Outcome in children who nearly drown: a British Isles study

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Abstract

Objective—To determine the outcome in nearly drowned children in the British Isles and identify factors that might predict a poor prognosis.

Design—Study of drowned and of nearly drowned children aged ≤ 14 . Information on nearly drowned children admitted to hospital obtained from consultant paediatricians returning monthly notification cards through the British Paediatric Surveillance Unit. Information on drowned children obtained from Office of Population Censuses and Surveys and other national epidemiological offices.

Setting—British Isles, 1988 and 1989.

Subjects—330 children who had confirmed submersion incidents. 142 died before admission to hospital and 188 children were admitted after nearly drowning.

Main outcome measures—Death, full recovery, or degree of handicap after near drowning and signs on admission to hospital.

Results—All of the children who were conscious on admission fully recovered. Of the 64 children unconscious on admission, 31 had normally reactive pupils and all but three (all of whom had severe pre-existing neurological disease) recovered fully. Of the 33 children with fixed dilated pupils on admission, 10 fully recovered, 13 died, and 10 had severe neurological deficit. Spontaneous respiratory effect on admission was associated with normal survival. Pupils that remained dilated six hours after admission and fits continuing 24 hours after admission predicted a poor outcome.

Conclusion—Children can survive normally after near drowning in the British Isles, particularly if they have been hypothermic. Resuscitation should not be abandoned in nearly drowned children until they have been rewarmed.

Introduction

Drowning is the third most common cause of death by accident in children in the United Kingdom after road traffic accidents and burns.¹ Death rates from drowning are as high as 1 in 8000 among boys aged 2-3 in Los Angeles county.² Unlike most accidents near drowning is a rare cause of hospital presentation, and individual paediatricians see few cases. There have been few studies of drowning and near drowning in children in the United Kingdom. Information has come mainly from researchers in the more water oriented societies of Australia, the United States, and Canada.^{3,6}

There is controversy about the incidence of severe neurological deficit after near drowning. Peterson in California identified a 20% incidence of severe neurological deficit after submersion in children admitted to hospital unconscious.³ This compares with rates of severe handicap of 5% in Brisbane⁷ and 0% in Hawaii.⁵ There is also controversy about the factors on admission that might predict the outcome in the nearly drowned

child. Three studies from the United States have found that patients who were unconscious on admission and had fixed dilated pupils either died or had permanent brain damage.^{3,7,8} In contrast Orłowski reported a good outcome after prolonged immersion in very cold water in children who had fixed dilated pupils on admission.⁹

We conducted an integrated study of drowning and near drowning of children in the British Isles for the years 1988-9. We examined the outcome in nearly drowned children, the incidence of neurological deficit in survivors, and the factors on presentation that might predict outcome.

Subjects and methods

We studied children aged 14 or less from the United Kingdom and the Republic of Ireland who had drowned or nearly drowned during 1 January 1988 to 31 December 1989. Cases of near drowning were notified through the British Paediatric Surveillance Unit inquiry system, to which consultant paediatricians throughout the British Isles return monthly notification cards for a series of rare conditions. Details of each case were obtained from a questionnaire completed by the admitting paediatrician and from retrospective analysis of hospital case records.

Deaths from drowning were ascertained from the Royal Society for the Prevention of Accidents' press cutting survey on a quarterly basis, the final statistics were received from the Office of Population Censuses and Surveys for England and Wales, the Scottish Government Record Office, the Northern Ireland Office, and Irish Republic Statistical Office. Case details were extracted from coroners' reports.

Near drowning is used to describe children who were admitted to hospital and survived, at least temporarily, after asphyxia due to submersion in water,¹⁰ excluding children who received unsuccessful cardiopulmonary resuscitation in the accident and emergency department or who were discharged from the accident department after minor immersion incidents. A serious immersion accident^{4,5} is one in which a child loses consciousness in the water and is subsequently admitted to hospital. Drowning is used only for children who died of suffocation by submersion in water.¹⁰

Results

In the two years submersion incidents were notified and confirmed for 330 children. The table shows the outcome in these children. There were 142 cases of drowning; children in these cases died at the site of the accident or were certified dead before admission to hospital. One hundred and eighty eight children met our criteria for near drowning, of whom 146 had serious immersion incidents. One hundred and twenty five of these children received resuscitation at the scene of the accident adequate enough to be conscious on admission. All of these children, together with the 42

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	No of children		
	Died	Handicapped	Fully recovered
<i>Type of accident</i>			
Drowning deaths	142		
Minor immersion			42
Serious immersion	16	10	120
<i>Signs on admission after serious immersion</i>			
Conscious			82
Impaired consciousness:			
Normal pupils	3		28
Fixed dilated pupils, respiratory effort			5
Fixed dilated pupils, no respiratory effort	13	10	5

who had minor immersion incidents, fully recovered.

Most of the accidents analysed were in fresh water. Only 24 were in salt water, and 12 of these children died before admission, four had minor immersion incidents, and four were unconscious on admission (all of whom died). These numbers were insufficient for any comparative analysis of salt and fresh water drowning.

CHILDREN UNCONSCIOUS ON ADMISSION

Sixty four children had an impaired level of consciousness on admission. Of these, 31 had normally reactive pupils on admission. All had spontaneous respiration and blunted consciousness (Glasgow coma score 6-10). All but three of the children made a full recovery, two who died had severe cerebral palsy, the other had poorly controlled epilepsy; all died from secondary complications of drowning.

Thirty three of the unconscious children had fixed dilated pupils on admission. They were all deeply unconscious with a Glasgow coma score of 3-5. Ten children made a full recovery, five of whom had some spontaneous respiration on admission. Of the other 23 patients, 13 died and 10 sustained severe neurological deficit.

An example of a child who made a full recovery was a girl aged 7 months who was admitted after an estimated 60 minute immersion in a cold bath. She was not resuscitated at the accident site. On admission she was unconscious, asystolic, and apnoeic with fixed dilated pupils. Her body temperature was 23°C. She was given cardiopulmonary resuscitation, rewarmed over 12 hours and hyperventilated; her fluid intake was restricted and she was given phenobarbitone and antibiotics. She made a full recovery with no neurological deficit.

All children had similar treatment regimens: they all received cardiopulmonary resuscitation on admission, were hyperventilated, and received similar treatment for raised intracranial pressure.

FACTORS THAT MIGHT PREDICT OUTCOME

The consultant paediatricians found it difficult to estimate immersion time reliably from the information available to them. We were therefore unable to compare immersion time in these children. All were hypothermic with a mean core temperature of 30.9°C. Three patients who survived normally and three of the handicapped survivors were profoundly hypothermic (temperature <28°C). All patients were profoundly acidotic and no patient with a pH <6.85 recovered normally.

All the children who recovered fully from being unconscious with fixed dilated pupils had sustained normally reactive pupils within six hours after successful cardiopulmonary resuscitation. In the group who were subsequently handicapped normal pupil reactivity returned, but in half these children the improvement

was not sustained and there were periods when pupils were fixed and dilated throughout the first week in hospital. Of the children who died, only two regained any pupil reactivity, which again was not sustained.

Respiratory effort on admission was associated with a full recovery in all cases. None of the children who died or had neurological deficit in the group of 64 unconscious children showed any respiratory effort on admission. None of the patients who subsequently died ever regained sustained regular respiration. Fits limited to the first 24 hours and responsive to treatment were also associated with a full recovery. Fits were seen in half of the children who became neurologically handicapped and in three who died. In all these cases the seizures were difficult to control and persisted well beyond the first 24 hours after the accident.

None of the children who died regained consciousness while in hospital and eight died within 24 hours after admission. No child who died survived beyond five days after the episode.

NEUROLOGICAL AND DEVELOPMENT OUTCOME

The 10 children who sustained neurological deficit all had spastic quadraplegia. Three died of anoxic encephalopathy and secondary pneumonia two to six months after admission. Six remained severely spastic quadraplegic and required full time nursing care. One 3 year old made a gradual neurological recovery over two years. All the other children who survived near drowning episodes were recorded by their paediatricians as developmentally and neurologically normal.

Of the children admitted to hospital after nearly drowning, 8.5% died and 5.3% had a neurological deficit, giving a rate of overall normal survival of 86%. Among children admitted to hospital unconscious, neurological deficit was found in 15.6% and 20.3% died.

Discussion

Over a third of children in the British Isles admitted unconscious after near drowning did badly, either dying or having a subsequent neurological deficit. On the other hand we found that most children admitted unconscious with reactive pupils did survive normally after severe submersion incidents, and a third of children admitted to hospital unconscious with fixed dilated pupils also did well. Our results contrast with studies in the United States that have shown that fixed dilated pupils and coma predict those patients who will die or have neurological deficit after severe submersion incidents.^{3,7,8} These studies referred largely to children drowning in relatively warm swimming pools, and differences in the temperature of the water probably account for experience. Frewen *et al* in Canada report on two patients who survived normally despite having fixed dilated pupils.¹¹

In view of the high survival rate in near drowning incidents and the potential for neurological improvement in some patients all children should have full cardiopulmonary resuscitation after severe submersion incidents.¹² This should not be abandoned until they are rewarmed. If fixed dilated pupils persist after six hours and the child is rewarmed brain death criteria should be sought.

Our results confirm the results of Pearn *et al* that children either survive normally or have severe handicap after severe submersion incidents.^{4,13} All our survivors with neurological deficit had spastic quadraplegia, and only one subsequently recovered. In contrast, all the other children who survived are described by their paediatricians as normal. We will later try to discover whether the children had any minor or emotional problems. Our figure of subsequent neurological defect for unconscious children (15.6%) is

similar to that found in Toronto (14%)⁶ but lower than figures in America (20% in California³) and higher than those in Hawaii (0%)⁶ and Queensland (5%).⁴

Although fixed dilated pupils on admission are not a reliable predictor of outcome after a serious submersion incident, the pupillary reflex is unaffected by the drugs given to electively ventilated paralysed patients and is thus a useful indicator of outcome during this form of treatment. All children who fully recovered had normal sustained pupil reactivity within six hours after starting cardiopulmonary resuscitation. A longer period before the onset of pupil reactivity and the recurrence of periods of fixed dilated pupils was associated with neurological deficit or death.

Respiratory effort is probably the most sensitive prognostic sign on admission in the unconscious nearly drowned child: all children with established respiration in our study made a full recovery. Nevertheless, especially in the very hypothermic children, absence of respiratory effort does not necessarily predict a poor outcome. Prolonged, poorly controlled fits beyond the first day after admission to hospital were associated with neurological deficit. This agrees with the findings of Conn and Barker⁶ that late poor electroencephalographic traces are associated with a poor outcome.

Why should some patients apparently dead on admission with fixed dilated pupils survive normally? It has been suggested that this is because of the diving reflex, which is more pronounced in children than adults, in which the peripheral circulation is shut down with a profound bradycardia, the brain achieving most of the circulation.¹⁴ Other work, however, suggests that the diving reflex is not active in humans¹⁵ and submersion hypothermia is more likely to account for some people surviving prolonged periods under water. The rapid fall in body temperature on immersion in cold water exerts protective cranial hypothermia before the circulation fails.¹⁶ Orlowski used the term ice water drowning⁹ as a review of published reports showed that all the cases with a good outcome after prolonged immersion occurred in water of temperature $\leq 10^{\circ}\text{C}$. The protective effect of hypothermia would be more

pronounced in children than in adults because children have a higher surface area to body weight ratio and therefore cool more rapidly. Most outdoor drownings in the United Kingdom are in water temperatures of $<20^{\circ}\text{C}$; four of the children in our series who survived normally with fixed dilated pupils and no respiratory effort had body temperatures less than 32°C and three were profoundly hypothermic.

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Epilepsy: disappearing lesions appearing in the United Kingdom

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Abstract

Objective—Investigation of spontaneously resolving lesions associated with epilepsy.

Design—Observational study during one year.

Setting—One neurology department.

Patients—4 cases in patients (one of Indian parents, one African, one white English, and one Afro-Caribbean) resident in the United Kingdom, who presented with transient epilepsy.

Main outcome measures—Findings on computed tomography and on screening for infections.

Results—In all four cases a small mass lesion in one cerebral hemisphere was observed on computed tomography, which resolved after 9, 4, 3 and 1.5 months respectively without surgery.

Conclusions—The number of cases seen in one year suggests that the lesions may be more common in the United Kingdom than previously recognised and that research into their cause is warranted.

Introduction

In the United Kingdom only about 8% of adults with epilepsy of recent onset have mass lesions on computed

tomography of the brain. Almost all of these lesions, however, are due to cerebral tumours; infectious and granulomatous masses are rare. In contrast, in India up to 40% of such patients have solitary, small, contrast enhancing, lesions in the cerebral hemisphere.¹⁻⁴ The remarkable feature of these lesions is that most undergo spontaneous resolution within six months. The cause of these "disappearing" lesions remains controversial. An infectious aetiology is most likely; current evidence favours cysticercosis^{5,6} rather than an isolated tuberculoma.¹ It is not clear why similar cases have so rarely been reported outside India.^{7,8} In this paper four such cases are described in patients who presented to our unit during the past year, suggesting that they may be commoner in Britain than previously recognised.

Case reports

Case 1—A 16 year old boy of Indian parents, who had been born in Ireland and who had lived exclusively in Ireland and England except for two periods of three months in India at ages 6 and 15, presented after a single tonic-clonic seizure. There were no physical abnormalities, and the only abnormal finding was in

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