency.
2. CT head scan to be performed within 1 hour of arrival for high-risk patients.
3. CT report to be available within 1 hour of CT scan of the head.

NICE has published the best practice standards for assessment of the HI patients in ED. These best practice standards are provided in [box 1](#).

If met, these standards of care not only benefit the patient in terms of recovery and discharge, but also attract a best practice tariff ([box 1](#)).

The RCEM also has published 10 standards that should be met when managing a patient with HI ([box 2](#)) (online supplemental appendix 1).

Rationale/analysis of the problem

No risk stratification of the HI patients at triage resulted in delays for the ED assessments and this poses a significant risk to the patient safety at our ED.

Context of intervention

After thorough analysis, we were at the point of planning the change. We referred to the institute for health improvement to look for appropriate resources and found out that the Gantt chart would be useful in the planning process for the changes.¹⁰

Box 2 Royal College of Emergency Medicine standards²⁰ (online supplemental appendix 1)

1. Assessed for features of high-risk brain and/or cervical spine injury by an emergency department (ED) clinician within 15 min of arrival.
2. Discharged patients—90% should receive written head injury (HI) advice.
3. Re-attending within 72 hours with symptoms relating to the initial HI—90% seen by a senior clinician.
4. CT imaging—90% performed within 1 hour of the radiology department receiving the request or within 1 hour of a mutually agreed time for the scan to be performed.
5. CT imaging—90% reported by an appropriately qualified person within 1 hour of completion of the scan.
6. Glasgow Coma Scale (GCS) <13 CT cervical spine done at the same time.
7. EDs should have clear, agreed and written protocols for referral and transfer to a neurosurgical centre.
8. Observations on patients admitted are GCS, pupil size and reactivity, limb movements, respiratory rate, heart rate and blood pressure.
9. GCS<15—observations recorded every 30 min until GCS is 15.
10. Admitted patients—minimum frequency of observations is:
 - Half-hourly for 2 hours.
 - Then 1-hourly for 4 hours.
 - Then 2-hourly thereafter.

Gantt chart

Gantt chart lists the tasks to be performed on the vertical axis, and time intervals on the horizontal axis.¹⁰ The width of the horizontal bars in the graph shows the duration of each activity.¹⁰ Gantt charts illustrate the start and finish dates of the terminal elements and summary elements of a project. I have used the Gantt chart to illustrate the project planning (figure 1), further details are also mentioned in online supplemental appendix 2.

SWOT analysis

We noted that SWOT analysis¹¹ would be useful to help identify the positive and negative factors, both internal

and external for our project. This specifically highlighted the need to monitor the whole process and project closely, and to ensure good communication between all stakeholders. The aim was to successfully achieve the end goal and to help shape the planning stages later, as shown in figure 2.

Quality improvement tools

After SWOT analysis and having identified the strengths and weaknesses, we worked on a process map (figure 3) to understand the flow of HI patients at Sandwell General Hospital (SGH) ED. The process map also helped us analyse the focus areas; we highlighted the problems in red boxes to help implement the changes later on as shown in figure 3.

Then we decided to use the driver diagram (figure 4) to help us focus on the key areas required to make the project work. A template was adapted from the Institute of Healthcare Improvement website as shown in figure 4.^{12,13}

Plan-Do-Study-Act cycle

Having studied the QI methodology further, we decided that Plan-Do-Study-Act (PDSA) cycle¹⁴ would be most relevant methodology to study and measure outcomes and processes postinterventions. After applying PDSA cycle on our project (figure 5), we conducted biweekly audits, acted on the results of the audits, analysed and studied while the interventions were being applied and eventually acted on the changes and interventions to ensure sustainability (figure 5). This cycle was repeated multiple times until we overcame all difficulties related to specific interventions. This method of focused questioning followed by PDSA cycles allowed small areas to be addressed, and lessons to be learnt along the way.

Data analysis preintervention

Finally, our QIP team started working on the analysis of the data received from the clinical effectiveness team. 678 patient cases with a diagnosis of the HI were identified from October 2018 to March 2019. We



Figure 1 Gantt chart.

Table: 3 SWOT analysis [11]

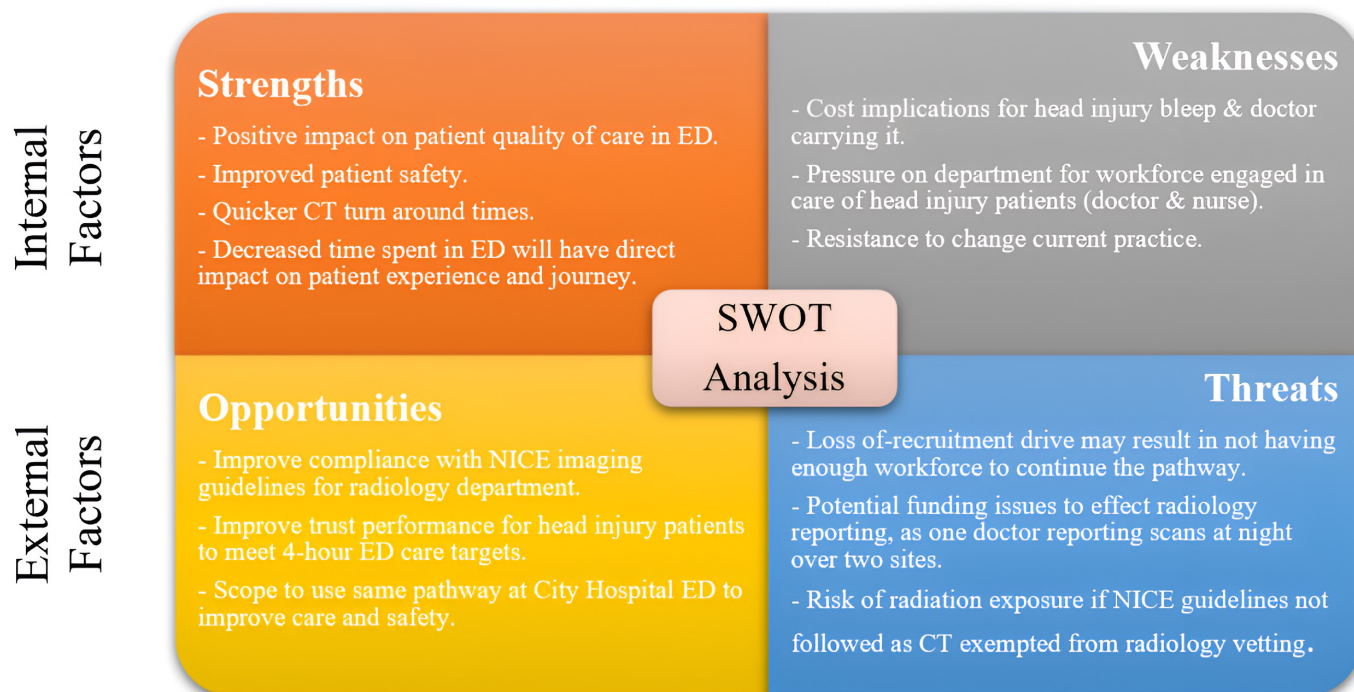


Figure 2 SWOT analysis.¹¹ ED, emergency department; NICE, National Institute for Health and Care Excellence.

focused on the time patient had to wait to see an ED doctor, time to CT scan performed and reported. We also looked at the time before patient was admitted or discharged from the ED. Only 31% patients were seen within 15 min of their arrival in ED, with vast majority of patients (54%) were seen between 16 and 60 min. Average time for the HI patients to see an ED doctor was reported to be 55 min as described in [figure 6](#).

Out of 678 patients, 479 patients had a CT head requested from ED. 79.4% of the patients had their scan performed within 60 min of request being put on the ICM, while 16% of the patients had their scan performed between 60 min and 110 min ([figure 7](#)). Average time to scan performed was reported to be 69 min. Looking at the CT scan reports timing, it was noted that 57.6% of patients had their scan reports available within 60 min of the scan being performed. While 37% of patients had their scans reported between 60 min and 135 min. Average CT reporting time was noted to be 98 min as described in [figure 7](#). As per NICE guidelines, CT head should be performed in 1 hour and reported within 1 hour of scan for all HI patients in emergency ([box 1](#)).

Looking at the times for patient's stay in the ED showed that 58% of the patients were admitted or discharged from the SGH ED within 4 hours, while 42% of the patients stayed more than 4 hours ([figure 8](#)). This delay eventually caused the patients to breach the 4-hour National Health Service (NHS) target for standard of care for patients attending the ED as can be seen in [figure 8](#).

Looking at the data overall, it was clear that all the areas needed improvement.

Interventions

1. Introduction of the new HI risk stratification pathway.
2. Education of the staff on NICE HI guidelines.
3. Modification of CT vetting process and patient transport to the scanner.
4. Quick decision-making from ED shop floor.

Study of the interventions

Introduction of the new HI risk stratification pathway

The new HI risk stratification pathway was introduced on 1 August 2019. I worked with my team to design the content of the new pathway. The creation of the new pathway took 6 weeks to design and needed to be redesigned several times before it was signed off and approved by all stakeholders including the trauma team, radiology and intensive care unit (online supplemental appendices 3–6). I had the responsibility to liaise with the neurosurgery team at QE hospital via email and over the phone if needed to discuss any complexity of the pathway.

Education of the staff

The pathway was new and using the pathway appropriately needed to be taught to ED team. We first started with approaching ED consultants to add HI topic in their clinical educators shifts on the shop floors. Then, we decided to deliver the teaching presentations at junior doctors teaching days, and nursing staff teaching days. We also

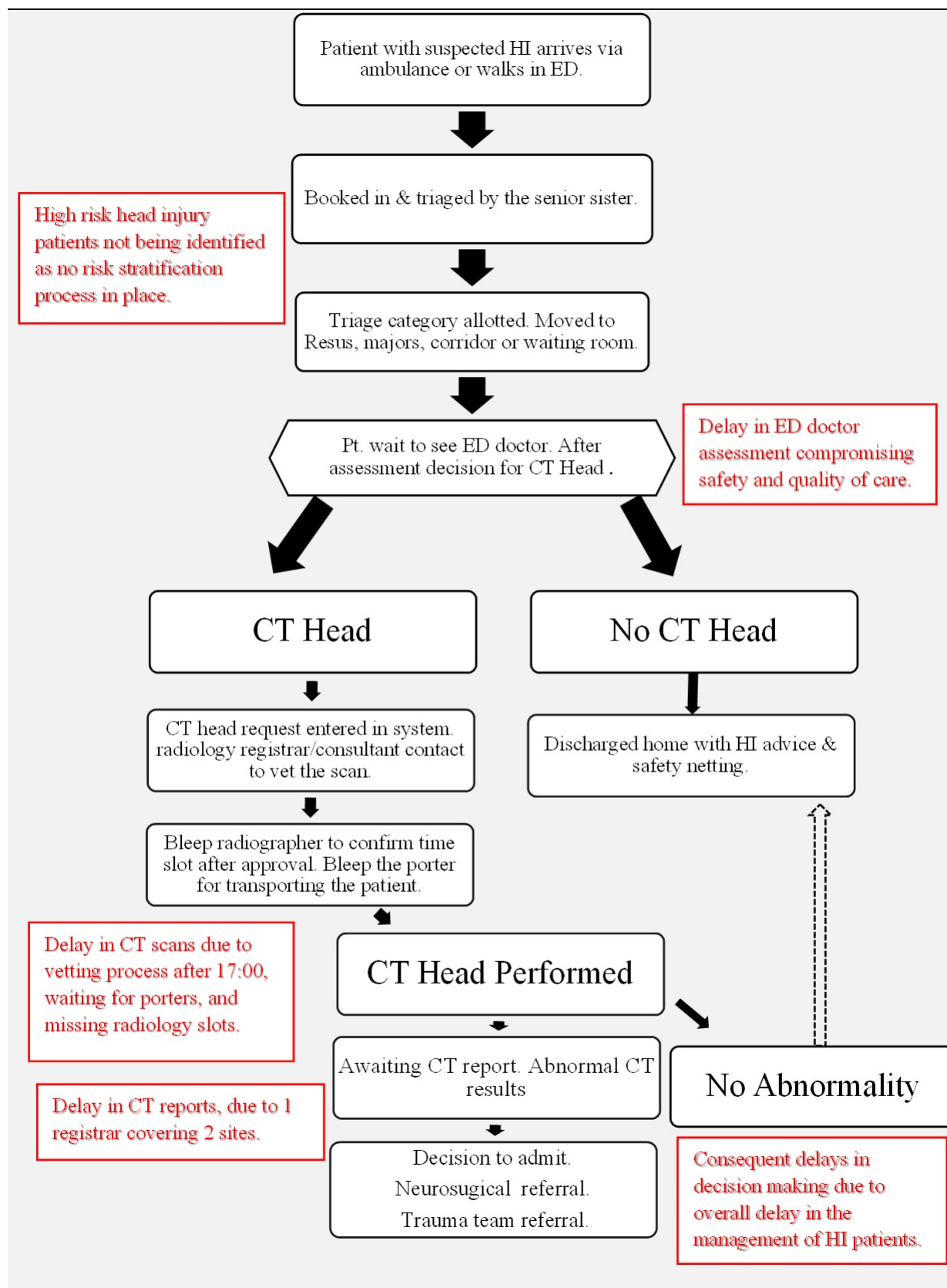


Figure 3 Process map for QIP. ED, emergency department; HI, head injury.

prompted consultants on daily hand overs to encourage the use of pathway for HI patients. A meeting was organised with the HR induction team, and it was mutually

agreed that HI pathway should be included in the induction teaching pack for all new doctors and it was decided

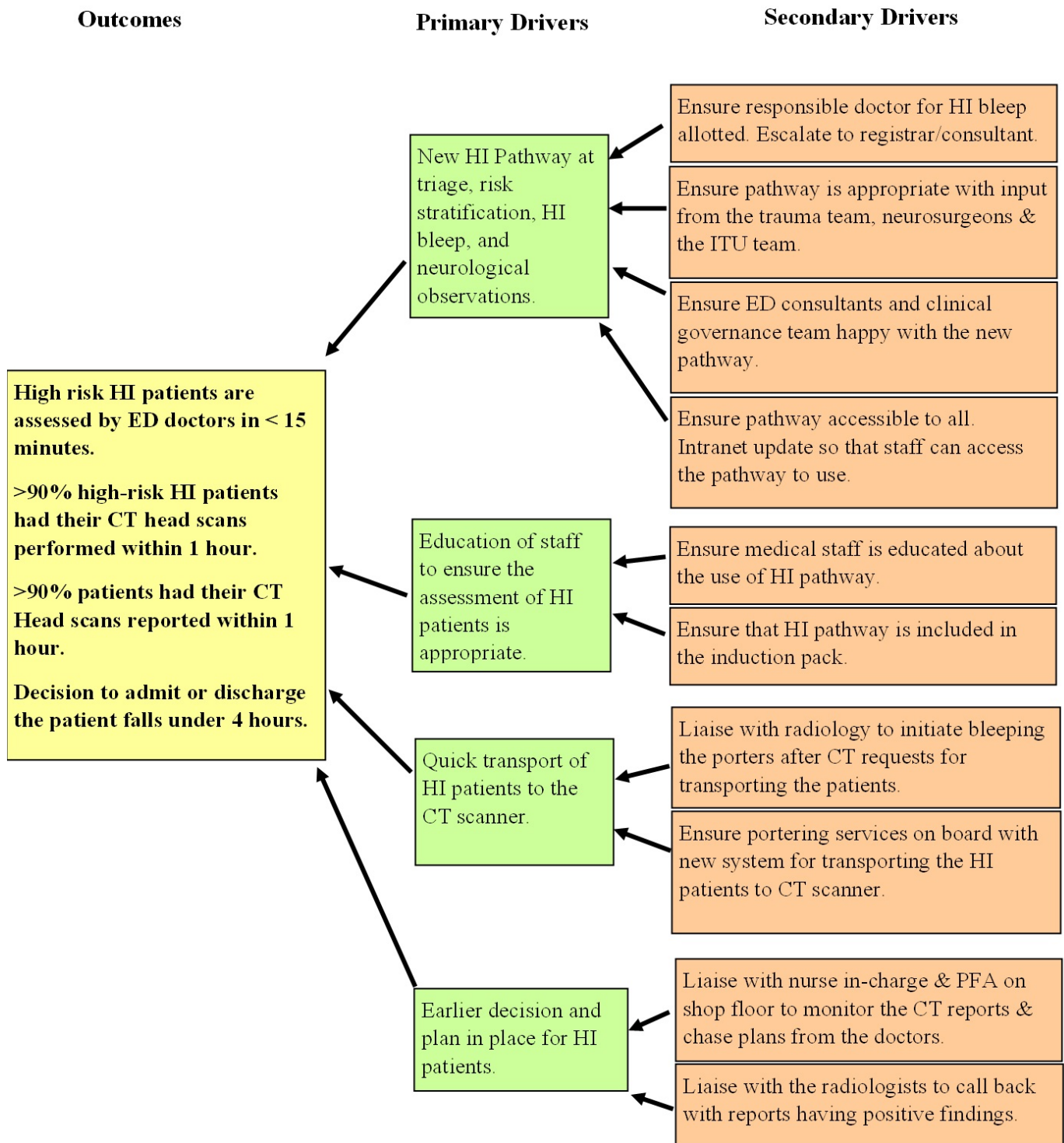


Figure 4 Driver diagram. ED, emergency department; HI, head injury; ITU, intensive therapy unit.

to add the HI pathway to trust intranet page (online supplemental appendix 7).

Modification of CT vetting process and patient transport to the scanner

After the first two interventions were completed, we focused on our third intervention. We arranged a meeting with the radiology team to present our data and analyses with current CT imaging pathways. It was identified

that the radiologist vetting for traumatic head scans from 17:00 to 09:00 caused an obstruction to the flow of imaging and needed to be changed. The radiology team was initially reluctant to accept the idea as there was a possibility of excessive radiation to the patients without radiologist input for CT requests and also it may result in extra workload to report all scans within 1-hour standard. However, further discussion and reassuring that an auto

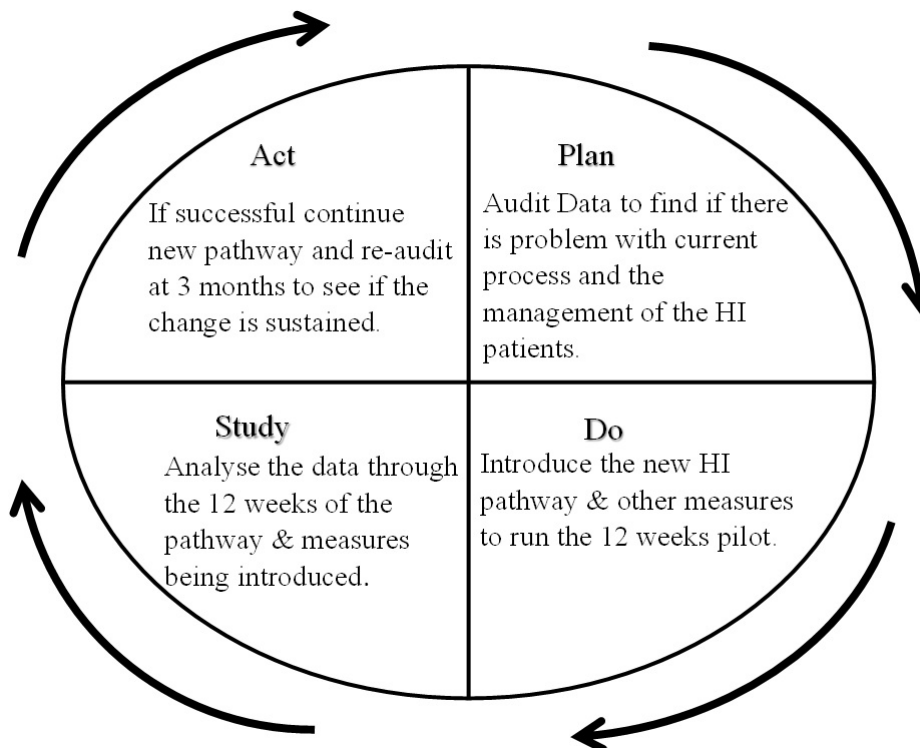


Figure 5 Plan-Do-Study-Act cycle. HI, head injury.

vetting system would be initiated where NICE guidelines checklist would be mandatory to request the scan from ED. The radiology team agreed to modify the vetting process of CT Head scan requests as trial to see if it would help in patient care and journey.

We then set up a meeting with the transport services manager to discuss and understand their aspect of patient care services and the implications of the new proposed changes. It was agreed that the designated porter for ED was not to be used for other hospital areas.

Quick decision-making from ED shop floor

Our final intervention was focused on speeding up the decision-making process for HI patients. I met with ED matron and discussed the idea for shop floor in-charge nurse to liaise with the senior ED doctor for decisions on HI patients. Input from QIP team suggested to take help from patient flow assistants in ED. Just before the launch,

we also ensured that new pathway was uploaded on the intranet and that everyone was aware of how to access it.

Data analysis

The new HI pathway went live at 12 am of the on 1 August 2019 as scheduled. Data of all HI patients were collected on a weekly basis, audited and analysed. A total of 387 patients were coded as having HI and 279 ended up having CT scans to exclude the serious HI between 1 August 2019 and 31 October 2019. The data were plotted to record time to see ED doctor (time difference from booking to being assigned to a clinician) ([figure 9](#)).

Similarly, we used the system generated reports of the HI patients who had CT head scans from ED. These reports were analysed based on the time the request was entered in the system to book a CT head scan for the patient. Further, we looked at the time CT head scan was performed by CT radiographer and eventually the time when the CT head scan was reported by the duty radiologist ([figure 10](#)).

Finally, we looked at the time patient spent in ED until they had a decision made and entered in the system for either an admission or a discharge from the hospital. We used the time when patient was booked in the system on first presentation to the time when the doctor decided to admit the patient in the ward or to discharge the patient from ED ([figure 11](#)).

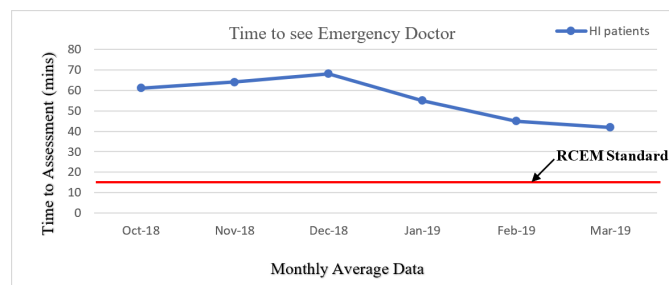


Figure 6 Time to see an emergency doctor after registration in emergency department at Sandwell General Hospital. HI, head injury; RCEM, Royal College of Emergency Medicine.

RESULTS

Data were collected biweekly, audited and analysed which showed that percentage of HI patients seen by ED doctors

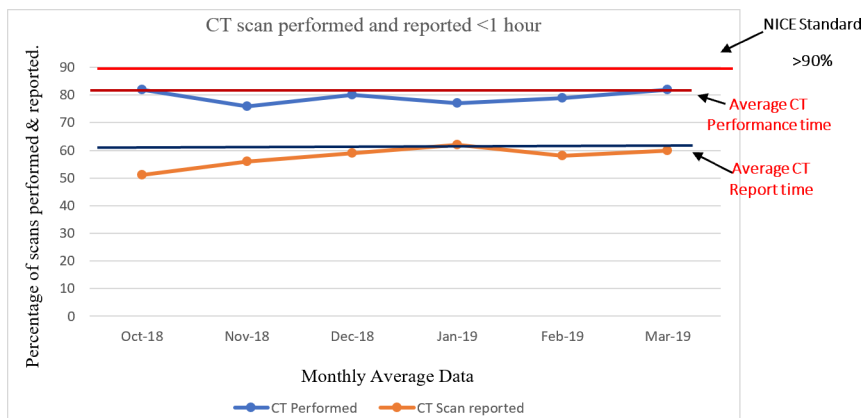


Figure 7 Percentage of the CT head scans performed and reported within 1 hour. NICE, National Institute for Health and Care Excellence.

within 15 min of arrival in ED increased from 31% to 63%. The data were averaged on a weekly basis and plotted against the time to doctor assessment.

Table 3 shows analysis and comparison of data collected (table 1). Data were analysed at 2 months' time to have a comparable result with audits done pre implementation of HI pathway.

Time to see ED doctor

Preintervention: mean duration was 76.9 min with an SD of 62.1 min. The time to doctor assessment ranges from 7 min to 4 hours and 29 min. It is evident that after implementation of HI pathway the mean duration reduced significantly to 17.0 min with an SD of 9.6 min. The range for time to see ED doctor was from 6 min to 56 min. The p value of <0.001, indicates a highly significant difference. Looking at the results, it is evident that the difference is statistically and clinically significant.

The overall trend (shown by the black line) shows a reduction in the time to see an ED doctor. There are a couple of spikes above the 15 min target. Looking at these spikes the delay in assessment was due to a busy ED, short staffing, exit block and introduction of a new online patients note keeping system 'UNITY' by Cerner on 20 September 19.

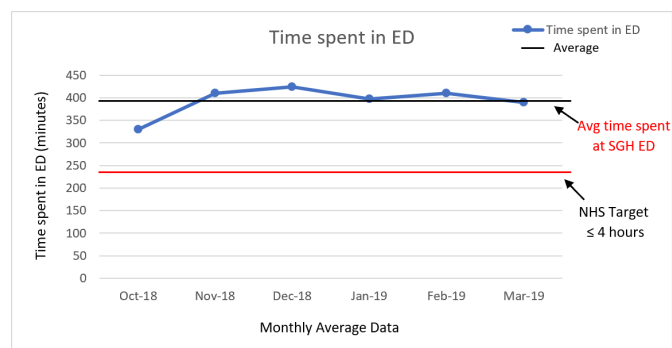


Figure 8 Time spent in the ED before patients admitted or discharged. ED, emergency department; NHS, National Health Service; SGH, Sandwell General Hospital.

Time to CT scan and reporting

Looking at the time to CT head scan being performed, the overall percentage of patients receiving a CT scan within 60 min increased to an average of 89% of patients with most of the weeks hitting the RCEM standard of 90% or greater. There seems to be a decrease in compliance to the NICE standard for 2 weeks post-UNITY transition, but it seems to catch up once staff gets used to ordering CT requests onto system.

Average time to CT report fell from an average of 98 min to 71 min once the new pathway was introduced. Percentage of patients having CT reported within 1 hours improved from 57.6% to 66.5%. Although there are some spikes of improved performance for 2 weeks postpathway, but it may have resulted from a Hawthorne effect with the radiology registrars being aware of a new pathway. Afterwards it falls to similar performance as prepathway.

Stay in ED

Figure 11 took the average weekly data and shows again an overall downward trend (black line) in the time before a patient was admitted or discharged from the SGH ED.

It is noted in table 1 that before pathway implementation, the meantime duration for ED stay was 5 hours and 6 min with an SD of 1 hour 41 min with a range of stay in ED from 1 hour 27 min to 12 hours 36 min. After the HI pathway was introduced, it is evident from data that the mean duration for ED stay reduced to 4 hours and 31 min with an SD of 1 hour 9 min. The range of stay in ED was from 2 hours and 55 min to 8 hours and 53 min.

The p value comparing pre-HI and post-HI pathway was <0.002, indicating a statistically significant difference. The data analysis clearly shows that the patients had decisions made close to 4-hour NHS standard with an average time of 4 hours 31 min. There are some spikes causing skewing of the data. This was mainly due to UNITY system introduction, long waiting times and no capacity to see the patients in cubicles. Available evidence suggests it is preferable to have shorter stay in ED and longer ED stay has impact on patient safety and mortality.¹⁵⁻¹⁸

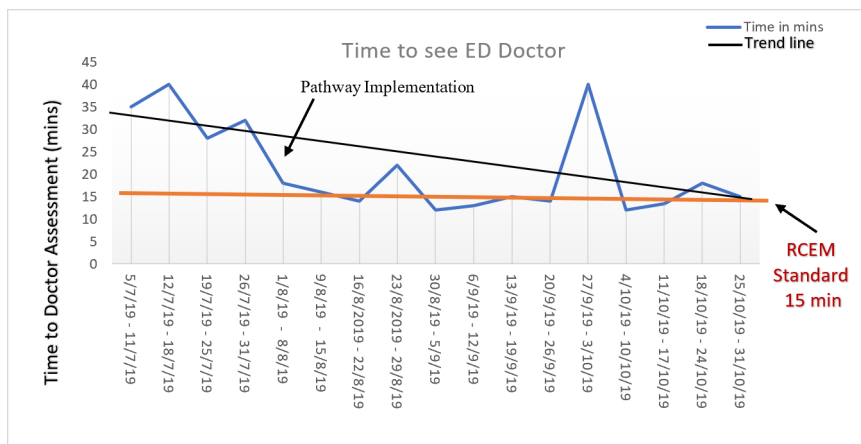


Figure 9 Time to ED doctor assessment. ED, emergency department; RCEM, Royal College of Emergency Medicine.

In Summary, both variables (time to see ED doctor and patients stay in ED) showed improvements post-HI pathway implementation. It is evident that both variables are statistically and clinically significant for HI patients in ED.

Limitations

We came across certain limitations in relation to our interventions. As the hospital moved from paper-based notes to electronic notes, we struggled to get the HI pathway incorporated into the online Cerner system. We had to manually fill in the pathway and scan it in the patient records. This means that there is a possibility of missing scanned HI performa, however, as we used system generated metrics including clinical coding and scans performed in emergency, we included all patients with HI in our results. Eventually, IT generated online performa will fix this problem permanently.

Second limitation we came across is about the education of staff. We used multiple means of educating our staff in emergency including hand over discussion, group teaching and individual meetings, however, we were unable to analyse the comprehension of the new process

among staff. As the metrics improved during our project, we assumed that staff has better understanding of the new process. Staff surveys did help us in understanding the difficulties and we worked to rectify the issues during the project.

There were however a few more problems that occurred. A total of three serious incident forms were filed. One of them was in relation to no response to the bleep for an HI patient after multiple attempts. However, after investigating it was found out that the doctor holding bleep had taken it home by accident. To prevent this in the future, we introduced a checklist at handovers to ensure bleeps were handed over. We also modified the pathway with the registrar, and the consultant bleeps added as a back up to avoid such problems in the future.

The other incident was filed by the trauma team as a clinically unstable patient was transferred to the ward. As a result of this, we decided to add an early warning score NEWS to be incorporated into checklist before transferring patients from the ED. Evidence suggests that NEWS cut-off 3 has good sensitivity to identify the sick patients in the ED.¹⁹ We used the NEWS cut-off value of 3 to be

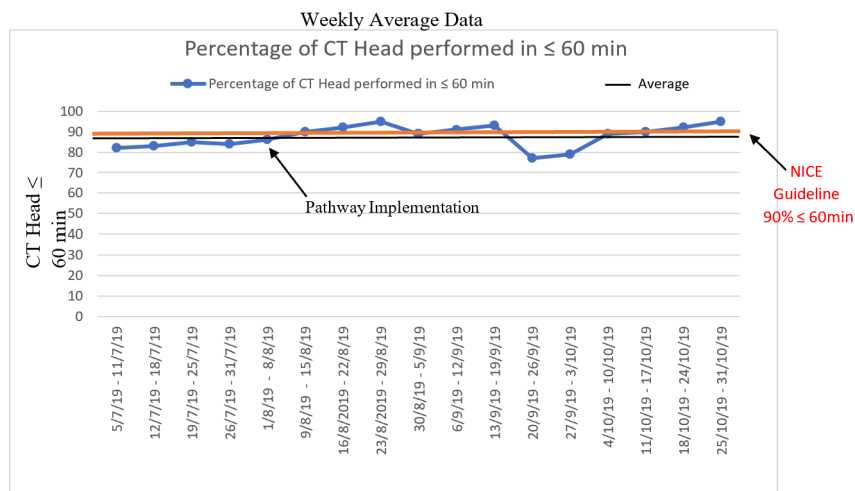


Figure 10 Percentage of CT Head performed in 60 min or less. NICE, National Institute for Health and Care Excellence.

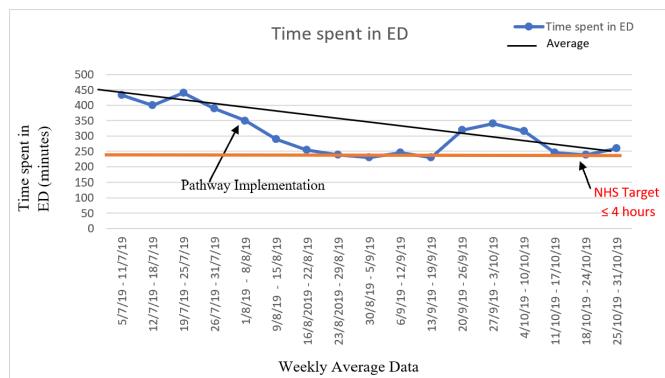


Figure 11 Time spent in emergency department (ED) at Sandwell General Hospital. NHS, National Health Service.

incorporated into the pathway to ensure sick patients are not transferred to non-monitored beds in the wards.

The third and last incident was reported by the medical team, where the cervical spine injury was identified on the medical ward. It was revealed after investigation that the patient was under influence of alcohol and the cervical spine injury was overlooked. This prompted us to incorporate the NICE guidelines and the Nexus criteria for CT cervical spine as part of pathway to avoid any such incidents in the future.

Interpretation

Although the new HI pathway appears to have an overall positive effect on the management of the HI patients, further work is required to ensure better quality of care provision. Regular audit cycles will be required to see if the standards are being maintained and the new pathway is being used.

This project resulted in the improvement of the 4-hour emergency care standard performance. On reflection, even if an early decision to admit the patients, they still must wait in ED until a bed to becomes available.

Reflection

This project was learning curve for the whole team. We came across the logistical issues due to a shift-based working pattern in ED.

The changes eventually resulted in the early decision-making by ED doctors, which is probably the cumulative and overall effect of the QIP measures.

	Preintervention N=161	Postintervention N=169	P value
Time to see emergency department doctor			
Mean±SD	76.9±62.1	17.0±9.6	<0.001
Time in min	7–269	6–56	
Stay in emergency			
Mean±SD	306.4±160.8	271.6±69.1	<0.002
Duration in min	87–757	175–533	

If we were to run this project again, there is room for improvements. First, we would work to include the HI alerts in the ambulance protocols for sick patients. This would help the ED doctors see the sick patients on arrival within 10 min.

Another improvement would be to provide training session on the HI assessment, video record the session and share it on SGH intranet. Adding this video to the induction teaching pack would be helpful.

This quality improvement project was a challenging, but steep learning experience. We learnt about the quality improvement methodology and used it to produce the work which was useful for our ED.

Conclusion

The new HI risk stratification/assessment pathway and QIP measures at SGH has reduced the time to see the emergency doctor, CT head scans being performed and reported quickly, and there is a decrease in overall stay of patients in ED. Thus, improving the quality of care, and safety for the HI patients at the SGH ED.

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Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval We printed the new HI pathway in emergency after approval from the quality lead for use in patient notes. Ethics approval was granted from the quality lead in our department.

Provenance and peer review Not commissioned; externally peer reviewed.

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