PAPERS AND ORIGINALS

Survival of patients ventilated in an intensive therapy unit

J F NUNN, J S MILLEDGE, J SINGARAYA

British Medical Journal, 1979, **1**, 1525-1527

Summary and conclusions

The survival of patients who were artificially ventilated in an intensive therapy unit (ITU) of a district general hospital was studied. The first 100 such patients admitted were followed up for at least four years. Of these, 67 survived treatment in the ITU, 47 were discharged from hospital, and 30 survived four years. (Survival in the ITU of patients who did not require ventilation was 89%.) The effects of age, duration of ventilation, and disease were studied, and a higher survival was found in children, in patients ventilated for under 24 hours, and in patients admitted with drug overdosage. Survival was poor in patients aged over 75 and in those who required ventilation after cardiac arrest or myocardial infarction or for chronic obstructive lung disease.

The cost of a bed in an ITU is about four times that of a bed in a general ward. For ITUs to be used to the greatest effect it is important to define those patients who are most likely to benefit from the facilities they offer.

Introduction

Intensive therapy units (ITUs) are now common in district general hospitals. The pattern of admissions and mortality within such units has been reviewed,[1-3] but little information exists on the long-term results of this expensive form of treatment. Survival figures over one year are available from a study in the United States,[4] but we are unaware of any comparable information from this country. We report a study of 100 patients ventilated for four hours or more in the ITU of Northwick Park Hospital. Survivors were followed up for four years.

Division of Anaesthesia, Clinical Research Centre, Harrow, Middlesex HA1 3UJ

J F NUNN, MD, FFARCS, head of division

Northwick Park Hospital and Division of Anaesthesia, Clinical Research Centre, Harrow, Middlesex HA1 3UJ

J S MILLEDGE, MD, FRCPE, consultant physician and member of scientific staff

Broken Hill and District Hospital, Broken Hill, NSW 2880, Australia

J SINGARAYA, MRCP, specialist physician

Patients and methods

Northwick Park Hospital is a typical district general hospital, serving a population of 230 000 and with no facilities for cardiothoracic surgery or neurosurgery. The accident and emergency department did not open until shortly before recruitment to the study was completed, and therefore few cases of trauma were included. Patients with myocardial infarction are treated in the adjacent coronary care unit but are admitted to the ITU in the event of overt myocardial failure or cardiac arrest. Most of the admissions are for general medical emergencies or care after surgery. The criterion for admission is "failure or threatened failure of a vital system in a patient who is deemed recoverable."

We followed up only patients who had been ventilated artificially for more than four hours. This criterion was chosen to include, so far as possible, only those patients with failure of a vital function whose survival depended on intensive treatment. The study was approved by the hospital ethical committee, and permission to follow up individual patients was obtained from the referring consultants. A questionnaire was sent to the general practitioners of patients who had been discharged from hospital requesting information on their present state of health if alive or, if dead, the cause of death. When the patients had left the area we approached their next-of-kin, the family practitioner committee, or the Department of Population Censuses and Surveys, who kindly provided information on dates and causes of death of certain patients who could not be traced in any other way.

Results

Altogether, 422 patients were admitted during October 1970 to May 1974; of these, 100 were ventilated for more than four hours. Of the 322 other patients, 36 (11%) died, 25 from a catastrophic lesion resulting in death within four hours of admission to the unit. The remaining 11 died after more than four hours in the ITU but were not ventilated. Most of them sustained some catastrophe such as massive pulmonary embolus or cerebrovascular accident while in the ITU. They were not ventilated either because they did not have respiratory failure or because they were deemed irrecoverable. Of the 100 patients ventilated for more than four hours, six were lost to

follow-up. Since no death had been registered for any of these patients, they were presumed to be alive. All the remaining survivors were followed up for a minimum of four years.

SURVIVAL

Overall survival and quality of life (table I)—Thirty-three of the patients died in the ITU, a further 20 after returning to the ward, and 17 during the first three years after discharge from hospital. No deaths occurred during the fourth year. We assessed the quality of life in 24 of the 30 surviving patients: in 17 it was normal for the patient's age. Three patients were disabled for psychological reasons, but the disability had been present before admission in two. The third patient was disabled by deafness and poor memory after meningitis. Four patients were physically disabled to varying degrees: one had angina, one asthma, one severe emphysema, and one renal failure controlled by home dialysis. In all four patients the disability had been present before admission. Of the six patients lost to follow-up but presumed to be alive, five had been admitted for drug overdosage.

TABLE I—*Overall survival of 100 patients ventilated for more than four hours in ITU*

Duration of survival	ITU*	Ward†	1 year	2 years	3 years	⩾4 years
No of patients	67	47	40	33	30	30

*Survived time spent in ITU.
†Survived time spent in ward.

AGE

Effect of age (table II)—Mortality within the ITU was highest in the age range 15-44 years though numbers in these groups were small. Four-year survival was highest in patients aged under 15. In the other groups the survival rate was generally similar except in those over 75. Of 15 patients aged over 75, none survived four years, and in the four patients who left hospital alive the mean survival was 1·3 years.

TABLE II—*Effect of age on survival of 100 patients ventilated for more than four hours*

Age	No of patients	No (%) of patients surviving:		
		ITU	Ward	4 years
0-14	9	6 (67)	6 (67)	5 (56)
15-29	4	1 (25)	1 (25)	1 (25)
30-44	7	4 (57)	2 (29)	2 (29)
45-59	22	17 (77)	14 (64)	10 (45)
60-74	43	28 (65)	20 (47)	12 (28)
75+	15	11 (73)	4 (27)	0
Total	100	67	47	30

VENTILATION

Effect of duration of ventilation (table III)—There was no clear-cut relation between mortality and the duration of ventilation, except that the survival of those ventilated for under a day was good, with 93% (27/29) survival in the ITU and 45% (13/29) alive after four years. With longer periods of ventilation there was little obvious relation between the duration of ventilation and survival rates. A substantial number of patients recovered after receiving ventilation for over eight days.

TABLE III—*Effect of duration of ventilation on survival of 100 patients ventilated for more than four hours*

Duration of ventilation	No of patients	No (%) of patients surviving:		
		ITU	Ward	4 years
4-24 hrs	29	27 (93)	19 (66)	13 (45)
1-2 days	26	18 (69)	10 (38)	7 (27)
3-4 days	19	8 (42)	7 (37)	3 (16)
5-8 days	12	5 (42)	4 (33)	4 (33)
9-16 days	7	6 (86)	4 (57)	2 (29)
16+ days	7	3 (43)	3 (42)	1 (14)
Total	100	67	47	30

EFFECT OF DISEASE CATEGORY (table IV)

The patients were grouped according to the primary illness necessitating their admission, although in many cases more than one system was affected. Patients admitted after operation were divided into those with and without cancer. The best immediate prognosis was for patients admitted with drug overdosage, all of whom left hospital alive. One died during the succeeding four years, while five were lost to follow-up, but no death was recorded for any of them within the United Kingdom. Of the patients classified as having cardiac failure, seven had myocardial infarction. Of these, only one left hospital alive; this patient survived the full four years. Four patients had ischaemic heart disease with left ventricular failure, of whom two died in hospital and two survived for four years. The group presenting with cardiac arrest contained six patients with myocardial infarction, of whom only two left hospital alive. Three patients had cardiac arrests in the early postoperative period, and all died in the ITU within 48 hours.

TABLE IV—*Effect of disease category on 100 patients ventilated for more than four hours*

Disease category	No of patients	No (%) of patients surviving:		
		ITU	Ward	4 years
Overdose	7	7 (100)	7 (100)	6 (86)
Cardiac failure	13	9 (69)	3 (23)	3 (23)
Cardiac arrest	10	4 (40)	2 (20)	1 (10)
Respiratory failure	20	14 (70)	11 (55)	6 (30)
Trauma	7	4 (57)	4 (57)	2 (29)
Neurological	7	4 (57)	4 (57)	3 (43)
Postoperative patients:				
With cancer	13	11 (85)	5 (38)	1 (8)
Without cancer	19	13 (68)	11 (58)	8 (42)
Miscellaneous	4	1 (25)		
Total	100	67	47	30

Of the 20 patients presenting with primary respiratory failure, 11 had chronic obstructive lung disease. Five survived the treatment in the ITU but only two were discharged from hospital. Both survived four years but one was disabled with breathlessness. Of the remaining nine patients in this group, all were discharged from hospital and four were alive after four years. The relevant diagnoses were pneumonia (three cases), asthma (two), fibrosing alveolitis (one), pneumocystis (one), pulmonary tuberculosis (one), and pneumothorax (one). Three patients with trauma died in the ITU. The causes of death were head injury, extensive lightning burns to the central nervous system, and adult respiratory distress syndrome. The other four patients in the group were discharged from hospital but two subsequently died from cerebrovascular accidents.

TABLE V—*Mortality figures for patients dying within the ITU*

Mortality (%)	Reference
All patients	
17·5 (mean of 14 ITUs)	BMA report, 1967[8]
16·5-20·4	Safar and Grenvik, 1971[7]
18·0	Rogers *et al*, 1972[6]
12·5	Tanser and Wetten, 1973[1]
16·6	Bell *et al*, 1974[2]
23·6	Young *et al*, 1974[3]
16·4	Present study (all patients admitted)
Patients on ventilators	
30·4	Rogers *et al*, 1972[6]
30·4	Bell *et al*, 1974[2]
33·0	Present study

The group of patients with neurological disease included three with cerebrovascular accidents who died in the ITU. One child with meningococcal meningitis recovered fully, while an adult survived severely disabled. One child with Guillain-Barré syndrome also recovered fully, while another with acute demyelinating disease died six months after discharge. Of the patients admitted postoperatively, those with cancer had a good immediate survival but an extremely poor long-term survival. No clear pattern was seen in the course of patients without cancer, and there were many different causes of death. In four patients surgery was complicated by chronic obstructive lung disease: two of these patients died in the ITU and two survived four years.

Four patients with miscellaneous diseases are included in table IV.

Three of these patients died in the ITU with, respectively, septicaemia, Hodgkin's disease, and tetanus; the patient with tetanus died of adult respiratory distress syndrome. The fourth patient in this group, who had multiple myeloma, died in the ward.

Discussion

Mortality figures for an ITU depend critically on the criteria for admission. A high percentage of patients admitted with only threatened failure of a vital system will lower the mortality, while a high percentage of patients who are irrecoverable will raise it. Nevertheless, immediate mortality figures for deaths within the ITU are surprisingly constant between different units, and our own figures are closely in line with others (table V). Little information is available on mortality in the general ward after transfer from ITUs. Rogers[5] reports a figure of 8% for all such patients, of whom less than half were ventilated. This may be compared with our own figure of 17% of patients ventilated for more than four hours.

The only study of patients after discharge of which we are aware is that by Cullen *et al.*[4] He classified his patients according to the intensity of the care by doctors and nurses. His class 1 corresponds to normal recovery-room practice, while classes 2, 3, and 4 accord with our criteria for admission to the ITU. His class 4 is probably comparable with our own follow-up series, although he did not specify ventilation as a criterion and his patients were primarily admitted after operation. Mortality in his study was 73% at the end of one year, which may be compared with 60% in the present study.

Our results refute any suggestion that artificial ventilation is a wasted exercise in the elderly, at least up to the age of 75. For patients aged over 75 survival in the ITU was actually above the average for all age groups, but mortality on return to the ward was higher and survival after discharge extremely poor. These patients' mean survival after discharge of 1·3 years may be compared with a mean expectation of life of 5·7 years for healthy patients of the same age. Taking all 47 patients who were discharged from hospital, life tables would lead us to expect about four deaths during the four years after discharge if the patients were in normal health. In fact, 17 patients died after discharge.

No firm conclusions can be drawn on the prognostic importance of the duration of ventilation, but, not surprisingly, the best results occurred in patients who needed less than 24 hours' ventilation. Ventilation for more than eight days, however, does not necessarily preclude long-term survival.

Excellent results were obtained in patients who had taken a drug overdose, and good results in patients with respiratory failure due to recoverable neurological causes and respiratory diseases other than chronic obstructive lung disease. Postoperative ventilation was generally rewarding. Disappointing results were obtained in patients with chronic obstructive lung disease, myocardial infarction, and those who presented with cardiac arrest. These conclusions, however, apply only to patients in these disease categories who required more than four hours' ventilation. Good results were obtained in patients in these categories who did not require ventilation. Results were uniformly unsatisfactory in patients with cerebrovascular accidents or head injury, who required ventilation.

This survey shows that, of patients ventilated for more than four hours, 24% were definitely and 30% were probably alive and well after four years. These patients probably owe their lives to the facilities provided by the ITU. Of the patients who did not require ventilation for four hours, 89% survived their stay in the ITU. The cost of an ITU is high. In Cullen's survey[4] total charges were £163 per day (1972-3). Our own costs calculated for 1977-8 were £182 per day. This is over four times the cost of a bed in a general ward and is largely due to the high level of nurse staffing.[6] For ITUs to be used to the greatest effect it is important to define those categories of patients who are most likely to benefit from the facilities that are available. The most important factor is the primary disease, and the present study has adduced some information on the patients most likely to benefit.

We are indebted to Miss Brenda Dobson and a succession of registrars who have assisted with the documentation and location of patients. We should also like to thank Dr T W Meade, of the MRC Epidemiology and Medical Care Unit, for help with actuarial data.

References

1 Tanser, A R, and Wetten, B G, *British Medical Journal*, 1973, **3**, 227.
2 Bell, J A, *et al*, *British Medical Journal*, 1974, **2**, 483.
3 Young, R K B, *et al*, *British Medical Journal*, 1974, **1**, 307.
4 Cullen, D J, *et al*, *New England Journal of Medicine*, 1976, **294**, 952.
5 Rogers, R M, Weiler, C, and Ruppenthal, B, *Chest*, 1972, **62**, 94.
6 Milledge, J S, *Proceedings of the Royal Society of Medicine*. In press.
7 Safar, P, and Grenvik, A, *Chest*, 1971, **59**, 535.
8 BMA, *Intensive Care*, Planning Unit Report No 1. London, BMA, 1967.

(*Accepted 25 April 1979*)

ONE HUNDRED YEARS AGO M Duclaux has communicated to the Société Médicale of Nancy the following observation, which is one of a kind very interesting to practitioners. Being summoned in haste to a child aged four years, he found it in a condition of deep coma. The eyes were immovable and injected, the pupils dilated and insensible to light, the lips red and swollen, the limbs completely relaxed, the respiration stertorous, the pulse slow, hardly 45; the skin was cold, and covered with abundant perspiration. The sheets were wet and orange-coloured. On uncovering the child, it was seen that the urine dribbled away continually. The parents informed M Duclaux that they bought, the day before, twelve lozenges of "anthelmintic chocolate," thinking that their child was suffering from worms, and that they had given him two that morning, but that the boy, being left alone for a short time, swallowed the remaining ten in the space of a few minutes at eight am. The doctor was called in at 10.30 am. As there could be no doubt that the symptoms were due to santonine poisoning, an emetic was given; but the child hardly threw up the contents of half a lozenge. At the same time, energetic frictions were applied. When the patient was seen again, at 1 pm, five hours after the accident, the skin was cold, the respiration much slower, and the pulse 50. The urine was still dribbling away, and of a darker yellow colour. A little ammonia having been added, it took the colour of blood. During the morning, the child had vomited three times, and some particles of chocolate could be traced in the vomited matter. He was again energetically rubbed, mustard poultices were applied to the extremities, and a teaspoonful of a mixture of tea and rum given every fifteen minutes. At 8 pm (twelve hours after the accident), the patient looked better, the temperature and pulse had risen, the latter to 60; the pupils were still dilated; the flow of urine had decreased, and it was reddish; the perspiration still continued. The child gave no answers to questions, and hardly moved. An enema was prescribed for the night, and two or three cups of tea. The next morning at 9 am, the patient was still much exhausted, but had recovered consciousness. Four worms had been passed. He complained of headache and intense thirst, and kept continually rubbing his eyes. He had only passed urine three times in the night; the urine was lemon-coloured. At 9 pm the child was much better; his pupils had recovered their contractility; he sat up in bed and asked for food; his urine was normal. The next day, the child was well. Having learned how much santonine was contained in a lozenge, Dr Duclaux estimated the amount taken by the child at nearly four grains. Santonine is, therefore, more dangerous than is generally thought. It appears in the urine a few minutes after having been taken, and is only eliminated after twenty-four hours. It may produce coma, stupor, and very serious symptoms of depression of the nervous system. Great care must therefore be taken in giving it to children. Even very small doses, such as 75 *milligrammes* (three-fourths of a grain) daily, cause, on the fourth day, nausea and sometimes vomiting, and colour the urine orange or brown. (*British Medical Journal*, 1879.)