General Practice Observed

Anaesthesia and the Accident Flying Squad: A New Anaesthetic Machine

J. F. REDDEN, KEITH LITTLE

British Medical Journal, 1973, 1, 788-790

Summary

A new light-weight purpose-designed portable anaesthetic machine has been used for treating patients at the accident site. It was found to be safe and invaluable in the emergency treatment of the severely injured.

Introduction

Since its origin in 1955,¹ the Derbyshire Royal Infirmary Accident Flying Squad has used anaesthesia to allow necessary surgical procedures to be carried out at the scene in the emergency treatment of the seriously injured.² Owing to the development of new drugs, new equipment, and new techniques there has been a steady evolution in the anaesthetic procedures used "in the field."

History

In 1955, when the accident flying squad began, only intravenous anaesthetics were used—namely, thiopentone sodium and hexobarbitone sodium. It soon became apparent that while these agents were useful for brief procedures they were inadequate for more extensive ones. Inhalational anaesthesia was therefore introduced as an adjunct to the intravenous agents, using ether or chloroform from a drop-bottle on to a Schimmelbusch mask, this technique being used many times, even down coal mines.

As the work developed and experience was gained intubation of the trachea became routine in unconscious patients and, when necessary, in patients with crushed chests. This created a demand for prolonged artificial ventilation, and in 1958 the Beaver ventilator¹ was added to the equipment. Since this apparatus required mains voltage a mobile box containing accumulators and a transistorized inverter was developed (fig. 1). This equipment, although portable, was heavy and bulky and by present standards somewhat clumsy.

The only change introduced in the next half-decade was the replacement of thiopentone with methohexitone sodium (Brietal), since this was found to produce less cardiovascular effect and to give a more rapid recovery. In 1966 the Manley ventilator was incorporated on to a truly portable anaesthetic

machine which could deliver oxygen and/or nitrous oxide and/or halothane with or without ventilation. It became known as the Porta-Blease Derby (fig. 2). This machine was routinely taken to accident scenes, and although fitted with wheels it was occasionally difficult to transport from hospital to accident scene and from car to patient.

FIG. 1—Beaver ventilator with rechargeable power source.

The Porta-Blease Derby gave good, reliable service for five years until 1971, when the Manley ventilator was superseded by the Carden microvent, which immediately reduced the weight of the machine but, more important, made it possible to design a truly light, compact anaesthetic machine—the Derby Lipaco anaesthetic machine described below.

In 1970 propanidid (Epontol) was introduced as the usual intravenous induction agent. The advantages of this agent are (a) rapid induction period (usually about 10 seconds); (b) short duration of action (two to three minutes)—this may be prolonged in a severely injured patient and its use enables rapid manipulation and splintage, but if a longer procedure is required inhalational anaesthesia can be instituted; and (c) very rapid recovery phase. The latter is extremely important, since when the flying squad returns the patient to the casualty department a reliable clinical reassessment must be made by the neurosurgeons and general surgeons. Although severe anaphylactic and hypotensive reactions have been reported with the use of propanidid routine use in the department and by the flying squad have not produced any such effects, and it therefore at present remains the drug of choice.

Intravenous diazepam (Valium), recognized for its value in orthopaedic manipulations,³ has on several occasions been

FIG. 2—Porta-Blease Derby anaesthetic machine.

used successfully, but not to the point of full anaesthesia, its main advantage being its safe sedative effect. In 1972 ketamine hydrochloride (Ketalar) became generally available, it being an intravenous agent giving "dissociative anaesthesia."⁴ It appears to have a beneficial cardiovascular effect and protects the airway with profound somatic analgesia while maintaining a high margin of safety. Its main disadvantages at accidents would be its prolonged effect and its tendency to produce vivid hallucinations with or without psychomotor activity during the recovery phase. Although ketamine may play an increasingly important part in anaesthetic procedures carried out by the flying squad it will not be used routinely until experience is gained from a trial at present being conducted in the casualty department.

FIG. 3—Derby Lipaco anaesthetic machine folded for transport.

Derby Lipaco Anaesthetic Machine

As mentioned above, a new anaesthetic machine has been developed to fulfil all the needs of our accident flying squad. The requirements were as follows. (1) The machine should be as small as possible, enabling it to be placed in the boot of a car with other equipment and used in a confined space. (2) It should be as light as possible for ease of handling, and one person should be able to carry it easily for a short distance. (3) It should be of a convenient shape for carrying and fitting into a car or ambulance and should have a solid base for stability in use. (4) The machine must be designed to withstand the roughest handling, and the breakable parts—for example, the rotameters—must be protected. (5) To facilitate rapid, easy usage it must be as simple as possible, with accessible switches and dials, and require minimum preparation to be in full operation. (6) It should be able to deliver oxygen or anaesthetic gases or both with or without ventilation and should have a sufficient reservoir to maintain anaesthesia for emergency procedures—for example, amputation.

DESCRIPTION

The anaesthetic machine consists of a square tubular steel "speed frame," housing within its box shape the various, more delicate components. It is clipped together for carrying and

FIG. 4—Derby Lipaco machine ready for use.

hinges open at the rear to an L-shape for use (figs. 3 and 4). Stability is provided by the gas cylinders lying flat in the base of the frame, the delivery ends fixed by wing nuts. Easily visible are two large pressure meters, one for oxygen and one for nitrous oxide. The weight and dimensions of the machine are as follows: weight with gas cylinders 17.75 kg; weight without gas cylinders 9.45 kg; carrying height 24.5 cm; working height 60 cm; length 35.5 cm; breadth (excluding wing nuts) 28 cm.

The gases are fed through flexible tubing to the double rotameter and then pass through a Goldman vaporizer in

Injuries Sustained by Patients Given Anaesthetics at Accident Scene and Outcome

Case No.	Sex	Age	Procedure		Anaesthetic		Outcome	Injuries
			Release	Splintage	Induction Agent	Inhalation Agent		
1	M.	44	+	—	Propanidid	—	Discharged	Crushed foot
2	M.	29	+	—	Methohexitone	Fluothane and N ₂ O/O ₂	Discharged	Trapped crushed hand
3	F.	19	—	+	Propanidid	—	Discharged	Fractured femur
4	F.	60	—	+	Propanidid	—	Died after two days	Severe multiple injuries
5	M.	63	—	+	Propanidid	—	Discharged	Multiple injuries
6	M.	33	—	+	Propanidid	—	Discharged	Fractured femur
7	F.	74	—	+	Propanidid	—	Died after 26 days	Multiple injuries and carcinomatosis
8	F.	17	—	+	Propanidid	—	Discharged	Multiple injuries
9	F.	69	+	+	Propanidid	—	Discharged	Severe multiple injuries
10	M.	24	+	—	Propanidid	—	Died after 3 hours	Multiple injuries, including ruptured inferior vena cava
11	F.	14	—	+	Propanidid	—	Discharged	Fractured femur

which halothane may be placed. Just proximal to this is the emergency oxygen tap. The remainder of the parts may be carried separately or on the push clips placed inside the frame. The assembly is simple and rapid. The portable parts (listed from machine to patient) consist of a two-litre Warne rubber reservoir bag, a Carden microvent, safety blow-off valve, rubber tubing, a non-rebreathing valve, and transparent facemask or corrugated connexion to endotracheal tube.

The Carden microvent ventilator is a pressure-cycled volume divider, the valve opening only when sufficient pressure has developed in the reservoir bag. This pressure is then used as the pulmonary inflation force until the desired amount of gas has been delivered, the valve then reverting to its resting position before the cycle begins again. The microvent is an efficient, simple ventilator in the hands of an experienced operator.

FUTURE IMPROVEMENTS

It is intended to lighten the machine by making the frame of a light-weight aluminium alloy and by using light-weight gas cylinders. At present the machine must be carried with the halothane chamber empty, since otherwise the halothane flows into the rotameter, causing severe corrosion. Hopefully this problem will be overcome, although it is of only minor inconvenience.

Patients

From July 1971 to August 1972 11 anaesthetics were administered at the accident scene by the accident flying squad team. All were road-traffic accidents except one (case 2); (see table), which was a works accident. Three anaesthetics were given to release trapped patients, seven were given during manipula-

tion and splintage of fractured limbs, and one was given for both release and splintage.

The ages of the patients ranged from 14 to 74 years. No adverse reactions were noted, the induction, anaesthetic, and recovery phases all being uneventful. All the patients recovered completely from the anaesthetic before admission to the casualty department except one (case 2), who was kept anaesthetized during transport to the hospital and taken direct to the operating theatre.

Three of the patients subsequently died. At necropsy, however cases 4 and 10 were found to have sustained injuries not compatible with survival, and the other patient (case 7) died of her pre-existing carcinomatosis. There was no suggestion that the anaesthetics had in any way contributed to death. These figures confirm the earlier suggestion² that anaesthesia is safe and useful in the emergency treatment of the severely injured.

Conclusion

All accident flying squads should be capable of full anaesthetic practice, and the specially developed Derby Lipaco anaesthetic machine may have other applications, such as in dental anaesthesia and obstetric anaesthesia.

The help of Oxylitre Ltd. in constructing the Lipaco anaesthetic machine to the design produced by the staff of the Derbyshire Royal Infirmary's casualty department is acknowledged.

References

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