Predicting Outcome after Head Injury

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‘No head injury is so serious that it should be despaired of, nor so trivial that it can be ignored.’ This statement concerning the uncertainty that prevails about the likely course of events after head injury is as true today as when Hippocrates wrote it more than 2000 years ago. The uncertainty after mild injuries is different from that after severe damage. After mild injury, the problem is to know the likelihood of complications developing that can transform the case from a trivial to a life-threatening situation; the commonest complications are intracranial haematoma, infection, and epilepsy. After severe injuries the question is whether or not the patient will survive, and if he does, what the likelihood is of persistent disability.

The consequence of this uncertainty is that the management of head injuries depends more on intuition than on logically-based decisions. Thousands of mild injuries are admitted briefly to hospital every year, although the chances of a complication are very small in most of them. With severe injuries an undue proportion of effort is liable to be expended on patients who do not survive or who are left so severely disabled that even members of the victim’s family come to question whether it would not have been better if the patient had died soon after the accident. The price of improved intensive care, which saves the lives of many who would previously have died, is the accumulation in the community of young people with permanent disablement; over a thousand such patients leave British hospitals every year, most of them between the ages of 20 and 30, and half of them never to work again (London, 1967). It is the lack of reliable statistics by which to predict the outcome after severe injury that leaves the doctor feeling that he must treat all patients as though they had potential for recovery, and indeed many patients do make a good recovery. The problem is whether these patients can be recognised soon after injury and maximum effort devoted to their care.

Doctors dealing with patients with head injuries have to make a series of
management decisions; these begin in the hospital emergency room but continue, in the case of the severely injured, for months or years. Early decisions include whether or not to admit mildly injured patients to hospital, to which department the more severely injured should go, and whether or not expensive and elaborate investigations and treatment should be instituted or continued. Later decisions centre on where patients with persisting disability should be cared for and whether or not programmes of rehabilitation should be instituted or continued. While such decisions are common to the whole of medicine they have unusual significance after head injury because the stakes are high, with the ultimate outcome varying from complete recovery to permanent crippling.

If such decisions are to be made on logical grounds they should depend on the clinician’s estimate of the benefit likely to result from alternative courses of action—in Professor Lindley’s terms the clinician should choose that course of action which maximises the expected utility (page 225).

Prognosis is a probability statement that assumes a logical relationship between outcome and certain items of antecedent data. It requires the definition of outcome categories and the identification of items of data that have predictive power. The simplest kind of prediction is concerned with the development of complications after milder injuries. Our studies on the problem of traumatic epilepsy will serve as an example. There are only two outcomes, that this patient develops epilepsy or that he does not. The principle of test reduction has been found to operate and predictions can be based on very few items of data, many factors traditionally believed important having been shown to be either without influence or redundant. Depressed fracture of the skull has always been ‘known’ to be associated with a high incidence of epilepsy. In a series of a thousand cases we discovered that the incidence of epilepsy was 15 per cent; however, according to various combinations of three clinical features this rate could vary from over 60 per cent to less than 5 per cent. The range of risks predicted will vary according to the amount of information available (Fig. 1). This histogram, indicating the risk associated with various combinations of these three factors, is an example of the kind of simple predictive tool that can be put in the doctor’s hand at the end of a fairly extensive and elaborate investigation of this kind. The consequence of this investigation is that patients can be warned or reassured, according to which risk category they fall into, and prophylactic drugs may be given to those in whom the risk is high.

We are currently undertaking a similar study concerned with the prediction of intracranial haematoma in the early stages after mild injury. More than 100,000 patients are admitted to British hospitals every year, between a half and three-quarters of whom are discharged after 24 to 48 hours. One reason
for this is fear of the rapid development of a life-threatening clot. It is already apparent that the risk of haematoma in a considerable and recognisable proportion of these patients is of the order of 1 in 20,000, which suggests that hospitals might admit that number of patients unnecessarily for the sake of one who would develop this complication. If there was an alteration of hospital policy there would be considerable savings of money in the Health Service and of trouble to patients.

Consider now the more complex problem of predicting outcome after severe head injury. Severe head injury is defined as one that causes coma for more than 6 hours, which corresponds to post-traumatic amnesia exceeding 24 hours. Both the number of outcomes and the number of predictive criteria are almost infinite and the most difficult task for the clinician is to reduce these to manageable proportions. In regard to outcome, not only must a limited number of categories be defined but it must be decided at what time after injury assessment should be made, because patients may go on recovering for years. At a later stage it may also be necessary to ascribe a utility to different outcomes. We have evolved a five point outcome scale: death, persistent vegetative state, severely disabled (conscious but dependent), moderately disabled (independent but disabled) and good recovery. It is appropriate to collapse the number of outcomes during the early stages after injury; for example, in the first 24 hours the main issue is whether or not the patient will survive. Only later does it become possible to make more accurate predictions. The next important decision is whether or not the patient will remain vegetative or severely disabled or will make a reasonable recovery. It should be
emphasised that prediction is not a once-and-for-all activity, but one that continues over months in the case of surviving severe injuries. In the later stages it may be important to predict whether or not further recovery is likely to occur, because this may influence decisions about continuing rehabilitation.

Many features might be considered likely to influence outcome, and experienced clinicians usually claim to take account of a wide range of factors when making an intuitive prognostic statement. This is another example of the tendency of clinicians to acquire more information than they can effectively use, much of which is probably redundant. To discover which items have the most predictive power requires analysis of the correlation between each proposed factor and outcome, but the number of factors is so large that some initial choice must be made. Because trauma is no respecter of geography, and injuries will occur in hospitals with varying degrees of sophistication, preference should be given to clinical rather than laboratory data. Among clinical features emphasis should be on those that can be reliably recorded without undue observer error.

Clinicians generally agree that the most important factor in the prediction is the degree of coma ensuing after injury. Several recent studies have indicated that the depth or duration of coma is related to mortality and to the degree of disability in survivors. They have also emphasised that age is important, young patients being able to withstand deeper and more prolonged coma and still retain the capacity to recover well. While such studies can identify some factors that are of prognostic importance, and may also define the limits of recoverability for patients with certain features, they provide no basis for calculating the chances of survival in an individual patient, nor, if he lives, what degree of continuing disability there may be.

A system designed to make such individual predictions depends on analysing a large number of patients with full information about predictive criteria and outcome. The relative predictive power of different clinical features, alone and in combination, can then be calculated and a mathematical means devised for comparing newly occurring cases with the existing data bank in order to predict their likely outcome. Such a study has been in progress in Glasgow since 1968 and, in the last year, in collaboration with the Academic Hospitals in Rotterdam and Groningen in the Netherlands. The study is still at the stage where over 300 indicants are under scrutiny, and attention will be focused here on the preliminary results of relating coma to outcome, because of the importance traditionally ascribed to this feature.

It was first necessary to devise a means for defining coma and recording different levels against time in a way that would be of practical use at the bedside and of statistical value later. For this purpose, the Glasgow Coma Scale
was evolved (Teasdale and Jennett, 1974). Its essence lies in the independent assessment of three aspects of behaviour, motor responses, verbal performance and eye opening (Fig. 2). Various combinations of these responses enable all states, from mild confusion to deep coma, to be described. The various responses have been tested for observer error, not only in special units but in general hospitals and with junior doctors and nurses and with observers for whom English was not their first language. The patient’s progress is plotted on three elements of the coma scale independently, and the best and worst response during a number of time intervals is logged. It is possible to express the level of coma by giving each step in the scale a number, which is high for normal responses and lower for progressively less normal ones. For the moment it is assumed that steps between one level and another are equal, although further evaluation is expected to reveal what relative weight should be ascribed to different intervals in each element of the scale. The sum of the scale at different times can then be used to express the depth of coma. When this is plotted in relation to outcome, depth of coma is found to be in rank order according to outcome (giving the persistent vegetative state a lower level than death). Moreover, the slope of improvement over the first few days is likewise in rank order according to outcome (Fig. 3). When patients in Glasgow were compared with those in the Netherlands a close correspondence was found both between those with low coma scores and those with high coma scores in the first few days (Tables 1, 2). This is in accord with close correspondence between the Scottish and Dutch series in other aspects of this study and is evidence in support of the validity of the method of data collection.
Table 1. Outcome at three months with high total on coma scale

| No. of cases | 24 hours |         | 2–3 days |         |
|--------------|----------|---------|----------|---------|
|              | Glasgow  | Netherlands | Glasgow | Netherlands |
|              | 76       | 8       | 172      | 36      |
| Dead/PVS     | 58%      | 50%     | 34%      | 25%     |
| SD           | 4%       |         | 13%      | 11%     |
| MD           | 17%      | 50%     | 27%      | 31%     |
| GR           | 21%      |         | 26%      | 33%     |

Table 2. Outcome at three months with low total on coma scale

| No. of cases | 24 hours |         | 2–3 days |         |
|--------------|----------|---------|----------|---------|
|              | Glasgow  | Netherlands | Glasgow | Netherlands |
|              | 70       | 48      | 80       | 17      |
| Dead/PVS     | 67%      | 98%     | 80%      | 88%     |
| SD           | 17%      | 2%      | 12%      | 12%     |
| MD           | 11%      |         | 8%       |         |
| GR           | 5%       |         |          |         |
It should be emphasised that many other items of data are being collected and that we must wait further analysis before knowing what weight to ascribe to various factors. It is fair, however, to consider what practical predictive tool might be put in the hands of the clinician at the end of such an investigation as this. It would be possible to define limits of recovery negatively, as has been done previously; that is to say, to indicate that survival, or recovery beyond a certain level, has not been recorded for patients with certain clusters of features. Such predictions can never indicate that a certain degree of recovery will occur, only that it is possible. New complications may develop that adversely affect recovery, even when the degree of brain damage was initially recoverable.

As many patients with head injury go to smaller community hospitals, it is hoped that a simple scoring index may emerge, in which clinical features would be suitably weighted (negatively or positively) so that the sum would indicate the probability of different outcomes. This would probably be less accurate than a system that involved the use of a formal program and the type of desktop computer that many large hospitals now possess. Still more accurate would be on-line facilities to allow continuing interaction between the data on the present patient and the existing data bank.

Clinicians should be assured that the provision of such information is intended to assist them only in their assessment of their patients, and in reaching decisions about management. Certainly with a condition of the complexity of severe head injury it is likely that there will always be a number of patients in whom the system will indicate continuing uncertainty about outcome; the success of the system will be judged by how small a number of patients remain in that ambiguous category.

Once it is possible to predict the outcome after severe head injury a whole new set of decisions will be possible. Some of these will involve ethical judgments, and discussion about them must go beyond doctors. It is not uncommon to have pleas both from the laity and the profession that we should avoid producing hopelessly crippled survivors after head injury and other forms of acute brain damage. Such arguments remain academic until reliable predictions can be made.

References
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