PAPERS AND ORIGINALS

Hospital resuscitation from ventricular fibrillation in Brighton

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British Medical Journal, 1979, **1**, 511-513

Summary and conclusions

The overall results over three and a half years of the treatment of ventricular fibrillation secondary to ischaemic heart disease in the Royal Sussex County Hospital were reviewed. Records of all patients who were brought to hospital by resuscitation ambulances or who were admitted to the coronary care unit from any source were analysed. Eighty-seven of the 174 patients (50%) who developed ventricular fibrillation were discharged. The survivors included 13 out of 61 patients (21%) in whom fibrillation was secondary to cardiogenic shock or severe left ventricular failure.

The presence of resuscitation equipment and nursing staff trained to use it in the general wards and emergency areas ensured a uniformly high success rate throughout the hospital, similar to that achieved in the coronary care unit. Prompt defibrillation in the general wards and the accident and emergency department may improve overall survival.

Introduction

Coronary care units were developed primarily to treat ventricular fibrillation in the first few hours after myocardial infarction. Successful defibrillation with long-term survival in high-dependency areas is nowadays unremarkable. Unfortunately, many episodes of ventricular fibrillation occur before admission to hospital[1] or after discharge from specialised units,[2] and resuscitation procedures are not always satisfactory in ambulances, casualty departments, and general wards.

The facilities in Brighton have been arranged so far as possible to permit the prompt treatment of ventricular fibrillation throughout all stages of prehospital and hospital care. The resuscitation ambulance service has been reviewed.[3-4] Inside the hospital resuscitation equipment is available in all general medical wards and emergency areas. It can be used not only by a conventional cardiac arrest team and other junior medical staff, but also by many of the qualified nurses.[5] The importance of prompt defibrillation has been emphasised, conventional cardiopulmonary resuscitation (external cardiac massage and ventilation) being used only when no experienced staff are immediately available or defibrillation is initially unsuccessful.

Methods

We reviewed first episodes of ventricular fibrillation in all patients admitted with acute myocardial ischaemia to the coronary care unit or in those brought by the resuscitation ambulances to the accident and emergency department or the general wards during January 1974 to June 1977. Almost half of the episodes occurred outside the coronary care unit. In a few patients fibrillation was preceded by a period of asystole. Patients who arrived at the hospital with circulatory arrest were excluded.

Both the district coronary care unit and the accident and emergency department are based in the Royal Sussex County Hospital (425 beds), which therefore receives all patients admitted in the resuscitation ambulances and most other admissions for acute myocardial ischaemia. The coronary care unit has four beds and is adjacent to the general-purpose intensive care unit. Prophylactic lignocaine is given routinely by bolus and infusion unless contraindicated. During the study period patients with acute episodes of myocardial ischaemia were nursed in the coronary care unit for an average of 54 hours and subsequently in a general medical ward for a median total hospital admission time of 7·5 days. Monitoring is not usually available in the general wards, but these are of open design with a nursing station placed centrally.

Resuscitation equipment is positioned at key points throughout the hospital. During the study there were eight portable defibrillator-

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monitor units and three less mobile defibrillators with attached monitors. The three medical wards of the hospital are on the same floor, and no medical patient was more than 20 metres from a portable unit. Abnormalities of heart rhythm can be diagnosed promptly in patients without monitors by using defibrillation paddles as emergency electrodes for the electrocardiogram. Emergency drugs and intubation equipment are available in standardised sealed boxes in every ward and some departments throughout the hospital. Once a box has been opened it is repacked and resealed centrally before it is used again. All the ward equipment is portable and no trolley is required in the initial stages of a cardiac arrest. Our policy during the study period was to defibrillate with a DC shock of 200 joules unless circulatory arrest had been present for more than 30 seconds, when 400 joules was used. We now believe that 200 joules or less usually suffices for most cases.[6]

The importance of training non-medical staff in defibrillation procedures is accepted in the hospital. Ward sisters and staff nurses are encouraged to attend the coronary care course, which comprises one 90-minute lecture each week for six months, together with a minimum of one week working full time on the coronary care unit. After completing this course and success in an examination, nurses are encouraged to defibrillate patients without waiting for a doctor to arrive. The accessibility of the equipment means that this can often be achieved within 40 seconds of loss of consciousness due to ventricular fibrillation. In the accident and emergency department the trained resuscitation ambulance men sometimes remain with patients with suspected myocardial ischaemia and accompany them to the coronary care unit with a portable defibrillator-monitor unit. Several patients have been defibrillated by ambulance men in the accident and emergency department, in lifts, and even in the coronary care unit itself.

Myocardial infarction was diagnosed from necropsy findings or by the presence of at least two of the following: typical chest pain; clinically important rise in enzyme concentration; or characteristic electrocardiograms. Patients who died soon after admission in cardiogenic shock or severe left ventricular failure after an episode of chest pain were also included in this group, even if a necropsy was not performed. Acute coronary insufficiency was diagnosed after prolonged chest pain at rest due to acute myocardial ischaemia without evidence of infarction. By primary ventricular fibrillation we mean unanticipated ventricular fibrillation—that is, fibrillation without previously diagnosed cardiogenic shock or severe left ventricular failure. The term "initially resuscitated" implies a return to coordinated effective heart rhythm for at least one hour after ventricular fibrillation.

Results and comment

During the three and a half years 1329 patients with acute myocardial infarction were admitted to the coronary care unit or were treated elsewhere in the hospital after transport in resuscitation ambulances. A further 886 patients were admitted with acute coronary insufficiency. The series does not include patients admitted to surgical wards or a few medical patients with acute coronary disease who were admitted directly to general wards and did not travel in designated ambulances. One hundred and sixty-one (12%) of the patients with myocardial infarction and 26 (3%) of the patients with acute coronary insufficiency developed ventricular fibrillation at some time during their stay in hospital.

The open design of the general wards permits rapid recognition of circulatory arrest; during the study period we have no record of any patient being found dead without the possibility of early indentification of heart rhythm. Records are complete for all but 13 of the 187 patients who had fibrillation, and the results of resuscitation in these 174 patients form the remainder of this report. There were 140 men and 34 women (age range: 40 to 89 years; mean 64). Eighty-seven of the 174 patients (50%) survived to leave hospital (table I).

TABLE I—*Number of patients who went into ventricular fibrillation after myocardial infarction or acute coronary insufficiency and number (%) who survived to be discharged*

Myocardial infarction		Acute coronary insufficiency (primary)	Total
Primary	Secondary		
89	61	24	174
55 (62)	13 (21)	19 (79)	87 (50)

The results were analysed by location in the hospital when the arrest occurred (table II). The chances of success were highest in the accident and emergency department. The success rate in the general wards was similar to that in the high-dependency areas (coronary care unit and intensive care unit). The time between admission to hospital and the occurrence of ventricular fibrillation was known for the 138 patients admitted in the resuscitation ambulances (table III). The prospects of a successful outcome were only slightly better for those who developed ventricular fibrillation in the first two hours after arrival in hospital compared with those who developed fibrillation later. Twenty-two of the 138 patients had already been successfully defibrillated by ambulance men.

TABLE II—*Incidence and outcome of fibrillation by location. Figures are numbers (%) of patients*

Location	Ventricular fibrillation	Initially Resuscitated	Discharged
Accident and emergency	42	40 (95)	25 (60)
CCU or ICU	93	67 (72)	44 (47)
General ward	38	28 (74)	17 (45)
X-ray dept	1	1	1
Total	174	136 (78)	87 (50)

CCU = Coronary care unit.
ICU = Intensive care unit.

TABLE III—*Time between admission and onset of ventricular fibrillation for patients admitted in resuscitation ambulance*

Duration (hours)	No with ventricular fibrillation	No (%) discharged
$<\frac{1}{2}$	42	22 (52)
$\frac{1}{2}$-2	18	11 (61)
2-24	32	13 (41)
>24	46	22 (48)
Total	138	68 (49)

Resuscitation by nurses was usual in the coronary care unit, and commonplace in the general wards, especially at night. Unfortunately, our records do not provide an accurate measure of the proportion of defibrillation procedures undertaken by nursing staff. Chronic brain damage was rare. Some patients were unconscious for several days after prolonged or repeated resuscitation, but a return to apparently normal cerebral function usually followed over the next fortnight. One 55-year-old man sustained severe brain damage after repeated resuscitations for recurrent ventricular fibrillation. Eighteen months later he was unable to live independently. No other patient in this group was left with noticeable brain damage.

Discussion

Comparison of results after the treatment of ventricular fibrillation are difficult, for no two reports deal with similar populations. In some published series 40-70% of the patients who developed primary ventricular fibrillation in coronary care units were discharged,[7-9] but the description of ventricular fibrillation as "primary" was necessarily subjective. Moreover, many episodes of fibrillation occur elsewhere in the hospital and the chances of long-term success after resuscitation outside a coronary care unit have been reported to be small.[10]

Our overall results, particularly outside the high-dependency areas, compare favourably with those of most previous accounts. Half of the patients with acute myocardial ischaemia who developed ventricular fibrillation anywhere in the hospital were discharged. In many of the fatal cases, the ventricular fibrillation was clearly an inevitable terminal event. By contrast, Messert and Quaglieri[11] reviewed 183 patients with cardiac arrest due to various causes throughout a general hospital: only 11 were discharged. Concentrating on cardiac arrest outside a coronary care unit, Peatfield and colleagues[2] found a 15% long-term survival rate after arrests secondary to myocardial infarction.

They had a higher success rate in the accident and emergency department where the defibrillator was kept.

Two main reasons may account for our relatively high success rate. The availability of resuscitation ambulances encourages earlier admission after infarction[3] and therefore leads to more primary fibrillation in hospital. Of the 68 survivors of circulatory arrest who were admitted in these ambulances, 22 were resuscitated within 30 minutes of arriving at the hospital. In more conventional circumstances most of these 22 patients might have developed ventricular fibrillation before admission. The second reason is immediate access to resuscitation equipment throughout the hospital and the ability of nurses on the open general wards to defibrillate promptly on their own initiative. We believe that the chances of ultimate success are inversely related to the duration of the circulatory arrest, which must be shorter when observation is close and suitably trained personnel are at hand.

The role of coronary care units is being debated and it is becoming clear that some patients with an acute myocardial infarction can be managed at home,[12 13] particularly when complications are absent and diagnosis is made three or more hours after the onset of symptoms. We emphasise that our high success rate for defibrillation in general medical wards does not imply that a specialised unit is unnecessary. We believe that one of the principal functions of a coronary care unit is to train doctors and nurses from all areas of the hospital in resuscitation procedures. The influence of a successful unit should extend throughout the general wards and into other departments. We believe that our results underline the value of this philosophy. There is no real paradox in the statement that only a hospital with an efficient coronary care unit does not then need one.

Defibrillators and monitoring equipment have been donated by the Brighton Rotary Club, Brighton Lions, Hove Lions, and Hove Round Table. Contributions have also been made by many private individuals. Our resuscitation system could not have functioned so effectively without this help. Many nurses have studied long hours in their own time in order to play a leading part in resuscitation procedures.

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(*Accepted 7 November 1978*)

Current required for ventricular defibrillation

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British Medical Journal, 1979, **1**, 513-514

Summary and conclusions

The mean current required for ventricular defibrillation was measured and found to be 0·35 ± SE 0·03 A/kg body weight, which is about one-third of that predicted from animal experiments. There was no apparent correlation between the current required and body weight (r = −0·007 ± SE 0·213).

There is no evidence of need for defibrillators storing more than 400 J.

Introduction

A major problem regarding ventricular defibrillation is to determine the energy required for consistently effective treatment. Geddes *et al*[1] postulated that current, particularly current/kg body weight, is a better measure of requirements. We have therefore measured the peak current required for ventricular defibrillation and report here our results.

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Methods

Two DC defibrillators were modified by placing a 1 Ω resistor in series with the paddles. The peak current discharged through the resistor (and hence through the chest) was measured by an electronic circuit incorporated in the defibrillator. Results were displayed digitally. The defibrillators were sited in the coronary care unit and on the resuscitation trolley. Patients with ventricular fibrillation were given a shock of 100 J; if this failed 200 J was given (see table). In the few patients in whom low energy was unsuccessful ventricular fibrillation was terminated with 400 J. On each occasion the peak current was noted. The patients were weighed as soon as possible after resuscitation.

Results

Out of 24 patients resuscitated, 20 had acute myocardial infarction. The table gives the age and weight of the patients and the current required. The figure shows the minimum peak currents required plotted against body weight and the stored energy required in each

Details in 24 cases of patients resuscitated with shocks of 100, 200, and 400 J of stored energy. Mean values expressed ± SE

	Stored energy (J)		
	100	200	400
No of patients treated	9	11	4
No with primary ventricular fibrillation	6	7	4
No with myocardial infarction	9	8	3
Mean weight (kg)	65·5 ± 3·9	66·8 ± 3·1	67·2 ± 3·1
Mean age (years)	63·1 ± 4·3	59·2 ± 3·2	60·8 ± 5·6
Mean current (A)	17·9 ± 1·8	22·1 ± 2·4	39·3 ± 6·0