ANALYSIS OF THE INITIAL 100 SCANS FROM THE FIRST CT SCANNER DEPLOYED BY THE BRITISH ARMED FORCES IN A LAND ENVIRONMENT.

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Abstract

Aims: To examine usage of the first CT scanner installed in a UK field hospital, BMH Shaibah, over a 13 month period.

Methods: All request forms and reports for the first 100 studies were analysed retrospectively.

Results: An average of 7.7 scans per month was performed. Trauma was the most common indication followed by urinary symptoms and headache. Significant pathology was diagnosed in many cases.

Conclusion: A deployed CT scanner can make a significant contribution to the capability of a field hospital, shaping both the management and disposal of patients. A more easily deployable scanner will be needed in future.

Introduction

On 15 March 2005, a Phillips Brilliance 6-slice CT scanner (Koninklijke Philips Electronics NV, Netherlands) was installed at the MND(SE) Hospital at Shaibah Logistic Base near Basrah (Figure 1). This is the first time that computed tomography has been deployed by the British Armed Forces in a land environment. Our NATO allies have long enjoyed this valuable diagnostic aid which is routine in civilian practice and previously only available to the DMS on RFA Argus. The deployment of the CT scanner to Shaibah represented the culmination of considerable co-ordinated effort by radiology clinicians and technicians, the Medical Supplies Integrated Project Team and communications specialists.

Computed tomography has revolutionised diagnostic radiology in civilian practice and it is now a standard examination in many conditions relevant to military practice. In particular, its utility in the imaging of the injured patient is well established. The investigation of many neurological conditions, both traumatic and non-traumatic, depends upon the use of the CT scanner (1). With improving technology, CT scanning is supplanting other imaging modalities in many fields: it is likely that CT urograms will largely replace the intravenous pyelourogram (2).

The deployment of a CT scanner in a land deployment therefore marks a considerable innovation in British military medicine, but also raises several issues that need to be addressed. In future decisions will have to be made about when and where to deploy this technology. Investment will have to be made in new scanners and consideration given to how they are to be deployed, maintained and redeployed. Seeking to contribute to such discussions, we present data on how the scanner at Shaibah was used for its first 100 scans in the 13 months after its deployment.

Material and Methods

All radiology forms requesting CT scanning and the subsequent reports, including demographic data, were collected retrospectively from the first 100 studies undertaken by the scanner at Shaibah. Demographic data, indications, studies performed and findings were extracted into a database for analysis. Scans were designated positive or negative according to the presence of pathology relevant to the indication. Incidental findings were noted separately.

Results

The first 100 scans were performed over a period of 13 months, a rate of 7.7 scans per month. Full reports were available in 99 cases and request forms in 95. Ninety one percent of scans were on males and the median age was 28 years (range 11-61 years). Seventy scans were performed on UK citizens, 14 on Iraqis, 4 on Czech personnel, 3 on US citizens and four patients were of

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Region	Number (total)	Number (acute trauma)
Head and Neck	54	28
Thorax	14	9
Abdomen	41	17
Pelvis	17	10
Extremity	4	2

Table 1: Scans by body region

Indication	Number
Acute trauma (blast)	10
Acute trauma (penetrating)	2
Acute trauma (blunt)	27
Acute trauma (mechanism unclear)	4
Urinary	15
Headache	11
Acute abdomen	6
Other	23
Not stated/no data	2

Table 2: Indications

unknown nationality. Nearly three quarters (72%) of patients were military personnel. Table 1 details the scans performed by body area whilst Table 2 lists them by indication. Trauma was the most frequent indication for scanning followed by symptoms of ureteric colic.

Table 3: Head and Neck Scans

Indication	Number	Positive	Negative	Incidental finding
Trauma	27*	14 of which: Soft tissue 12 Facial #s 7 C-spine #s 2 Skull #s 3 Intracranial 4	13	3
Headache	11	3	8	0
Other	15†	5	9‡	0

** Excludes one repeat scan*
† Indications included collapse/seizure (4) and confusion (4)
‡ One scan result is not available

Table 3 gives details of the scans of the head and neck. There were 22 positive scans. Of these, intracranial pathology was found in 8 cases (i.e. in that region most difficult to assess without cross-sectional imaging). 4 of these resulted from trauma: 3 intracranial haemorrhages associated with midline shift and base of skull fracture and one case of hemicerebral swelling and base of skull fracture without haemorrhage. 3 were causing headache: one old subdural bleed, one extensive subarachnoid haemorrhage and one posterior fossa mass (likely a metastatic lung cancer). In the remaining case a lacunar infarct was found to be the cause of confusion and left-sided weakness.

Table 4 details the thoracoabdominal scans performed in cases of trauma. CT pulmonary angiography (CTPA) was also performed on 4 patients; all were negative although one did show a benign liver cyst. 15 CT urograms were carried out. 8 were positive for the present of renal tract calculi, of which 5

Table 4: Thoracoabdominal scans for trauma

Study	Number	Positive	Negative	Incidental finding
CT Chest (trauma)	8	6*	2	1
CT abdo/pelvis (trauma)	18	9 of which: Pelvic 4 Free fluid 3 Visceral injury 2 Other 3	9	0

** Lung collapse/consolidation in every case. Also rib fractures and endotracheal tube malposition in one case.*

showed obstruction. 9 other CTs of the abdomen and pelvis took place, mostly for patients with acute abdomens; 2 were positive.

Discussion

The deployed CT scanner is a large piece of equipment, requires specialist maintenance and must be in an air-conditioned building. The CT suite at MND(SE) cost approximately £500,000 to install and was not designed to be redeployed, although the scanner has subsequently been moved to Basra Air Station, albeit with some difficulty. Thus a considerable investment has been made to make this facility available to clinicians in theatre. It has been reasonably reliable: although no accurate data has been collected, radiology staff estimate that the scanner's availability was greater than 95%. A 6-slice scanner was chosen as it gave the best balance between the benefits of resolution and speed of acquisition and the burdens of cost and maintenance. The unusual population being served (mostly young, fit men), the small number of scans in each category and the partial nature of the available clinical data means it is impossible to compare the results obtained with published data.

The scanner has been used primarily for the treatment of British Servicemen and entitled civilians. Only 13 scans have been performed on Iraqis. During the earlier stages of Op TELIC, a high proportion of those admitted to the hospital were Iraqis (3). Changes in the security environment and improvements in the level of medical care available in Basra may account for the low number of Iraqis who attended and required CT.

CT scanning is an integral part of the management of haemodynamically stable trauma patients in civilian practice (4). Due to the scarcity of clinical information it is difficult to assess how important the findings in these reports were. However, it is reasonable to assume that it was valuable to rule out any operable intracranial lesion in the four cases of fractured base of skull with associated intracranial pathology. The same is likely to be true of other normal scans.

US experience has demonstrated the usefulness of CT scanners to military neurosurgeons. During Operation Desert Storm VII Corps hospitals treated 22 head injured patients (5). 11 of these had pre-treatment CT scans of which 7 demonstrated intracerebral missiles. In none of those 7 were there any significant lesions distant from the wound tract – a concern of military neurosurgeons since it was identified in the Second World War (6). The authors disparaged a "no CT, no neurosurgery" policy, pointing out that patients can benefit from neurosurgical interventions without prior scanning. No neurosurgeon was deployed to Shaibah; DMS general surgeons are given training on the drainage of extra-axial collections and the elevation of depressed skull wounds. It might be argued that non-specialists embarking on unfamiliar neurosurgical procedures would benefit even more from the reassurance of

seeing the results of a CT scan than specialists in the same circumstances.

As already noted, CT urogram is increasingly replacing the IVU in civilian practice. One of the advantages is that it can detect non-urinary causes of the patient's symptoms (2). This did not occur in this cohort but nevertheless this represents an enhancement in the standard of care given to these patients on deployment. One of the principal arguments for the continued use of the IVU in the investigation of renal colic is that suitable equipment and, particularly, radiologists are not always available out of hours (7). It is worth noting therefore that the scanner at BMH Shaibah was supported by a rota of two military consultant radiologists who were in a position to immediately report urgent scans at any time of day. This heavy commitment will be mitigated by the imminent introduction of additional radiologists onto the rota.

Servicemen with suspected PE that cannot be ruled out require urgent repatriation to the UK. While the introduction of the CT urogram is only a small improvement in the imaging of patients with ureteric colic, the availability of CTPA in theatre represents a significant change in the diagnosis of patients with suspected PE. Since V/Q scanning has never been available on deployment, diagnosis has previously depended on clinical findings, chest radiographs, ECGs and laboratory results. These are not definitive tests. By contrast, a negative CTPA rules out the diagnosis except in cases where there is a high pre-test probability (>70% prevalence of PE) (8).

The use of the CT scanner in the investigation of acute headache demonstrates a key benefit of this facility that is unique to the military environment. Whereas the normal justification and benefit of a scan is that a patient's care may thereby be altered, military patients also require decisions to be made as to their disposal. British Servicemen in Iraq who are returned to the UK on medical grounds do so by one of three principal means:

- Scheduled evacuation, usually on trooping flights, with nurse escort.
- Scheduled or urgent evacuation escorted by a medical specialist registrar and a nurse with appropriate equipment.
- Urgent evacuation by a Critical Care in the Air Support Team (CCAST), providing intensive care en route.

Urgent evacuation can involve the retasking of an aircraft, including strategic lift assets such as C-17, to facilitate the transfer. Three types of costs arise from these moves: fixed (e.g. the cost of aircraft), marginal (e.g. the cost of fuel) and opportunity (i.e. the cost of not being able to employ the assets on other duties). The marginal and opportunity costs of using a CCAST and retasking aircraft from operational duties (including routine trooping) are considerable, though difficult to quantify. A patient presenting with sudden-onset, severe headache that does not resolve is likely to require repatriation. However, a combination of CT head and lumbar puncture could rule out all those serious causes that might require urgent return to the UK. The patient could instead remain for a period in theatre, in the hope that his symptoms would settle. If they did not he could be aeromedically evacuated on a routine flight. Either course would result in a considerable saving to the Services.

Roentgen invented radiography in 1895. Its first military application followed in 1897/8 when John C Battersby employed the technique on British servicemen in the Sudan. By contrast, 30 years passed between Hounsfield's development of a usable computed tomography scanner in the early 70s and the deployment of a scanner on RFA Argus. The US Army deployed CT scanners during the first Gulf War and have found them useful in the management of combat trauma and disease and non-battle injury. Subsequent experience in several theatres has confirmed this: the US Army Combat Support Hospital at Bagram Airbase in Afganistan performed 55 CT scans for craniofacial trauma between December 2002 and March 2003 (9). In at least 5 of these cases it was thought that effective diagnosis and management of the injuries would have been impossible without cross-sectional imaging. A CT scanner was available during the Battle of the Black Sea in Mogadishu in October 2003 – also known as the Blackhawk Down incident (10). The scanner was used, particularly for neuroimaging. However, injured patients with abdominal and cervical wounds where penetration could not be ruled out clinically underwent operative exploration, in accordance with long established military principles during mass-casualty events (11). While a conservative attitude to the adoption of practices that have been validated in civilian practice is appropriate (4,12), the alterations that the availability of computed tomography will make to treatment protocols in future conflicts should be a subject of active debate among British military surgeons.

The tempo of operations on Op TELIC was relatively low during the study period. The usage of the scanner has now increased more than threefold; 66 scans were performed in July 2007 alone. Availability has also improved, with only 2 hours of unservicability during the last 3 months. The role of a deployed CT scanner is still developing. A more easily deployable scanner has been procured and deployed to support Op HERRICK. Such a scanner could find greater utility in periods of high intensity warfighting where there are more patients likely to benefit from this technology. We would suggest that a prospective audit should be conducted to determine how often the results of CT scans alter management or disposal decisions in theatre.

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