A clinical audit of cardiopulmonary resuscitation

ABSTRACT—The structure, process and outcome of cardiopulmonary resuscitation (CPR) at one hospital have been reviewed to determine where failings in the system could be improved, whether the existing training programme was adequate and well directed, and whether survival rates were reasonable. In the first seven months 143 reports were received; 49% of them were cardiac, 17% respiratory, and 24% mixed cardiorespiratory arrests. Overall, immediate survival was 43% of those with cardiorespiratory arrests. Seventy per cent of the immediate survivors were alive at 24 hours, and 69% of them survived to six weeks or beyond. The most important indicator for a successful outcome was the heart rhythm at the time of the resuscitation team’s arrival, with 71% surviving from ventricular fibrillation, 20% surviving from apparent asystole, and only 9% surviving from electromechanical dissociation. No patient with the latter two rhythms survived to six weeks or left hospital. Neither the location or time of the arrest, nor the patient’s age influenced the immediate survival. The audit revealed a need to improve telephone connections to the hospital switchboard, modify some equipment, and improve knowledge of the geography of the hospital site. Changes in emphasis in the training programme will alter the process of resuscitation. Outcome measures indicate that survival figures are comparable with published data, including recent data which act as a benchmark for quality control.

The United Kingdom Resuscitation Council recommended techniques of basic life support in 1982 and of advanced life support in 1984. They were modified in 1989 [1] and provide an excellent basis for the training of nurses, junior doctors and other NHS staff. At the City Hospital in Nottingham, such training has taken place for four to five years, but interest in its effectiveness grew with the introduction of the hospital Resuscitation Working Group. As in many other hospitals, there was no measure of the number of arrest calls or success rate for resuscitation in either the short or the long term. The team’s general impression was that resuscitation attempts were frequently unsuccessful except for patients on the coronary care unit. Previous published data were less pessimistic, reporting immediate survival rates of 39% from resuscitation [2]. Recommendations that each hospital should audit resuscitation [3] have not been quickly adopted, though recently the overall results of a survey conducted in 12 British hospitals have been reported [4].

We organised an audit of cardiopulmonary resuscitation to determine the number of ‘cardiac arrest’ calls made by the hospital switchboard and to measure short-term survival in patients who had been resuscitated. It was hoped that reporting problems in a systematic way would identify common failings in cardiopulmonary arrest procedures, and that data on types of cardiac arrests, initial rhythms, and survival would lead to changes in the teaching of advanced life support. Before this audit took place the emphasis of training in advanced life support was on the management of ventricular fibrillation and asystole, while electromechanical dissociation and other rhythm disturbances were covered more briefly.

Methods

The audit began in September 1991 after a two-month pilot period to test data collection procedures. Details of all cardiopulmonary arrest calls were reported on a proforma by the team leader. The top copy was filed in the patient’s notes, and the undersheet was collected by the arrest audit co-ordinator who stored the data using a customised computer programme. The completeness of reported arrests was cross checked with hospital switchboard’s list of arrest calls. The resuscitation team leader for the relevant day was contacted if a form was not received when an arrest call had been made.

The audit form collected essential information about the patient, details of the site and place of cardiac arrest, and the number and seniority of members of the resuscitation team. The team leader was asked to classify the type of arrest calls (cardiac, respiratory, mixed cardiorespiratory, not an arrest, or other), the primary diagnosis (myocardial infarction, airways disease, carcinoma, less than five days after an operation or to specify any other) and the initial heart rhythm on arrival of the team (ventricular fibrillation (VF), asystole, or other). Simple details of basic life support, intravenous access, defibrillation, and drugs used were recorded. The duration of the resuscitation, its immediate outcome, and place of subsequent care of sur-

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vivors were noted, and there was room on the form for a free text section (with prompts) for specific difficulties or comments. Any difficulties in interpreting the responses on the forms were dealt with by a doctor (AMcI) or, if need be, referred to the relevant resuscitation team leader. Omissions in data collection which could not be corrected later resulted in a few patients’ data being excluded from some of the analyses. Survivors were followed up at intervals by the audit co-ordinator by reviewing ward discharge books, hospital records, and/or the patient’s notes.

We report here the overall success of resuscitation, and the importance for the final outcome of the initial rhythm, location, age of the patient, time of arrest, and duration of attempts. A measure of survival to discharge from hospital and some of the problems identified in the process of resuscitation are presented.

Results

General

Details of 143 resuscitation calls were recorded over the seven months from 1 September 1991, ie an average of 20 per month. Initial reporting rates of 50% have improved rapidly and now more than 95% of resuscitation calls are being traced by the audit co-ordinator; the few calls not reported were usually in patients who had not had a cardiopulmonary arrest.

Altogether, 60 patients (43%) survived as the result of CPR. Cardiac arrests accounted for 70 (49%) of the 143 arrest calls, 25 (17%) were respiratory, 35 (24%) mixed cardiopulmonary and 12 (8%) were non-cardiac events, eg epileptic fits, hypoglycaemia. Fifty-eight (44%) of those who had cardiac, respiratory, or mixed types of arrest survived through the arrest period; survival was better in those with respiratory arrest (68%) than in those with cardiac arrest (36%) \( \chi^2 = 7.78 \) \( p < 0.01 \).

Importance of initial rhythms

In the 133 patients who had cardiopulmonary arrests or events with changes in cardiac rhythm, 21% had ventricular fibrillation, 23% had asystole, 17% had electromechanical dissociation, and 47% had other rhythms on the arrival of the resuscitation team. After CPR survival rates between these groups were significantly different; patients with ventricular fibrillation did better (71% - 20/28) than those with asystole (20% - 6/30, \( \chi^2 = 15.5 \ p < 0.001 \)) or electromechanical dissociation (9% - 2/23, \( \chi^2 = 20.3 \ p < 0.001 \) (Fig. 1). The distribution of rhythms in the groups comprising ‘others’ was diverse with variable success rates for resuscitation (Fig. 2).

Importance of the location of arrest

The majority of cardiopulmonary resuscitation was performed on medical (35%), or geriatric (25%) wards or the coronary care unit (CCU) (18%), with only 25% occurring elsewhere. There was no significant difference between initial outcome of resuscitation in the locations studied (immediate survival for medical 21/50, for geriatric = 17/36, for CCU = 17/27, for other = 15/30), though a trend suggesting higher response rates in the coronary care unit was evident. Subgroup analysis suggested that response rates forVF arrests were similar in medical wards (83%), geriatric wards (86%), and coronary care units (75%). More asystolic arrests were observed on medical wards (\( n = 13 \)) and geriatric wards (\( n = 7 \)) than on coronary care unit (\( n = 4 \)). Similarly more non-VF, non-asystolic arrests occurred on medical (\( n = 26 \)) and geriatric (\( n = 20 \)) wards than coronary care unit (\( n = 9 \)), though the immediate survival rates from the resuscitation were similar (42%, 45%, and 55% respectively).

Importance of age

Survival through the initial resuscitation varied from 67% in those less than 60 years old, through 48% in those aged 60 to 79, to 14% in those aged 80 or over (\( r = -0.83 \), \( p = ns \)). Subgroup analysis again suggested
that the lack of success in the elderly group (age > 80 years) was due to asystolic (0/8 survived) and other initial rhythms (primarily electromechanical dissociation where 1/12 survived). The two aged over 80 years old, with an initial rhythm of ventricular fibrillation, both survived the arrests.

Importance of time of arrest

To analyse the importance for success or failure of the time of day at which resuscitation occurred we divided the 24 hours into a day (0900 to 2100) and a night (2100 to 0900) period. These times roughly cover a nursing night shift and/or the time when junior doc-

Fig. 2. An analysis of the immediate outcome of resuscitation attempts in patients whose initial rhythm was not ventricular fibrillation, asystole or electromechanical dissociation. AF/flutter=atrial fibrillation/flutter, brady-cardia-sinus, first or second degree heartblock, CHB=complete heartblock, idioventricular=idioven-tricular rhythm, SVT=supraventricular tachycardia, sinus=sinus rhythm or tachycardia, VT=ventricular tachycardia, other=a selection of other abnormalities, no record=those in whom no record of the initial rhythm was available.

The duration of CPR attempts was recorded in 106 arrests. The mean duration of resuscitation attempts was 15.8 min, with a range of 1 min to more than 30 min. The proportion of patients surviving arrests appeared unrelated to the duration of the resuscitation attempts except for those being successfully resuscitated within the first 5 min (94% - 15/16). For subsequent 5-min time periods, 8-45% of patients survived with minimal success at the 10-15 min period, and thereafter success up to 45%, indicating that success was not simply related to the duration of attempts (Fig. 3).

Fig. 3. An analysis of the duration of resuscitation attempts and its relationship to survival through the arrest. The length of time from arrival of the resuscitation to termination of attempts (presented as five min time intervals) and the immediate outcome of the attempt was recorded on the audit proforma by the team leader.
Longer term outcome

Twenty-four-hour survival following CPR occurred in 42 patients (29% overall), which represented 70% of those whose resuscitations were initially successful. By 48 hours a further six died, and seven more died while in hospital. At the time of analysis, 22 patients (15% of those surviving through resuscitation) were alive (19 discharged, three inpatients). These figures represented a conservative measure of success since details of seven patients could not be traced. This indicates that 69% of survivors at 24 hours after the arrest survive a median of more than six weeks after resuscitation.

None of the 19 long-term survivors who left hospital had either asystole or electromechanical dissociation as an initial rhythm at the time of CPR. Nine had ventricular fibrillation (associated with a myocardial infarction) five had bradycardias, and seven had respiratory arrests without serious arrhythmic events complicating them.

Recording difficulties and comments

Several difficulties were reported with the structure and process of resuscitation. In one case a seven-minute delay occurred while an area not connected directly to the hospital switchboard attempted to summon help. Delays occurred because some newly appointed doctors were unfamiliar with outlying areas of the hospital campus; some equipment appeared to give repeated problems, most often connectors for endotracheal tubes and masks; some delays and logistical problems recurred following successful resuscitation in transferring patients from the geriatric block to high-intensity nursing areas (e.g. the coronary care unit).

Discussion

Cardiorespiratory arrest is one of the commonest medical emergencies. Clear guidelines exist for management which depends primarily on the cardiac rhythm disturbance. Yet recommendations that cardiopulmonary resuscitation is an ideal subject for clinical audit [3] appear to have resulted in relatively few attempts at measuring and monitoring the quality and outcome of resuscitation attempts. We have introduced a simple system which records details of the arrest and outcome. Data collection is probably successful because of the design of the form which avoids duplication of records by busy doctors, and due to the enthusiasm of the audit co-ordinator. We are continuing to make refinements but data collection methods are now established and over the next few years will permit comparisons of outcome and types of arrest. Our experience has indicated that the audit of resuscitation rapidly produced evidence of the quality of care provided and identified defects in the structure, process, and outcome of resuscitation attempts.

The immediate survival rate of 43% following CPR which we have observed is comparable to rates from other recently reported studies (34–44%) [4–6]. These results indicate that the standard of resuscitation at the City Hospital, Nottingham, is similar to those reported from other units. These units may have a higher success rate than other hospitals because of local interest and possible reporting bias. Our immediate success rate is not likely to be due to selection bias because the majority of arrests have been recorded. Other measurements are distributed similarly to those in the reported studies, e.g. the type of arrest: cardiac 50%, respiratory 18%, mixed 24%, compared with 56%, 11%, and 18% respectively from a recent large audit [4]. Our higher success rate for respiratory arrests than for cardiac arrests is not in agreement with previous studies and remains unexplained. The number of such arrests is at present too small to allow us to draw any conclusions.

Our data agree with previous studies [7] that immediate survival is far more likely from an arrest where the initial rhythm was ventricular fibrillation than asystole or electromechanical dissociation. A recently described prognostic index [8] suggests that the initial rhythm is the most important determinant of survival through resuscitation, with 47% success in those with ventricular fibrillation. Not only did more patients in this group survive after resuscitation but this group was also the largest of those who were able to leave hospital. These figures are encouraging since they suggest that the resuscitation training, accessibility of defibrillators (recently relocated on the recommendations of our Resuscitation Working Group), and the skill of the resuscitation teams are all good. Whether further improvements in any of these areas will substantially increase survival is unclear since little or no data are available indicating better success in unselect ed groups.

In contrast, the survival from asystolic or electromechanical dissociation arrests was poor, though our data agree with previous reports both in the relative frequency of each initial rhythm at arrests and in survival figures [2,6]. None of our patients left hospital when either of these disturbances was witnessed as the initial rhythm. Stueven et al [9] studied the effect of atropine in asystolic arrests, and though six of 43 patients who received atropine were resuscitated compared with 0 of 41 controls, none left hospital. In another study, only one of 90 patients presenting with electromechanical dissociation survived to hospital discharge [10]. The poor survival with these rhythms would appear to be a reflection of the grave prognosis of the underlying disease process and the lack of effectiveness of recommended treatments rather than an indictment of our training and skills. Nonetheless, the results suggest that we should change the emphasis of training. We support the concept of attempting defibrillation for asystole when ventricular fibrillation cannot be excluded [11], because evidence suggests that
changes in rhythm can occur in 8% of such circumstances [12]. Experience suggests that a search for a cause of electromechanical dissociation is often slightly delayed. A prompt assessment of treatable causes of secondary electromechanical dissociation (hypovolaemia, pneumothorax, cardiac tamponade) should be instituted and corrected if present. Some evidence points to the efficacy of $\alpha$-adrenergic agonists [13] but any major changes in advice are likely to depend on further research.

The place where resuscitation was carried out did not affect the success rate. The trend for better initial survival in the coronary care unit appeared to be due to the smaller numbers of asystolic and electromechanical dissociation arrests in that group. This contrasts with a recent report [4] where survival through the arrest was worse on general wards than in specialist areas. However, outcome related to rhythm type has not yet been reported from the BRESUS study [4]. The high initial survival rate for elderly patients with ventricular fibrillation indicates that the initial rhythm is more important than age in determining reversibility of the situation. The trend towards a worse prognosis with increasing age appears to be related to a greater likelihood of the patient presenting with an irreversible rhythm disturbance. The final outcome also depends on co-morbidity [6]. We have not recorded that because of the extra burden on the reporting doctor and the fact that ‘not for resuscitation’ orders might bias the data. The effect of such ‘not for resuscitation’ orders on our results are not clear, but might account for the somewhat lower frequency of asystolic arrests reported from the geriatric unit than from the medical wards. An audit of ‘not for resuscitation’ orders would be of great interest.

We have not analysed the time taken for the full resuscitation team to assemble. Rapid institution of basic life support, performed well with prompt backup with advanced life support measures, is known to be important [1]. Nurses and non-medical staff have had resuscitation training in our hospital for some time. However, we recognised that at night the number of nursing staff and non-medical staff is substantially lower than during the day, and doctors are often further away from the wards where arrests are most likely. Nonetheless, the similar resuscitation success rates for each of the different initial rhythm types indicated that any differences in the speed of instituting basic and advanced life support were of minor importance to outcome. The number of asystolic arrests was not appreciably higher at night than during the day, suggesting that delays in the arrival of the resuscitation team were not so great as to allow conversion of ventricular fibrillation arrests to asystolic ones.

It is interesting that the proportion of subjects surviving resuscitation appeared to be independent of the duration of resuscitation. This is probably because resuscitation attempts are terminated early in some patients when the rhythm disturbance is deemed to be irreversible, while in patients with a potentially reversible pathology attempts continue. It would appear that there is no clear time at which attempts should be discontinued without due regard to the cardiac rhythm. This contrasts with evidence from other studies which suggested that survival from an arrest lasting longer than 15 minutes was extremely low [7]. Prolonged resuscitation may be appropriate for ventricular fibrillation and some other rhythm disturbances in the hope of a response.

The free text section of the report indicated a series of problems. Some were easy to correct at low cost and probably depended on the local situation (eg linking patient areas to switchboard). Problems with pieces of equipment not fitting together may be improved by centralising the packing and checking of equipment; this has proved to be effective elsewhere. The Resuscitation Working Group now issues a quarterly revision of the approved contents of cardiac arrest trolleys (including drugs). This heightens awareness and ensures all equipment is compatible.

Conclusion

This audit has shown that resuscitation from cardiac arrest due to ventricular fibrillation is as good in our unit as reported elsewhere, and that success depends only to a small extent on the patient’s age or location. Asystolic and electromechanical dissociation arrests have a poor outcome and training is being altered to take account of this, though no great improvements in recovery from such rhythm disturbances should be expected. As a result of the audit, several minor changes in structure and equipment have been recommended in the hospital. The process of resuscitation is being changed by adaptation of the training programme.

Most, if not all, hospitals should audit the quality of resuscitation since it is one of the commonest medical emergencies. Simple audit is likely to change both the structure and process of resuscitation. Our data and those of other studies [4] indicate the levels of immediate and long-term survival which should be achieved.

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