Progressive deterioration is a feature in some cases of repeated minor head injury in boxers (Roberts 1969), but remains a questionable entity after a single severe injury (Corsellis & Brierley 1959). Fifteen patients in this series had progressive intellectual deterioration which could have been due to normal ageing superimposed on traumatic defect. Three others demented after improvement and could have had Alzheimer's disease unrelated to the injury. In 3 paretic limbs became more spastic after many years. Five more, all with complicated injuries, developed what appeared to be a communicating hydrocephalus after a delay of some years, and in 4 of these after a further head injury due to falls.

In almost 80% of the consecutive series deaths due to head injury took place within six months. In those unconscious for longer than a month who died of their injury there were some prolonged survivals, most of these mute, akinetic and decerebrate. It is to be hoped that earlier and more accurate prediction in the future may limit the number of these.

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Predicting Outcome after Head Injury

[Abstract]

We have heard from other speakers what *can* happen after head injury, but the doctor dealing with the head injured patient wants to know what *will* happen. He must decide whether or not to admit the mild case to hospital and whether or not to persist with all-out intensive care for a severe injury. Deprived of reliable predictive data doctors admit thousands of mild injuries briefly to hospital every year, although only a tiny proportion develop complications, whilst an undue proportion of effort on severe injuries is liable to be expended on those who either do not survive or are left very severely disabled. If we could recognize soon after injury which mildly injured patients were at risk from complications, and which severely injured patients had a reasonable chance of recovery, we could concentrate our maximum effort on those patients. Reliable predictions would also make it possible to assess the efficacy of newly proposed methods of management.

Prognosis is a probability statement which assumes a logical relationship between outcome and certain items of antecedent data. It requires rigorous definition of outcome, and then identification of which items of data have predictive power and what is their relative influence alone and in combination. The simplest kind of prediction is of a specific complication, such as epilepsy or intracranial hæmatoma, because there are only two outcomes – either the complication appears or it does not. The probability that traumatic epilepsy will develop can now be calculated accurately on the basis of very few items of clinical data, and patients in the low risk category can be reassured and the others given anticonvulsants (Jennett 1975). It is hoped that the risk of acute intracranial hæmatoma may likewise prove predictable. Preliminary studies indicate that the risk in a fully conscious adult without a skull fracture, even if he has been briefly unconscious, is very small indeed (Galbraith 1973). Under the present system of large scale admission of mild head injuries to hospital, hæmatomas are frequently overlooked for many hours. This may derive from an inability to maintain a high state of vigilance when the complication rate is so low. More selective admission might not only reduce demand on acute surgical beds but might result in more effective management of those who are taken in.

Outcome after severe head injury is more complex and we began studies on predicting this in 1968. We recently described a 5-point outcome scale – death, persistent vegetative state, severe disability, moderate disability and good recovery (Jennett & Bond 1975). In selecting criteria to test for predictive power emphasis has been on clinical features which are likely to be available in all circumstances. In Britain most head injuries are treated in general hospitals and systems which rely on special investigations would have limited application. Observations are made serially and both the best and the worst state of a patient in a series of epochs after injury is recorded; this approach generates a large amount of data and a computer is required for the analysis. However, the ultimate aim is to evolve a simple system which could be applied by any clinician.

Over 500 patients have now been studied in a collaborative investigation between the Institute of Neurological Sciences in Glasgow and the Academic Hospitals in Rotterdam and Groningen. All patients were in coma for at least 6 hours (neither obeying commands nor giving any verbal response); some had been temporarily lucid before the development of persisting coma. Treatment was not standardized but all patients were treated with the techniques and vigour which is normal in a fully equipped unit but controlled ventilation was not used routinely. A close similarity in outcome has been found between successive cohorts of Glasgow cases and between the Glasgow and the Netherlands series.

This investigation has confirmed the prognostic significance of various single features already known to be important – age, pupil reaction, spontaneous eye movements, oculo-cephalic and oculo-vestibular reflexes. Also the depth and duration of coma, which has been rigorously defined and quantified by the use of the Glasgow Coma Scale (Teasdale & Jennett 1974). Within the coma scale the best motor response is itself a powerful predictor throughout the first week after injury. Further computer analysis is required to discover the predictive power of combinations of features; it is hoped that these will enable the outcome of groups of patients with these features to be calculated with some degree of accuracy. However, such an approach will always be limited in its capacity to indicate the likely outcome in an individual patient. Even if analysis shows that only 5% of patients with a certain characteristic will survive, there is no way of knowing whether the patient is in the 5% or the 95%. Therefore, the probability of outcome for individual patients has also been calculated. The Bayesian discriminant method is used, which assumes independence between all features and which compares the data available for a given patient with that from a previous large series of patients in whom the outcome has been recorded (Jennett *et al.* 1975). When this was done for 92 new patients, on the basis of 255 previous patients, it proved possible to predict correctly, on the basis of data available on the first day, all patients who were left dead or vegetative; predictions were correct in 95% of patients whose outcome was moderately disabled or good recovery. Errors of prediction were always towards over-optimism – due to the fact that some patients in the early stages showed potential for recovery before the development of complications. Predictions became more certain when based on information available on the third day, as distinct from that available on the first day; accuracy did not further improve by the end of the first week.

The possibility of reliably predicting a bad outcome could be of considerable value. It makes it possible to test new management regimes in such patients, in order to discover whether they improve the outcome. Unless such a new method is available the consequence of predicting that outcome will be death or vegetative survival might rationally be the withdrawal of active treatment. Certainly there have been many advocates for this philosophy in the medical and lay press in recent years. There is reluctance to accept it in practice because of the uncertainty of prognosis, and one consequence is that intensive care resources, which are restricted and expensive, are often diverted away from patients who are more likely to benefit.

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The following papers were also read:

Sequelæ of Minor Head Injuries

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