The Introduction of Coronary Care Units (1960-1985)

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An Unparalleled Triumph

By

Leo van Bergen

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ABBREVIATIONS

AMI: acute myocardial infarction
BMJ: British Medical Journal
CCU: Coronary Care Unit
CPI: Coronary Prognostic Index
ECG: electrocardiogram
ICCU: Intermediate Coronary Care Unit
ICU: Intensive Care Unit
MCCU: Mobile Coronary Care Unit
NHS: Nederlandse Hart Stichting (Dutch Heart Foundation)
WHO: World Health Organisation

INTRODUCTION

The history of (the introduction of) medical technology is fascinating. Is the wish to turn sick bodies and minds into healthy ones the only driving force behind it, or do economics, culture, politics, or even simple vanity have something to do with it as well? When I started this research, my intention was to just have a look at the rise of intensive heart control units in the Netherlands. But it turned out quickly that this question could not be answered without looking at the swift and general rise of the Coronary Care Units (CCU) (as they are usually called in the Anglo-Saxon world) in countries like the United States, Great Britain, Canada, and Australia, and at the international discussion of their sense and nonsense. It´s introduction was so swift and general that, when stating that "the second half of the 20th century may well be considered the era of 'coronary care' in Europe and North America", in their history of the CCU, K.K. Khush, E. Rapaport and D. Waters emphasised the importance of the units. In 1998 E. Braunwald called the CCU "the single most important advance in the treatment of AMI" (acute myocardial infarction). One of the pioneers of the CCU, Desmond Julian, wholeheartedly agreed. (Braunwald 1998; Khush, Rapaport, Waters, 2005; Julian, 2001)

In the next part I hope to give an impression of this international discussion of the CCU in the years 1960-1975, followed by a short summary of how the introduction in the Netherlands developed. I will try to throw a light on the arguments given in favour of and against its introduction, an introduction that was as good as completed by the time medical technology criticism – among other topics focusing exactly on the CCUs – came to the fore. By that time the CCUs – looking for a justification of their existence – had already changed directions and goals several times. I hope to show that the

frequent shifts in the use of the CCUs resulted from a continuous struggle between expectations and impediments in clinical practice. The medical scientific arguments given in favour of the CCU – often presented as the most important if not only factor when explaining its existence – proved to be less sound than presented. The portrayed future of a healthy heart was built on quicksand, and the very rapid introduction of the CCUs in several countries – such as the Netherlands – only partly resulted from medical argumentation.

Although the introduction was a *fait accompli*, the CCU discussion didn't stop until the end of the seventies, because around 1975 it had received a new impulse with the criticism on medical technology in general by men like Ivan Illich. Around the same time as the welfare state reached its peak, the protest against authority – political as well as medical – also reached its peak. Healthcare, it was said, only created a relationship of dependency and moreover, the medical world was inhabited by people who watched not only – not even for the most part – over the health of their patients, but also – or even prominently – over their own position of power and the healthy state of their wallets. On top of that it was a health care system that created all kinds of iatrogenic effects.

For this reason, Illich protested the march of technological medicine at a time when not only the trust in technology in general was in decline, due to, for instance, the Vietnam War and the report of the Club of Rome, but trust in the medical world as well, because of, for example, the thalidomide disaster in the nineteen-fifties and -sixties, when a drug used by pregnant women resulted in the birth of thousands of deformed babies. Furthermore, the results of the heart transplants, so greatly admired at the end of the sixties and the beginning of the seventies, weren't as favourable as first expected, to say the least.

Nevertheless, technology was seen as the outstanding difference between modern medicine and old, or in the eyes of some, even obsolete medicine. This raised questions, formulated, for instance, by G. Wackers in his *Constructivist Medicine*:

> However, it is also technology that is held responsible for the disruption of traditional value systems, for objectionable moral and social consequences. (Wackers, 1994, 12)

The CCU can be seen as an article that exemplifies both glorification and disruption. It was greeted extensively as a warrior against death from heart disease or cardiac arrhythmia, but also as one of the reasons "death" itself faded. Because of the invention and practice of artificial respiration in the fifties, intensive care units were set up, later followed by more specialised units such as the CCU. This not only resulted in longer life, but also raised the question where life ended and death began. When exactly does a human being die? Or better yet: when exactly did we *decide the moment* that a human being had died? Is a patient allowed to die? The word "death" became diffused and terms like "brain death" replaced it, itself again subdivided into different categories. (Wackers, 1994, 282-283) Because of this, modern technology not only brought therapeutic progress, but changed the medical profession completely, as the children's surgeon Jan Molenaar, for instance, stated.

> When at the beginning of the sixties reanimation and long term artificial respiration became possible and challenged death to the utmost, the audience began to wonder. Not about the skills, but about the discretionary powers of doctors at the boundaries of life and death. The time of the paternalistic, authoritarian, Hippocratic way of healing that had existed for centuries, had definitely ceased to exist. (Molenaar, 1999, 97-98)

In an article in the *British Medical Journal* (BMJ) "Taking acute stroke care seriously" in July 2001, the authors argue that even when evidence is absent, "we should manage acute stroke as a medical emergency". They wondered if specialised acute stroke care should be discussed in the same way as the CCU and myocardial infarction thirty years before. For CCUs "were introduced without an evidence base but, more importantly, they did allow trials to be mounted and found successful treatments such as thrombolysis". (Wolfe et al., 2001) Without raising questions on the actual subject of the article, I

do want to question this reference to the discussion of how profitable or good-for-nothing the CCU was. Firstly: internationally it was a marginal discussion, although it waged most fiercely in Great Britain. (Mather et al., 1971; Mather at al., 1976; Hill, 1978) Almost all internal and cardiological specialists accepted the lifesaving importance of the CCUs without any further ado. The CCU made earlier diagnosis and thus earlier treatment possible and so it just *had* to have a substantial influence on the mortality caused by heart or coronary disease. Hence every discussion was pointless and a waste of time. Evidence-based trials, therefore, were in fact considered unethical. (Grace, Keyloun, 1970, 19)

Moreover, the introduction of the CCU *was* accompanied by all sorts of so-called proven reduction figures. Several cardiologists of name stated that, after the introduction of the CCU in their hospitals, mortality showed a sometimes 40 percent decline and, although without reference, the president of the American College of Cardiology reported that in the US 100,000 lives a year could be saved by massive introduction. (Corday, 1965; Day, 1963; Day, 1965; Day, 1968; Meltzer, Kitchell, 1966) In fact a situation was created that, as early as 1964, one of the few sceptics of all the "cardiac gadgets", Robert M. Farrier, the assistant director of the Clinical Center National Institutes of Health, remarked that a cardiologist criticising the CCUs would be as suicidal as a Congressman opposing "motherhood, God, and country". (Farrier, 1964, 389)

Furthermore, from the remark of the authors in the BMJ one could surmise that the introduction of the CCU had been laborious work. Nothing could be farther from the truth. Despite the discussion they pointed out, which included some early critical remarks, especially on the speed and vastness of the introduction, there are not many examples, and perhaps even none, of medical technology accepted and introduced that fast. It was indeed a victory march unequalled, an unparalleled triumph. (Fracheboud, 1987, 10; Meltzer, Kitchell, 1972, 8) In fact we will see that, despite what the authors of the 2001 BMJ-article claimed, the discussion of the introduction and practice of the CCU proved quite the opposite of

introducing new medical equipment, no matter what. It rather proved that discussion of the introduction of a new medical device should be held over and over again, as long as sound proof for its effectiveness remains absent.

Before telling this story of the international rise and discussion of the CCU, I want to thank all those that contributed to it. First of all Eddy Houwaart for the trust he had in me. Also, a word of gratitude to Murk Dijkstra, for taking over some of the most laborious work and to Sirkka Blanken-Russo for time and again locating all the different kinds of books, reports, and articles concerning the subject I wanted to look into. Also of course the Ministry of Health, for making this study financially possible. A special word of gratitude goes to Renee Schoffelen and Herman Simissen for polishing my English. For their cheerful presence I thank Marleen, Charlotte, and Irma. They not seldom saved me from having a heart attack. Slight disadvantage, of course, is that for this reason this study isn´t based upon participating observation.

Leo van Bergen

1 THE FIRST CORONARY CARE UNITS

The customary conception of CCU development

"The concept of intensive coronary care was born of despair not ingenuity." With these words Lawrence E. Meltzer and J. Roderick Kitchell, two pioneers in the field of coronary care, opened their story on the development and status of coronary care in the voluminous *Textbook of Coronary Care* (1972), edited by the aforementioned Meltzer and the Amsterdam cardiologist, Arend Jan Dunning. (Meltzer, 1972, 3) Therefore it is somewhat surprising that in the story itself it isn´t the despair about the high mortality in heart and coronary disease – in the sixties responsible for about half of the total death rate – that springs from the pages. On the contrary: as in most stories concerning the rise of the CCU, (Khush, Rapaport, Waters, 2005; Mehta, Khan, 2002) all attention is aimed at the genius of a couple of doctors, who in the decades before the opening of the first CCUs invented something new or brought existing knowledge to a higher level. Meltzer and Kitchell saw five phases in CCU development (to which R.M. Norris would add a sixth one ten years later): resuscitation, vigorous management of arrhythmias, investigation, and treatment of pump failure and prevention of sudden death (and limitation of infarction size). (Meltzer, Kitchell, 1972, 8-18; Khush, Rapaport, Waters, 2005, 1042; Julian, 1987, 498)

Did Meltzer and Kitchell assume that their audience was familiar with the despair, even in such a young, post-war phenomenon? Was it seen as a fact not worth further elaboration? Be this as it may, in any case it was despair resulting from the rising number of heart and coronary diseases, for which no cure was found at first. And so, in the forties and fifties, a lot of energy was spent to attempt

containing the disease and lowering its prevalence, or at least prevent it from rising further.

Prevention was the magic word and it led to grand scale investigations like in the American cities of Framingham and Tecumseh. Since then, the English language has been enriched with terms like "epidemiology of heart disease", "risk factors", but also "the coronary care unit" (or intensive heart monitoring unit), which after a while developed into the most important attempt to give healing back its place in the fight against heart and coronary disease. Also, terms like primary and secondary prevention came to the fore (Van Herpen, 1979) which, as we shall see, wasn't devoid of any importance. The word "prevention" was used and defined in different, sometimes almost contradictory ways, because of the positive effect just using the word could and would have.

Anyhow, Meltzer´s and Kitchell's story discusses inventions that show that medical innovation – and innovation in general – is a matter of little steps taken by different people, until at last one individual or research group makes the final step crossing the line, until at last one individual or research group puts in the last piece of the puzzle. (Rigter, Dercksen, 1995, 39, 47) More specifically, they were inventions without which the CCU could never have been taken into use, at least according to Meltzer and Kitchell and with them numerous other cardiologists or internists. It had, however, become clear that, in spite of all the knowledge built up and all the inventions made, again according to the writers, coronary arteriosclerosis could not be prevented and that the continuously rising number of deaths as a result of acute myocardial infarction, the heart attack, could not be stopped by ordinary means. For instance, around thirty to forty percent of all patients admitted into hospital because of a heart attack in 1960, died. The huge death toll, combined with the fact that by far most of them died shortly after having the attack, would become one of the major reasons for giving special attention to the patients in the first days after they suffered an attack. (Goble et al., 1966; Lown, Shillingford, 1967) Meltzer and Kitchell commented: "It was only then that a new approach of this

overwhelming problem was conceived: an attempt to salvage the lives of the patients who died suddenly of rhythm disturbances of the heart." (Meltzer, Kitchell, 1972, 3)

Resuscitation and acute heart death

As Joel Karliner confirmed in his 1981 "History of the Coronary Care Unit and its Contribution to Mortality Reduction", the story that followed the opening of Meltzer and Kitchell had been a story many cardiologists had told in shorter versions time and again before them, (Day, 1968, 252; Goble et al, 1966, 1005; Grace, Keyloun, 1970, 18; Hofvendahl, 1971, 9; Weinberg, 1969, 254; Lown, 1968, 19-21) and it would be repeated time and again after them. (Fleischmann, Lee, 1998, 3; Lie, 1983, 4) As if to underline his own conclusion, even the story Karliner himself told was heavily indebted to Meltzer and Kitchell. According to them, unlike the complicated birth history of most medical innovations, the story of the CCU was simple and rectilinear. It resulted from gathering two separate lines of research, namely one into heart resuscitation and one into the causes of death resulting from acute myocardial infarction. On the one hand the CCU was one example of the trend towards larger organisations and increasing specialisations, (Killipp III, Kimball, 1969, 281) and on the other hand no more than the next logical step – "a natural outgrowth" as John T. Kimball and Thomas Killipp III, two other CCU-pioneers, called it – (Killipp III, Kimball, 1969, 282) in a journey that was started by D.R. Hooker, W.B. Kouwenhoven, and A.R. Langworthy with an article in the *American Journal of Physiology* in 1933: "Effects of alternating electrical currents on the heart".

Based on animal experiments Hooker, Kouwenhoven, and Langworthy developed a method of heart reanimation in which a hand massage of the naked heart was followed by an open chest electrical defibrillation. Unfortunately, the method remained unsuccessful for many years, but bit by bit the reasons for its failure were discovered. First of all, it became clear that blood circulation had to remain intact up until the moment defibrillation could start.

Moreover, it became clear that the period in which the resuscitation had to be applied lasted no longer than just a few minutes. If it was applied just a bit later, death was unavoidable.

Although all this was known by the end of the thirties, it took until 1947 before the Hooker method was applied successfully. It was the American surgeon Claude Beck, famous for his always and everywhere – so we cannot stay behind – quoted phrase: "hearts too good to die", who immediately after a chest operation reopened the wound of a 14-year-old boy because he had developed ventricular fibrillation. Beck massaged the heart and applied electrical defibrillation using two electrodes. The boy survived. Although this incident also made it clear that conditions had to be very favourable to reach a good ending, after this many hospitals began to equip their operation wards with defibrillators and started to train their surgeons in resuscitation techniques. (Meltzer, Kitchell, 1972, 3-4; Karliner, 1981, 83; Day, 1972, 405; Julian, 1987, 497; Khush, Rapaport, Waters, 2005, 1041)

Nine years later it was Beck again who succeeded in applying that same technique successfully on a man with acute myocardial infarction, in other words: on someone getting an attack outside the operation ward. While making his round in 1956 a 65-year-old colleague of Beck suffered a heart attack and almost immediately ventricular fibrillation occurred. He was taken to the surgical ward and treated immediately. Beck wrote: "This one experience indicates that resuscitation from a fatal heart attack isn´t impossible and might be applied to those who die in the hospital and perhaps to those who die outside the hospital." (Meltzer, Kitchell, 1972, 4; Karliner, 1981, 83; Khush, Rapaport, Waters, 2005, 1041) This conclusion was shared by L.B. Reagan, who came across a similar incident around the same time. He too concluded that a myocardial infarction no longer equalled a one-way ticket to heaven. But again, it was evident that circumstances had to be very favourable. Therefore, it isn´t surprising that these incidents had hardly any influence on the daily practice of treating myocardial infarctions. As Meltzer and Kitchell put it:

> The necessity of having to surgically expose the heart to perform massage and defibrillation posed serious problems for both the physician and the patient. The formidableness of the procedure tended to dissuade all but the surgically-trained physician from even attempting this lifesaving measure to say nothing of the consequences of opening the chest cavity of a patient already at the door of death from myocardial infarction. In addition, very fortuitous circumstances had to prevail for resuscitation even to be attempted. Specifically, a physician had to be in attendance when the catastrophe occurred (practically with a scalpel in his hand) and then a defibrillator had to be brought to the bedside (or, more likely, the patient brought to a stationary defibrillator) all within a precious few minutes after the onset of ventricular fibrillation. It is hardly surprising therefore that open chest resuscitation never assumed a major role in preventing death from acute myocardial infarction. (Meltzer, Kitchell, 1972, 4)

However, at the same time an alternative was suggested for one of the above-mentioned difficulties, namely the necessity to open the chest and expose the heart to make defibrillation possible. In the magazine *Circulation,* Paul Zoll and his associates published an article on administering electric shocks to stop ventricular fibrillation without having to open the chest. Two years earlier Zoll had already published about ways to stimulate the heart with an electric current, especially when, not fibrillation, but cardiac arrest was the cause of the problems that had to be resolved. Through this way of fighting fibrillation and asystole from outside the body, the number of possibilities to resuscitate were expanded, and Zoll saw marvellous prospects to expand it even further emerging at the horizon. For instance, as Meltzer and Kitchell said, continuous cardiac monitoring could "be accomplished (referring specifically to operating rooms) so that the onset and mechanism of cardiac arrest could be identified instantly". (Meltzer, Kitchell, 1972, 5; Karliner, 1981, 84; Khush, Rapaport, Waters, 2005, 1042)

But without in any way wanting to downplay the importance of Zoll's techniques, they offered no solution whatsoever for the second major problem, to keep the circulation going until the

moment the outside defibrillation could start. Here, too, success depended on the immediate vicinity of the right equipment. This could only be the case in a very small number of incidents. And so, in the vast majority of cases, direct heart massage remained necessary until the moment patient and equipment could be brought together. It wasn't for nothing that John Shillingford and Bernard Lown – the man who would rise to be perhaps the fiercest defender of the CCU concept in the sixties – would say in 1969 that the unit was in fact no more than the translation of the accidental presence of the necessary tools at the place of calamity into a deliberate and continuous monitoring. (Lown, Shillingford, 1967, 449; Dekker, 2000, 25)

A year before, Lown had already paid attention to another piece of the puzzle by looking at the role of technology itself. The CCU wasn't just a medical answer to a medical question. One should never forget, that no matter how much one wanted to solve a problem by technological means, one simply will have to be able to produce the necessary machinery. However, that was the case here. "At this very time electronic techniques of monitoring heart rhythm reached a high state of perfection." Therefore, in his eyes the CCU combined new medical expertise with technological progress, both taking place at the same time. (Lown, 1968, 21)

Four years after the innovations of Beck and Zoll, the solution to the problem of blood circulation was found. In cooperation with J.R. Jude and G.G. Knickerbocker, Kouwenhoven, of the Johns Hopkins Hospital in Baltimore, published an article in the *Journal of the American Medical Association* in 1960, entitled "Closed–chest cardiac massage". In it, he came up with a method for massaging the heart without opening the chest, usually combined with mouth-to-mouth resuscitation. It inspired Hughes W. Day to install a so called "mobile crash cart" in his 200-bed private Bethany Hospital, in Kansas City, Missouri. It sounds somewhat disrespectful, but it could be described as a first aid kit on wheels, even though it was equipped with a defibrillator and an external pacemaker. Furthermore, he developed a resuscitation program in which an

especially trained team immediately came into action as soon as a patient suffered a cardiac arrest. (Kouwenhoven, Jude, Knickerbocker, 1960; Day, 1972, 405; Day, 1968, 252; Khush, Rapaport, Waters, 2005, 1042)

The expectations were high, but the results were, to put it bluntly, appalling. In more than 96 percent of the cases, the efforts were in vain, no lower than the national average. It clearly showed the inefficiency of the resuscitation method. At a re-evaluation three months later, this situation still had not changed for the better. After a visit to the laboratory of Zoll, with its monitors, pacemakers, and defibrillators, (De Neeling, 1985, 7) Day probably thought that this had to be the result of the fact that the patients weren't continuously monitored. In a vast majority of cases the time wasted because of this, just had to be the reason for the fatal outcome. Therefore, the machine should not be brought to the patient, but the patient should be brought to the machine. Moreover, so he himself stated ten years later, it had become clear to him that the nurses didn´t possess enough theoretical knowledge to fulfil their task successfully. For that reason it was of the utmost importance to establish a specially trained nursing team. (Quinn, 1999)

According to other sources however, it was Meltzer and Kitchell who were the first to emphasise the importance of specially trained nurses. Although Day observed a lot, he hardly edited his many data, whereas Meltzer and Kitchell tried to draw some conclusions from the enormous number of data they collected. Be this as it may, Day's conclusion was that patients should be under constant surveillance in a surrounding completely equipped for recognizing and treating heart failure and, if necessary, reanimating a patient at any time. (Day, 1968, 252; Day, 1972, 405; Meltzer, Kitchell, 1966, 1; Meltzer, Kitchell, 1972, 5; Karliner, 1981, 84; Interview Dunning) In fact machine and patient should become one. By the way, this idea doesn't seem to be as original as has been said many times, for instance in sentences like "the insight of Hughes Day and others". (Grace, Keyloun, 1970, 18) To give an example, J.O. Leibowitz wrote in 1970 that Day probably borrowed his insight from special units

after open heart surgery, of which the first ones were set up in Minnesota in 1958. (Leibowitz, 1970, 171)

An interesting marginal note to this straightforward story, leading directly to the intensive coronary units, came from cardiologist F.W.A. Verheugt in his inaugural speech for the Free University of Amsterdam in 1989. Not as dazzling as the technological developments, but perhaps of more importance were the developments in pharmacology, especially the development of drugs that combatted the coagulation of blood. Or at least: they could have been. For instance, in Germany in the fifties a drug was made from the bacteria streptococcus. It had an enzyme capable of dissolving coagulations. It was Sol Sherry from Philadelphia who first gave this drug, streptokinasis, to patients suffering from a heart attack, hoping it would dissolve the coagulation in the coronary artery that was causing the complaints. He published his findings in the *Annals of Internal Medicine* in 1959. Sadly, Sherry wasn't able to find out the exact amount that was needed of the drug, nor how long the treatment should take. It soon became clear that treatment with streptokinasis led to serious side-effects, such as internal bleeding, whereupon it was considered to be life-threatening. (Verheugt, 1989, 5-6)

As a result, when heart and coronary disease was acknowledged as the biggest enemy of mankind soon after, not the treatment of coagulation, but of rhythm disturbance was considered of the utmost importance. Attention was transferred from the coronary artery to the heart itself, although the treatment room was named *coronary* care unit (which also means that it wasn't Day who first came up with this name, as for instance Julian says in his "History of the CCU"). (Julian, 1987, 498; Khush, Rapaport, Waters, 2005, 1042) That's also why Verheugt thought the Dutch name "hartbewakingseenheid" (heart monitoring unit) was more appropriate. After that the invention of new drugs, such as lidocaine, was also focused on the heart itself. This means, however, that the effects were tackled, but the cause was left untreated. "Sadly the coagulation treatment with streptokinasis was completely forgotten," Verheugt said. (Verheugt,

1989, 6) The point he tried to make is clear. A linear history only seems to be linear in hindsight. If the experiments with streptokinasis had not been stopped after the first disappointing results, the future of the struggle against heart and coronary disease would most likely have been different, but that future would have been pictured afterwards as logical and linear as well.

The CCU of Hughes W. Day

Because of a lack of government support, Day and his companions started negotiations with a private foundation, the John A. Hartford, to develop a CCU of eleven-bed size in 1960. The Hartford Care Unit existed of a seven-bed ward for medical and surgical patients and four separate beds for patients with acute myocardial infarction. It isn't surprising that myocardial infarction had Day's keen interest. Heart and coronary diseases were responsible for about half the death rate in 1960, and of that half again half was caused by ischemic heart diseases. Of those the myocardial infarction is the most important one. (*Hart- en Vaatziekten*, 1972, 12, 16) According to Verheugt, ischemic heart disease in general and myocardial infarction in particular are to a cardiologist what a torn ligament and a damaged meniscus are to an orthopaedic surgeon: his main source of income. (Verheugt, 1989, 3)

Day was able to open his unit in May 1962. Indeed, he would not have been able to do so without the support of the Hartford Foundation, because the "intensive coronary care area" turned out to be quite expensive. Day hastened to comment that in the future this certainly would no longer be the case, without explaining why, however. Consequently, there is reason to doubt this opinion, a doubt that is strengthened by the fact that already two years later a new grant from the foundation was necessary to buy an apparatus making it possible to study electro cartographic patterns. (Day, 1962, 423, 425; Day, 1965, 51, 53; Day, 1972, 405, 406; Waitzkin, 1979, 1261) The foundation's enthusiasm did wane after this. In its 1963 annual report it wrote that Day's unit had shown that "a properly equipped

and designed physical setting staffed with a team trained to meet cardiac emergencies will provide prophylactic therapy which will materially enhance the survival of these patients and substantially reduce the mortality rates". (Waitzkin, 1979, 1265)

A monitor was bought that enabled the doctors to watch over blood pressure, breathing, temperature, and pulse of each patient. More important, however, was the special heart monitor that was put in each of the four rooms and was connected to an alarm system. These machines – compare the comment of Lown on the importance of technique already existing – had been developed in favour of the American space program and had only just been ready for use. This is confirmed for instance in *Aspecten van de Patiëntenbewaking* (Aspects of Patient Monitoring) from the Dutch firm G.L. Loos and Co, published in 1966. The opening sentences are that the space program had "highly stimulated electronic science. Because of that it is now possible […] to measure and register a multitude of physiological phenomena." (*Aspecten*, 1966, 1) But, as said before, in 1972 Day himself focused primarily on the nursing staff.

> Thus, our early concept of the coronary care unit was woven around improving patient care by placing the highly trained nurse back at the patient's bedside. With close supervision of medical care we hoped to lower the hospital mortality rate of myocardial infarction and salvage patients suffering from unexpected cardiac arrest. (Day, 1972, 405)

However, almost at that same moment Meltzer and Kitchell, although usually seen as the ones who really focused the attention on the importance of a "highly trained nurse", restricted their praise to the technological aspects of the Hartford Care Unit. Without much doubt the explanation for this is that they didn´t hold the nurse's role in Day's particular CCU in very high esteem.

> With this equipment it was possible to visualize the electrocardiogram continuously and at the same time for personnel to be alerted instantly whenever the heart rate exceeded or fell below present levels. (Meltzer, Kitchell, 1972, 5)

This time the first evaluations did show the success that was so greatly missed after the introduction of the crash cart. A mortality drop of twenty percentage points was ascertained: from 39 to 19. Factually this meant twelve deaths less in 62 patients. A venomous remark at the address of more conservative colleagues was in order.

> It is interesting to note that 42 coronary patients were treated by physicians on the general medical floors of the hospital during the first year that the Acute Coronary Care Area was open. These physicians apparently either didn´t accept the idea of electronic monitoring or felt their patients weren't critical enough for the type of care given in the acute coronary area. Eighteen deaths, however, occurred in this group of patients with a mortality rate of 43 per cent. (Day, 1963, 424)

To Day the success of the CCU was self-evident. In an article on the effectiveness of his unit, published in 1965, he based his findings solely on self-observation. No comparison whatsoever was made, not even a "before and after". Nevertheless, he concluded that the CCU, that, as he mentioned himself, was completely loaded with the latest technological gadgets, was the ideal place for treating patients who had suffered a myocardial infarction.

> Electronic equipment can be used with maximal effectiveness. Constant, well trained nursing service is reassuring to the patient and contributes materially to his recovery. The coronary care unit leads to a higher type of medical care and to more frequent visits by the attending physician. The mortality rate of the disease can thus be reduced. The incidence of successful resuscitation in the acute coronary patient, when unexpected cardiac arrest occurs, is much higher than on the general floors of the hospital. (Day, 1965, 53)

Although literature sometimes states that the technological revolution of medicine started the process of actual, as well as metaphorical, patient-doctor alienation – because the doctor started to give greater weight to and see more truth in the figures and statistics of his machines than in the patient's tale –, (Howell, 1996, 61) this quotation

shows that certainly in Day's eyes the CCU was an effective weapon against myocardial death. On the wave of this (alleged) success he gave in to beautiful prospects. Although the first CCUs had not existed for longer than a year, he estimated in 1963 that spreading them throughout the whole of the United States could save up to 45,000 lives a year. To underline this estimation, he first pointed out a personnel communication by Joseph Fitzgerald, senior surgeon and head of the coronary heart disease unit of the Department of Health, Education and Welfare, in a footnote. However, a footnote a bit further on ascribes the number back to E. Grey Dimmond, of the Scripps Clinic and Research Foundation in La Jolla, California. But because this second reference is also used elsewhere, the first one is most likely the right one. (Day, 1963, 425-426) The main point, however, is that it remains completely unclear on what evidence Fitzgerald or Dimmond based this number. Nevertheless, with or without reference to Day, in the following years it was mentioned time and again with peaks up to sixty thousand. (Lown, 1968, 24)

As said, the president of the American College of Cardiology, Elliot Corday, didn't even hesitate to say that up to 100,000 patients "with hearts too good to die" could be saved by establishing a certain amount of CCUs. Working in these units was hard and intensive, but also gratifying and, given the results, more than worth all the hardship. (Corday, 1965) The number he mentioned would also be repeated occasionally. At a symposium of the American College of Cardiology and their own Presbyterian University of Pennsylvania Medical Center, Meltzer and Kitchell, pointing out statistics of five different CCUs, claimed that "as a result of this care" mortality in hospitals themselves had dropped by 33 percent. Meltzer and Kitchell were certainly not among the least critical cardiologists and so they admitted that there were certain dangers in attaching so much weight to such "simple statistics". Nevertheless, it wasn't unreasonable to suggest that if a similar reduction could be reached in every hospital, "thousands of lives (perhaps 100,000)" could be saved in the United States every year. (Meltzer, Kitchell, 1966, 4-5)

The US Public Health Service published its most recent – positive – data in 1964, based on the units of Day and Meltzer/Kitchell. All in all, they had examined 300 patients. The outcome was that "patients treated in the two coronary care units […] had a mortality about one-third less than the fatality rate expected (or previous obtained) with customary care. Specifically, the mortality among the CCU group averaged 20% in contrast to the former death rate of 30-35%." According to the authors almost the entire drop in numbers had to be ascribed to the timely signalling of ventricular fibrillation. This made the Health Service remark that the introduction of CCUs on a grand scale should take place as quickly as humanly possible. If about 1000 out of 7000 American hospitals were equipped with them, about 25,000 extra lives could be saved every year. In later years Meltzer and Kitchell remarked: "This optimistic prediction was hardly necessary to encourage hospitals to develop coronary care units; apparently the concept in itself had enough theoretical appeal to make dozens of hospitals initiate this specialised care already, before any evidence had been presented to justify its value." (Meltzer, Kitchell, 1966, 8-9)

By the way, the reduction by one third, or between 30 and 40 percent, would become the most accepted number. (Lown, 1968, 24; Lown, Shillingford, 1967, 449; Lown et al., 1969, 718; Killipp, Kimball, 1969, 286) People like Lown or Julian, of the Royal Infirmary Edinburgh, would state that, for the time being, this reduction had marked the limit of possibilities, (Julian, 1968, 607; Lown et al., 1969, 718) a judgment underlined by Dutch cardiologist A.C. Arntzenius in his 1974 inaugural speech *Curatieve en Preventieve Cardiologie* (Curative and Preventive Cardiology). (Julian, 1968, 607; Lown et al., 1969, 718) However, it certainly was neither the only, nor the lowest reduction number mentioned in those years. For instance, Meltzer himself would come up with a percentage of 40 in 1966, a percentage again entirely ascribed to CCU care. And Paul N. Yu, Charles K. Friedberg and William J. Grace, professors of clinical medicine of St. Vincent's Hospital in New York, even mentioned a mortality reduction rate of 50 percent in 1972, provided the most was made of

all the possibilities the CCU could offer. (Meltzer, 1968, 6; Yu, Friedberg, Grace et al., 1971, 171, 181)

Other pioneers

It will by now be clear that Meltzer and Kitchell were no minor players in the field of coronary care. Around the same time Day set up his unit, they were the heads of one of the two teams of doctors who independently experimented with different ways to reduce mortality from myocardial infarction. Not reanimation, but investigation into the often fatal heart rhythm disturbances was their starting point. More or less by accident they had discovered that a large amount of the patients suffering from myocardial infarction admitted to their hospital, died suddenly during hospitalisation.

It was of course common knowledge that people could die seemingly suddenly after surviving the attack itself. However, how often this happened was unknown, and the high percentage amazed Meltzer and Kitchell. Analysis learned that most of these patients died because of rhythm disturbances or failing blood circulation, which was scientifically confirmed some years later. That study showed that the existing heart attack therapy, which mainly focused on the prevention of thrombosis embolism, was inadequate. Instead, attention should be paid to managing rhythm disturbances. Moreover, most patients died within three days after hospital admittance. That is why Meltzer and Kitchell concluded that heart attack patients should be under constant surveillance during the first days, in an environment suitable for immediate treatment of rhythm complications. (Meltzer, Kitchell, 1972, 5-6; Karliner, 1981, 84)

A simple sum taught them the effect would be huge. In the United States almost 10,000 people suffered a heart attack every day. Of them round about 1500 died immediately. Of those reaching hospital alive, another thirty percent quickly left the land of the living. More than half of these died within the aforementioned three day period, and almost all within five days. More than half the number of deaths was due to rhythm disturbances, a complication of

which Zoll had already proved that a fatal outcome wasn't inevitable. (Meltzer, Kitchell, 1966, 2-3)

All this led to the establishment of a two-bed unit in the Presbyterian University of the Pennsylvania Medical Center in October 1962, to test the Meltzer and Kitchell presuppositions. The unit was sponsored by the National Institutes of Health. It was completely independent of other medical work and fully self-supporting in matters of staff, equipment, and stock. But as in the case of Day's crash cart, the first results were rather disappointing. Meltzer and Kitchell:

> The resident physicians were hopelessly bored with the inactivity and the seemingly endless vigil, and it became necessary to discontinue the effort abruptly to avoid (what now would be called) a demonstration. By default, a *system* of specialised care was then conceived wherein nurses rather than physicians assumed the primary responsibility for surveillance as well as for emergency treatment. In this plan nurses were taught to assess the patient's clinical course, identify and interpret rhythm disturbances and, above all, to act on their own if necessary in terminating lethal arrhythmias. This concept, which represented a radical departure from traditional nursing practice, was enthusiastically accepted by the nursing and medical professions and later became the keystone of intensive coronary care. (Meltzer, Kitchell, 1972, 7)

Specially trained nurses had to take over certain medical tasks from the doctors, who weren't constantly available. Meltzer and Kitchell hoped that this constant surveillance would not only have a positive effect on the original target, treatment of rhythm disturbances, but also on death ascribed to heart pump failure. (Meltzer, Kitchell, 1966, 4)

At the same time in the Toronto General Hospital, K.W.G. Brown, R.L. MacMillan, and others executed similar experiments. They reported their experiences in an article entitled "Coronary Unit: An *Intensive Care* Centre for Acute Myocardial Infarction", and it was published in the *Lancet* in 1963. Brown *cum suis* reported on their

study into rhythm disturbances associated with heart attacks and concluded that more than half of the patients suffered from them. So, they had to be monitored in one way or another. Even before Day they opened a four-bed intensive care unit in March 1962, making constant electrocardiographic and clinical observation possible, in an environment fit for resuscitation. (Brown et al., 1963, 349-50; Day, 1972, 406; Meltzer, Kitchell, 1972, 7; Killipp, Kimball, 1969, 281; Khush, Rapaport, Waters, 2005, 1042) It was striking that in their first evaluation of the unit Brown gave praise to all kinds of things attached to it – it made nursing more efficient and, in an emergency, all possible aid was available – but he didn´t cheer the *raison d'être* of his unit, keeping more patients alive, at all. Dropping the death rate by 36 percent wasn't achieved, which proofs that also the "before and after" research, that in later years was attacked fiercely methodologically and was seen commonly as too optimistic, didn´t always provide the success one hoped for. Nevertheless, Brown tried to put a positive spin on it.

> Although the results for the first year in the coronary care unit do not indicate any conspicuous lowering of mortality, vigorous early treatment could *possibly* reduce the incidence of fatal arrhythmias. [italics mine: LvB] (Brown et al., 1963, 352)

The word "possible" used by Brown stood not on its own. Words like "possible", "probable" or "likely" were frequently used in articles praising the possibilities of CCUs. For instance, Day wrote in the *American Journal of Cardiology* in 1965 that it was "doubtful" that the results obtained in the CCUs could also be obtained in an ordinary hospital room. (Day, 1965, 51) Lown *cum suis* wrote in 1969 that it "seemed" certain that resuscitation and survival in the long run had improved because of the CCU. (Lown et al., 1969, 718) Killipp and Kimball were also of the opinion that it "seemed" to be abundantly clear that the CCU had improved the efficiency and effectiveness of the struggle against cardiac disease, because of the concentration of staff and technology. (Killipp, Kimball, 1969, 284) And in the three sentences he needed in a 1968 article to describe the

blessings of the CCU in combatting myocardial infarcts, also Robert M. Marshall used the words "appeared", "suggested", "seems reasonable to expect" and "suggest" once again. It didn´t stop him from opening his last sentence, in which he once more summed up these blessings, with the words: "It is clear". (Marshall, 1968, 475)

Brown's list of CCU advantages looked very much like the lists Day delivered in 1963 and 1965. Day again described the advantages as proven five years later. Brown's expectations had come through, although at that same time Day admitted that in the meantime his first findings and extrapolations had proved to be slightly optimistic. A vast part of early concepts and ideas had been only partly correct, but now, by 1968, "with further investigation and research", even higher expectancies were realised indeed. (Day, 1968, 252)

The first effectiveness studies

Besides the early CCUs already mentioned, one could also point out those of Gaston Bauer and Malcolm Whyte (Sydney Hospital, Australia, 1962). They were a direct result of cooperation with Julian who in the *Lancet* article "Treatment of Cardiac Arrest in Acute Myocardial Infarction" from 1961, had proposed to train all nursing and paramedical staff in closed chest resuscitation, after first presenting his CCU ideas to the British Thoracic Society. Not for nothing the first CCU presentation was given by the Sydney Hospital to the British Cardiac Society in 1964. (Julian, 1987, 498; Mehta, Kahn, 2002) Followed by Paul Unger (Miami Heart Institute, Novembre 1963); Graeme Sloman (Melbourne 1963); Grace (St. Vincent's Hospital New York, June 1964); Killipp (Cornell University New York) and of course the one Lown opened (Peter Brent Brigham Hospital, Boston, October 1965). Furthermore, all departments that admitted heart attack patients had to be equipped with a monitoring system, that enabled on the one hand automatic registration of the heart rhythm, and on the other raised the alarm in the case of rhythm disturbances. (Meltzer, Kitchell, 1972, 8; Khush, Rapaport, Waters, 2005, 1042) Unger's unit, by the way, was the first one especially built instead of