The intermediate coronary care unit A stage in continued coronary care¹

LEON RESNEKOV

From the Department of Medicine (Cardiology), University of Chicago, Pritzker School of Medicine, Chicago, Illinois, U.S.A.

The concept of continued and progressive coronary care rather than intermediate coronary care is proposed. At each clinical stage the patient may be at risk and his management needs to be planned appropriately—prevention of the development of coronary disease, prehospital care, acute coronary care, subacute coronary care, and late hospital stay. Meticulous continued care once the patient leaves the hospital and returns home may be needed for a long time.

Although the benefit of an intermediate coronary care unit has not yet been proved, significant patient risk continues beyond 12 days of hospital admission. High risk patient subsets are emerging requiring careful continued monitoring and the ability to undertake emergency measures as needed, and this is particularly so in patients suffering large anterior infarction, in those with infarction associated with cardiac failure, when infarction is associated with fascicular block and other types of conduction disturbances, and in patients who continue with rhythm disturbances after their admission to the hospital. Electrocardiograph leads III and V1 displayed simultaneously should be routinely monitored in patients with fascicular blocks and acute anterior infarction as a guide to instituting prophylactic transvenous pacemaking.

The continuation of intensive patient care and monitoring beyond the usual 2 to 5 days in a coronary care unit allows early mobilisation of patients in safety, thus speeding their ultimate rehabilitation.

There is, as yet, no satisfactory study documenting the need for intermediate coronary care units, but much presumptive evidence is available to indicate that this is so. A carefully controlled randomised study would be invaluable.

'Keep your enthusiasm, but let strict verification be its constant companion'—
Pasteur.

Despite some contrary views (Mather *et al.*, 1971) most agree that coronary care units (CCU) reduce the mortality of acute myocardial infarction provided that the patient survives long enough to be admitted (Meltzer, 1968; Pantridge, 1970; Hofvendahl, 1971; MacMillan and Brown, 1971). In our own CCU an analysis of more than 500 proven cases of acute myocardial infarction has shown a progressive decline of mortality in the acute phases of myocardial infarction from more than 28 per cent

before the unit was opened to less than 8 per cent (Resnekov, 1975). The patient who suffers acute myocardial infarction continues at risk even after surviving its first hazardous days after its onset. Indeed, the mortality during the later in-hospital phase of the illness when the patient is usually no longer being cared for in the CCU may be as high as that within the Unit itself (Fig.). In consequence, the concept of intermediate coronary care, or as it is sometimes called 'progressive coronary care' was proposed, whereby patients could be cared for in close proximity to the CCU and where all necessary monitoring equipment would be to hand with personnel trained in the interpretation of arrhythmias and in emergency resuscitation (Gotsman and Schrire, 1968; Grace and Yarovate, 1971; Whipple *et al.*, 1972). Though advocated almost a

¹Supported in part by grants from the Myocardial Infarction Research Unit (MIRU), and Specialised Center of Research in Ischemic Heart Disease (SCOR-IHD), and by the Chicago Heart Association.

Received for publication 8 September 1976

Fig. Forty-one sequential fatal cases of acute myocardial infarction, showing the days of death and its cause.

decade ago, there is still considerable controversy about the benefits of such intermediate care units.

It should be recognised that the patient with coronary heart disease continues at risk from the moment the first clinical manifestation becomes apparent. The risk does not end once the patient who has suffered acute myocardial infarct leaves the coronary care unit, after being cared for there for 3 to 4 days. It does not end once he leaves the hospital. Sudden devastating arrhythmias are all too frequent in the weeks or months after recovery from acute infarct, and further infarction may occur suddenly and without warning. Fascicular blocks may be followed by sudden and dramatic deterioration of conduction resulting in sudden death. Perhaps then, appropriate patient care is one of continued management, recognising the particular risks that the patient runs at each stage of his illness, instead of locking our thoughts and practice into a rigid geographical system which for administrative purposes we label as coronary care unit, intermediate care unit, and general medical ward.

HISTORY OF CORONARY CARE

Coronary care units were established as a logical sequel to the successful abolition of ventricular fibrillation in a patient using electrical current (Beck *et al.*, 1947), but almost a decade elapsed before Beck *et al.* (1956) and Reagan *et al.* (1956) reported the successful defibrillation of a patient who had suffered ventricular fibrillation after acute myocardial infarction. The parallel development and refinement of closed chest massage and cardiac resuscitation (Kouwenhoven *et al.*, 1960) also served to spur medical thinking towards coronary care. The third element for the practical implementation of coronary care units, namely electronic monitoring of heart rhythms, was also being de-

veloped rapidly at this time, but the fourth element, namely trained nursing staff, able to interpret correctly the electrocardiographic patterns was yet to be realised, and until achieved, was to delay the benefit that should have been provided to patients who were being monitored during the formative phases of coronary care units (Day, 1972).

Eventually the concept of a separate coronary care unit, staffed by nursing personnel trained particularly in the recognition of cardiac rhythm disturbances and in the technique of cardiac resuscitation was brought to fruition. The first such unit in the U.S.A. opened during 1962 (Day, 1963). At almost the same time Brown *et al.* (1963) established a unit in Toronto and other early units were organised in London by Shillingford and Thomas (1964), in New York by Gregory and Grace (1967) and by Julian *et al.* (1964) in Australia.

Exciting as these developments were it soon became apparent that though these units might well reduce the in-hospital mortality after acute myocardial infarction, they could only have a minimal effect on the overall mortality of coronary heart disease (McNeilly and Pemberton, 1968).

Accordingly Pantridge and his group set up a mobile coronary care unit in Belfast during 1966 (Pantridge and Geddes, 1966, 1967). The importance of this concept becomes immediately apparent when one considers that more than 40 per cent of deaths from acute myocardial infarction occur within one hour of the onset of symptoms (McNeilly and Pemberton, 1968). Furthermore, 63 per cent of deaths occurring in middle-aged and younger men happen within one hour of the symptoms developing (Bainton and Peterson, 1963), yet only 16 per cent of patients are admitted to the hospital within the first 4 hours (McDonald, 1968). A mobile coronary care unit was therefore set up to give intensive care to the patient wherever the infarct occurred and as soon as possible after the onset of symptoms (Pantridge, 1970).

Finally, in 1968 the concept of intermediate coronary care emerged with the realisation that the risk of sudden death did not end when the patient was allowed to leave the CCU. It is likely that it was Gotsman and Schrire (1968) who first proposed setting up an intermediate coronary care unit (ICCU). Though no description of a functioning ICCU followed, these authors clearly had in mind continued and progressive coronary care. Grace and Yavote (1971) began monitoring patients beyond the 5th hospital day as a routine in a specially equipped and staffed area separate from the CCU, and Whipple *et al.* (1972) were also early in developing dedicated units of this type.

As can be appreciated, we are now well along the path of providing the patient continued and uninterrupted specialised care from the moment the clinical effects of coronary arterial disease become manifest, even before the patient arrives at the hospital, and throughout the acute and subacute phases of his illness. We still, however, lack imaginative programmes for continued care once the patient has left hospital and have not yet succeeded in defining each patient's risk of developing a life-threatening arrhythmia or a recurrence of myocardial infarction; much less so their prevention. No doubt careful study and consideration of this later stage of the disease will be as rewarding as the development of mobile coronary care units, coronary care units, and intermediate coronary care areas.

CONTINUED CORONARY CARE

As long as the patient continues at high risk, acute infarction should be treated in hospital according to the following principles:

- (1) Patients should be nursed in one area.
- (2) Continuous electrocardiographic monitoring and analysis should be available.
- (3) Cardiac arrhythmias should be managed appropriately and aggressively.
- (4) It should be possible to obtain additional specialised care as needed, including haemodynamic monitoring, circulatory assistance, and emergency surgery.

Consideration of the data from the University of Chicago shown in the Fig. reveal that of 41 fatal in-hospital cases of acute myocardial infarction, 17 (41.5%) occurred between days 1 and 3 of admission, 19 between days 4 and 10 (46.3%), and there were 5 deaths after the 10th day (12.2%). Sixty-seven per cent of deaths occurred in the CCU but 33 per cent occurred after the patient left the Unit and while he was being cared for in an immediately adjacent cardiology ward. The causes of death were cardiac failure in 54 per cent, rhythm disturbances in 40 per cent, and the remaining 6 per cent died as a result of other causes. It will be noted that there is no obvious time pattern for these late deaths and indeed the majority occurred beyond the 5th hospital day. Similar data noting the high incidence of death from acute myocardial infarction after discharge from the CCU have been well documented (Oliver *et al.*, 1967; Hofvendahl, 1971; McGuire and Kroll, 1972; Weinburg and Col, 1972). In our own series, the largest proportion of these late deaths were sudden and unexpected. Subsequent review of patients' CCU courses did not show any definite predictors of sudden death. It is important to realise, however, that by the end of the 10th day after admittance to hospital for acute

myocardial infarction, only 75 per cent of all deaths have been accounted for (Grace and Yarbote, 1971). It is clear, therefore, that there is a need for continuing close observation and monitoring of patients beyond the traditional 3 to 5 CCU days.

The usual CCU is not ideal for prolonged patient stay since there is always considerable pressure on the available beds as new patients require to be admitted. Furthermore, medical practice now recommends mobilising patients as soon as possible after acute infarction. This requires additional personnel and modification in monitoring techniques and these are best done away from the CCU.

An intermediate coronary care unit should provide the following:

- (1) Continued patient monitoring allowing immediate recognition of cardiac rhythm and conduction disturbances.
- (2) Immediate cardiopulmonary resuscitation.
- (3) Nursing personnel trained as for those in the coronary care unit.
- (4) Early mobilisation.
- (5) Definition of individual risk and plans for continued care.

A progressive care unit of this type should be geographically close to the coronary care unit and ideally should share medical, nursing, and paramedical staff. Telemetry electrocardiographic monitoring can be recommended since it eliminates hard wiring and makes it possible for the patient to be mobilised more easily while still under constant electrocardiographic control.

Although many units provide electronic monitoring systems which can be extremely sophisticated, analysis of the information being collected is sometimes less than ideal, and even highly skilled nursing personnel miss important arrhythmias if the system involves their watching oscilloscopes over a prolonged period of time. Some method of computer monitoring can be recommended, but only if it is in real-time and on a beat-to-beat basis so that the nursing and medical staff can be immediately apprised of the cardiac rhythm disturbance, and, furthermore, can obtain from the computer an analysis of premature beats and other rhythm disturbances which have occurred in the immediate past. Several such systems are now available, some of which have been extensively tested in practice and found to be satisfactory in the use (Fozzard and Kinias, 1976).

ARE INTERMEDIATE CORONARY CARE UNITS WORTH WHILE?

Although many units have been set up, very few controlled trials of intermediate coronary care have been reported.

Grace (1975) analysed 136 patients with acute transmural myocardial infarction admitted to the hospital. There were 36 deaths (26.5%). Of these, 32 (89%) occurred in the coronary care unit, 2 (5.6%) in the intermediate coronary care unit, and 2 in the general ward (5.6%). The substantial decrease in mortality outside the CCU compared with the previous reports from the same unit (Grace and Yarov, 1971) was used to substantiate the role of the ICCU in lowering mortality.

An interesting study was reported by Reynell in 1975, which documented a controlled trial of intermediate coronary care over a 5-year period at a district general hospital. One thousand male patients under 65 years old were allocated at random to a group kept in the same ward as the coronary care unit, and a control group was discharged from the coronary care unit to a general medical ward. Those in the 'intermediate care area' were nursed by the same CCU staff using resuscitation equipment which was immediately to hand. Thus, 520 patients were cared for in the intermediate care area, and 480 were randomised to the general medical ward. Forty-four of the ICCU patients died (8.5%) compared with 43 of the general medical ward patients (9.0%). The difference is not statistically significant. Attempts at resuscitation were made on 35 patients in the ICCU and 41 in the general medical ward. The initial success in the ICCU patients was 46 per cent compared with 22 per cent in those who were being cared for in the general medical ward. The numbers who left the hospital, however, were almost the same; 4 from the ICCU group and 5 from the general medical ward group. From this study it would be hard to conclude that an intermediate coronary care unit had any dramatic impact on in-hospital mortality of acute myocardial infarction, though it must be admitted that the plan of the trial was far from ideal.

Weinberg (1976) has published data comparing the results in 341 patients with acute myocardial infarction cared for during 1969 and 1970 when no ICCU was available, with 354 patients between 1971 and 1972, when an ICCU was operative. He found a 13 per cent CCU mortality between 1969 and 1970 and an 11 per cent CCU mortality between 1971 and 1972. Before the ICCU was opened (1969-1970) the incidence of late hospital deaths was 4 per cent. In 1971 to 1972 with patients being cared for in the ICCU once they had been discharged from the CCU the late mortality was 5 per cent. The two groups were said to have had an equal incidence of rapid or slow arrhythmias, and conduction disturbances. There was no significant difference in heart size, previous infarction, or electrocardiographic localisation of infarction. Once

more, it would be hard to conclude that if mortality were the criteria, the case for nursing patients in an ICCU has been proved.

That the patient does continue at risk after discharge from the coronary care unit, continues to be confirmed (Bornheimer *et al.*, 1975). Frieden and Cooper (1976) have documented that an important effect on in-hospital coronary care has followed the introduction of a 22-bed monitored intermediate coronary care unit. The ICCU was established adjacent to an 8-bed coronary care unit and is staffed by the same medical and nursing personnel. Bedside and central station monitoring is available, and, in addition, one area of the ICCU is provided with telemetry electrocardiographic monitoring for the early ambulant patient. Patients remain in the CCU for 2 to 6 days and are then transferred to the ICCU where they remain until the 10th day after admission. Thereafter, uncomplicated patients are transferred to an adjacent special convalescent unit which has no monitors but emergencies can be handled there as needed: 1917 patients were cared for in the ICCU of whom 27 (1.4%) had cardiac arrest and 18 (67%) were successfully resuscitated. The authors believe that the low incidence of cardiac arrest was a result of 24-hour monitoring and the prompt institution of antiarrhythmic therapy by the trained ICCU staff. An interesting additional finding was that the availability of adequately monitored and staffed intermediate coronary care beds allowed an increase in admission to CCU of over 15 per cent. Furthermore, direct admission from the emergency room to the ICCU not infrequently occurred. The duration of hospital stay of patients with acute myocardial infarction was shortened by 3 days using this progressive form of coronary care which also included early mobilisation, and an overall more efficient and successful hospital management of cardiac patients was claimed.

PATIENTS AT PARTICULAR RISK

Although, as already indicated, all patients after acute myocardial infarction should be considered to be at risk of serious arrhythmias and sudden death, it is now clear that certain groups of such patients are more liable to life-threatening situations. Bornheimer *et al.* (1975) who analysed the records of 48 patients dying suddenly and unexpectedly after discharge from the coronary care unit, showed that 25 had myocardial infarction as the sole cause of death, but 23 had additional important features including congestive heart failure.

The following groups of patients are at particular risk and require more intensive and more prolonged

monitoring than other patients with acute myocardial infarction:

- (1) Those suffering large anterior infarction, usually associated with the development of severe left ventricular dysfunction, or congestive cardiac failure. These lesions usually result from important occlusive lesions of the proximal portions of the left coronary system, and, therefore, a large proportion of the left ventricular myocardium is compromised.
- (2) Myocardial infarction associated with cardiac failure. Often these patients have suffered previous myocardial infarction, or systemic hypertension was known to be present.
- (3) Myocardial infarction in association with fascicular block. Such patients require very careful electrocardiographic monitoring. It is indeed remarkable that routine electrocardiographic monitoring has been allowed to continue using leads which are inappropriate for monitoring patients with fascicular blocks. Since it is known that sudden and unheralded changes in conduction may occur, information about changes in mean frontal QRS axis, length of PR interval, and the development of bundle-branch block is required. The routine CCU monitoring lead is ill-chosen for this need. In our unit such patients are routinely monitored with standard lead III and lead V1 simultaneously displayed.
- (4) Patients who continue with premature beats or other arrhythmias after acute myocardial infarction.

Conclusions

From available published data it will be apparent, therefore, that while the benefit of the intermediate coronary care unit as a separate area of patient management has not yet been proved, patients suffering acute myocardial infarction continue to be at risk even beyond 12 days of hospital care. High risk subsets of patients are now being recognised who require diligent and continued intensive care. It is, therefore, logical to define the risks patients who suffer coronary heart disease run at each stage of their disease and to provide them with continued and progressive care, before, during, and after admission to hospital. With this goal in mind, the 'intermediate coronary care unit' may be defined as an area staffed and equipped as is the coronary care unit and as close to it as possible, not only for the prevention and emergency treatment of life-threatening arrhythmias but also where early ambulation of the patient may begin in safety. Such a progressive care area helps to free beds for the acute myocardial infarct patient without in any way compromising

care during the less acute stages of the illness. A carefully controlled randomised study to determine the effectiveness of such continued coronary care would be invaluable.

References

- Bainton, C. R., and Peterson, D. R. (1963). Deaths from coronary heart disease in persons fifty years of age and younger: community wide study. *New England Journal of Medicine*, **268**, 569-575.
- Beck, C. S., Pritchard, W. H., and Feil, H. S. (1947). Ventricular fibrillation of long duration abolished by electric shock. *Journal of the American Medical Association*, **135**, 985-986.
- Beck, C. S., Weckesser, E. C., and Barry, F. M. (1956). Fatal heart attack and successful defibrillation. New concepts in coronary artery disease. *Journal of the American Medical Association*, **161**, 434-436.
- Bornheimer, J., de Guzman, M., and Haywood, L. J. (1975). Analysis of in-hospital deaths from myocardial infarction after coronary care unit discharge. *Archives of Internal Medicine*, **135**, 1035-1038.
- Brown, K. W., MacMillan, R. L., Forbath, N., Melgrano, F., and Scott, J. W. (1963). An intensive care centre for acute myocardial infarction. *Lancet*, **2**, 349-352.
- Day, H. W. (1963). An intensive coronary care area. *Diseases of the Chest*, **44**, 423-427.
- Day, H. W. (1972). History of coronary care units. *American Journal of Cardiology*, **30**, 405-407.
- Fozzard, H., and Kinias, P. (1976). Computers for recognition and management of arrhythmias. *Medical Clinics of North America*, **60**, 291-298.
- Frieden, J., and Cooper, J. A. (1976). The role of the intermediate cardiac care unit. *Journal of the American Medical Association*, **235**, 816-818.
- Gotsman, M. S., and Schrire, V. (1968). Acute myocardial infarction—an ideal concept of progressive coronary care. *South African Medical Journal*, **42**, 829-832.
- Grace, W. J. (1975). Intermediate coronary care units revisited (editorial). *Chest*, **67**, 510.
- Grace, W. J., and Yarovate, P. M. (1971). Acute myocardial infarction: the course of the illness following discharge from the coronary care unit. *Chest*, **59**, 15-17.
- Gregory, J. J., and Grace, W. J. (1967). Resuscitation of the severely ill patient with acute myocardial infarction. *American Journal of Cardiology*, **20**, 836-841.
- Hofvendahl, S. (1971). Influence of treatment in a coronary care unit on prognosis in acute myocardial infarction. *Acta Medica Scandinavica*, Suppl. 519.
- Julian, D. G., Valentine, P. A., and Miller, G. G. (1964). Disturbances of rate, rhythm and conduction in acute myocardial infarction. *American Journal of Medicine*, **37**, 915-927.
- Kouwenhoven, W. B., Jude, J. R., and Knickerbocker, G. G. (1960). Closed chest cardiac massage. *Journal of the American Medical Association*, **173**, 1064-1067.
- McDonald, E. L. (1968). Coronary care units, the London Hospital. In *Acute Myocardial Infarction*, p. 29. Ed. by D. G. Julian and M. F. Oliver. E. and S. Livingstone, Edinburgh and London.
- McGuire, L. B., and Kroll, M. S. (1972). Evaluation of cardiac care units and myocardial infarction. *Archives of Internal Medicine*, **130**, 677-681.
- MacMillan, R. L., and Brown, K. W. G. (1971). Comparison of the affects of treatment of acute myocardial infarction in a coronary care unit and on a general medical ward. *Canadian Medical Association Journal*, **105**, 1037-1040.

- McNeilly, R. H., and Pemberton, J. (1968). Duration of last attack in 998 fatal cases of coronary artery disease and its relation to possible cardiac resuscitation. *British Medical Journal*, **3**, 139-142.
- Mather, H. G., Pearson, N. G., Read, K. L. Q., Shaw, D. B., Steed, G. R., Thorne, M. G., Jones, S., Guerrier, C. J., Eraut, C. D., McHugh, P. M., Chowdhury, N. R., Jafary, M. H., and Wallace, T. J. (1971). Acute myocardial infarction: home and hospital treatment. *British Medical Journal*, **3**, 334-338.
- Meltzer, L. E. (1968). Coronary care units. Current policies and results. In *Acute Myocardial Infarction*, p. 3. Ed. by D. G. Julian M. F. Oliver. E. and S. Livingstone, Edinburgh and London.
- Oliver, M. F., Julian, D. G., and Donald, K. W. (1967). Problems in evaluating coronary care units. *American Journal of Cardiology*, **20**, 465-474.
- Pantridge, J. F. (1970). Mobile coronary care. *Chest*, **58**, 229-234.
- Pantridge, J. F., and Geddes, J. S. (1966). Cardiac arrest after myocardial infarction. *Lancet*, **1**, 807-808.
- Pantridge, J. F., and Geddes, J. S. (1967). Mobile intensive care unit in the management of myocardial infarction. *Lancet*, **2**, 271-273.
- Reagan, L. B., Young, K. R., and Nicholson, J. W. (1956). Ventricular defibrillation in a patient with probable acute coronary occlusion. *Surgery*, **39**, 482-486.
- Resnekov, L. (1975). University of Chicago Myocardial Infarction Research Unit. Comprehensive Clinical and Laboratory Research. USPHS Report PH-43-68-1334-A-73.
- Reynell, P. C. (1975). Intermediate coronary care. A controlled trial. *British Heart Journal*, **37**, 166-168.
- Shillingford, J. P., and Thomas, M. (1964). The organisation of a unit for the intensive care and investigation of patients with acute myocardial infarction. *Lancet*, **2**, 1113.
- Weinberg, S. L. (1976). Intermediate coronary care—the failure of a concept? (abstract). *American Journal of Cardiology*, **37**, 181.
- Weinberg, S. L., and Col, J. J. (1972). The changing coronary care unit: cardiovascular therapy. In *Changing Concepts in Cardiovascular Disease*, p. 79. Ed. by H. Russek and B. Zohman. Williams and Wilkins, Baltimore.
- Whipple, G. H., Peterson, M. A., Haines, V. M., Leamer, E., and McKinnon, E. L. (1972). *Acute Coronary Care*. Little Brown, Boston.

Requests for reprints to Dr. Leon Resnekov, Hospital Box 423, University of Chicago Medical Center, 950 East 59th Street, Chicago, Illinois 60637, U.S.A.