Teleradiology for Traumatic Brain Injury Management

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Abstract Teleradiology experiences from workstation to wireless technology and discrepancies from an “ideal world” of guidelines and a “real world” of medical practice are detailed. The real predictive value of Glasgow Coma Scale admission for the outcome of brain-injured patients and differences regarding the outcome of traumatic brain injury patients treated with or without neurosurgical facilities are outlined. Also examined is how to detect the computed tomography evolution before the neurologic change and the application of guidelines with area protocol and “hub and spoke” systems is discussed.

15.1 Background Information

The selection of patients admitted to the neurosurgical center is usually based on a telephonic consultation (TC) with the neurosurgeon on duty. In many neurosurgical units, it is available as teleradiology (TR) where the TC is integrated with the direct view of each patient’s computed tomography (CT) scans via image transmission. Guidelines for the management of severe traumatic brain injury (TBI) patients have been published both in the USA [7, 10] and in Europe [27]. Unfortunately, none of these guidelines, except in part those from Italy (Table 15.1) [44], contain clear statements about which patients should be admitted to a neurosurgical center.

When an interaction occurs between a primary-care physician at one site and a specialist at another, the accuracy of information exchange during a TC depends on the reliability and completeness of the information received from referral hospitals [51] and the experience of the referring physician [31, 63]. The use of TR reduces the incidence of unnecessary transfer and adverse effects occurring during transfer [18], when there are guidelines and information technology is a well-established part of the physician’s experience. This dual-authority system within health-care organizations creates opportunities for potential conflicts in telemedicine-related decisions.
The quality of the imaging, the feasibility of sharing pictures, and software play an important role in the efficacy of TR. The technological knowledge should be rapidly upgraded in the cultural background within health-care organizations.

The DICOM standard represents the only established technical protocol, while many workstations for telemedicine are available with different software.

### Table 15.1. Italian guidelines for the treatment of traumatic brain injury patients: summary on transfer of comatose patients [44]

<table>
<thead>
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<th>Scenario</th>
<th>Details</th>
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<td><strong>First scenario</strong></td>
<td>At the scene of an accident, a comatose patient is not yet stable despite all therapeutic efforts. The patient must be taken to the nearest hospital with a general surgery department, an ICU, and a radiology department with full X-ray and ultrasound diagnostic facilities. Brain CT scans may be postponed until respiratory and circulatory stabilities are achieved. The neurosurgical department should anyway be informed so as to be ready to admit the stabilized patient.</td>
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| **Second scenario** | At the scene of an accident, a comatose patient has stable circulation and respiration. Whenever direct access to a neurosurgical center is not feasible, the patient must be admitted to a hospital providing, at least, the following:  
  – An ICU that can ensure ventilatory assistance, invasive arterial monitoring, serial blood gas analysis, hourly neurological assessment (GCS and pupils), 24 h medical staff, and, at least, one nurse to every two patients  
  – 24 h CT scan facilities and immediate interpretation  
  On admission the following are indispensable:  
  – Continuation and optimization of intensive care  
  – Diagnostic definition of brain injury (brain scan) and cervical spine (including the cervicodorsal junction), within 3 h of injury  
  – Diagnosis of concomitant lesions (X-ray of the chest and pelvis and abdominal ultrasonography)  
  – Neurosurgical consultation, either directly or by transmission of images and clinical information, to establish whether transfer is urgent or can be planned subsequently |
| **Third scenario** | At the scene of an accident or during transport to the first hospital, a comatose patient presents with worsening of the GCS, progressive papillary alterations, and/or motor signs of cerebral coning. The patient must be taken to the nearest neurosurgical center since the risk of a surgical intracranial hematoma is extremely high. |

ICU intensive care unit, CT computed tomography, GCS Glasgow Coma Scale