

# Controversies in Cardiology

## The Coronary Care Unit\*

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### Part I: Dr. Lown

MORE THAN one school of thought confronts every issue in medicine. The coronary care unit, or CCU, is no exception, and this is as it should be. The objective of this discussion is to disentangle fact from the maze of differing and frequently ill-founded opinions. The problem of dissecting truth from fancy is always a complicated one. It is best illustrated by the utterance of a famous American philosopher who made a living as a National League baseball umpire: Someone commented to Bill Klem's after a disputed call, "At least you called it the way you saw it, Bill," to which Klem's tart reply was, "I did not call it the way I saw it; I called it the way it was." I do not pretend to possess any special capacities of divination, as is the case with baseball umpires. I simply hold to the view that the basic facts and logic of the CCU are readily evident.

Although many significant advances have reduced death from a diversity of afflictions, mortality from coronary artery disease has progressively risen. In the United States, it has now reached a figure of 600,000 annually. Hospital death from acute myocardial infarction has consistently ranged from 30 to 40 per cent. It is against this background that the CCU must be examined as a therapeutic innovation. The

essential concept underlying the CCU is that sudden death is frequently not the inexorable result of extensive myocardial damage but is due to a completely reversible electrical derangement of rhythm. The time available for restoring a normal rhythm and survival is of the order of one to two minutes. Coronary deaths are generally sudden and unpredictable and occur at the very onset of illness. To reduce such sudden, arrhythmia-provoked death requires a proper conjunction of afflicted patient and special arrangement or CCU.

*There are four requirements for an effective coronary care unit:* (1) It is necessary to segregate patients with acute myocardial infarction in a special place in the hospital. It is important to have individual rooms for patients located in the proximity of a nursing station providing a noise-free, tranquil and reassuring environment. (2) It requires the continuous monitoring of heart rhythm with automatic activation of audio and visual alarms when preset conditions have been altered. (3) It is essential to staff the unit with a cadre of well trained nurses fully rehearsed in analysis of heart rhythm and mandated to initiate a number of therapeutic interventions. (4) It is necessary to evolve a coherent policy oriented to the prophylaxis of major arrhythmias.

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mias and to the aggressive management of complications at their very onset. In short, the coronary care unit represents a system of care consisting of a number of interrelated components.

*Cardiac Arrhythmias:* Although coronary care units have been in operation for slightly over 5 years, in this period more has been learned about myocardial infarction that is of practical and life-saving importance than in the more than 50 years since Herrick's first delineation of the syndrome. The most significant findings relate to arrhythmias. About 90 per cent of patients exhibit rhythm disorders; of this number 70 per cent demonstrate ventricular extrasystoles. In about 30 per cent ventricular tachycardia develops, and ventricular fibrillation in slightly over 10 per cent. This latter arrhythmia is the major electrical catastrophe. Primary asystole, long regarded as of equal incidence, is a rather unusual occurrence. The development of ventricular fibrillation is related to the time of onset of the coronary episode and then diminishes in incidence almost exponentially. Pantridge and Geddes<sup>1</sup> estimated that ventricular fibrillation was 25 times more likely to occur during the first 4 hours of a heart attack than in the ensuing 24 hours.

In the overwhelming majority of cases, ventricular fibrillation is preceded by ventricular ectopic beats. The trivial and usually innocuous extrasystole in the patient with acute myocardial infarction may discharge during the vulnerable period and trigger ventricular fibrillation. Thus, the extrasystole may be a harbinger of potential disorganization of the heart-beat. Perhaps the most important lesson learned to date in the CCU is that, when ventricular premature beats are controlled by continuous administration of an antiarrhythmic drug such as lidocaine,<sup>2</sup> ventricular fibrillation can be nearly completely prevented. The significance of this finding is that it shifts the focus of therapy from resuscitation to the prevention of the need for resuscitation.

*Significant data have been accumulated in areas other than those related to arrhythmias.* As a matter of fact, every aspect of the acute episode of myocardial infarction is being scrutinized and is being subjected to more thoroughgoing analysis. Already substantial information has been accumulated on the accompanying hemodynamic changes, on the action of various drugs, ranging from analgesics to digitalis glycosides, on the effects of posture and diet, on the physio-

logic and pathologic alterations in other organs, etc.<sup>3-5</sup> The clinical approach hitherto practiced, largely anecdotal and intuitive and based on remembered experience, is being replaced by a disciplined and scientific evaluation of concrete and repeated measurements of heart rhythm, blood gases, central venous pressure, oxygen saturation, selected hemodynamic variables and other parameters. Thus, the CCU is coercing a change in the practice of medicine, itself, which is increasingly being guided by the physiologic state and specific response to therapeutic measures.

*Mortality:* Gertrude Stein once said that "a difference to be a difference must make a difference." In the last analysis, the value of the CCU will be assessed by the difference it makes in mortality rates in coronary disease. It appears certain that the chances of cardiac resuscitation are improved within a CCU. Minogue et al.<sup>6</sup> reported the best results outside of a CCU. Of 60 patients with acute myocardial infarction who suffered cardiac arrest, 9 patients or 15 per cent were effectively resuscitated and were able to leave the hospital. The average rate of success in resuscitation reported from coronary care units was 31 per cent.<sup>7</sup> However, this latter figure can be improved upon by employing policies that almost completely abolish the need of resuscitation for primary derangements in heart rhythm. Three policies are involved: (1) abolition of ventricular ectopic beats during the first 48 to 72 hours after onset of acute myocardial infarction; (2) acceleration of the ventricular rate in the presence of bradyarrhythmias that are associated with ectopic beats or with hemodynamic deterioration; and (3) early detection of left ventricular failure and prompt digitalization. When these policies are adhered to, it is possible to reduce the incidence of ventricular fibrillation to less than 1 per cent.<sup>8</sup>

There are some who maintain that patients treated within the CCU have not been compared with carefully matched, randomly selected control patients. This is indeed so. However, it is nearly impossible to structure adequate control for the CCU experience since it represents a system of care with many diverse components, such as an improved physical plant, closer medical supervision, more responsive nursing care, continuous monitoring and utilization of multiple therapeutic measures. But how is one to account for the fact that until the introduction of the CCU, mortality rates in the large hospitals persisted at a figure in excess of 30 per cent and

now consistently hover at 20 per cent? This reduction is accounted for by control or prevention of death from ventricular fibrillation, which in the past has been responsible for about one third of coronary deaths. It is pertinent that mortality from cardiogenic shock, for which the CCU affords no special remedies, has remained unaltered. There have been several reports from hospitals where patients were admitted on a basis of bed availability to either the CCU or general care; results have consistently favored the coronary unit.<sup>9,10</sup>

### CONCLUSIONS

The introduction of the coronary care unit represents a key advance in cardiology. It was not the result of heavily endowed academic investigations, but rather the work of medical practitioners. The academic institutions have joined the effort only belatedly. This constitutes a criticism of the university hospitals and the research-oriented medical institutes, since it reflects an aloofness and even insouciance to some of the pressing problems in medicine. It is a malady of the academician to look askance at developments that have not been initiated or corroborated in his own bailiwick. One is reminded of another baseball umpire, Charlie Moran, who used to say, "There may be balls; there may be strikes; there ain't nothing until I calls them!"

Pruitt<sup>11</sup> has emphasized that to the patient with coronary disease the coronary care unit represents an extension of an optimal hospital environment. Unlike many other advances, it does not represent a distinct form of therapy entailing its own set of risks to the life and comfort of the patient. It has already lowered mortality for the hospitalized patient with acute myocardial infarction. It has enhanced education and has upgraded the responsibility of the nurse. It has provided an environment conducive to investigation of a number of challenging problems. It is changing the practice of medicine

by prompting a system of care continuously guided by monitored changes in patient response. However, the most important contribution emerging from the CCU is the demonstration that sudden coronary death can be prevented. The majority of these deaths occur outside the hospital. These facts require the development of new technics in large-scale social engineering to encompass the problem within the community.

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## Part II: Dr. Selzer

WHEN I WAS first invited to participate in this debate, a colleague of mine remarked that being against coronary care units is like being against motherhood. I felt bad about this, but it suddenly occurred to me that, with the population explosion, I really am against

motherhood, so I accepted the assignment. Actually I am not against coronary care units; I am not a real antagonist, but I am speaking against an overenthusiastic and uncritical approach to this problem which now widely prevails.

*Classification of Coronary Care Units:* The problem of coronary care units can best be discussed if we arbitrarily divide the units into four classes:

*Class I:* This represents the ideal unit, combining service with research. All facilities are available, not only monitoring and resuscitation facilities but facilities for the performance of all necessary chemical, physical and hemodynamic measurements. It includes provisions for emergency open heart surgery (in case of ruptured septum or papillary muscle) and the 24 hour attendance of cardiologists or Fellows in cardiology on the premises.

*Class II:* This unit has many, but not all, of the facilities found in Class I units. Interns or residents are available around the clock, perhaps not in the area, but in the hospital.

*Class III:* This type of unit has monitoring facilities augmented by limited emergency laboratory facilities and a means of following central venous pressure in an institution without house staff but with part-time coverage by staff physicians.

*Class IV:* This is the minimal unit with an electrocardiographic monitoring system entirely staffed by nurses.

This classification brings into focus the wide differences among the various types of facilities covered by the general term *coronary care unit*.

*Accomplishments of Coronary Care Units:* Next we might turn to the question, what has been accomplished by the coronary care unit (CCU) in the five years that have elapsed since the first units were organized? In my opinion, four such accomplishments can be listed: (1) The CCU has proved to be a valuable research tool. Its educational aspects are particularly valuable, for both physicians and nurses. In some institutions, the CCU may have raised the general level of patient care in the hospital. From the research standpoint, the CCU has helped clarify many previously unknown points about myocardial infarction. (2) The CCU has demonstrated the feasibility of resuscitation and the reversibility of ventricular fibrillation in a large number of cases. (3) Some other complications of myocardial infarction previously considered hopeless have been shown to be reversible: for example, the use of pacemakers has reversed the effects of complete heart block. (4) It is alleged to have greatly reduced the mortality from myocardial infarction. This point is a matter of opinion; I consider it unsettled.

*Evaluation of Therapy for Myocardial Infarction:* Coronary care units should be considered a specific form of therapy for myocardial infarction and, as such, can be compared with other methods used in the treatment of this disease. In the history of myocardial infarction, one finds many examples of overenthusiastic evaluation of therapy. Three such examples may be mentioned. First, routine prophylactic use of drugs such as quinidine, atropine, or even digitalis has been recommended in the past, but such treatment is not now accepted because it was not placed on a sound basis. Second, anticoagulants were introduced 22 years ago with the claim that they reduce mortality from 22 to 16 per cent. Yet, routine use of anticoagulants has never been universally accepted because of doubts regarding the statistics. It is my impression that the present trend is against wider use of anticoagulants rather than for it. Third, cardiogenic shock after myocardial infarction has been recognized as presenting a mortality of about 80 per cent. During the past 20 years, many agents have been introduced for the treatment of cardiogenic shock: plasma infusions, intra-arterial blood transfusions, digitalis, pressor agents, dextran solution, even vasodilator drugs. Enthusiasts of each form of therapy presented figures claiming reduction in mortality to 30 or 40 per cent. Yet, today few of these agents are used and mortality from cardiogenic shock is still estimated at between 60 and 80 per cent.

*Evaluation of Mortality Statistics:* Why these conflicting figures? It is recognized that myocardial infarction is a clinical entity with a great variability of course which makes mortality figures subject to large errors. A run of seriously ill patients at one time and a succession of milder cases at another make figures difficult to compare unless massive numbers, beyond the scope of a single institution, are used. Figures dealing with changes in mortality after introduction of coronary care units may be even more misleading than other statistics dealing with myocardial infarction. It is difficult to set up proper criteria for diagnosis. In addition, the availability of such a unit may encourage the inclusion of patients with questionable or milder forms of the disease who in the past might have been treated at home. Series of cases in a coronary care unit thus may be preselected when compared with another series of cases of more rigidly defined myocardial infarction. Even if

this were not the case, it is worthwhile to present some figures submitted by Grace<sup>1</sup> from a New York hospital:

	Patients with Myocardial Infarction	Mortality (%)
1/65 to 9/65	103	16
10/65 to 3/66	98	35

During these two time periods, no change in treatment took place. It does not require imagination to visualize that if the order of these two periods were reversed and if, between one period and the other, a coronary care unit were introduced in this hospital, these figures would be used to prove the success of the unit.

*Possible Damages of CCU:* The coronary care unit as a method of treatment of myocardial infarction has its indications, contraindications and dangers. Among its dangers, I consider first of all the possibility of overtreatment. We know that arrhythmias occur virtually in all patients with myocardial infarction, and serious arrhythmias, such as ventricular tachycardia, in as many as 50 per cent. In the past most patients survived without treatment or with minimal treatment. Now aggressive therapy is recommended. In Lown's unit such treatment is very successful; however, in less experienced hands adverse effects of such therapy may outweigh its positive contribution since drugs are not innocuous but may produce serious consequences if improperly used. Second, resuscitation procedures may be invoked in response to an artifact or a misinterpreted electrocardiogram, and thereby harm the patient. Finally, the presence of a coronary care unit may provide the physician with a false sense of security, particularly in the case of a Class iv unit. Here the exclusive attention is paid to arrhythmias, which represent only one of the many problems in patients with myocardial infarction. Furthermore, statistics implying a major reduction in mortality from myocardial infarction may provide the impression that treatment of myocardial infarction has been solved to such an extent that we have very little to look forward to, which is, of course, incorrect.

*Unanswered Questions:* Finally, I wish to pose a series of questions to which, in my judgment, answers are not clear. (1) Are we ready to have a coronary care unit in every hospital? I believe that we may be ready in terms of hardware and gadgetry but not in terms of properly trained personnel. It may take a long time

before fully trained personnel become widely available. (2) Is the class iv CCU desirable? I should like to see more research on this point. A real problem to be solved is the situation of the medium-sized community with three or four hospitals. Should each hospital have a two bed, class iv CCU, often empty, or should resources be pooled into one class iii, or the aim be a regional class ii unit with much broader therapeutic potential? This question deserves serious study. (3) If funds are limited, should the CCU have top priority? In general, we are an affluent society and can afford such units, but some hospitals still may have difficulty in buying and budgeting for such a unit. Furthermore, we often serve as a model for other countries. Should we tell everybody abroad that unless a hospital has a CCU, modern medicine is not being practiced? I believe that this is premature. (4) How important is the CCU in the over-all treatment of myocardial infarction? I contend that present statistics are unreliable, and the answer to this question is not yet known. I take particular issue with the misleading, often nonsensical statistics based on class iv units claiming reduction of mortality to one half or one third, in which results are obviously slanted by other factors.

#### CONCLUSION

Let me repeat that I am not against the coronary care unit. I believe, however, that the initial overenthusiasm brought the pendulum way out of line, and I hope that careful consideration will restore the pendulum to the center so that we can take a dispassionate and objective look at this problem.

My presentation has shown in detail why statistics mentioned by Lown are unreliable and should not be accepted at face value. What we need is a properly designed alternate case study with good controls. However, this may be morally impossible, and we may be left permanently with conflicting statistics and no real answer.

There is an additional point to be made on data on resuscitation. Many statistical reports rely on the number of patients defibrillated in a coronary care unit with the assumption that they would otherwise be dead. We have to remember that ventricular fibrillation often stops spontaneously and may be reversible. This has been amply demonstrated in our study on quinidine syncope. I am not advocating that when

ventricular fibrillation develops one should wait for it to subside, but I am pointing out another source of faulty statistics.

The educational value of the coronary care unit is undisputed. Better nursing care in general is an important by-product. On the other hand, we are overwhelmed by gadgetry. The equipment of the coronary care unit has become a status symbol. Every hospital is proud of its unit and wishes to show it off. It is important to appreciate that hardware by itself is useless

and to avoid falling into the trap of believing that monitoring alone is doing the job for the patients.

In closing, I repeat once again that all studies and figures quoted have built-in biases that do not satisfy a statistician or a scientist trying to find the true facts.

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## DRUGS IN USE

320  
Cholesterol Reducing Agents—  
Other

76-08-00  
Metabolic—  
Hypocholesterolemic

U 0287/21  
D-thyroxine Sodium

5/68 - 2427  
CHOLOXIN  
Baxter

Experimental Design	Clinical Pharmacology	Observations
Nb. Patients 48	<u>Purpose:</u> Study lipopenic action	<u>Serum total cholesterol (mg./100 ml)</u>
Age: -		<u>Reduction</u>
Dosage: 2-4 mg. qd. Max. 6-8 mg. qd.		# Range Avg. % 8 - 329 107.5 3 - 61 31
Route: oral	<u>Description of subjects:</u> Hyperlipemic subj. (most) 48	Base line val. # Reduction # before treat. pts. (%) pts. (mg./100 ml.)
Duration: 1-45 mos.		>400 6 43 - 61 5 <300 13 3 - 46 13
	Detailed tables given.	<u>Placebo response during study</u> (short periods)
		D-T <sub>4</sub> disc. - prompt rise D-T <sub>4</sub> resumed - decrease
		<u>Lipoprotein cholesterol levels (17)</u> (avg.) (mg./100 ml.)
		before after
	<u>Compared with:</u> Placebo (U 00/953)	$\alpha$ 81.4 76.7 $\beta$ 256 102.5
		Mean decrease ratio $\beta$ to $\alpha$ - 3.16 to 2.53
		<u>Conclusion:</u> Hypolipemic response could be maintained for prolonged periods in most cases, therefore drug may be useful in managing hyperlipemia.

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