Hospital Topics

Pre-hospital Coronary Care Service

G. F. GEARTY, N. HICKEY, G. J. BOURKE, R. MULCAHY

British Medical Journal, 1971, 3, 33–35

Summary

The Dublin cardiac ambulance service operates two specially-equipped ambulances from a private ambulance station; five metropolitan hospitals provide coronary care beds on a rota system. The service covers an area of 450 square miles (1,165 sq km) and a population of 800,000. The ambulances are staffed solely by trained ambulance personnel. During the first three years 1,973 patients were transported to hospital. Primary ventricular fibrillation was encountered in 20 patients and successfully treated in 17. No deaths occurred in the ambulance.

Over 98% of the patients were transferred uneventfully to hospital, so a medical team from the hospital on duty was called on 30 occasions only. A feature of the Dublin service is the low cost of a standard ambulance call, at about £7·50.

Introduction

Sudden death from ventricular fibrillation is a feature of the early stages of acute coronary heart disease. In such cases the fatal arrhythmia is often preventable or reversible.[1 2] Unfortunately there may be a long delay between the onset of symptoms and the provision of adequate medical supervision,[3] hence many early coronary deaths occur outside hospital.[4]

The challenge now is to provide full resuscitation facilities and competent medical supervision as early as possible for patients with myocardial infarction. In September 1967 the Irish Heart Foundation set out to consider this problem in relation to Dublin city and county, an area of 450 square miles (1,165 sq km) with a total population of 800,000. This area is served by several general hospitals. A co-operative scheme was designed, co-ordinating the activities of five hospitals with coronary care units and utilizing a mobile coronary service which was designed and developed in the context of an existing private ambulance service.

Present Study

The five hospitals operate a duty rota which ensures that one hospital in the north city and one hospital in the south city are always on duty. At weekends, because traffic is less dense, one hospital covers the entire area. During its rota on duty each hospital provides coronary care beds and a post-registration doctor from its staff to go to the patient's home if called, and arranges rapid and direct admission to the coronary care unit.

Two fully-equipped cardiac ambulances are available, operating as part of a fleet of six which provide a general emergency service. The cardiac ambulances are staffed by crews trained in the use of cardiac equipment and in the care of coronary patients. These ambulances when called are under way on average within one minute and are in two-way radio contact with their base. Communication with the coronary unit on duty is effected through their base.

The service is available to doctors who telephone direct. If specifically requested by the caller one or more members of the cardiac team from the rota hospital are taken by radio taxi to the patient. The ambulance can also be called by the city's 999 emergency service when suspected heart-attack cases are encountered.

Cardiologists from the Dublin hospitals form a committee of the Irish Heart Foundation which is responsible for the overall direction of the project. The Foundation undertakes general management of the service and arranges hospital duty rotas. It provides the equipment, drugs, and other consumable medical items.

The ambulances have large conventional bulkhead-type bodies mounted on standard Bedford SP2 ambulance chassis, giving inside dimensions of 9 ft 11 in by 6 ft 7 in by 5 ft 10 in (302 cm by 201 cm by 178 cm).

Each ambulance has two-way voice radio within a 30-mile (48-km) radius and carries the following equipment on accessible stands or racks: fixed monitor, portable monitor, D.C. defibrillator, direct E.C.G. writer, wall-mounted sphygmomanometer, cardiac and general emergency drugs, intratracheal tubes/airways, Ambu bags, piped oxygen, suction pumps, and oxygen/nitrous oxide mixture (Entonox). A separate D.C./A.C. convertor/transformer set gives an interior voltage of 220 volts A.C. from two parallelled 12-volt heavy-duty batteries.

Each ambulance is staffed by a driver and an ambulance officer, while a rota of teams ensures 24-hour cover every day of the week. The ambulance staff attends the Foundation for special training in cardiopulmonary resuscitation; the operation of the monitoring equipment and the direct writer; the assessment of coronary patients and of monitor tracings; the operation of the D.C. defibrillator; and the use of airways, suction pumps, Entonox, and other equipment. The officers take the same examination in intensive coronary care as that taken at the Foundation by senior nurses.

The average ambulance response time from receipt of call is one minute. The ambulance station is sited in the south city, and the mean journey times are 11·6 minutes to calls in the south city area and 14·6 minutes to calls in the north city area. The average time from call to arrival in hospital is variable, as this depends almost entirely on the patient's condition. A crew has spent up to two hours with the patient before removal to hospital.

St. Vincent's Hospital, Dublin
N. HICKEY, M.B., M.R.C.P.I., Senior Research Fellow
R. MULCAHY, M.D., F.R.C.P.(LOND., IRE.), Cardiologist
University College, Dublin
G. J. BOURKE, M.D., D.P.H., Associate Professor of Epidemiology and Community Health
Dublin Federated Hospital Group
G. F. GEARTY, B.SC., F.R.C.P.I., Cardiologist

A fee is charged for each ambulance call either to the individual in the case of private patients or to the appropriate health authority in the case of entitled patients. The fee depends on the time and distance involved, but in about 80% of cases the charge has been at a standard rate of £5·50 per call.

Charges borne by the Irish Heart Foundation, for which no allowance has been made in the pricing structure, include the provision of the cardiac equipment, the training of ambulance crews, the provision of drugs, and certain administrative costs. A figure of £2 per call has been estimated to cover these costs, giving an overall cost of £7·50 per call.

Results

During the period December 1967 to November 1970 inclusive 1,973 calls were taken. For the last two years of operation the calls averaged 16 a week, with a small drop in numbers during the summer months.

About 75% (1,370) of admissions were for cardiac emergencies —acute coronary heart disease, left ventricular failure, and serious arrhythmias (Table I). Of the 1,204 patients with acute coronary heart disease 1,079 had myocardial infarction and 125 had acute coronary insufficiency. Almost 12% (218) had congestive heart failure or lower respiratory tract disease, while the remaining 13% (241) consisted of patients with stroke and other non-cardiac problems.

TABLE I—*Hospital Diagnosis of Patients admitted by Cardiac Ambulance*

Diagnosis on Admission	No.	%
Acute coronary heart disease	1,204	65·8
Left ventricular failure and/or serious arrhythmias	166	9·1
Congestive heart failure, lower respiratory disease	218	11·9
Stroke and non-cardiac conditions	241	13·2
Total	1,829*	100

*Of the total 1,973 patients 144 were dead before admission and are not included in hospital diagnosis.

Altogether 78% of calls were from doctors, 18% from the city's emergency ambulance service (999 calls), and the remaining 4% from police, industry, etc.; 342 different doctors used the service (Table II). The length of time between the onset of symptoms and the arrival of the ambulance is available for 310 cases of myocardial infarction (Table III). In 3·5% (11) the ambulance was called within one hour of the onset of symptoms and in 62·6% (194) within six hours. In 22·6% (70) the ambulance was not called until 12 hours or longer after the onset of symptoms.

TABLE II—*Source of Ambulance Calls*

Source	No.	%
Doctors	1,537	77·9
City ambulance service	354	17·9
Miscellaneous—e.g., police, industry, etc.	82	4·2
Total	1,973	100

TABLE III—*Time between Onset of Symptoms and Arrival of Ambulance in 310* Cases of Acute Myocardial Infarction*

Time (hours)	No. of Patients	%
Less than 1	11	3·5
1- 2·9	99	32·0
3- 5·9	84	27·1
6-11·9	46	14·8
12 and over	70	22·6
Total	310	100

*Information is unavailable on 769 patients out of the 1,079 patients with acute myocardial infarction.

During the three years cardiopulmonary resuscitation and/or defibrillation was attempted on 164 patients. Of these, 144 (87·8%) had cardiac arrest or asystole on E.C.G. at the time of arrival of the ambulance. In the remaining 20 patients arrest occurred either during transit (10 patients) or at the place of collapse immediately before or after the arrival of the ambulance (10 patients). Of these 20 patients 17 were successfully resuscitated by the ambulance crew. No patient died during transit in the ambulance. Among the 17 patients successfully resuscitated 6 died in hospital and 11 were eventually discharged well from hospital. Apart from the 144 patients considered non-viable all but 20 of the remaining 1,829 were transferred uneventfully to hospital; the hospital medical team was called on only 30 (1·6%) occasions.

A family doctor was present either before the arrival or before the departure of the ambulance in 70% of calls. All necessary drugs and instructions are available in the ambulance to assist him in the immediate problems. While exact information is not available concerning the use of drugs before the departure of the ambulance to hospital, the frequent use of atropine and lignocaine probably contributed to a reduction in arrhythmic complications.

Discussion

The ideal treatment for ventricular fibrillation is immediate external countershock. In coronary care units senior nurses are trained to recognize arrhythmias and to use standard and safe resuscitation equipment. The use of paramedical staff in cardiac resuscitation can be extended to ambulance personnel, and this has been shown by our results. These men are already trained in first aid, including external cardiac massage and artificial respiration. It is difficult for one man to provide effective massage and ventilation in the case of cardiac arrest, and in a moving ambulance it is difficult even for two trained operators. The risks from massage are greater than those from defibrillation, and in primary ventricular fibrillation the chance of a successful outcome after massage is less. Because of the efficiency and safety of defibrillation in trained hands it is essential that all people coming into frequent contact with cases of cardiac arrest should be trained to recognize ventricular fibrillation and to perform external defibrillation.

Important considerations in the use of ambulance personnel for special duties include: (1) careful selection of individuals for training—a small reliable group is preferable to general training of large numbers; (2) close day-to-day supervision of the service by an experienced director; (3) regular reviews of performance, with training and retraining sessions; and (4) education of family doctors in the diagnosis and management of acute coronary heart disease.

The integration of a mobile coronary service in a comprehensive ambulance system, and the employment of specially-trained ambulance personnel without direct medical supervision, has permitted the development of an economically feasible service for the community. The estimated cost of a call by the service is little more than that of a standard ambulance call if the resources and educational facilities of an organization such as the Irish Heart Foundation are available.

The hospital-based medically-staffed mobile coronary service pioneered in Belfast[5] provides an ideal arrangement which is widely and justifiably acclaimed. Other centres, however, have had difficulty in providing doctors to support such a service, and many cities are without mobile coronary services because of the lack of medical staff to join the ambulance crews and because of the expense of providing such staff. If the statement by the working group of the World Health Organization[6] is accepted that it is essential for the leading member of the mobile coronary care unit team to be a physician with specialized training, then these difficulties must continue.

Over 98% of the patients in this study were transferred uneventfully to hospital, so a hospital team was called on only

30 (1·6%) occasions. In the light of this experience the routine employment of doctors may be unnecessary and involve an uneconomical use of special skills.

Despite the shortage of doctors in many countries much can be done by the organization of available resources to bring earlier skilled attention to patients with acute coronary heart disease. We believe that the routine use of paramedical personnel in cardiac resuscitation within the limits of economic circumstances is the best system for most urban areas using a hospital rota system. Nevertheless, we envisage a further improvement in the efficiency of the service when radio-telemetry is incorporated to provide immediate and continuous transmission of E.C.G. information[7] about the patient before admission, thus allowing the doctor on rota duty to advise the family doctor and ambulance crew about immediate management. Improved public and professional education should see a reduction in the present unsatisfactory time interval between the onset of symptoms and the arrival of the ambulance.

The resuscitation of a limited number of patients with primary ventricular fibrillation is an important benefit of mobile coronary care. Other benefits, including education of medical and paramedical personnel in cardiopulmonary resuscitation and in the recognition and management of acute coronary heart disease, may prove to be important long-term advantages of the service.

The Irish Heart Foundation wishes to acknowledge with thanks the co-operation of the Dublin Health Authority; the Dublin Fire Brigade Ambulance crews; the governors and medical staffs of the Dublin Voluntary Hospitals; and the doctors and nurses attached to the coronary care units. Special thanks must be extended to Mr. Noel Gleeson, Director of the Stillorgan Ambulance Service, for the major part he has played in the success of this mobile coronary care programme, and to his crew members, who have worked on the programme with ability and enthusiasm.

References

[1] Lawrie, D. M., *et al.*, *Lancet*, 1968, **2**, 523.
[2] Adgey, J. A. A., *et al.*, *Lancet*, 1969, **1**, 1169.
[3] Dewar, H. A., McCollum, J. P. K., and Floyd, M., *British Medical Journal*, 1969, **4**, 226.
[4] McNeilly, R. H., and Pemberton, J., *British Medical Journal*, 1968, **3**, 139.
[5] Pantridge, J. F., and Geddes, J. S., *Lancet*, 1966, **1**, 807.
[6] World Health Organization, *Role of Mobile Coronary Care Units*, Copenhagen, W.H.O., 1970.
[7] Uhley, H. N., *American Heart Journal*, 1970, **80**, 838.

Computers in Medicine

Doctors as Decision-makers: A Computer-assisted Study of Diagnosis as a Cognitive Skill

T. R. TAYLOR, J. AITCHISON, E. M. McGIRR

British Medical Journal, 1971, **3**, 35–40

Summary

When viewed as a sequence of decisions clinical diagnosis becomes amenable to detailed investigation in terms of standard statistical concepts. A study of six clinicians diagnosing identical sets of cases of non-toxic goitre is used to illustrate an objective technique for studying the diagnostic process with the aid of a digital computer. Considerable variation in clinicians' routes to correct diagnosis is shown when these routes are compared in detail by five statistical measures related to the effective use of the information available to the clinicians. For rapid analysis of diagnostic skill two visual methods are presented. These can be developed for teaching undergraduates the interpretative skills involved in diagnosis and for studying such skills in experienced clinicians.

University Department of Medicine, Royal Infirmary, Glasgow, C.4
T. R. TAYLOR, M.R.C.P.(ED., GLASG.), D.P.M., Lecturer in Medicine
E. M. McGIRR, M.D., F.R.C.P.(LOND., ED., GLASG.), Muirhead Professor of Medicine
University of Glasgow, Department of Statistics
J. AITCHISON, M.A., F.R.C.S.:D., Titular Professor of Statistics

Introduction

In recent years considerable effort has been directed towards the construction of computer programmes to aid diagnosis in specific areas of medicine. Examples are reported by Warner *et al.*[1] for congenital heart disease; by Overall and Williams,[2-7] Overall and Hollister,[8] Boyle *et al.*,[9] Fitzgerald *et al.*,[10] and Taylor[11] for thyroid disease; by Bishop and Warner[12] for polycythaemia; by Lodwick *et al.*[13 14] for bone tumours; and by Ferriss *et al.*[15] for Conn's syndrome—see also Taylor.[16] A necessary step towards the acceptance by clinicians of the value of such computer-aided diagnosis is the comparative study of the diagnostic behaviour of clinicians with the diagnostic performance of the computer programme. Such comparisons are usually based on rather crude differences between the results obtained by the clinician and by the computer. For example, the difference in their percentages of correct diagnoses or in the average probability ratings they assign to the correct diagnosis has been commonly used.[1 9 12 17] Moreover, in such studies diagnosis has been considered only at the end of the complete process of data collection.

Many writers[18-20] have pointed out that the diagnostic process is essentially a sequence of decisions, and some [21] have suggested that it would be interesting to compare clinician and computer in the context of such a sequential decision-making process.

The primary purpose of this paper is to explain how such a sequential comparison may be made between clinician and computer. The objective techniques developed are illustrated