General anaesthesia in sickle-cell disease

JOHN HOMI, JENNIFER REYNOLDS, ALISON SKINNER, WADIA HANNA, GRAHAM SERJEANT

British Medical Journal, 1979, **1**, 1599-1601

Summary and conclusions

General anaesthesia was administered on 284 occasions to 200 patients with sickle-cell disease at one hospital during July 1958 to June 1978. No intraoperative but six postoperative deaths occurred. The management of anaesthesia may have contributed to two of the postoperative deaths. Clinically uneventful anaesthesia did not appear to provoke severe sickling crises or to be responsible for mortality, but a contribution to postoperative morbidity could not be excluded.

A simple, careful anaesthetic technique and selective but not routine blood transfusion appears to be associated with minimal anaesthetic morbidity and mortality in patients with sickle-cell disease.

Introduction

Many reports state that general anaesthesia may be hazardous to patients with sickle-cell disease.[1-3] Much of the evidence, however, consists of case reports in which the contribution of antemortem sickling to mortality is conjectural and the importance of postmortem sickling difficult to interpret.[4 5] Many patients with sickle-cell disease undergo uneventful general anaesthesia. We therefore present our experience of 284 general anaesthetics in patients with sickle-cell disease at the University Hospital of the West Indies over the period July 1958 to June 1978.

Patients and methods

Analysis of the records of the sickle-cell clinic at this hospital in June 1978 showed 1485 patients regularly attending and a further 198 patients with sickle-cell disease who had died from all causes in the preceding 20 years. A retrospective review of the hospital notes of both living and dead patients indicated that 284 procedures had been carried out under general anaesthesia in 200 patients. Of these patients, 151 had homozygous sickle-cell (SS) disease, 32 sickle-cell haemoglobin C (SC) disease, seven sickle-cell β^+-thalassaemia, and 10 sickle-cell β^0-thalassaemia (S-β^0-thalassaemia). Diagnostic criteria for these genotypes were as reviewed by Serjeant.[6] The age at anaesthesia varied from two months (bronchoscopy in a child with SS disease) to 69 years (abdominal surgery in a man with SS disease), with a mean age varying from 19·0 years in patients with SS disease to 26·7 years in those with S-β^0-thalassaemia. There were 111 female and 89 male patients.

We obtained details of the surgical and anaesthetic procedures by retrospective review of patients' case notes and anaesthetic charts and by prospective recording for the last two years of the study. Special attention was paid to the duration of anaesthesia, methods of inducing and maintaining anaesthesia, intubation, spontaneous or controlled respiration, use of muscle relaxants, whether procedures were elective or emergency, and the use of tourniquets. The preoperative haemoglobin (Hb) concentration was recorded, as was the use of blood or other intravenous fluids preoperatively, intraoperatively, and postoperatively. The overall outcome of the procedure was noted as well as any complications occurring during the intraoperative, immediate postoperative (up to 48 hours), and delayed postoperative (up to discharge from hospital) periods.

Department of Anaesthetics and Intensive Care, and Medical Research Council Laboratories (Jamaica), University of the West Indies, Kingston, Jamaica

JOHN HOMI, MB, FFARCS, professor of anaesthetics
JENNIFER REYNOLDS, medical student, MRC Laboratories
ALISON SKINNER, medical student, MRC Laboratories
WADIA HANNA, MD, FFARCSI, lecturer in anaesthetics
GRAHAM SERJEANT, MD, FRCP, head of MRC Laboratories

Results

Table I shows the number of anaesthetic procedures in patients of different genotypes, and table II the types of surgery. The duration of anaesthesia varied from 15 to 270 (average 75) minutes. Procedures were elective in 242 cases and emergency in 42. Tourniquets were used in four operations.

TABLE I—*Numbers of general anaesthetics administered according to genotype*

Genotype	No of general anaesthetics							
	1	2	3	4	5	6	7	Total
SS	112	29	6		2	1	1	211
SC	22	4	5			1		51
Sickle-cell-β^+ thalassaemia	6	1						8
Sickle-cell-β^0-thalassaemia	8	1		1				14
Totals	148	70	33	4	10	12	7	284

SS = Homozygous sickle-cell disease.
SC = Sickle-cell haemoglobin C disease.

TABLE II—*Types of surgical procedures for which 284 anaesthetics carried out*

	No of procedures		No of procedures
Abdominal	74	ENT	25
Gynaecological	52	Genitourinary	21
Orthopaedic	46	Ophthalmic	11
Plastic	30	Miscellaneous	25

HAEMOGLOBIN CONCENTRATIONS

Of the 202 procedures in patients with SS disease for which preoperative Hb concentrations were available, 159 (79%) were conducted without preoperative blood transfusion at a mean Hb concentration of 8·2±1·5 g/dl. Among the 43 patients who received preoperative blood transfusion Hb concentrations were below steady-state values in 20 (18 with hypersplenism indicating splenectomy, two with renal failure); the other indications for transfusion were major abdominal (seven), gynaecological (four), orthopaedic (four), and other surgery (eight). Blood transfusion was given intraoperatively in 31 patients, 16 of whom had not received preoperative transfusion, and postoperatively in 15 patients, eight of whom had not received transfusion either preoperatively or intraoperatively. Thus 137 patients underwent general anaesthesia and convalescence without any blood transfusion.

ANAESTHETIC MANAGEMENT

Premedication included combinations of a narcotic and a drying agent (110 cases), a sedative and a drying agent (48), and a drying agent alone (71). It was not given in 36 cases and was unspecified in 19. Induction was achieved by inhalation (61 cases) or intravenous agents (220), and was unspecified in three cases. Tracheal intubation was performed during 170 anaesthetics, and in only three were difficulties

recorded. Of the muscle-relaxant drugs used to facilitate intubation, suxamethonium was used in 145 procedures.

Anaesthesia was maintained by volatile agents in association with nitrous oxide and oxygen (198 cases) or oxygen alone (17). Nitrous oxide and oxygen alone or supplemented with narcotics was used 62 times and cyclopropane in oxygen seven. Volatile agents included halothane (158 cases), trichloroethylene (54), and ether (three). Intraoperative oxygen concentrations were 30% (157 cases), 50% (61), 70% (27), 100% (24), and unspecified (15). Preoxygenation (inhalation of 100% oxygen for about five minutes before induction) became routine after 1970. Ventilation was controlled in 96 cases, spontaneous in 167, and unspecified in 21. Preoperative alkali treatment consisting of intravenous lactate or bicarbonate was given to 84 patients and was most common during 1962-75.

OUTCOME OF ANAESTHESIA

Complications occurred during the operative and immediate postoperative periods in 10 patients (table III), one of whom (see case 2 below) died. Complications in the delayed postoperative period occurred in 45 patients (table IV), of whom five died (cases 1 and 3-6 below). Five of the six patients who died were undergoing emergency surgery and were in poor physical condition (physical state 3-4 on the American Society of Anesthesiologists' classification).[7] Further analysis failed to show any differences in surgical or anaesthetic management between patients with and without complications. Details of the patients who died are summarised below.

TABLE III—*Complications occurring during intraoperative and immediate postoperative periods in 284 anaesthetic procedures*

	Genotype			
Complications*	SS	SC	Sickle-cell-β⁺ thalassaemia	Sickle-cell-β⁰-thalassaemia
Airway obstruction	1	1		
Hypotension	4			
Dysrhythmia	2			
Asystole	1			
Apnoea	1			
Total	9	1		

*Includes one death 24 hours after operation.

TABLE IV—*Complications occurring during delayed postoperative period in 284 anaesthetic procedures*

	Genotype			
Complications*	SS	SC	Sickle-cell-β⁺ thalassaemia	Sickle-cell-β⁰ thalassaemia
Lung problems	10	4		
Wound infection	8	3		
Fever > 7 days	3			
Sickle-cell related†	7	3		1
Others	4	2		
Total	32	12		1

*Includes five deaths occurring 48 hours or more after operation.
†Includes increased jaundice and bone pain.

Case 1—A 4-year-old girl, who had been in hospital for three months because of complications of SS disease, died from salmonella septicaemia and pneumonia five days after incision and drainage for severe infection and swelling of both hands. Necropsy confirmed septicaemia and bronchopneumonia.

Case 2—A 16-year-old man with SS disease developed cardiorespiratory arrest after carotid arteriography performed under a combination of local and neuroleptic analgesia (fentanyl and droperidol) for investigation of a head injury. He was promptly resuscitated but failed to regain consciousness and died 24 hours later. Necropsy showed multiple skull-bone fractures, severe tearing, distortion and herniation of the brain, and bronchopneumonia.

Case 3—A 22-year-old man with SS disease developed hypotension and anuria during a septicaemia acquired in hospital. General anaesthesia was needed to cannulate the femoral vessels for haemodialysis and then to control bleeding from the cannulation sites. Two days after the second anaesthetic repeated episodes of hypotension and ventricular dysrhythmia culminated in cardiac arrest. Necropsy confirmed renal tubular necrosis.

Case 4—A 26-year-old man with SS disease required a further laparotomy to correct a duodenal fistula and recurrent bleeding 15 days after gastric surgery for a bleeding duodenal ulcer. Twelve days later he died of peritonitis confirmed at necropsy.

Case 5—A 40-year-old man with SS disease died from pneumonia four days after a procedure for retinal detachment. Review of the notes indicated a temperature of 99°F on the day before the operation, which suggested a pre-existing infection. Necropsy findings were consistent with a pneumonia of viral origin.

Case 6—A 12-year-old boy with SC disease became unconscious and oliguric 11 days after elective splenectomy, cholecystectomy, and appendicectomy. He died one day after an emergency laparotomy, which showed 2 l of blood-stained fluid in the peritoneal cavity. Necropsy failed to show any anatomical cause of death. No evidence of renal necrosis or pulmonary disease was found, although inactive cirrhosis was present.

Two patients died before operations that had been postponed in order to improve the patients' condition. One died of a pulmonary embolus and the other at home while awaiting admission after a preoperative blood transfusion.

Discussion

The sickle-cell clinic that our patients attended performs regular follow-up of over 1000 patients with homozygous SS disease. Although most of the patients had initially presented or were referred with symptoms, this bias was reduced by prolonged follow-up at their steady state. Our population may, therefore, differ from the smaller groups with more symptoms on which previous anaesthetic studies have been based. We chose a study period after 1958 because the diagnostic evidence and anaesthetic details were inadequate for retrospective study before this date. Two deaths in 1954 at this hospital were believed to be associated with anaesthesia in sickle-cell states but anaesthetic details and genotypes were unrecorded.[8,9] Rigorous screening of all necropsy reports and records from the operating theatres, recovery room, intensive care unit, and casualty department makes it unlikely that we underestimated anaesthetic morbidity or mortality. By excluding anaesthetic procedures carried out in other hospitals because adequate records were unavailable we may well have underestimated anaesthetic morbidity, but all deaths in patients with sickle-cell disease at other hospitals were followed up and investigated separately.

We found that general anaesthesia was well tolerated in patients with SS disease. Intraoperative and immediate postoperative complications were rare, although delayed postoperative complications occurred in 32 out of 211 (15%) patients with SS disease. The commonest causes were lung problems (10 cases) and wound infection (eight), but in the absence of control data this prevalence of complications is difficult to interpret. Matching paired controls with normal (AA) Hb was not feasible since the distribution and pattern of surgical procedures in patients with SS disease are quite different from those in the normal population (unlike in patients with sickle-cell trait (AS), in whom they are similar).[10] Postoperative complications were not obviously linked to any aspect of anaesthetic or surgical management and were more common in patients with SS disease who received preoperative transfusions (12/43; 28%) than in those who did not (20/159; 13%). The latter figure compares favourably with results in two other series in which preoperative transfusion was used, when postoperative complications occurred in 7 out of 28 patients (24%) and 6 out of 21 (28%) respectively.[11,12] Probably this reflected the severity of the underlying condition, which determined both the prevalence of postoperative complications and the need for preoperative transfusion.

Two of the six deaths reported in this series may have been related to the anaesthetic, but evidence of widespread antemortem intravascular sickling or major tissue infarction as the cause of death was lacking in these cases at necropsy. Supplementing local anaesthesia with neuroleptic analgesia without supplementary oxygen, tracheal intubation, or controlled

ventilation (as in case 2) would have been detrimental to any patient with traumatic brain damage regardless of their Hb genotype. Giving general anaesthesia for an elective procedure in a patient with unexplained preoperative pyrexia (as in case 5) would be considered to be questionable anaesthetic practice, particularly in a patient with SS disease. The remaining deaths could not be attributed to anaesthesia or its management but rather to the poor physical condition of patients at the time of surgery, which is often associated with a high incidence of complications even in the absence of Hb S.[13]

Without physiological monitoring at the capillary level no anaesthetic can be claimed to be truly uneventful, but in this series there was no evidence to suggest that "clinically uneventful" anaesthesia provoked fatal or even serious manifestations of sickle-cell disease. Indeed, two prospective studies have shown that the number of circulating sickled cells is not increased and may actually be decreased during general anaesthesia and for some time postoperatively.[14 15] Furthermore, even major surgery could be accomplished at steady-state Hb concentrations without harm to the patient. Anaesthetic management following the important recommendations of Oduro and Searle[16] and using selective blood transfusion seems appropriate for patients with sickle-cell disease. More complex methods of management based on theoretical considerations do not appear to offer any proved advantages and may not be practical where the disease is most prevalent.

We should like to acknowledge the help of Professor S E H Brooks, head of the department of pathology, University Hospital of the West Indies, in interpreting the histological and necropsy material.

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(*Accepted 18 April 1979*)

Whooping cough after stopping pertussis immunisation

ROBERT K DITCHBURN

British Medical Journal, 1979, **1**, 1601-1603

Summary and conclusions

An epidemic of whooping cough occurred in a rural practice in Shetland, containing 144 children under 16. Before July 1974 all children were immunised against pertussis, but after that date immunisation was stopped. Of the 134 children studied, 93 had been immunised. Sixty-five of the children developed whooping cough. The incidence of infection was similar in those who had and had not been immunised. The incidence was also similar in those born before and after July 1974.

There was no evidence to support the routine use of pertussis immunisation in rural Shetland.

Introduction

Routine immunisation against pertussis in my Shetland practice was discontinued in July 1974. I therefore viewed the advent of the British epidemic of whooping cough in the autumn of 1977 with apprehension. In the practice no child aged under 3 years 3 months had been immunised against pertussis, whereas nearly all children over that age had been immunised in infancy. In these circumstances I considered the whooping cough outbreak to be worth study and report my findings.

Walls, Shetland ZE2 9PF
ROBERT K DITCHBURN, MD, MRCP, general practitioner

The practice

The practice covers about 50 square miles (130 sq km) of the west mainland of Shetland and the three off-shore islands of Foula, Vaila, and Papa Stour. It contains the villages of Walls and Sandness, but the population is widely scattered and the practice entirely rural. Agriculture and fishing are the main industries, and most of the patients are in social classes I, II, or III. At the time of the epidemic the practice covered 721 patients, of whom 144 were children under 16 years. There are four primary schools in the practice. From the age of 12 the children attend secondary schools outside the practice area.

Method of study

The immunisation state of the children was determined from their medical records. Whooping cough was defined as an illness characterised by a cough lasting at least four weeks associated with either whooping or vomiting.[1] In each case the date of onset and the course of the disease were recorded. The parents of all children who did not present to the doctor with whooping cough were contacted to determine whether their children had developed the disease.

Since there is no bacteriology laboratory in Shetland, the specimens have to travel by road and air to Aberdeen City Hospital. Throat swabs for routine bacteriology were taken from all the infants and from many of the older children. In 10 of the infants throat swabs were also placed in transport medium and sent for virology. In these infants pernasal swabs were also taken. These were plated out in Bordet-Gengou medium and incubated at 37°C overnight before transport to Aberdeen.

The epidemic

Table I shows the pertussis immunisation state of the children in the practice. Ten children born after July 1974 are not included,