SHORT COMMUNICATION

A 12 month clinical audit of cervical spine imaging in multiply injured and intubated patients

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ABSTRACT. Previous work has questioned how plain films should be used when imaging the cervical spine of trauma patients. The authors wanted to identify whether the National Institute for Clinical Excellence (NICE) guidelines were being followed with respect to the imaging of patients presenting with cervical spine injury over a 1 year period. Data retrieved from the Electronic Digital Information Service (EDIS) computerised database records of all patients presenting with a triage code 1 or 2 between 1 September 2007 and 31 August 2008 were used to conduct a retrospective audit that identified multiply injured and intubated patients who did not undergo CT of the cervical spine and to highlight the use of plain films when the patient was to undergo CT of the head and cervical spine. A clinical record search identified 52 patients with a mean age of 32 years, of whom 73% were males, who had been admitted with multiple traumas and had undergone imaging of the cervical spine. Although no patient was intubated without undergoing CT of the cervical spine or head, seven patients had plain films when it was clear that they were to undergo CT. In conclusion, the audit emphasised the excellent work of emergency department and radiology staff in identifying and imaging multiple trauma patients, as all patients requiring CT of the cervical spine received this investigation. However, careful thought should be given to ordering plain films before CT, as some patients who clearly required CT of the cervical spine underwent unnecessary lateral plain films in the emergency department, delaying their progression to definitive care.

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Studies suggest that 2–3% of patients who present to the emergency department with blunt trauma undergo some kind of imaging, be it plain radiography or CT. It is worth considering that only 1.5% of patients who present with trauma suffer injury to the cervical spine. Selective use of an appropriate cervical spine imaging modality is vital. If a cervical spine fracture is missed, the long-term neurological outcome is of high consequence, as it is estimated that, historically, up to 29% of patients who have a delayed diagnosis of cervical spine injury suffer full paralysis [1]. One must also consider the institutional cost of missed cervical spine injury as a result of inadequate imaging. A study in the USA found that, although the estimated costs of plain cervical radiography and CT were \$120 and \$329, respectively, the reduction in litigation costs as a result of missed injury rendered the difference insignificant. It found that the average cost of the investigation, once litigation for paralysis by a missed injury had been taken into account, was \$2022 for plain films and \$553 for CT — a fourfold decrease [2]. For these and other reasons, the threshold for CT of the cervical spine in blunt trauma remains low. Guidelines aim to reduce unnecessary

imaging, in turn reducing costs, waiting times and patient radiation. UK-developed National Institute for Clinical Excellence (NICE) guidelines state that, when a patient presents with a head injury and has any of the following, the cervical spine should be immobilised:

- Glasgow Coma Scale (GCS) score <15 on presentation.
- Neck pain or tenderness.
- Focal neurological deficit.
- Paraesthesia in the extremities.
- Any other clinical indication of cervical spine injury [3].

The patient's cervical spine should remain immobilised until it can be cleared clinically or by imaging.

Currently, plain cervical spine radiography is the investigation of choice for most patients presenting with possible injury of the cervical spine. However, if any of the following occur, then CT of the cervical spine is indicated:

- GCS <13 on initial assessment.
- The patient has been intubated.
- Plain film was inadequate, suspicious or definitely abnormal (C7/T1 junction cannot be demonstrated).
- Continued clinical suspicion of injury despite normal radiograph.
- Patient is being scanned for multiregional trauma [3].

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Figure 1 outlines a pathway published on the NHS library that incorporates the Canadian and the National Emergency X-ray Utilization Study cervical spine rules.

The Canadian rule appears more sensitive and specific than the NEXUS rule; however, the implementation of either rule has been avoided in some centres owing to the morbidity and mortality of a missed injury [4].

Figure 1. Incorporation of Canadian and NEXUS criteria in both stable and unstable patients, enabling decisions about imaging to be clearer. However, for this study, patients were already intubated and a trauma referral (right arm) was already made. NHS Library; Cervical Spine Guidelines; Dr. Song-Seng Liao; May 2005 (<http://www.library.nhs.uk/SpecialistLibrarySearch/download.aspx?resID=83269>). ED, emergency department; C-spine, cervical spine. GCS, Glasgow Coma Scale; P, pulse; RR, respiratory rate; ATLS, advanced trauma and life support; XR, X-ray.

Purpose of audit

The purpose of the audit was to:

- identify multiply injured intubated patients who did not receive CT of the cervical spine;
- identify the use of plain cervical films in patients for whom CT was the initial investigation of choice.

For the purpose of this audit, we accepted the NICE Head Injury Quick Reference Guide as the standard of care. The author notes that these are UK-developed guidelines. Some subtleties in the guidelines may not be directly applicable to New Zealand and Australia, where emergency medicine has been an established specialty for 25 years. Although anaesthetic and intensive care colleagues are often included in trauma teams, all Australasian-trained FACEMS (Fellow of the Australasian College for Emergency Medicine) undergo anaesthetic and critical care training as registrars.

Methods

An audit was conducted of all patients who presented to the Emergency Department, Wellington Hospital, New Zealand, with a triage 1 or 2 trauma as specified by the triage nurse between 1 September 2007 and 31 August 2008. Wellington Hospital uses the EDIS [5] computerised patient database for all medical and nursing notes. Data retrieved from the EDIS record included hospital number, date of birth, sex, attendance date, arrival time, departure time and destination. The investigations undertaken and the patient's outcome, *e.g.* cervical spine fracture present/not present, were reviewed. All films were interpreted by consultant radiologists.

Results

The search revealed 114 trauma patients. 52 had the desired criteria for the audit, *i.e.* head, neck or multiple traumas. 73% were male and the mean age was 32 years (range, 0–88 years). Figure 2 shows a summary of the care pathways for all 52 patients who were included in the audit.

Of the 52 patients who presented to Wellington Emergency Department, 21 (Pathways 1 and 5) had plain cervical films upon initial presentation. Seven of these patients (Pathway 5) were cleared, as no cervical spine fracture was identified and they did not require intubation. This finding fulfils the main aim of the audit, as no trauma patients who were intubated received only plain cervical films. This finding contrasts with standard practice in Wellington Hospital's Emergency Department in 2001 prior to purchase of a helical CT scanner [6].

14 of these patients then underwent CT of the head and cervical spine (Pathway 1). Although on two occasions this was necessary, as fractures were identified on the plain films, seven patients received plain cervical spine films and then CT because they were multiply injured and required CT of other areas also. The pre-test probability of these patients having injury of the cervical spine is much higher. According to NICE guidelines, intubated patients should proceed directly to CT [7]. In

Figure 2. Summary of care pathways for patients presenting with head/neck or multiple traumas. Pathway 1 indicates that 14 of the 52 patients (24%) identified underwent plain films and then CT of the head or neck, of whom 7 were intubated. Three patients were identified to have a fracture of the cervical spine (6% of all patients). Pathway 2 indicates that 20 patients had immediate CT of the head and cervical spine (39%), 13 of whom were intubated and 1 of whom was identified as having a fracture of the cervical spine (2% of all patients). Pathway 3 indicates that four patients had CT of the head only (8%), one of whom was intubated; there were no cervical spine fractures detected. Pathway 4 shows that six patients had immediate CT of the cervical spine (12%) but only one of these underwent CT of the head. Two fractures of the cervical spine were identified (4% of all patients). Pathway 5 shows that 7 of the 52 patients (17%) had plain cervical films only, with no follow-up CT of the cervical spine. No cervical fractures were detected. C-spine, cervical spine.

the patients who received CT of the head and cervical spine after plain films, two initial fractures that were identified on plain films were also visualised on CT. One patient was found to have a fracture on CT that was not visible on plain film. The cervical spine CT was ordered correctly in line with NICE guidelines, as there was ongoing clinical suspicion that a fracture of the cervical spine was present.

20 patients went straight for CT of the head and cervical spine (Pathway 2), of whom 13 were intubated. This is the correct initial investigation as identified by the NICE guidelines. One fracture of the cervical spine was identified in these patients. The other seven patients went straight to CT instead of having an initial trauma series conducted. Pathway 3 shows that 4 of the 52 patients included in the search criteria underwent CT of the head only (*i.e.* no CT of the cervical spine). One of these patients did meet the NICE criteria for CT of the cervical spine, as he/she was intubated; however, there was a low level of clinical suspicion, as he/she had only fallen from his/her own height. Finally, Pathway 4 shows that six patients underwent CT of the cervical spine only, of whom only one was intubated; he/she subsequently underwent CT of the head. Two fractures of the cervical spine were identified.

Discussion

Injury of the cervical spine has an incidence of 2–4% in patients with associated blunt trauma; 70% of these injuries are fractures that result in no spinal cord injury. It is thought that approximately 1% of cervical spine injuries are missed [5]. A missed diagnosis can have devastating results. Currently, in many centres, patients with multiple trauma undergo a plain radiograph trauma series that (in addition to chest and pelvic films) includes a lateral cervical spine view, followed by anteroposterior and open-mouth films. These can be superseded by CT or MRI if the views are inadequate or if there is ongoing clinical suspicion of an injury.

Eight patients in our audit required CT as a result of inadequate plain cervical films. Although the purpose of this study was not to determine whether there is a role for plain cervical spine films in multiply injured or intubated patients, it does illustrate one limitation of plain cervical radiographs: imaging the upper cervical spine may be difficult owing to positioning problems and superimposed nasogastric and endotracheal tubes. The cervicothoracic junction is often obscured by the shoulder girdle [6]. This was the case in seven of the eight patients in whom the audit identified inadequate plain films.

One patient who was seen to have a single C5 fracture on plain film was shown to have multiple fractured vertebrae on CT. Although this had little clinical significance in this case, as the patient underwent CT of the cervical spine, it demonstrates again the limitation of plain films. Previous studies have revealed that only 26% of cervical spine fractures are correctly identified on primary plain film investigation. The sensitivity of CT is 99% [6].

Only one intubated patient did not undergo CT of the cervical spine (a deviation from the NICE guidelines). This patient was felt by the treating clinician to be at low risk of a cervical spine injury. This does serve to reinforce the importance of clinician judgement in a specialist-led department.

The second desired outcome of the audit was to identify patients who received unnecessary plain films and then also underwent CT. Seven intubated patients had plain cervical films followed by CT of the cervical spine. The disadvantages of undergoing unnecessary radiological procedures include delayed disposition to definitive care, increased radiation to the thyroid gland and increased cost. There is little to be gained from a lateral cervical film performed in the resuscitation bay if the patient clearly requires CT as the initial investigation.

Retrospective chart reviews are often plagued by common limitations. The identification of cases was at times problematic, as clinician notes contained variable detail. Careful consideration by the auditor was required, and this may have caused inclusion bias. This audit included only one year's data, identifying 52 patients. The main aim of the audit was to look at the effectiveness of the clinical decisions of emergency department staff within the desired data period; to ensure further accuracy, a longer data period and more patients would be needed. To ensure such accuracy of future audits, it is essential that all emergency department notes are completed with consistency. A standardised trauma pathway that included imaging criteria would assist greatly.

Summary

The main aim of this audit was to determine whether intubated trauma patients seen at Wellington Hospital's Emergency Department over a one year period received appropriate imaging of the cervical spine.

One patient who required intubation for CT of the brain did not receive concurrent CT of the cervical spine. This patient had fallen to the ground from standing and was deemed to be at minimal risk for injury of the cervical spine. This suggests that the management was in accordance with the NICE head injury guidelines, even though these guidelines had not been formally adopted in Wellington during the audit period.

Some patients who clearly required CT of the cervical spine underwent unnecessary lateral plain films in the Emergency Department, delaying their progression to definitive care. For a patient with an extra-axial haematoma and a rapidly falling level of consciousness, any additional delay to theatre may have had a tangible detrimental effect on outcome. For many years, Emergency Physicians have been trained to order cervical spine, chest and pelvis radiographs for all multiply injured patients. Although the plain chest film remains an integral part of the initial trauma work-up, the lateral cervical spine and (to a lesser extent) the anteroposterior pelvis films have been superseded by helical CT. As the audit shows, sometimes old habits die hard!

A standardised trauma pathway incorporating NICE guidelines could assist with selection of the most appropriate imaging modality for a multiply injured patient who requires endotracheal intubation. Although application of such a guideline would not have detected any missed fractures in this audit population, it might have slightly reduced time to definitive care.

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