Computerised tomography scans of the head in a district general hospital

ABSTRACT—We report the results of a retrospective study of all computerised tomography (CT) brain scans of adult patients carried out over a 10-week period, based on radiological and clinical records. The commonest scan results were normal (51%) and stroke (26%), with an overall diagnostic accuracy of 43/80 (54%). On the basis of a retrospective blind survey by a neurologist, 42% of scans were thought not to be indicated. The results indicate the need for:

- guidelines on the use of CT scanning in stroke
- emphasis of current guidelines on the use of CT scanning in head injury
- neurological assessment of some suspected diagnoses before scanning.

The Royal United Hospital, Bath, is a district general hospital (DGH) with 686 inpatient beds. There are two consultant neurologists, and one Siemens DRG computerised tomography (CT) scanner. Radiologists supervise all routine and out-of-hours CT scans. To assess the use of a limited resource, an audit of inpatient and outpatient CT scanning of the head was done, to:

- obtain information about which departments were requesting scans
- ascertain for what indications CT scans were requested
- assess the accuracy of clinical diagnosis
- determine the clinical usefulness of the results.

Method

Cases were ascertained by including all adult inpatients and outpatients who had undergone CT of the brain between May and July 1993, as recorded in the CT scanner log book. One member of the audit team took details of each case (age, sex, consultant specialty, symptoms/signs leading to the CT request, clinician’s diagnosis, CT scan result) from the medical notes and CT scan request form. The notes, without the CT scan result, were studied by the neurologist who indicated his diagnosis for the case, his prediction of the outcome of the CT scan, and whether or not in his opinion the scan was indicated. For the purposes of this study, an unnecessary CT scan was one where focal neurology was evident clinically with a clear cause which did not require CT confirmation, or where focal neurology was absent, with an alternative explanation for the neurological picture such as metabolic disturbance or non-organic disorder. Cases with insufficient clinical data (usually due to loss of the notes) were excluded.

Results

There were 441 CT scans over the 70-day period; 155 were scans of the head (35% of the total), and of these 114 were inpatients. A total of 104 cases was included in the audit after the exclusion of 17 paediatric cases, 22 cases whose records were inadequate or unavailable, and one (2 scans) where the attempt to scan had been unsuccessful. Physicians requested the largest number of scans of the head (60%), followed by neurologists and paediatricians (11% each). Significantly more inpatient scans were requested by physicians (85%) than by neurologists (30%) (p < 0.001, based on the standard error of difference in percentages (SEDP)). The cases were grouped according to their chief presenting feature (Table 1) and the clinician’s and neurologist’s diagnosis (Table 2). Table 3 shows the scan results, according to whether they were normal or showed some specific abnormality.

The result of the scan was correlated with the clinician’s and the neurologist’s diagnosis in each case. Table 4 shows the proportion of cases in which the

| Main presenting feature (all patients) | No. of patients |
|----------------------------------------|-----------------|
| Focal neurology: total                | 29              |
| signs only                            | 3               |
| symptoms only                         | 6               |
| both                                  | 20              |
| Headache                              | 17              |
| Confusion                             | 11              |
| Head injury                           | 10              |
| Generalised convulsions               | 10              |
| Abnormal conscious level              | 7               |
| Repeat/follow up scans                | 10              |
| Others*                               | 10              |

* psychosis, vertigo (2), gait disturbance (2), neck pain, visual field loss, depression, episode of automated behaviour, increasing leg spasticity in patient with ventriculo-peritoneal shunt.
The clinician’s diagnosis was confirmed by the scan and the proportion that were normal where no specific CT abnormality would have been anticipated. In the main diagnostic categories where a major abnormality on scan would confirm the diagnosis, the CT scan confirmed the diagnosis in 43/80 cases (54%) for the physician and 47/52 cases (90%) for the neurologist (p < 0.001, SEDP). The neurologist’s diagnosis (in the patients not under his care) agreed with the physician’s in 48/89 cases (54%), and the scan was thought to be unnecessary in 37/89 (42%) (see discussion section). The neurologist correctly predicted the CT outcome in 82/89 cases (92%). In 29/89 cases (33%) the result of the CT scan influenced subsequent management. The most frequent intervention was transfer to the regional neurosurgical unit (12 cases); other interventions were the commencement of anticoagulation therapy (6), referral to a neurologist (5), lumbar puncture (3), and other drug treatment or radiotherapy (3).

**Table 2. Clinicians’ and neurologist’s diagnoses (non-neurology patients)**

| Diagnosis                  | Clinicians | Neurologist |
|----------------------------|------------|-------------|
|                            | Definite   | Possible    | Total | %    |        |
| Stroke                     | 23         | 5           | 28    | 31   | 27     |
| Tumour                     | 15         | 12          | 27    | 30   | 10     |
| Head injury                | 11         | 2           | 13*   | 14   | 10*    |
| SAH                        | 4          | 5           | 9     | 10   | 3      |
| SDH                        | 6          | 3           | 9     | 10   | 3      |
| Epilepsy                   | 3          | –           | 3     | 3    | 7      |
| Toxic confusion            | –          | –           | –     | –    | 6      |
| Functional disorder        | –          | –           | –     | –    | 7      |
| Viral meningitis           | 1          | –           | 1     | –    | 3      |
| Others                     | –          | –           | 5*    | 6    | 14*    |

SDH = subdural haematoma
SAH = subarachnoid haemorrhage

% = percentage of the 89 non-neurology patients for each diagnosis (total). Some patients have more than one diagnosis (see below)

1 includes 6 patients also listed under SDH
2 includes 3 patients also listed under SDH
3 dementia, psychosis, blocked ventriculo-parietal shunt (VPS), cerebral abscess (2 in same patient)
4 syncop (3), cerebral oedema (2), tension headache (2), migraine, transient global amnesia, corticobasal degeneration, blocked VPS, prolactinoma, dementia, glaucoma

**Table 3. Computerised tomography scan results (all patients) (104)**

| Outcome                  | No. of patients | (%) |
|--------------------------|-----------------|-----|
| Normal                   | 53              | 51  |
| Stroke                   | 27              | 26  |
| Tumour                   | 9               | 8   |
| Contusion                | 5               | 5   |
| Subarachnoid haemorrhage | 4               | 4   |
| Subdural haematoma       | 4               | 4   |
| Hydrocephalus            | 2               | 2   |

of these were for suspected subarachnoid haemorrhage (SAH). Head injury and generalised convulsions were the presenting feature in 9.5% (each) of the cases scanned.

The clinician’s initial diagnosis in the majority of cases was either stroke (31%) or tumour (30%). The overall agreement between the neurologist’s and the clinician’s diagnoses was 54%. Significantly fewer patients were given non-structural neurological diagnoses by the clinicians (10%) than by the neurologist (42%) (p < 0.001, SEDP). The neurologist’s diagnosis of stroke agreed with that of the clinician in the majority of cases, but he diagnosed tumour significantly less frequently (11% vs 30% of cases) (p < 0.01, SEDP).

The commonest scan outcomes were normal (51%)
and stroke (26%). The clinicians’ diagnosis of stroke was accurate (definite CT features of haemorrhage or infarction) in 82%, but they considerably over-diagnosed brain tumour (only 33% confirmed by CT). SAH and subdural haemorrhage (SDH) were also over-diagnosed by clinicians, with an overall positive CT result in 5/18 cases (28%). In only one case of suspected SAH with a normal CT scan did a lumbar puncture support the diagnosis of SAH.

There was a high proportion of positive scans (70%) when scans were requested for complicated head injury. However, this result is not as straightforward as it initially appears: four of the 13 scans for head injury were done on the same patient over one week (all showed cerebral contusion only), six were requested for suspected SDH (confirmed in 3), and the remaining three were in cases presenting with coma, coma with focal neurology, and an episode of loss of consciousness. The neurologist disagreed with the diagnosis of head injury in these last three cases, diagnosing SAH and stroke in two of them (both confirmed by CT) and syncope in the third (normal scan). In the seven of the 10 cases where he agreed with the diagnosis, he agreed with the need for a scan. Although guidelines for the use of CT scanning in head injury are available, it appears that they are not always applied.

Overall, the clinicians’ diagnoses were confirmed by CT in 43 of 80 cases (54%) in the main diagnostic groups expected to show abnormalities on scan (stroke, tumour, head injury, SAH and SDH). In the same diagnostic groups, the neurologist’s diagnostic accuracy was significantly better ($p < 0.001$, SEDP), his diagnosis being confirmed in 47 of 52 cases (90%); over-diagnosis of tumour, SAH and SDH accounted for this discrepancy. The neurologist predicted the CT result correctly in 80/89 cases (90%); the scan outcomes in the nine cases he incorrectly predicted were normal (5), cerebral infarct (3) and SDH (1) (the haematoma in the last case was not thought to be clinically significant).

An important part of this study is the assessment of the proportion of cases where CT scanning was thought to have been unnecessary. The neurologist’s diagnoses in these cases were stroke (10 cases), toxic or metabolic confusional state (6), epilepsy (5), functional disorder (5), head injury (4 scans, with 3 scans in 1 case), meningitis (2) and others (5). This part of the study is open to criticism; there are bound to be differences of clinical judgement as to the justification of imaging in each case, and the decision that scanning was unnecessary was made retrospectively. However, the high proportion of cases (37/89, 42%) in this category suggests that there is scope for more efficient targeting of the use of CT scanning. Despite this, a relatively high proportion of scans (29/89, 33%) appear to have had a clear influence on patient management.

In a similar retrospective study by Curley et al [1] of 108 cranial CT scans, the findings differed in a number of ways. The commonest clinical presentation in their study was epilepsy (25/108 cases, 23%), a high proportion of which had abnormal scans (15, including 2 tumours). In our study, 10 patients presented with generalised convulsions but a diagnosis of epilepsy was made in only three of them; in the others there were clinical diagnoses of tumour (4 cases, all normal CTs) and stroke (3 cases, 1 with an old cerebral infarct). The neurologist diagnosed epilepsy in seven cases, two of whom had abnormal scans (possible infarcts and a clinically insignificant SDH). The overall proportion of normal scans was higher in our
study, 50/104 (48%) compared with 40/108 (37%) in the study by Curley et al, despite no scans in their study showing SAH or SDH—presumably because some acute neurological presentations were referred directly to the neurological team and were not included in their audit. The differences between the two sets of results may be accounted for by:

- different organisation of acute neurological care
- different interpretations of what constitutes a normal CT scan (especially with regard to the finding of cerebral atrophy)
- the difficulty of obtaining a clear clinical picture and diagnosis from a retrospective study of medical notes.

There is no clear consensus on the role of CT scanning in the management of generalised seizures. A recent audit by Edmonstone [2] of the management of first seizures was combined with a survey of the views on this issue of 95 general physicians and 82 neurologists. The survey showed that half the physicians and neurologists would scan all such patients, and a further third would scan only above a certain age. Approximately a third of first seizures are related to alcohol withdrawal with no focal symptoms or signs [3]: the yield of abnormal scans in these cases is variably reported as 1–6% [4,5], some authors recommending [5] and others opposing [4] the routine use of CT scanning in alcohol withdrawal-related seizures. In our study, none of the generalised seizures was thought to be due to alcohol withdrawal (this may reflect inadequate history taking), but 4/10 patients (40%) had underlying pathology such as metabolic disturbance and in two others the history was more typical of syncope. CT was thought to be indicated in only four of these 10 cases.

In 10 of 27 cases (37%) presenting with stroke it was thought that CT scanning had been unnecessary. The use of CT scanning in stroke has also been the subject of conflicting recommendations. In a prospective study of 828 patients with acute stroke [6], 684 had CT scanning; the CT result altered diagnosis in 2.2% and management in 1.5%. The authors concluded that this was a relatively inefficient use of medical resources. CT scanning has been advocated in all cases of stroke. A recent review article [7] recommended a scan at the time of presentation followed by another scan at 7–10 days, but this is probably an unrealistic proposition for most DGHs. Our data show that the mean time to scan for stroke cases was nine days. Sandercock et al [8], reporting on the Oxfordshire Community Stroke Project, concluded that CT scanning was necessary only in specific subgroups which could be readily identified and which amounted to approximately 28% of all strokes. However, they concluded that scanning was important for those who were either on or being considered for anticoagulant medication (17%). In our study, eight of 28 stroke cases (29%) were scanned with a view to introducing or stopping anticoagulation on the basis of the scan result. At the time of the study, there was no local policy on the use of aspirin or anticoagulants in stroke, the decision being left to the discretion of individual consultants. As more data become available from controlled trials of anticoagulant therapy, the local management of stroke may change and more CT scans of the head may be requested for stroke. Given the limited resources available and the number of scans requested, there appears to be a need for guidelines on the use of CT scanning in stroke.

Conclusions

The major findings of this study are:

1. Forty-two per cent of CT scans of the brain were not indicated, mainly for some types of stroke and non-focal neurology.
2. There was poor agreement (54%) between the initial diagnosis made by clinicians and that made ‘blind’ by the neurologist.
3. There was failure to apply head injury guidelines.

The results suggest that improvements in the use of CT scanning can be made. Our proposals are:

- to put in place locally agreed guidelines for the use of CT in stroke
- to remind junior staff and consultants of the existence of agreed guidelines for the use of CT in head injury
- to improve the use of CT scanning by promoting attendance of junior staff at weekly joint neuroradiological meetings
- to assess the impact of these measures using a similar audit but with some additional data such as the waiting time for the scan to be carried out and the proportion of emergency scans.

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