

## Case Report

## The Use of CT Scanners in the Emergency Department

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The use of CT scanners has increased significantly over the last few decades. This is especially so in the setting of Emergency Departments (EDs), where many investigations are now being brought forward to the frontline. Third generation CT scanners now have better resolution and imaging quality, leading to the trend towards more non-invasive test. Trauma centres and tertiary referral centres too have CT scanners in their EDs, and this has reduced the time required to get a definitive diagnoses, thus improving patient outcomes.

In this paper, we reviewed some of the current indications for performing CT scans in the ED, following which we analysed the positive pick up rates for some of these indications. We evaluated the potential benefit of having CT scanners available 24 hours a day in the ED, and weighed this against the possible harm. Finally, we discussed whether or not there was a need to have these CT scanners available 24 hours a day in order to influence time-sensitive outcomes and prevent out of our complications.

**Keywords:** CT scanners; Emergency department; 24 hours**Introduction**

The use of Computed Tomography (CT) scans has skyrocketed in the last few decades, increasing approximately 21-fold, and is not yet tapering [1-4]. This increase is happening at a higher rate in the emergency department as compared to anywhere else, accounting for approximately 72% of the 62 million scans in 2009 [4,5].

With better technology and imaging quality, CT scans have become a vital part of the diagnostic process [6-9]. Increasing medico-legal pressure from patients to reach a quicker, more accurate diagnosis, coupled with a trend towards less invasive testing, has also contributed to the exponential increase in scan rates [4,9]. Moreover, more trauma centres have CT scanners in their own departments now [9,10]. This increasing ease of access leads to a shortened transfer time, hence a quicker diagnosis and better patient outcomes [10]. However, increasing numbers of scans also leads to increasing costs of healthcare and exposure to unnecessary radiation [9,11]. Is having a CT scanner in the ED leading to overutilization?

This article aims to review the indications for doing a CT scan in the ED, look at the positive pick-up rates of these scans, and subsequently analyze the need for a 24 hour CT scanner in the ED.

**Methods**

A search of electronic databases (MEDLINE, EMBASE etc.) was performed, using keywords such as “computed topography”, “emergency department” and “24 hours”. Articles were then narrowed down to include studies that reported CT scanner utilization rates in the ED, positive pick-up rates for certain pathologies, or those that discussed a need for 24 hour availability in the ED.

**Results****Indications for scanning in the ED**

There are many different indications for scanning in the ED, ranging from chest CTs for suspected pulmonary emboli to Whole-

Body CTs (WBCT) for polytrauma. The incidence of all these scans have been steadily rising [12]. Looking more specifically at head CT scans, minor head injuries [13], new onset headaches, stroke-like symptoms and alterations in mental state [10] are just some of the many possible indications for scanning. As such, to tackle the problem of when to scan and when to withhold, many countries have come up with various guidelines (Table 1 and 2).

In the UK, the National Institute for Health and Care Excellence (NICE) have separate guidelines for adults and children who have sustained head injuries as detailed in Table 3. While different countries have different guidelines for CT head scanning, most depend on factors such as GCS score, age and signs of neurological impairment.

However, there are loopholes in these guidelines, such as the anticoagulant loophole as pointed out by Prowse et al. [14]. This revealed that patients on anticoagulation therapy should be scanned even if they do not fulfill the criteria as injury is more likely to be missed. As such, NICE guidelines recommend performing a head CT for patients for patients on anticoagulation who have sustained a head injury even in the absence of other indications.

Moreover, positive findings are often found on the CT scans of

**Table 1:** The New Orleans Criteria [1,2].

CT scan if any one of the seven occurs after head injury:
Headache
Vomiting
Age over 60 years
Drug or alcohol intoxication
Deficits in short-term memory
Seizure
Evidence of injury above the clavicles

**Table 2:** The Canadian CT Head Rule [1,5].

High risk (for neurological intervention)	Medium risk (for brain injury on CT)
GCS score <15 2 hours after injury	Amnesia for events more than 30 minutes before impact
Suspected open or depressed skull fracture	Dangerous mechanism of injury
Any sign of basal skull fracture	
More than two episodes of vomiting	
Age > 65 years	

**Table 3:** NICE guidelines for head injury: Criteria for performing a head CT within 1 hour [1].

Adults	Children
GCS < 13 (initial assessment)	Suspicion of non-accidental injury
GCS < 15 (2 hours after injury)	Post-traumatic seizure (no history of epilepsy)
Suspected open or depressed skull fracture	GCS < 14 (initial)
Any sign of basal skull fracture	GCS < 15 (2 hours after injury or for children under 1 year)
Post-traumatic seizure	Suspected open or depressed skull fracture/tense fontanelle
Focal neurological deficit	Any sign of basal skull fracture
More than 1 episode of vomiting	Focal neurological deficit
	Presence of bruise, swelling or laceration > 5cm on head (children under 1 year)

patients for whom those scans were not ordered in compliance with guidelines. As such, doctors are advised to order scans not only in compliance with guidelines but also clinical judgment [15]. Is the positive pick-up rate for CT scans thus heavily affected?

### Positive pick-up rate of CT scans in ED

A study by Lee et al. [11] showed that from January 2001 to December 2007, while there was a 60% increase in utilization of head CTs, the rate of intracranial hemorrhages found went from 3.6 per 100 to 3.0 per 100. This was not statistically significant, and there was a proportionate increase in positive findings for the increase in scans ordered, hence yield remained unchanged. This does not support the premise that the increasing number of CT scans ordered is unnecessary. However, it is debatable whether these positive findings were of equal importance. A study by Chen et al. [16] yielded similar results, with a 30% increase in utilization but a steady positive study rate from 12.3% to 12.2%.

Oguz et al. [10], however, did correlate the installation of a CT scanner in the ED with a decrease in the overall rate of positive scans. Their study showed an increase in utilization from 8.0% of patients to 13.0% following CT scanner installation, with a 69% increase in total volume of scans ordered. The positive pick-up rate for head trauma patients, however, decreased from 34% to 15.8%. This was similarly reflected in patients who required facial CTs and cervical spine CTs.

With regards to minor head injury, where the ordering of CT scans is sometimes questionable, Schunk et al. [17] showed that in children with normal neurological examinations, CT scans were abnormal in a startling 28% of them. A study by Shackford et al. [6] similarly demonstrated that out of 2766 patients with minor head injury, 2112 had normal neurological examinations but 59 of these required a craniotomy. It also showed that the negative predictive

value of the CT scan was 100%, comparable to the 99.70% in the study by Livingston et al. [8]. This was calculated to save significant cost in terms of hospital admission as many of these patients would otherwise have had to be observed.

### 24-hour availability in the ED

The REACT-1 study [18], a prospective randomized controlled trial carried out in two Dutch hospitals involving 1124 patients, showed a 13 minute reduction in the time taken from arrival to CT scan when the scanner was located in the ED.

A Malaysian study by Ismail et al. [19] analysed the need for a CT scanner in the emergency department, looking at the scan and pick-up rates. They found that the overall rate of ordering CTs was 2.83%, and the overall scan yield 65.8%, with non-traumatic cases at 70.5%.

Another study done in the US by Runde et al. [4] found that the rate of scanning increased from 114 per 1000 patients to 139 per 1000 patients following the installation of a CT scanner in their emergency department. Of these, head CTs had increased by 14 per 1000 scans. As such, it can be seen that having a CT scanner available in the emergency department leads to increased utilization. However, this study also showed that the rate of CT scan ordering did not drop during a 5 month period where to scanner was unavailable. This is possibly due to the reluctance of physicians to decrease scan ordering rate. The rate, however, did remain constant after the CT scanner was made available again.

A study by Mac Namara et al. [20], aiming to analyse whether 24 hour access was vital, showed that 53% of CT scans were ordered "out of hours", and 97% of the scans were of the brain. So many of the scans were head CTs, and it is known that strokes and trauma are extremely time sensitive [21]. As a result, the availability of a CT scanner in the emergency department 24-hours a day may make a significant difference in terms of patient outcomes.

Many countries have increased their scan rates in the ED, and this increase may also be due to the guidelines surrounding management of trauma patients. For example, in Japan, the Japan Advanced Trauma Evaluation and Care (JATEC) revised guidelines to focus more heavily on CT imaging [22,23]. This comprises 3 steps of a Whole-Body CT scan (WBCT) – first a Focused Assessment with CT for trauma (FACT) looking for pathology such as massive intracranial hematomas and aortic injury. This is to ensure rapid treatment. The second and third steps involve investigation of active bleeding and any other missed findings.

Studies have subsequently shown a decrease in mortality of polytrauma patients managed initially with a WBCT, not only in Japan but also in Germany and many other European countries. A study by Huber-Wagner et al. [24], looking at the effect of this integration of a WBCT into initial blunt trauma care, revealed a significant decrease in the standardized mortality ratio of patients given WBCTs as opposed to those not. Japanese studies by Kimura et al. [25] and Wada et al. [26] showed similar trends, with significantly lower mortality rates in blunt trauma patients receiving WBCTs as part of initial management. Incorporating FACT allows a quicker response and a more comprehensive assessment, and this speed may be increasing survival [27]. As established by Hilbert et al. [28] and supported by others [29], it is the elimination of transfer time from

the ED to the scanner that is beneficial. Having a CT scanner in the emergency department, available 24 hours a day, may hence have a significant effect on patient mortality.

## Discussion

It is undeniable that the rate of CT scanning has been skyrocketing, especially in the emergency department. However, it is difficult to ascertain how much of this increase is due to the convenience of having a scanner available, and how much of it is necessary [4,10]. It is paramount that physicians remember that while CT scanning is an excellent diagnostic tool, it must not replace examination of the patient.

There are many obvious benefits of CT scans, but these must be balanced against the possible harm, especially in light of their increasing utilization. It is well documented that CT scans carry significant ionizing radiation exposure [9,11]. A study done in Japan, a country with a high prevalence of CT scanning (235.4/1000 patients having CT scans per year), revealed an estimated 277.4 \*10<sup>3</sup> Sv of radiation per person [30]. This can lead to adverse effects later in life, most notably cancer. In many cases, the benefit of scanning well outweighs this risk, for example in cases involving trauma. However, many physicians have begun ordering otherwise unnecessary scans to avoid malpractice litigation. The benefit from these scans is unlikely to justify the unnecessary radiation; are CT scanners being over utilized?

Moreover, incidental findings on CT scans, while often benign, can cause unnecessary worry. Thompson et al. [31] showed that of 682 CT scans done, a total of 348 incidental findings were reported in 228 scans.

Finally, with increasing CT scans also comes the increasing financial burden of healthcare [3,9]. Especially in societies where healthcare is subsidized or free, this can lead to diversion of resources away from other much needed areas. This is not only from the scans themselves but also from other investigations following incidental findings or radiation related disease.

## Conclusion

CT scanners have become necessary to have in major trauma centres today. However, more specific data is needed to demonstrate whether CT scanners should be in the ED and available 24 hours a day to influence time-sensitive outcomes and prevent out of hours complications. Future studies focusing on the economic cost benefit analysis of 24 hour availability would be particularly useful in changing current practice.

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