Management and health status in the first year after out-of-hospital cardiac arrest

ABSTRACT – The one-year survival, functional and cerebral capacity and patient management following out-of-hospital cardiac arrest were examined in a follow-up study of 143 prospectively identified patients discharged from a West Yorkshire hospital between January 1987 and July 1993. One-year survival was 87%; 13 of the 18 deaths were cardiac related; 89% of survivors had no further cardiac related admissions; 98% of patients surviving to one year were capable of independent daily activities. There was low utilisation of simple drug therapy: 23% of patients were discharged taking beta-blockers and 52% aspirin; 50% of patients discharged after a primary arrhythmic event were taking antiarrhythmic therapy or were given an implantable defibrillator. Irrespective of the availability of invasive cardiac facilities, there was underutilisation of investigations: only 39% of patients were seen by a cardiologist and 54% were not evaluated for ischaemic risk. Significant improvements in patient management could probably be achieved quickly without substantial increases in resources.

Despite advances in the management of patients with known ischaemic heart disease, sudden cardiac death remains a major cause of mortality. It has been estimated that approximately 30 sudden cardiac deaths per million population occur each week in industrialised countries. The majority of these deaths occur outside hospital2-4. A large proportion of these are attributable to ventricular fibrillation (VF). The development of systems for intervention in patients suffering an out-of-hospital cardiac arrest has enabled some patients to survive such an event5-8. Studies have reported up to 40% of patients being successfully resuscitated and admitted to hospital9, and up to 25% of patients eventually being discharged alive10.

Patients surviving an out-of-hospital cardiac arrest merit special attention. Previous studies have shown a high subsequent mortality (1- and 2-year sudden death rates in the ranges 10-35% and 15-47% respectively) in patients surviving an episode of VF unassociated with acute (Q-wave) myocardial infarction9,10,11. These heterogeneous patients require investigation and treatment following resuscitation. Aggressive treatment with antiarrhythmic therapy11,12 and/or the use of automatic implantable cardioverter defibrillators (AICD)15,16 has been advocated for patients who remain at high risk for recurrence of VF. There have, however, been no randomised, controlled trials of AICD. An increased frequency of sudden death has been reported with empirical antiarrhythmic therapy17.

Previous studies suggest that significant deficiencies may exist in the management of patients surviving an out-of-hospital cardiac arrest3,6,18,19. These studies concentrated on management in the predischarge hospital period or on long-term survival rates. Appropriate investigations may occur following hospital discharge. This is particularly so in the United Kingdom, where a high proportion of investigations occurs on an outpatient basis and sometimes in a different hospital. Little is known about the long-term cerebral and functional capacity of these patients20. This study addresses patient management both prior to hospital discharge and in the following 12 months, from a well defined geographical area. Its aims were to assess 1-year survival, together with cerebral and functional capacity, following an out-of-hospital cardiac arrest within West Yorkshire, and also patient management in the first year after discharge and the influence of the availability of invasive cardiac facilities.

Methods

The West Yorkshire Metropolitan Ambulance Service (WYMAS) attends a predominantly urban population with some rural components, totalling approximately 2.2 million people. Paramedic staff, that is ambulance personnel trained to give advanced cardiac life-support, were first introduced in 1986. Since the initiation of paramedic training in 1986, each of the 9 districts within the West Yorkshire region has had increasing numbers of paramedical staff. During the first 2 years of this study, as described previously21,22, these staff were sent out in a rapid-response vehicle backed up by a conventional ambulance. In October 1988 this system was discontinued and paramedic staff have since been sent out in standard emergency vehicles. Since 1990 all ambulances responding to emergency calls have had advisory defibrillators (devices capable of analysing electrocardiographic recordings and advising if defibrillation is appropriate or not) with trained ambulance technicians. Ambulance technicians are basic trained ambulance personnel, able to use advisory defibrillators but unable to give additional advanced cardiac life-support. By July 1993, 95 (22%) of the ambulances responding to emergency calls contained a paramedic.

P D BATIN, MD, MRCP, Senior Registrar in Cardiology
J BANNISTER, BSc, Senior Physicist
M RYDER, Research Assistant
A F MACKINTOSH, MD, FRCP, Consultant Cardiologist
St James’s University Hospital, Leeds
Within West Yorkshire there are two teaching centres with invasive cardiac facilities, both in Leeds. At the time of this study none of the surrounding district general hospitals had invasive cardiac facilities, except for one hospital which opened a catheter laboratory in January 1993.

Patient identification and follow-up

Patients discharged from hospital following an out-of-hospital cardiac arrest were prospectively identified from WYMAS data sheets in conjunction with hospital notes. Patients of trauma, suffocation and drowning were not included. Resuscitations were defined as ‘initially successful’ if cardiac output was restored, and ‘survivors’ as patients discharged from hospital. Patients were categorised as having sustained an acute myocardial infarction or a primary arrhythmia on the basis of the diagnosis made by their attending physician. We reviewed all the patients’ hospital notes to look for electrocardiographic evidence of new Q-wave formation and the results of cardiac enzyme analysis.

Long-term follow-up of patients was by a review of hospital, general practitioner and Family Health Service Authority records. Patients were prospectively registered with the Office of Population Censuses and Surveys who reported all subsequent deaths to us, and provided a copy of the death certificate. Data analysis is for patients attended from January 1987 to July 1993, with potential for 1-year follow-up to July 1994.

Data analysis

We analysed data pertaining to mortality, patient management (and the influence of ‘readily available’ invasive cardiac facilities, which we defined for the purpose of this study as meaning within the same building or a nearby hospital), cardiac events requiring further hospital admissions, and functional capacity of survivors 1 year after hospital discharge. Patients were reviewed in hospital or records obtained from the patients’ general practitioners to assess functional capacity. Assessments were made using the widely adopted Glasgow-Pittsburgh cerebral (CPC) and overall (OPC) performance categories (Table 1)\(^2\).\(^3\)

Statistical analysis

We calculated Kaplan-Meier survival functions to display graphically the survival experience of the patients over a 4-year interval. Comparisons of drug therapy, investigation and interventions were made using Fisher’s Exact test. Two-tailed \(p\)-values are quoted, with \(p < 0.05\) regarded as significant. Comparison of survival in patients aged 65 years or under was made with that for patients over 65 using a log rank test.

Results

During the study period January 1987 to July 1993, 2,398 patients were recorded as suffering an out-of-hospital cardiac arrest and attempted resuscitation by West Yorkshire ambulance staff. Some additional resuscitations were not recorded in a 10-month period during 1989–90 owing to industrial action.

Ventricular fibrillation or ventricular tachycardia (VF/VT) was the first recorded rhythm in 1,208 (50%) patients. Asystole, electromechanical dissociation (EMD) or other rhythms was found in 1,153 (48%) patients. In 37 (2%) patients no rhythm was recorded. Of these attempted resuscitations, 318 (13%) patients were admitted and 143 (6%) were subsequently discharged (131 VF/VT, 8 asystole/EMD, 4 from unrecorded rhythms).

Discharged patients

Of the 143 discharged patients aged 18–89 years (mean 62 years), 99 (69%) were male and 44 (31%) female; 117 (82%) were diagnosed by their attending physician as having sustained an acute myocardial infarction and 26 (18%) as having a primary arrhythmia. In this unselected population, from a wide range of hospitals, the majority of patients were admitted under general physicians and not under the care of a cardiologist. On review of the clinical data available for the patients diagnosed as having sustained an acute myocardial infarction, 66 developed new Q-waves, 50 did not develop Q-waves (10 of whom had no elevation in cardiac enzymes); for one patient no electrocardiogram was available. Two patients diagnosed as having had a primary arrhythmic event developed new Q-waves. There was a past history of ischaemic heart
disease (previous myocardial infarction or angina) in 62 (43%) patients.

Long-term follow-up/mortality

Of 143 patients discharged over the 7-year study period, none was lost to follow up which ranged from 12 to 90 months. One-year survival for patients discharged following an out-of-hospital cardiac arrest was 87% (Fig 1). Of the 18 deaths in the first year, 13 (72%) were cardiac related (or sudden and therefore assumed to be cardiac related). Of the 13 (62%) cardiac related deaths, 8 occurred in patients diagnosed as having an acute myocardial infarction at the time of their initial presentation. This represents a first-year mortality of 6.8% for the 117 patients diagnosed as having sustained an acute myocardial infarction. Cardiac related mortality in patients diagnosed as having had a primary arrhythmic event was 19% (2 cardiac deaths and 3 sudden and therefore assumed to be cardiac related). If we analysed mortality occurring within the first year in terms of electrocardiographic evidence of new Q-wave formation, 6 (9%) of the 66 patients with new Q-waves died, compared with 12 (24%) of the 50 patients without diagnostic electrocardiographic changes. A Kaplan-Meier survival curve for all patients is shown in Fig 1.

Cardiac events requiring further hospital admissions

Of the 125 patients who survived for the first year, 111 (89%) had no further cardiac related admissions in that year (excluding admission for elective investigations or procedures). All the cardiac related admissions occurred in patients diagnosed as having sustained an acute myocardial infarction at the time of their out-of-hospital cardiac arrest. Patients diagnosed as having had a primary arrhythmic event had no further cardiac related admission during their first year of follow-up.

The influence of age on survival and further cardiac related admissions

Of the patients discharged, 78 (55%) were aged 65 years or under. One year after discharge, 71 (91%) of these patients were alive compared with 54 (83%) of those older than 65 (chi-squared = 5.53, p < 0.02). Age was not a significant factor in further cardiac related admissions, which occurred in 9 (12%) of the younger age group and 5 (8%) of the older patients.

Functional capacity

Assessments of functional capacity were made using the Glasgow-Pittsburgh cerebral and overall performance categories. OPC and CPC scores were available for 133 (93%) patients at discharge and 139 (97%) at 1 year.

At the time of hospital discharge, OPC and CPC scores were as follows: 116 (87%) category I, 14 (11%) category II, 3 (2%) category III, and no patients in categories IV or V. OPC and CPC scores 1 year after discharge are shown in Table 2. At 1 year, of the 121 (97%) patients who survived and had OPC and CPC scores available, 103 (85%) were in OPC category I and 111 (92%) in CPC category I. By definition, these patients had only minor psychological, neurological or functional disability. Of those patients surviving to 1 year, 98% were in OPC and CPC categories I or II,

Fig 1. Kaplan-Meier survival curve (with 95% confidence intervals) of 143 patients discharged following out-of-hospital cardiac arrest in West Yorkshire from January 1987 to July 1993.
charged taking aspirin than of those who had had a primary arrhythmic event ($p = 0.002$) (see Table 3). The converse was true for antiarrhythmic therapy ($p = 0.004$). Similar proportions of patients were discharged taking diuretics and angiotensin converting enzyme inhibitors.

There were no significant differences in drug therapy at the time of hospital discharge between teaching hospitals and non-teaching hospitals. The proportion of patients discharged taking aspirin and beta-blockers was relatively low from both institutions. Of the 26 patients diagnosed as having a primary arrhythmic event 13 (50%) were discharged from hospital taking antiarrhythmic therapy or with an AICD.

### Patient investigation and intervention

Cardiac investigations, interventional and revascularisation procedures performed in the first year are summarised in Table 4. Of the 77 (54%) patients not assessed for ischaemia risk (by exercise tolerance testing, isotope scanning or coronary angiography), 92 were aged under 65, 33 between 65 and 74 and 12 over 75 years old. Of the 18 patients who died in the first year (16% (89)) were not subjected to any of these three investigations. Although teaching hospitals were more aggressive investigators than non-teaching hospitals, both made little use of simple diagnostic procedures; their overall rates of revascularisation were similar. Electrophysiological evaluation (including signal-averaged electrocardiography) of arrhythmic substrates was performed in 9 (6%) patients. Permanent pacemakers were implanted in 5 (3%) patients and 3 (2%) received an AICD.

During their admission, 56 (39%) patients were seen by a cardiologist. Of these patients, 26 (46%) had an exercise tolerance test, isotope scanning or coronary angiography, compared with 24 (28%) of those not seen by a cardiologist ($p = 0.03$). Altogether 63 (44%) patients were not seen by a cardiologist and did not have any of these three investigations.

### Table 2. Number of patients in the various overall performance and cerebral performance categories at hospital discharge and one year after. Scores were available for 133 (97%) of the 143 patients at discharge and 121 (97%) of the 125 who survived to 1 year.

| Category | Overall performance | Cerebral performance |
|----------|---------------------|----------------------|
|          | At discharge | At 1 year | At discharge | At 1 year |
| I        | 116        | 103       | 116        | 111       |
| II       | 14         | 15        | 14         | 7         |
| III      | 3          | 3         | 3          | 3         |
| IV       | 0          | 0         | 0          | 0         |
| V        | 0          | 0         | 0          | 0         |

### Table 3. Drug therapy at the time of hospital admission and discharge, and changes made from admission to discharge; 117 of the 143 patients had suffered an acute myocardial infarction (AMI) and 26 had not.

| Admission | Discharge | Change |
|-----------|-----------|--------|
|            | AMI n (%) | No AMI n (%) | Total n (%) | AMI n (%) | No AMI n (%) | Total n (%) | Stopped n (%) | Started n (%) |
| Aspirin    | 12 (10)   | 2 (8)     | 14 (10)    | 68 (58)   | 6 (23)†      | 74 (52);$    | 3 (2)       | 63 (44)       |
| Diuretics  | 29 (25)   | 12 (46)*  | 41 (29)    | 50 (43)   | 12 (46)‡     | 62 (43);$    | 12 (8)      | 33 (23)       |
| Beta-blockers | 16 (14)   | 2 (8)     | 18 (13)    | 30 (26)   | 3 (12)       | 33 (23);$    | 12 (8)      | 27 (19)       |
| Antiarrhythmics | 7 (6)    | 6 (23)*   | 13 (9)     | 21 (18)   | 12 (46);†    | 33 (23);$    | 0 (0)       | 32 (22)       |

AMI v. No AMI: *$p < 0.05$; †$p < 0.01$.

Drugs on admission v. drugs on discharge: = ‡$p < 0.05$; §$p < 0.005$.

being capable of independent daily activities. There were 3 (2%) patients with significant residual disability and dependent upon others for normal daily activities.

### Patient management and influence of readily available cardiac facilities

Fifty-two (36%) patients were admitted to teaching hospitals with readily available invasive cardiac facilities, and 91 (64%) were admitted to district general hospitals without such facilities.

### Drug therapy

At the time of hospital discharge, 33 (23%) patients were taking beta-blockers, 74 (52%) aspirin and 62 (43%) diuretics. Antiarrhythmic drug therapy other than beta-blockers was prescribed for 33 (23%) patients. Angiotensin converting enzyme inhibitors were being taken by 14 (10%) patients admitted and 19 (13%) patients discharged. Prescribed medication at discharge, together with changes in medication during admission, is shown in Table 3.

A higher percentage of patients diagnosed as having sustained an acute myocardial infarction was discharged taking aspirin than of those who had had a primary arrhythmic event ($p = 0.002$) (see Table 3). The converse was true for antiarrhythmic therapy ($p = 0.004$). Similar proportions of patients were discharged taking diuretics and angiotensin converting enzyme inhibitors.

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mean 1-year OPC and CPC scores of these patients not investigated were both 1.1.

Discussion

As in other studies we have shown that long-term survival and functional capacity following discharge after an out-of-hospital cardiac arrest are good, but there was low utilisation of both simple drug therapy and investigations, irrespective of the availability of invasive cardiac facilities. Significant improvements in patient management could potentially be achieved quickly and without substantial increases in resources.

The few studies of the functional and cerebral capacity of patients surviving an out-of-hospital cardiac arrest, have mostly concentrated on the pre-discharge period. Although in this study the survival rate to hospital discharge after an out-of-hospital cardiac arrest was relatively small, the survivors did well thereafter. Survival and functional capacity 1 year after discharge were good. As expected, survival was better in the younger patients, but patients over the age of 65 still fared well with an 83% 1-year survival. With the event rate for deaths being relatively low, much larger patient numbers would be required to draw statistically valid conclusions relating to age and survival. Over 95% of patients surviving to 1 year were capable of independent daily activities. Only a small minority of patients had significant residual neurological or functional deficit rendering them dependent upon others for their normal daily activities. These findings are similar to or better than those seen in previous studies of out-of-hospital cardiac arrest and in patients surviving a cardiac arrest within hospital.

Deaths occurring in the first year of this study were predominantly cardiac related (or sudden and therefore assumed to be cardiac). Although a high proportion of these deaths occurred in patients diagnosed as having sustained an acute myocardial infarction, the 1-year mortality of 6.8% is similar to that in patients with acute myocardial infarction in the absence of VF. For patients with an out-of-hospital cardiac arrest without an acute myocardial infarction, previous studies have shown a 1- and 2-year mortality of 10–32% and 15–47% respectively. In this study, 19% of patients diagnosed as having had a primary arrhythmic event died within the first year. However, in contrast to previous studies, we observed a relatively low proportion of patients diagnosed as having sustained a primary arrhythmic event.

In this study, the diagnosis of acute myocardial infarction was made by the admitting physician. Even if this was incorrect, it was the diagnosis upon which the subsequent management plan was based. In the absence of new Q-wave formation on the electrocardiograph, the diagnosis of acute myocardial infarction made solely on the basis of an elevation in cardiac enzymes, particularly after defibrillation, remains subjective and open to debate.

A high proportion of recurrent cardiac events often occurs within the first 12 months after hospital discharge. Investigation and management strategies are best performed during, or soon after, initial hospitalisation. The relatively low number of patients seen by a cardiologist is consistent with the findings of Weston et al. and probably reflects working practice in the UK. It is interesting that almost three-quarters of our patients who were not seen by a cardiologist and 16 of the 18 patients who died had not been evaluated.
for ischaemic risk. Previous studies have reported significant coronary artery disease in 75% of patients surviving an out-of-hospital cardiac arrest. Coronary artery bypass surgery may reduce the incidence of recurrent sudden death in suitable patients resuscitated from an episode of out-of-hospital cardiac arrest. These data, together with previous studies, suggest that evaluation of underlying ischaemic heart disease is mandatory in the management of these patients.

A significant proportion of patients was admitted taking diuretic therapy, and by the time of discharge almost half the patients were prescribed heart failure therapy. It is unclear from this study whether the latter reflects the left ventricular function of this group of patients, or an incorrect assumption that out-of-hospital cardiac arrest is always associated with haemodynamically significant myocardial infarction. The latter hypothesis may be correct as it would be unusual for one-third of patients to require diuretic therapy following a myocardial infarction.

Despite the purported risks of a high rate of recurrent events in this population of patients, there was underutilisation of simple drug therapy and investigations. Teaching hospitals used more investigations than non-teaching hospitals; both made little use of drug therapy. The underutilisation of investigations could not be attributed to cerebral or functional disability of the patients making them unsuitable for interventional procedures, or to a preponderance of elderly patients.

Conclusions

Although the 1-year survival rate was good and the majority of survivors did not require further cardiac related admission, we identified potential deficiencies in the management in the first year. A very small proportion of patients may have severe cerebral impairment on admission, but 1 year later 98% of survivors are functionally capable of independent daily activities. Concern regarding cerebral impairment should not inhibit continuing vigorous care by medical staff following hospitalisation. Although hospitals with readily available invasive cardiac facilities were more active, all hospitals showed underutilisation of both investigations and simple drug therapy. We conclude that significant improvements in patient management could be achieved quickly and without substantial increases in resources.

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Addendum

After this paper was submitted, an article was published (Grubb et al. Br Med J 1996;313:143-6) describing chronic memory impairment in 13 of 35 survivors of cardiac arrest outside hospital. Detailed assessments of memory function showed impairment in some, but not all, aspects of cognitive function. The Rivermead behavioural memory test (a test of episodic long-term memory) showed impaired performance but no impairment of digit recall. This cognitive profile is suggestive of hippocampal damage, which has been previously described in the classic amnesic syndrome following hypoxia.

Address for correspondence: Dr P D Batin, Consultant Cardiologist, Pinderfields Hospital NHS Trust, Aberford Road, Wakefield WF1 4DG.