HEAD INJURIES IN CHILDREN

OBSERVATIONS ON THEIR INCIDENCE AND CAUSES WITH AN ENQUIRY INTO THE VALUE OF ROUTINE SKULL X-RAYS

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A blow on the head, especially if followed by symptoms of concussion, causes anxiety which is born of the knowledge that injury to the brain and other serious complications may occur. A child who attends hospital on account of a head injury is usually admitted for observation for signs of these complications and it is a common practice to x-ray his skull in order to find out whether it has been fractured. The primary object of the present investigation was to determine whether a routine skull x-ray of a child with a recent head injury gives information which helps the doctor either to give a prognosis or to decide on the treatment of his patient. The additional objects of the survey were to assemble information about the age, sex incidence, and causes of head injuries in children.

With these objects in mind I looked through the notes of all the children up to 13 years of age who had been admitted with head injuries into a general hospital in London during the years 1951 to 1956 inclusive. The relevant information was collected from the notes and has been analysed and tabulated. The parents of each patient were then sent a letter requesting their help and were invited to supply the answers to questions relating to the history of the child after discharge from hospital. The answers were scrutinized and the information so provided has been analysed and tabulated.

Criteria

A case was included in the survey if there was a history of a blow on the head and the child showed either some external evidence of the injury (laceration, haematoma or abrasion) or had had symptoms suggesting concussion (disturbance of consciousness or memory, drowsiness). Cases were not included where it was clear from the history and appearance of the wound that the injury was merely a simple incised wound and there were no symptoms of

concussion. Wounds of the face and eyes only with no symptoms of concussion were also excluded. Some patients had other injuries in addition to the head injury but they were not included unless the head injury satisfied the above criteria.

Classification

The cases were classified according to the severity of the concussion into the following three groups:

Group 1. Slight concussion. Injury to the head with no disturbance of consciousness or memory.

Group 2. Moderate concussion. Injury to the head with any of the following symptoms: Irritability, amnesia or drowsiness, with or without initial loss of consciousness or inaccessibility of less than one hour's duration or, loss of consciousness of less than one hour's duration without other symptoms.

Group 3. Severe concussion. Injury to the head with unconsciousness or inaccessibility for one hour or longer.

Owing to the lack of precise information in the notes about the accident it was necessary in a few instances to make a somewhat arbitrary decision as to the correct classification of the case, and this inevitable weakness of a retrospective survey from case notes must be borne in mind.

Criteria for Admission

Admission of cases to hospital depends upon the assessment of the admitting doctor. Over this period of six years when many different doctors were concerned, each one with his own views and judgment, it is unlikely that there has been true

uniformity of the criteria for admission into the hospital. Furthermore, it is possible that in London some cases of head injury may have been admitted to other hospitals. This would be most likely in the case of very severe injuries obviously in need of neurosurgical treatment. Such cases cannot be dealt with at St. James's Hospital and would very probably be admitted direct to a neurosurgical unit. For these reasons, therefore, the series under review cannot be taken to represent the whole picture of children with head injuries in this part of London and must be regarded merely as a series of 238 children with head injuries who were considered suitable for admission to a general hospital. The facts disclosed by this survey must therefore be interpreted accordingly. The series consists of 238 children, 182 boys and 56 girls. This gives a ratio of 3.25 boys to 1 girl.

Age and Sex Incidence

The figure shows the incidence by age and sex. The maximum incidence for both sexes is between the ages of 8 and 9 years (26 boys and eight girls) with secondary peaks in boys at 12 to 13 years (25 cases) and 4 to 5 years (15 cases) and in girls at 5 to 6 (6 cases) and 11 to 12 (7 cases). Table 1 shows the causes of the head injuries in numerical order of frequency in the boys and girls. The ratio of boys to girls injured by each cause is also shown.

Traffic Accidents (60 boys : 18 girls). These include collision with road vehicles of all kinds, including bicycles and cases where the child was in a vehicle which was involved in an accident. They do not include falls from vehicles—notably bicycles when the bicycle or other vehicle itself was

TABLE 1

Cause of Head Injury	Boys	Girls	Ratio	
			Boys	Girls
Traffic accidents	60	18	3.3	1
Miscellaneous falls	42	19	2.2	1
Fall from height	29	7	4.1	1
Fall off bicycle	20	2	10	1
Hit by moving object	10	3	3.3	1
Fall off moving vehicle	10	0	10	0
Fall down stairs	5	2	2.5	1
Fall off swing	1	3	0.3	1
Fall out of bed	2	0	2	0
Fall in bus	0	1	0	1
Assault	0	1	0	1
Cause uncertain	3	0	3.0	0
Overall ratio { Boys 3.25 Girls 1.0	Total .. 182	56	3.25	1

not involved in a collision. Thus if a boy simply falls off his bicycle the injury is classified as 'fall from bicycle' but if he runs into another bicycle or a car it is a 'traffic accident'.

Miscellaneous Falls (42 boys : 19 girls). These include all falls when the child was on the ground or, in the case of a few infants, was being carried and the carrier either fell herself or dropped him. Most of these occurred while at play, and frequently occurred in the school playground.

Falls from Height (29 boys : 7 girls). These include injuries when the child fell to the ground from something above the ground—e.g. out of windows, off walls, trees, tables or ladders.

Falls off Bicycle (20 boys : 2 girls). These falls were much commoner in boys.

Hit by Moving Object (10 boys : 3 girls). This category includes all injuries caused by impact with a moving object other than a vehicle, such as

TABLE 2
CASES CLASSIFIED ACCORDING TO SEVERITY SHOWING PRESENCE OR ABSENCE OF FRACTURE

	Total Cases	Total	No Fracture % of X-rayed Cases	Total	Fracture Present % of X-rayed Cases	Total X-rayed	Not X-rayed
Severe	17	8	50	8	50	16	1
Moderate	135	96	80	23	20	119	16
Slight	86	52	78	15	22	67	19
Total cases ..	238	156		46		202	36

stones, bricks, falling ladders. The other causes listed in the table do not need further explanation or comment.

Fracture of the Skull in Relation to Severity of Concussion

In Table 2 the cases have been arranged to show the numerical relation between the severity of the concussion and the presence or absence of a fracture of the skull. It will be seen that out of x-rayed cases with severe injury 50% had a fracture of the skull; of x-rayed moderately concussed cases 20% had a fracture; and of those with slight concussion 22% had fractures. A proportion of cases in each category did not have an x-ray of their skull, so that they cannot be included in this particular analysis.

Site of Injury. Table 3 shows the site of the injury to the head in order of frequency and occurrence. It will be seen that right-sided injuries are commoner than left but that the majority of injuries involve the midline and both sides of the head adjacent thereto.

Cases with Complications. When localizing signs were present at the time of the initial clinical assessment, or if the patient's condition deteriorated,

TABLE 3
SITE OF INJURY

	Right	Left	Midline with involvement of both sides	Total
Frontal	23	13	28	64
Occipital	3	4	21	28
Parietal	18	7	2	27
No external signs of injury ..				26
Facial	4	2	17	23
Uncertain			0	21
Temporal	8	11		19
Injuries at two sites ..				13
Injury at one site; fracture at another				11
Bleeding from nose only ..	2	1	0	3
Bleeding from ear only ..	2	1	0	3
	60	39	68	238

or some new symptom or sign made its appearance, the case was considered to have been attended by a complication. Thus, for instance, if some hours after the injury a patient who was conscious, complained of a headache and had hitherto not done so, the headache was regarded as a complication of the injury. If, on the other hand, the patient had complained of a headache as soon after the injury as he was able to express himself, that would not be classed as a complication.

Table 4 shows the cases with complications as

TABLE 4
CASES WITH COMPLICATIONS SHOWING SEVERITY, PRESENCE OF FRACTURE AND SEQUELAE

Case No.	Severity	Fracture	Nature of Complications	Sequelae	Nature of Sequelae
22	Severe	+	Unconscious 18 days; blindness; dementia	+	Dementia; blindness
33	Moderate	+	Meningitis	+	Headaches frequent→occasional
73	Slight	○	Headache	+	Occasional headache
76	Moderate	+	Headache	+	Occasional headache
91	Severe	+	Subarachnoid haemorrhage	○	
96	Slight	○	Headache	+	Occasional headache
99	Slight	+	Headache; vomiting	○	
102	Moderate	○	Diplopia for 5 days	*NR	?
124	Moderate	○	Headache; depression	+	Nerves; occasional headache
140	Severe	+	Lt. hemiparesis; 2 major fits; giddy spells; ocular palsy; attended special school for 10 months	*NR	(Last seen 10 months after injury; well; no fits; no paresis)
142	Severe	+	Died	—	
154	Moderate	○	Headache	†NT	
193	Moderate	○	Headache	○	
207	Severe	○	Weakness of rt. arm 2 weeks	+	School work worse
215	Moderate	○	Headache	+	Aggressive; headaches frequent→occasional
217	Slight	+	Large occipital subaponeurotic haematoma	○	
235	Moderate	+	Rt. facial weakness 3 weeks	+	Headaches frequent→occasional

* NR = No reply.

† NT = Not traced.

defined above. The severity of the concussion and the presence or absence of a fracture of the skull are shown in each case.

Table 4a shows the relationship between the

TABLE 4A
CASES WITH COMPLICATIONS ACCORDING TO SEVERITY
AND PRESENCE OF FRACTURE

Severity	Number	% of Total in Each Category	With Fracture	No Fracture
Severe ..	5	29	4	1
Moderate ..	8	5	3	5
Slight ..	4	4	2	2
Totals ..	17		9 (19%)	8 (5%)

severity of the concussion and the presence or absence of a fracture in these cases with complications. It will be seen that nearly half (8/17) of these patients had no fracture of the skull and that just over half (9/17) did have a fracture. The figures in brackets show the percentage of cases in the three categories of severity which were attended by complications. Of severe injuries 29% were followed by complications; the rate with moderate injuries was 5% and with slight injuries 4%. Table 4a also shows the number of cases in each grade of severity in which a fracture was found. Four out of five severe cases with complication had a fracture; three out of eight moderate cases had a fracture and two out of four of the slight cases had a fracture.

Follow-up

Further information is available about 135 of the original 238 cases. This number includes the one

patient who died shortly after the injury (Case 142) and the one with dementia and amaurosis (Case 22), who is in a home. Information about the remaining 133 cases is derived from answers to a questionnaire which was sent to the mothers of all the patients in the original series. The minimum period between the original injury and the date of the reply was one whole year and the maximum period was six whole years.

Sequelae. The symptoms and untoward effects under consideration were regarded as sequelae if they occurred after return home from hospital and they had not been present before the injury occurred.

Tables 5 and 6 show the incidence of various sequelae about which information was specifically sought. In Table 5 the cases are grouped according to the presence or absence of a fracture of the skull, and in Table 6 the grouping is according to the severity of the concussion. It will be seen from these two tables that of cases with fractures 66% had sequelae and of those with no fracture 49.5% had sequelae. Of cases classed as severe (including the one who died), 61.5% had sequelae; of cases classed as 'moderate', 51.5% had sequelae and of cases classed as 'slight' 52% had sequelae.

With the single exception of the one child who is permanently demented and blind, there is no surviving child in the follow-up series who is suffering from sequelae which would be noticeable to anyone who did not know the child before the accident, and the majority of symptoms complained of in the answers might readily be explained away as coming within the range of normality.

TABLE 5
CASES WITH SEQUELAE ARRANGED ACCORDING TO PRESENCE OR ABSENCE OF FRACTURE (PERCENTAGES TO NEAREST ½%)

Nature of Sequela	Fracture +	% of Total Cases with Fracture	No Fracture	% of Total Cases without Fracture	Not X-rayed	% of Total Cases not X-rayed	Total Cases
Fits ..	0	0	1	<1	0	0	1
Personality change ..	8	29.5	19	21	3	17.5	30
Better ..	0	0	10	11	1	6	11
School work ..	3	11	10	11	2	12	15
Worse ..	1	3	2	2	0	0	3
Ataxia, etc. ..	1	3	0	0	0	0	1
Blindness ..	5	18	14	15.5	4	24	23
Occasional ..							
Headaches ..	4	15	3	3	2	12	9
Frequent ..							
Frequent→occasional ..	4	15	5	5.5	1	6	10
Died ..	1	3	0	0	0	0	1
Compensation paid ..	2	7.5	6	6.5	2	12	10
No sequelae ..	9	33	46	50.5	9	53	64
With sequelae ..	17	66	45	49.5	8	47	70
Total cases ..	27		91		17		

TABLE 6

CASES WITH SEQUELAE ARRANGED ACCORDING TO SEVERITY OF CONCUSSION (PERCENTAGES TO NEAREST ½%)

Nature of Sequela	Slight Injury	% of Total Cases with Slight Injury	Moderate Injury	% of Total Cases with Moderate Injury	Severe Injury	% of Total Cases with Severe Injury	Total Cases
Fits	0	0	1	<1	0	0	1
Personality change	13	25	13	18.5	4	30	30
Better	6	11	4	6	1	7.5	11
School work							
Worse	3	5.5	7	10	5	38	15
Ataxia, etc.	1	2	1	2	1	7.5	3
Blindness	0	0	0	0	1	7.5	1
Occasional	7	13	15	21	1	7.5	23
Headaches							
Frequent	4	7.5	3	4	2	15	9
Frequent→Occasional	3	5.5	7	10	0	0	10
Died	0	0	0	0	1	7.5	1
Compensation paid	7	13	2	3	1	7.5	10
No sequelae	25	48	34	48.5	5	38	64
With sequelae	27	52	36	51.5	7	54	70
Total cases	52		70		13		

Fits. Personality changes were reported in 30 (22%) of the cases in the follow-up series. Table 7

TABLE 7

THE 30 CASES WITH CHANGE OF PERSONALITY

Description	No.
Nervous or highly strung	14
Outbursts of anger and bad temper	6
Sleep difficulties	4
'Phobias' (ladders: heights)	2
Depression	2
Faints	1
'More careful now'	1
Nervous stomach aches	1
Laziness	1
Stuttering	1
Aggressive	1

shows the changes of personality described by those who replied to the questionnaire. In none of the above cases was the change of personality very pronounced and it is, of course, impossible to say whether the change was the result of the injury or of other causes. The only evidence that the injury contributed to these changes is that, according to the parents, they made their appearance shortly after the injuries had been sustained.

School Work. In 11 cases (8%) the parents reported an improvement in school work dating from the return to school after the injury. In 15 (11%) there was a deterioration. The only case who could not receive normal education was Case 22 who is in an institution for mentally defective children and who is also blind as a result of the accident. The parents of some children could not judge the change in intellectual status because they were too young at the time of the accident to attend school. In all cases the change in school work was

not very great and in all there was a steady improvement up to the time of the receipt of the questionnaire, the majority of cases having completely regained their previous status.

Ataxia. Parents were questioned specifically about muscular paralysis or weakness and none of the parents who replied to the questions would admit to muscular paralysis in their children, but one child was stated to have lost her sense of balance, one was stated to be more clumsy after the accident, and one to have 'weakness' with no further amplification of the term. The blind child (Case 22) had cortical blindness.

Headaches. Forty-two children (31%) of the follow-up series were reported as having had headaches which dated from the head injury. They have been grouped according to whether the headaches were stated by the parents to be 'frequent' or 'occasional'. No great reliance must be placed upon this classification because no definition of these terms was suggested to the parents, so that the numbers included under these headings are not properly comparable. A third heading is assigned to cases whose headaches were stated to have been frequent at first but which had become only occasional by the time the questionnaire was received. As with the school work and personality change none of these children was seriously handicapped by the headaches, and it is easy to argue that they might well be no more frequent or severe than the headaches felt by any child from time to time.

Compensation. The parents had been asked whether compensation for the injury had been sought

TABLE 8
CASES IN WHOM COMPENSATION WAS PAID

Case No.	Cause of Injury	Severity	Skull Fracture	Other Injuries	Sequelae
36	Fell off swing	Moderate	○	○	Headaches frequent
71	Traffic accident	Slight	○	Leg injury	Nerves; insomnia
82	Traffic accident	Moderate	○	○	Photophobia; nerves; temper; sleep difficulty; headaches
87	Fell off bus	Slight	○	○	○
95	Traffic accident	Slight	+	Abrasions	Nerves; afraid of heights; school work worse
106	Traffic accident	Slight	○ ×	Abrasions	Nerves; frequent headaches
121	Hit by ladder	Slight	+	○	Frequent headaches
165	Traffic accident	Slight	○ ×	Abrasions	○
207	Traffic accident	Severe	○	Abrasions	School work worse
221	Traffic accident	Slight	○	Leg	Occasional headaches

○ × = Not x-rayed.

or received. The object of this was to provide evidence about the frequency of litigation in these cases and also to determine what relation existed between the litigation and the incidence of sequelae. In 10 (7·4%) cases compensation had been paid. Information about these cases is set out in Table 8. In seven out of the 10 patients receiving compensation the head injury had been assessed as 'slight', for two the assessment was 'moderate' and one 'severe'. In six cases there was no fracture of the skull, in two a fracture was present and one was not x-rayed. In one case the compensation was admitted by the parents to have been paid on account of a leg injury sustained at the same time. In seven of the compensated cases the injury was sustained in a traffic accident, one fell off a swing in a public playground, one fell off a moving bus, and one was hit by a falling builder's ladder.

Depressed Fracture. Table 9 shows the four cases in which a diagnosis of depressed fracture was made, either clinically or radiologically. In one case a depressed fracture was missed clinically, and in one it was suspected clinically but not confirmed radiologically. In one case, in spite of the assessment of the injury as 'slight', the patient's depressed fracture was surgically elevated, and the patient had no complication or sequelae. In the patient whose injury was compound and obviously very severe, brain toilet was carried out but the patient died without recovering consciousness. In the remaining

two, treatment was conservative, and of these two patients one had 'frequent-becoming-occasional' headaches as a sequela.

Discussion

Sex Incidence. That boys injure their heads more often than girls is a fact which will not surprise those who are familiar with the ways of children. 'Boys will be boys' is a proverbial truth which must be remembered when planning a programme of investigation into the causes of accidents in children or when preparing any scheme for preventing their occurrence. The restless exploration and aggressiveness of the male are biologically useful to the species in many obvious ways and the tendency of boys to behave as if they were expendable is to the more sedate and careful behaviour of girls, as the reckless mobility of the spermatozoon is to the more sedentary and egocentric habits of the ovum.

Age Incidence. The two age peaks of head injuries shown in the figure provide scope for speculation as to their significance. They are capable of being interpreted as reflecting, in the first peak a phase of development when the child's co-ordination is unequal to his demands upon it, and in the later peak, the intense preoccupation with his activities which makes a boy so heedless of danger.

Cause of Injury. As might be expected traffic accidents accounted for about 33% of the injuries

TABLE 9
CASES WITH DEPRESSED FRACTURE

Case No.	Site of Fracture	Diagnosis		Severity	Treatment	Complications	Sequelae
		Clinical	X-ray				
76	Rt. frontal	○	+	Moderate	Nil	Headache	Occasional headache
92	Rt. parietal	+	+	Slight	Elevation	○	○
102	Lt. frontal	?	○	Slight	Nil	○	○
142	Rt. temporal	+	+	Severe	Brain toilet	Died	—

to both sexes. The only cause which affected girls more often than boys was 'falls off swing', 'fall in bus' and 'assault'. It is perhaps important to know that boys are more liable to be injured by most of the listed causes and not only by traffic accidents, because the chances of a boy being partly responsible for his injury in a traffic accident would appear to be greater than is the case with a girl.

Other Aetiological Factors. Because of lack of the necessary data in the notes it was not possible to go into several other possible aetiological factors which might have been interesting. Among these are the time of the day, the month of the year, the state of the weather, the number in the family, the economic status of the family, the psychological set-up in the home and the emotional or physical state of the child at the time. In planning a future investigation these things might profitably be taken into account.

The Value of Diagnosing a Fractured Skull. The primary object of this investigation was to assess the value, if any, of x-raying the skull in children with head injuries. An x-ray of the skull might possibly be of value if it provided affirmative answers to three questions: (1) Does the finding of a fracture of the skull in the x-ray make necessary any change in the treatment of the case? (2) Does the finding of a fracture of the skull in the x-ray afford more reliable guidance than clinical assessment alone as to the probability of complications? (3) Does the finding of a fracture of the skull in the x-ray afford more reliable guidance than clinical assessment alone as to the probability of sequelae?

With regard to Question 1 relating to immediate treatment, all the cases in this series had been admitted to hospital on account of injuries and all were kept at rest and under close observation. This line of treatment is generally accepted as correct for all cases of head injury and no one would dispute the wisdom of it. If it could be shown that the absence of a fracture of the skull made admission unnecessary, that in itself would fully justify the taking of an x-ray. That such criterion for admission is invalid is shown by Table 4 where it will be seen that of the 17 cases who developed complications nine had a fracture and eight had none.

The Closed Depressed Fracture. Apart from rest and close observation and symptomatic treatment all but two of the cases had no other treatment. The two who were treated surgically both had depressed fractures. One (Case No. 142)

was very severely injured and died after brain toilet in another hospital. The gross and obvious damage to the skull was the indication for this treatment rather than the finding of a depressed fracture, an x-ray finding which merely supported the clinical decision to operate. The second case (No. 92) of depressed fracture had his fracture elevated in accordance with surgical tradition. As has already been pointed out, this child's injury according to the criteria adopted in this investigation was classified as 'slight'. This boy had no untoward symptoms at the time or afterwards. On the other hand one of the four cases with depressed fracture (No. 26) had no surgical treatment and still does complain of occasional headaches. This child's fracture had not been diagnosed clinically. Might he have been saved from these headaches if his depressed fracture had been elevated? If the answer to that question is in the affirmative there can be said to be a case for x-raying all skulls in order to detect missed depressed fractures.

In one case (No. 120) a depressed fracture had been suspected clinically but was not confirmed radiologically. The information about depressed fractures to be had from this investigation is insufficient to justify any conclusion and the writer's experience of the management of such cases is also too meagre for him to venture an opinion. There is wide agreement among leading authorities that operation is advisable for closed depressed fractures of severe degree but for depressed fractures of lesser extent, just the kind that might most easily be missed without an x-ray, a number of authors advise conservative treatment. Dickson Wright and Handfield-Jones (1957) write: 'Simple depressed fractures in children should not be operated upon at first because a great many recover spontaneously. If later elevation of the fragment is deemed necessary all bruising of the soft tissues will have subsided and the danger of infection is thereby lessened'. Browder (1949) writes: 'Instances in which the extent of the depression of the inner table is estimated to be only a few millimetres require only conservative measures unless there is evidence of intracranial complication'. Aird (1957) writes: 'Certain depressed fractures require operation. Most depressed fractures in adults are compound and require operation for that reason; pond fractures in children do not *per se* require operation'.

Wakeley (1952) states: 'In closed depressed fractures in adults always operate; in children if gutter shaped operate; if pond shaped wait for symptoms unless the fracture is a bad one'.

Rowbotham (1949) gives four indications for operating on a closed depressed fracture. (1) When

a patient is unconscious and thought to be suffering from cerebral compression. (2) When there are signs of underlying brain damage. (3) When a fragment of bone is thought to have penetrated the dura. (4) Cosmetic considerations. *Christopher's Textbook of Surgery* (1956) states, 'the majority of patients with simple depressions should be operated on except those having slight depression in the frontal area and small simple depression in the midline and the large venous sinuses'. Bailey and Love (1956) state, 'treatment depends on the extent of the depression and the site of the injury'.

After considering the views expressed by the authorities quoted above one must concede that where there is a clinical suspicion that a depressed fracture may exist it is advisable to x-ray the skull in order to settle the matter. But in a large number of cases which are being discussed the clinical findings were such that even if a depressed fracture were present it would only be a slight 'pond' fracture, of the type that would merely require conservative treatment. It does not seem, therefore, to be necessary to x-ray the skull immediately merely to detect a slight depressed fracture. It should be quite safe to confine x-rays to those cases where there was clinical suspicion of a depression or where surgical intervention was clearly indicated on account of a deterioration in the patient's condition.

The Non-Depressed Fracture. After leaving the troubled waters of the depressed fracture question, one encounters much plainer sailing, and it is beyond dispute that treatment of children with head injuries is exactly the same whether a fracture is demonstrated by the x-ray or not. The chief function of the skull is to protect the brain from damage and this it does remarkably well, though in absorbing the force of a blow, the bone often sustains a fracture. It is a matter of physics that the harder the blow the greater will be the chance of a fracture, but Table 2 shows that, whereas, among severe cases, as defined in this paper, there is a 50/50 chance of the skull having been fractured, the chance of a fracture in cases of moderate or slight severity is approximately the same, namely around 20%.

Question 2 relating to the likelihood of complications can be answered by study of Tables 4 and 4a. These tables show that of the 17 cases which were attended by complications five were severe, eight were moderate and four were slight. Nine had fractures and eight had no fracture and in none of these cases was an x-ray of the skull omitted. Table 4a shows that 29% of severe cases and less

than 10% of the moderate and the slight cases were attended by complications. This table also shows that 19.5% of cases with fractures and 5% of those without fractures were attended by complications. If the incidence of complications in the severe cases is compared with the incidence of complications in the combined slight and moderate cases, the percentages are found to be 29% and 5% respectively. The occurrence of complications can be substantially as accurately forecast, therefore, if judged according to the clinical assessment as according to the presence or absence of a fracture.

The conclusion with regard to Question 2, therefore, is that a skull x-ray is a no better means of foretelling the occurrence of complications to head injury than the clinical assessment of the case alone.

With regard to Question 3, if the cases with sequelae are arranged according to whether a fracture was present or absent, as in Table 5, and then according to severity as in Table 6, a comparison between the two tables will throw some light on the prognostic value of the two methods of classification in regard to the incidence of sequelae.

The three sequelae which occurred in sufficient numbers to merit comparison, are 'Personality Change', 'Changes in School Work' and 'Head-aches'. These sequelae were all slight and did not really cause any material disability. Indeed in most cases it would be hard to refute the allegation that the sequelae reported by the parents were in fact quite unrelated to the head injury and were chance occurrences such as might befall any child. It is important to bear in mind that the writer is not attempting to convey the impression that the figures quoted are an accurate numerical account of the incidence of sequelae of head injury. To do this would require a proper control series consisting of children of similar ages who had been in hospital for similar periods of time on account of some disease such as appendicitis. Nevertheless the cases can be used as their own controls to test the relative merits of classification by x-ray and by severity as a means of assessing the likelihood of occurrence of sequelae.

Personality Change. When the cases are arranged according to the presence or absence of a fracture, Table 6 shows that a personality change occurred in 29.5% of cases with fractures and in 21% of cases with no fracture. When classified according to severity, the results are as follows: Severe 30%, moderate 18.5% and slight 25%. If slight and moderate cases are combined, the percentages are: Severe 30%, slight or moderate 21%.

School Work. It was surprising to receive so many replies to the effect that school work had, in the opinion of the parent, actually improved after the injury, but this must be accepted with considerable reserve as to its significance and certainly should not be construed as a possible line of treatment for the mentally sluggish. If the cases showing an improvement are arranged in the same way as was done for cases with a change in personality the results are as follows:

Fracture present ..	0.0%	
No fracture ..	11.0%	
Severe ..	7.5%	
Moderate ..	6.0%	} Combined 8%
Slight ..	11.0%	

A greater incidence in the slightly injured cases is what might be expected.

The corresponding figures for cases where school work deteriorated are:

Fracture present ..	11.0%	
No fracture ..	11.0%	
Severe ..	38.0%	
Moderate ..	10.0%	} Combined 8%
Slight ..	5.5%	

Headaches. With regard to headaches the figures are as follows:

(a) *Occasional headache*

Fracture present ..	18.0%	
No fracture ..	15.5%	
Severe ..	7.5%	
Moderate ..	21.0%	} Combined 18%
Slight ..	13.0%	

(b) *Frequent headache*

Fracture present ..	15.0%	
No fracture ..	3.0%	
Severe ..	15.0%	
Moderate ..	4.0%	} Combined 5%
Slight ..	7.5%	

(c) *Frequent headaches becoming occasional*

Fracture present ..	15.0%	
No fracture ..	5.5%	
Severe ..	0.0	
Moderate ..	10.0%	} Combined 8%
Slight ..	5.5%	

The figures as set out above show that with the possible exception of 'occasional headaches' the incidence sequelae of these cases is as well correlated with the severity of the injury as with the presence or absence of a fracture. It is therefore possible to conclude that an x-ray of the skull is no more reliable as a guide to assessing the likelihood of sequelae than the clinical assessment of the case alone.

Conclusion

The facts and figures here presented, though perhaps not statistically conclusive, suggest that apart from the possibility of diagnosing a depressed fracture the routine taking of a skull x-ray in cases of children with head injury serves no useful purpose. It does not help the doctor in his immediate treatment of the case and it is no more reliable than clinical assessment alone as a guide to the likelihood of complications or of sequelae. When a limb bone is fractured the most important consideration is the restoration of the limb's function, which is movement. The limb bones serve as an attachment for the muscles and provide the levers whereby movement of the limb is brought about. When a limb bone is broken abnormal movement may occur at the point of fracture and, if the fragments of the broken bone are not properly aligned, there may be a permanent impairment of the efficiency of the limb. It is therefore important when limb bones are fractured to use x-rays in order to help to bring about as perfect a realignment of the bones as possible. The skull bones, however, are not mainly concerned with the function of movement, and they are so arranged that they are very well splinted by each other and by the overlying aponeuroses and other structures. Their outstanding function is that of a protective armour and as such are designed to be bent and battered to a considerable degree without losing their protective function. There is, therefore, no clinical need to know in every case the precise extent to which the bones have been broken and battered and it is this difference coupled with the knowledge suggested by this investigation which justifies the doctor in omitting to take a routine x-ray of the skull after a head injury and to reserve this investigation for cases for whom it is considered on clinical grounds to be necessary.

The indications for an immediate skull x-ray in children with head injuries appear to be as follows:

- (1) In order to obtain evidence that the head has been struck in cases where the suspicion exists but where no external signs of damage to the head can be found.
- (2) In order to confirm a clinical suspicion of depressed fracture.
- (3) In order to define the extent of damage to the bones in cases where immediate surgical treatment is contemplated.

Many doctors continue, as a routine, to x-ray the skulls of their patients with head injuries although they are by no means convinced of the value of doing so. If asked why they do so they will reply that they do it to provide themselves with 'medico-

legal cover'. Lawyers do not know much about medical practice but they rightly expect a doctor to have acted in accordance with accepted medical practice. If, therefore, doctors always take skull x-rays merely to satisfy the lawyers, one can hardly blame the lawyers for expecting them to continue to do so. It is the doctors' duty to teach the lawyers that when treating a child with a head injury an x-ray of the skull is not always an essential item in the correct management of the case. It is only after they have been taught this lesson that the lawyers will cease to expect a skull x-ray on all occasions.

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