

## ANAESTHESIA AND DEATH

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MUCH INTEREST has been shown in deaths associated with anaesthesia by both the profession and lay public ever since Hannah Greener died on induction with chloroform in 1848.<sup>1</sup> This first reported death occurred within eighteen months of the introduction of anaesthesia to clinical medicine. Certain sections of the medical profession have always been ready to attribute these unfortunate occurrences to therapeutic misadventure. Happily, others have been anxious to look further and seek more rational explanations.

It was felt that the publication of a review of deaths in an 800-bed general hospital in which anaesthesia played a part might be of wide interest and perhaps instructive as well.

Any attempt to assess the part played by anaesthesia in a fatality will be hedged with difficulties. These have been well summarized by Beecher & Todd,<sup>2</sup> but in the final analysis there are three factors which must be taken into consideration: (1) patient disease, (2) surgery, (3) anaesthesia; and each of these must be weighed against the others when the cause of a particular death is being evaluated.

In this study consideration is given to all deaths in surgical and obstetrical patients occurring within ten days of surgery or delivery, and to those in which jaundice and liver failure or pulmonary complications were mentioned in either the death certificate or the autopsy report.

It is recognized that some delayed deaths in which anaesthesia played a part might have been missed, but every hospital medical record which satisfied the above criteria from 1958 to 1964 inclusive (i.e. 7 years) was scrutinized. Twenty-one cases were found in which anaesthesia was entirely or partially responsible for the death. These are summarized in Table I.

Over the seven years, 129,336 anaesthetics were given, 86,013 general anaesthetics, 25,706 locals, and 17,617 spinals and epidurals, producing a death rate of 1:6158. This compares with 1:1560 in Beecher and Todd's analysis, and 1:3955 reported by Clifton<sup>8</sup> from Sydney, Australia, in 1963.

Closer examination will show that there was only one death where the anaesthetist alone appeared to have been responsible (case 6) and one where the recovery room staff, and thus vicariously the anaesthetist, could be blamed (case 1).

There were three cases of aspiration (nos. 8, 12, and 21) and two cases of circulatory collapse on moving the patient from the operating table to the stretcher at the conclusion of surgery (nos. 13 and 15), but the major cause of death was respiratory failure (cases 2, 3, 5, 16, 18, 19, and 20).

Inadequate pre-operative assessment was also of some moment in eight cases

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(nos. 7, 9, 10, 14, 16, 17, 18, and 20), and other unidentified and unidentifiable disease in one case (case 11). In three cases (nos. 2, 10, and 19), the cause of death was obscure and is open to speculation. In one case (no. 4), hypovolaemia occurred and could not be corrected owing to an administrative misunderstanding.

Thus, in order of frequency of occurrence, the list would read:

|  |   |
|--|---|
| Respiratory failure                          | 7 |
| Hypovolaemia                                 | 4 |
| Regurgitation or vomiting<br>with aspiration | 3 |
| Movement with circulatory<br>collapse        | 2 |
| Postoperative respiratory<br>obstruction     | 1 |

#### DISCUSSION

In the classification of 1000 deaths from the United Kingdom in 1956, Edwards<sup>4</sup> listed the commonest causes as regurgitation and vomiting, circulatory failure associated with sodium thiopentone, obvious under-transfusion, and postoperative respiratory obstruction.

In 1964, however, Dinnick<sup>5</sup> classified a further 600 deaths from the United Kingdom and found the emphasis quite changed. By far the largest number now had died as a result of an uncorrected hypovolaemia, and this was followed by under-ventilation, regurgitation and vomiting, and collapse with thiopentone, in that order.

Clifton in the meantime (1963), had listed inhalation of vomitus, respiratory obstruction, circulatory collapse after thiopentone, anaesthetic overdosage, and respiratory insufficiency. These findings are compared and contrasted in Table II.

It must be remembered that there is a greater awareness now among anaesthetists of the importance of reducing the dose of thiopentone for the induction of sick patients, or indeed, of avoiding its use altogether; in this hospital fatal circulatory collapse resulting from thiopentone has not been noted.

In spite of the provision of a recovery room with a well-trained staff, there was one death attributable to postoperative respiratory obstruction. At least the danger emphasized by Edwards,<sup>4</sup> of anaesthetized patients being wheeled to distant parts of the hospital, often along dark corridors by junior staff members, has been avoided in this institution.

But our old friends, or enemies, crop up again. The prominence given to hypovolaemia by Dinnick shows that there is now a greater recognition of the importance of replacing and maintaining the circulating blood volume than in past years; and the fact that underventilation has received such widespread recognition is of special interest. It results from the ease with which blood-gas studies can now be done, and the consequent realization of the ready occurrence of hypercarbia, and sometimes hypoxia, with their attendant dangers. Thus the preoperative and postoperative ventilation of patients is undertaken much

TABLE I

| Age | Sex  | Disease | Operation   | Site of surgery   | Time of death  | Anaes. technique and drugs used  | Preop. assess.   | Autopsy | Cause of death                             |   |
|-----|------|---------|---|---|--|--|--|---------|--|---|
| 1   | 37   | M       | Rt. inguinal hernia.  | Herniorrhaphy.  | Inguinal region.   | Cardiac arrest 15 min. post-op. Card. massage and death in 3 days.             | C <sub>2</sub> H <sub>6</sub> , N <sub>2</sub> O, O <sub>2</sub> and Pento. 2½%. Closed circuit. | 1       | Yes  | Probable obstruction of airway in recovery room with hypoxia and hypercarbia.   |
| 2   | 25   | F       | Endometriosis.  | D & C. Laparotomy. Pre sacral neurectomy and cauterization of implants. | Lower abdomen.   | 30 hrs. postop.  | Subarachnoid block, 6 mg. hyperbaric pontocaine. Pento. 2½% and .2% drip.                        | 1       | Yes  | 1. Respiratory failure<br>2. Coning of medulla and cerebral oedema. (A large thymus found.)                                       |
| 3   | N.B. | M       | Multiple congenital abnormalities. Intra-septal defect. Hermaphroditism and abdominal contents in thorax. | Repair of defect in diaphragm.  | Rt. thoracotomy.   | At conclusion during closure.  | Open ether, then intubation. Unassisted respirations.  | Yes     | 1. Respiratory failure.<br>2. Atelectasis. |   |
| 4   | 33   | F       | 1. Carcinoma, breast.<br>2. Path. fracture of rt. femur.  | Internal fixation of femur.   | Cardiac arrest during surgery. Died 10 hrs. later. Heart restarted by massage. | Cardiac arrest during surgery. Died 10 hrs. later. Heart restarted by massage. | Pento. 2½%. s. choline intubation, O <sub>2</sub> only.  | 2       | No   | Hypovolaemia. Blood loss was recognized but could not be replaced. Resultant myocardial hypoxia and arrest. Blood later obtained. |
| 5   | 80   | M       | Benign prostatic hypertrophy.   | Suprapubic prostatectomy.   | Lower abdomen.   | 4 days postop.   | Spinal, N <sub>2</sub> O, O <sub>2</sub> , and Pento. (75 mg.)                                   | 2       | No   | Respiratory depression during surgery. Never regained consciousness.  |
| 6   | 43   | F       | Varicose veins.   | Stripping and ligation.   | Lower extremities.   | Cardiac arrest perop. Heart restarted. Died in 30 hrs.                         | C <sub>2</sub> H <sub>6</sub> , N <sub>2</sub> O, O <sub>2</sub> .                               | 1       | Yes  | 1. Possible airway obstruction.<br>2. Deep anaesthesia.   |

TABLE I—Continued

| Age | Sex | Disease | Operation  | Site of Surgery                               | Time of death  | Anaes. technique and drugs used   | Preop. assess.   | Autopsy | Cause of death |  |
|-----|-----|---------|--|---|----------------|---|--|---------|----------------|--|
| 7   | 59  | M       | 1. Gastric ulcer.<br>2. Carcinoma of colon.            | Gastrectomy.                                  | Upper abdomen. | 7 days postop.  | Subarachnoid block, 7 mg. hyperbaric pontocaine. Pento., intubated. CaH <sub>4</sub> and O <sub>2</sub> .      | 3       | Yes            | New and old myocardial infarction. No. E.C.G. taken. Patient in congestive cardiac failure before operation started. Condition recognized but not treated. |
| 8   | 72  | M       | Benign prostatic hypertrophy.                          | Suprapubic prostatectomy.                     | Lower abdomen. | 5 hrs. postop.  | Pento., N <sub>2</sub> O, CaH <sub>4</sub> , and O <sub>2</sub> . D.T.C. 9 mg.                                 | 2       | Yes            | Aspiration of vomitus 1 hr. postop. (food eaten the previous night). Was only in the recovery room a very short time.                                      |
| 9   | 93  | F       | Fractured femur.                                       | Pinning and plating.                          | Rt. femur.     | Peroperative cardiac arrest.  | Pento. (50 mg.) intubation N <sub>2</sub> O and O <sub>2</sub> .   | 4       | No             | Hypoxia, anaemia. 2nd operation in 10 days (blood not replaced during 1st procedure).  |
| 10  | 13  | M       | 2 wk. old burns to face, neck, body, and thighs (60%). | Removal of dressing and debridement of burns. |                | At intubation.  | N <sub>2</sub> O, O <sub>2</sub> , and ether for removal of dressings. Given anectine for intubation (10 mg.). |         | No             | 1. Was on steroids.<br>2. May have been hypovolaemic.<br>3. (?) Anectine effect in burned patient.   |
| 11  | 29  | F       | Twin pregnancy.  | Vaginal delivery, low forceps.                |                | Cardiac arrest 10 min. after block. Inter-ventricular cardiac massage. Died 2 hrs. later. | Subarachnoid block, pontocaine, 7 mg., hyperbaric.   | 1       | Yes            | 1. Congenital narrowing of coronary arteries.<br>2. Hypotension from block with myocardial hypoxia and cardiac arrest.                                     |
| 12  | 87  | F       | Fractured femur.                                       | Insertion of Moore's prosthesis.              | Rt. hip joint. | 3rd postop day.   | N <sub>2</sub> O, O <sub>2</sub> , and fluothane. Intubated.   | 6       | Yes            | Aspiration of vomitus 6–12 hrs. postop.  |
| 13  | 69  | F       | Acute cholecystitis.                                   | Cholecystectomy.                              | Upper abdomen. | Moving to stretcher from O.R. table.  | Pento, CaH <sub>4</sub> , He, O <sub>2</sub> , D.T.C. 15 mg., not intubated.                                   | 2       | No             | Movement causing circulatory collapse.   |
| 14  | 60  | M       | Sarcoma of prostate.                                   | Suprapubic cystostomy.                        | Lower abdomen. | 9 hrs. postop.  | N <sub>2</sub> O, O <sub>2</sub> , and fluothane.  | 2       | Yes            | 1. Hypertensive heart disease.<br>2. Congestive cardiac failure.   |

TABLE I—Continued

| Age | Sex | Disease  | Operation          | Site of surgery                                | Time of death                        | Anaes. technique and drugs used   | Preop. assess. | Autopsy | Cause of death   |
|-----|-----|--|--------------------|--|--------------------------------------|---|----------------|---------|--|
| 15  | M   | Bronchial carcinoma.   | Pleural biopsy.    | Rt. thoracotomy.                               | Moving to stretcher from O.R. table. | Pento, N <sub>2</sub> O, O <sub>2</sub> , and Fluothane. Intubated.   | 2              | No      | Movement causing circulatory collapse.   |
| 16  | F   | 1. Pregnancy.<br>2. Kyphoscoliosis.                                | Caesarian section. | Lower abdomen.                                 | 7 hrs. postop.                       | Pento, N <sub>2</sub> O, O <sub>2</sub> , and C <sub>2</sub> H <sub>6</sub> . Intubation and controlled respiration. (Sparline pre-partum.) |                | Yes     | Respiratory failure. Sedated pre-partum. Possibility of development of resp. insufficiency was recognized pre- and post-operatively. |
| 17  | M   | 1. Ependymoma of posterior fossa.<br>2. Paraplegia in flexion.     | Cordectomy.        | Laminectomy, T <sub>11</sub> -L <sub>2</sub> . | Cardiac arrest at conclusion.        | Pento., N <sub>2</sub> O, O <sub>2</sub> , and Fluothane. Intubation with controlled respiration.   |                | No      | Prone position, blood volume probably low.   |
| 18  | F   | 1. Strangulated ventral hernia.<br>2. Gross obesity.               | Herniorrhaphy.     | Mid-line abdomen.                              | 2 hrs. postop.                       | Brietal, N <sub>2</sub> O, O <sub>2</sub> , and Fluothane. D.T.C. and controlled respirations.  | Poor           | No      | Respiratory failure. Preop. tracheotomy should have been considered.   |
| 19  | F   | Diaphragmatic hernia.  | Repair of defect.  | Transsthoracic.                                | 3 days postop.                       | Pento., N <sub>2</sub> O, O <sub>2</sub> , and Fluothane. Intubation and controlled respiration.  |                | Yes     | Respiratory failure. Bilateral pulmonary collapse. Adrenal hemorrhage. Cause of death obscure.                                       |
| 20  | M   | 1. Chronic pneumonitis.<br>2. Bronchial carcinoma.                 | Pneumonectomy.     | Rt. thoracotomy.                               | 5 hrs. postop.                       | Brietal, N <sub>2</sub> O, O <sub>2</sub> , and Fluothane. Intubation. D.T.C. and controlled respiration.                                   |                | Yes     | Respiratory insufficiency. Poor preop. assessment.   |
| 21  | M   | Pyloric obstruction 4 days after pyloroplasty. Gastric dilatation. | Laparotomy.        | Abdomen.                                       | Cardiac arrest 25 min. after block.  | Subarachnoid block, 12 mg. pontocaine, 20 mins. after block, C <sub>2</sub> H <sub>6</sub> and O <sub>2</sub> .                             | Fair           | Yes     | Aspiration of vomitus regurgitated around a naso-gastric tube.   |

TABLE II

|   | Edwards (1956)                        | Clifton (1963)                               | Dinnick (1964)                  | This report (1965)                    |
|---|---------------------------------------|--|---------------------------------|---------------------------------------|
| 1 | Regurgitation and vomiting            | Regurgitation and vomiting                   | Low blood volume                | Respiratory failure                   |
| 2 | Overdose i.v. barbiturates            | Respiratory obstruction postoperatively      | Underventilation                | Hypovolaemia                          |
| 3 | Obvious under-transfusion             | Circulatory collapse after i.v. barbiturates | Regurgitation and vomiting      | Regurgitation and vomiting            |
| 4 | Postoperative respiratory obstruction | Anaesthetic overdosage                       | Collapse with i.v. barbiturates | Movement causing circulatory collapse |
| 5 | Mishaps with intubation               | Respiratory insufficiency                    | Mishaps with intubation         | Postoperative respiratory obstruction |
| 6 | Gross under-ventilation               | Failure of O <sub>2</sub> supply             | During bronchoscopy             |                                       |

more enthusiastically and effectively than heretofore, and failure in either of these spheres is more readily recognized as a cause of difficulty.

#### CONCLUSIONS

What lessons can be learned from the experiences presented in this paper? The anaesthesia in this hospital is that necessary for a wide range of surgical procedures, yet very few specialized techniques such as controlled hypotension are used. Thus the work is comparable with that done in most Canadian hospitals, the only difference being that all the anaesthetics, except for a few given by general practitioners for T & A, and for minor procedures in the emergency room, are administered by certificated anaesthetists.

Special consideration should be given to:

1. Careful preoperative assessment of the adequacy of the cardiac and respiratory systems.
2. The possibility of postoperative respiratory insufficiency developing insidiously, especially in the obese patient with an upper abdominal or thoracotomy incision.
3. The likelihood of the occurrence of circulatory failure in the hypovolaemic patient and the fact that this can be prevented by adequate intravenous therapy before and during operation.
4. The ever-present danger of aspiration.
5. The often unconsidered danger of circulatory collapse on change of position of the anaesthetized patient whose normal compensatory mechanisms are obtunded.

In conclusion, there are two items worth commenting upon:

1. No hepatotoxic deaths have occurred in our institution during the years under consideration. Halothane is widely used in the operating rooms.
2. A death from meningitis occurred three weeks post-partum in a 23-year-old girl who received, by chance, a gas anaesthetic at the time of her delivery. The first symptoms of her fatal illness appeared three days post-partum. This in a

hospital where 44 per cent of the patients receive a subarachnoid block for delivery!

#### SUMMARY

A survey was made in an 800-bed general hospital of all deaths occurring within ten days of operation or delivery or at any time where mention was made of pulmonary complications or jaundice, during the seven years from 1958 to 1964 inclusive. Those in which it appeared that anaesthesia was wholly or partly responsible are described in detail. An attempt has been made to draw conclusions from these occurrences and to make suggestions for the avoidance of similar happenings in the future.

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#### REFERENCES

1. SYKES, W. S. *Essays on the First Hundred Years of Anaesthesia*. Vol. II. London: Livingston (1960), pp. 18, 82, 96.
2. BEECHER, H. K. & TODD, D. P. *A Study of the Deaths Associated with Anaesthesia and Surgery*. Springfield: Charles C. Thomas (1954), p. 43.
3. CLIFTON, B. S. & HOTTEN, W. I. Deaths Associated with Anaesthesia. *Brit. J. Anaesth.* 35: 250 (1963).
4. EDWARDS, G.; MORTON, H. J. V.; PASK, E. A.; & WYLIE, W. D. *Anaesthesia* 11: 194 (1956).
5. DINNICK, O. P. Deaths Associated with Anaesthesia. *Anaesthesia* 19: 536 (1964).