

# Should doctors recommend defibrillators for use at home after myocardial infarction?

**Michael F O'Rourke** thinks that enthusiasm is an important factor; **Mathew Hutchinson** and **David Callans** say at home defibrillators do not save additional lives



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**YES** Ventricular fibrillation causes most of the sudden non-traumatic deaths in Western society—up to 400 000 deaths a year in the United States alone.<sup>1</sup> Most deaths occur in people without known heart disease, but many occur in people with known coronary artery disease.<sup>1</sup> Defibrillators in aircraft, airports, railway stations, sports stadiums, police patrol cars, gymnasiums, and various public places are designed for the population at large,<sup>2</sup> and in these locations their use is regarded as cost effective.<sup>3</sup> Like fire extinguishers, they seem to be for use in a rare emergency.

Guidelines for the implantation of defibrillators now include patients of all ages whose left ventricular ejection fraction is less than 30% but who have a prospect of living without major cardiac disability for two years.<sup>4</sup> Implantation of a defibrillator is encouraged by manufacturers and by proceduralists, who fear that deviating from guidelines may be a cause for legal action. Together with implanta-

tion, monitoring, and prior evaluation, they cost about \$100 000 in the United States during the first year. Defibrillators were introduced to save lives in patients with hearts “too good to die,” but now they are used more often in patients with hearts “too bad to live.”

Patients who have had a myocardial infarction have a much higher risk of further coronary events, including ventricular fibrillation, than other people of the same age. Is it reasonable to suggest that such patients have a defibrillator available in their home for use by others in the event of cardiac arrest?<sup>1</sup> Most such events do occur in the home, in the bedroom or adjacent rooms.<sup>5,6</sup> If such people work in a federal US building or in a casino, airport, or gymnasium or if they travel by air in or towards the United States such a device is available and a programme is in place for its use. But not at home.

### Economic argument

Those who argue against home defibrillators quote cost and the HAT (Home Automated External Defibrillator Trial) study.<sup>7</sup> Defibrillators can be purchased for around

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**NO** Few diseases have such disparate clinical outcomes in the absence of definitive treatment as sudden cardiac death. Many studies have shown excellent outcomes in patients resuscitated after sudden cardiac death who receive early defibrillation, so it is logical for doctors to seek to extend this powerful treatment to other populations at high risk. Unfortunately, the trials that have sought to protect individual patients with automated external defibrillators have been overwhelmingly unsuccessful. In light of the fortuitous convergence of circumstances that leads to a successfully resuscitated out of hospital cardiac arrest, the task of broad application of this treatment seems indeed daunting.

First, defibrillation works only for patients presenting with ventricular tachyarrhythmia. The current incidence of out of hospital cardiac arrest in the United States is 0.55 per 1000 people—about 160 000 events a year.<sup>1</sup> Of these arrests, only 20-38% will have ventricular tachycardia or ventricular fibrillation at presentation; thus most sudden cardiac arrests in the general popula-

tion are due to pulseless electrical activity, bradyarrhythmia, or asystole.<sup>2</sup> Although the proportion of arrests caused by ventricular tachycardia or ventricular fibrillation may be higher in selected populations, the concept is important. Furthermore, the overall incidence of ventricular tachyarrhythmia as a cause of sudden cardiac death is decreasing: undoubtedly a reflection of improvements in the treatment of coronary heart disease.<sup>1</sup> The proportion of sudden cardiac deaths not attributable to ventricular tachycardia or ventricular fibrillation is steadily increasing and has a uniformly poor outcome even when the arrests occur in the hospital with ready access to advanced life support systems. The reduction in rates of sudden death related to tachyarrhythmia is further underscored by the lower than expected event rates in trials of automated external defibrillators (2.2% over 37 months from the randomised, controlled Home Automated External Defibrillator Trial (HAT)).<sup>3</sup>

### Events need to be witnessed

Next, it seems intuitive that the successful resuscitation of sudden cardiac death requires the event being witnessed. Unfortunately less than 20% of out of hospital arrests occur in public locations. In the community based, randomised, controlled Public Access Defibrillation (PAD) trial, 95% of cases of

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\$1500, and people pay this much or more for metallic paint or alloy wheels in their new car, or for a better TV or sound system in their home. The cost of purchasing a semiautomatic defibrillator is around 2% that of implanting an internal defibrillator, and in a heart “too good to die” against a heart “too bad to live.” The economic arguments do not make sense.

The HAT trial randomised 7001 patients who had survived anterior myocardial infarction a mean of 1.8 years previously and who did not meet the criteria for implantation of an internal defibrillator.<sup>7</sup> One group was provided with a defibrillator at home and the primary carer was instructed in its use; the other group was not provided with a defibrillator. Both groups had access to community emergency care, which included defibrillation. After average follow-up of 37 months there was no difference in outcome of the two groups, and the primary end point (death) was the same in each, around 2% a year. The defibrillators that were used worked perfectly, and there were no problems with using them. I believe the HAT trial cannot be used to exclude value of home defibrillation:

sudden cardiac death who were dead on arrival at the emergency department had unwitnessed arrests.<sup>4</sup> In HAT, only 36% of the sudden deaths due to ventricular tachycardia or ventricular fibrillation occurring at the patient’s own home were witnessed. From this same study, neighbours or visitors to the study patient’s home were twice as likely to survive to hospital discharge from a “shockable” rhythm (2/4, 50%) than the study patients themselves (4/15, 27%). A particularly disturbing finding in HAT was the substantial number of cases of witnessed arrests in which family members did not even attach the defibrillator.

The most important factor for successful resuscitation of ventricular tachycardia or ventricular fibrillation is rapid defibrillation. The efficacy of rapid defibrillation is best assessed by time from onset of arrhythmia to termination, but most events are not witnessed, so many trials index the time from recognition of the arrest to defibrillation. A recent observational study by Chan and colleagues found that even in hospitalised patients who were defibrillated within two minutes of diagnosis, only 39% survived to hospital discharge, and 40% had at least moderate neurological disability.<sup>5</sup> The biases of in-hospital mortality studies notwithstanding, these results are both provocative and disappointing.

it shows the same problem as noted in an earlier small trial conducted in Seattle.<sup>8</sup>

Participants in HAT (patients, carers, doctors) showed far less enthusiasm than investigators had anticipated. This necessitated heavy promotion worldwide for entry of patients to the trial, liberalisation of criteria to less sick patients, and extension of the time from infarction to entry. Though it was not assessed, carers were not enthusiastic about using the device in elderly patients with cardiac and other comorbidities. Further, there was no organised follow-up to check the device or to check the training of carers or assess their motivation. The device was provided with “once-only” training; from there on, the household was on its own. This approach was justified at a national US meeting by a senior author who referred to a desire to apply a “real world” evaluation. When the trial finished, most devices were returned to the hospital or centre of origin, even when patients were still alive and at risk—resulting in a sudden worldwide glut of second hand but unused defibrillators, and reinforcing the view that people did not wish to have the defibrillator for the family member.

The study which evaluated the best case scenario for out of hospital resuscitation was the observational, casino based defibrillation study by Valenzuela et al. This study benefited from its highly public settings, strategic placement of defibrillators (to minimise the time to first defibrillation), and operators trained in basic life support and using defibrillators. In this study, arrests were witnessed in 86% of the patients and the mean time to the first shock was 4.4 (SD 2.9) minutes. Patients who were defibrillated within three minutes of their arrest had a 74% survival rate to hospital discharge.<sup>6</sup> To achieve such a rapid and consistent response for the typically unwitnessed arrest in a patient’s home seems unrealistic.

### Mortality benefit?

Given the above discussion, it is not surprising that HAT failed to show a mortality benefit with home use of defibrillators. At first glance the HAT participants would seem to be an ideal population to study, given their high prevalence of Q wave anterior infarctions (64%) and mild left ventricle dysfunction. However, even in the higher risk ischaemic population from MADIT II (the randomised, controlled Second Multi-center Automated Defibrillator Implantation Trial) who were treated with implantable

### Enthusiasm is important

What, then, of patients about to be discharged from hospital after a small or medium myocardial infarction? I believe that such patients and their spouses should be advised to consider buying a defibrillator for the home, and that there should be follow-up, such as did not occur in HAT, at intervals of 6-12 months. Such a service is arranged in Australia through the St John Ambulance organisation.

Enthusiasm seems to be the key to successful defibrillation. Lack of enthusiasm delayed the development of coronary care wards and led to delay in installing defibrillators in ambulances. Lack of enthusiasm led to withdrawal of defibrillators in some police services. There is no point providing a defibrillator to an unenthusiastic spouse, but there is every reason for suggesting purchase to an intelligent, enthusiastic spouse or carer, provided there is appropriate follow-up.

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defibrillators, divergence of the survival curves did not begin until nine months after implantation.<sup>7</sup> Furthermore, DINAMIT (the randomised, controlled Defibrillator in Acute Myocardial Infarction Trial) showed no mortality benefit for implantable cardioverter defibrillators in patients immediately after infarction. The high rate of non-arrhythmic death in the implantable defibrillator arm of DINAMIT further suggests that the dominant mechanism of mortality in post-infarction patients with important left ventricular dysfunction is heart failure, not ventricular defibrillation.<sup>8</sup>

In summary, the incidence of arrhythmic sudden death in post-infarction patients is steadily decreasing. The prophylactic use of defibrillators, either implanted or external, have not been proven effective in reducing overall mortality immediately post infarction. The high prevalence of unwitnessed sudden cardiac death and the dramatic reduction in patient survival with delayed defibrillation makes the routine recommendation of home defibrillators impractical. Further investigation is required to identify higher risk subgroups of patients who will benefit from implantation.

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