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Arrhythmia (R Kabra, Section Editor)

Recent Updates in the Role of Wearable Cardioverter Defibrillator for Prevention of Sudden Cardiac Death

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Abstract

Purpose of review The wearable cardioverter defibrillator (WCD) or LifeVest may protect against sudden cardiac death (SCD) in patients awaiting insertion of an implantable cardioverter defibrillator (ICD). The purpose of this communication is to review the rationale behind WCD therapy and to critically analyze recent data regarding its clinical efficacy. We seek to provide evidence-based recommendations regarding the potential role of the WCD in certain populations.
Recent findings The only randomized controlled trial that evaluated WCD therapy did not demonstrate a reduced rate of arrhythmic death in patients prescribed the WCD during the first 90-day post-myocardial infarction (MI). However, when considering trial results alongside previous retrospective data, patient noncompliance with WCD therapy—rather than ineffectiveness of WCD therapy—remains an important theme.
Summary The uncertainty of data regarding the use of WCD therapy in patients during ICD

waiting periods should be considered as part of the shared decision processes between healthcare providers and patients. Higher rates of adherence are needed to ensure efficiency. Well-designed future studies with appropriate cost-effectiveness analyses are indicated to define the clinical efficacy of WCD therapy on arrhythmic and non-arrhythmic morbidity and mortality in patients who are not yet candidates for ICDs.

Introduction

Guidelines for ICD implantation for primary prevention of sudden cardiac death (SCD) mandate a 40-day waiting period after MI, 90-day waiting period after coronary revascularization, and 90-day waiting period after cardiomyopathy diagnosis (Table 1) [1••]. Under specific circumstances, the WCD may protect against SCD during these waiting periods [2]. In this review, we outline the rationale behind WCD therapy and review recent data regarding its clinical use and effect on arrhythmic and overall mortality. We critically analyze the only randomized controlled study to determine the efficacy of the WCD and provide recommendations regarding the potential role of this therapy in certain populations.

Why a waiting period after MI before ICD implantation?

Several randomized studies have shown that ICD implantation early after MI does not result in a reduction in mortality [3]. In DINAMIT, patients with a left ventricular ejection fraction (LVEF) of 35% or less and impaired cardiac autonomic function who received ICD therapy 6 to 40 days after MI had the same overall mortality rate as compared with similar patients who did not receive ICD therapy [4]. Similarly, in the IRIS trial, prophylactic ICD therapy did not reduce overall mortality in patients with a LVEF of 40% or less and a heart rate or 90 or more beats per minute or non-sustained ventricular tachycardia during Holter monitoring 5 to 31 days post-MI [5]. Both groups of investigators found that although ICDs prevented death from ventricular tachyarrhythmias, this effect was offset by a significant increase in the rate of death from non-arrhythmic causes [4, 5].

Table 1. The 2017 AHA/ACC/HRS guideline recommendations for wearable cardioverter-defibrillator [1••]

COR	LOE	Recommendations
IIa	B-NR	In patients with an ICD and a history of SCA or sustained VA in whom removal of the ICD is required (as with infection), the wearable cardioverter-defibrillator is reasonable for the prevention of SCD.
IIb	B-NR	In patients at an increased risk of SCD but who are not ineligible for an ICD, such as awaiting cardiac transplant, having an LVEF of 35% or less and are within 40 days from an MI, or have newly diagnosed NICM, revascularization within the past 90 days, myocarditis or secondary cardiomyopathy or a systemic infection, the wearable cardioverter-defibrillator may be reasonable.

COR class (strength) of recommendation, *LOE* level (quality) of evidence, *NR* nonrandomized, *NICM* non-ischemic cardiomyopathy

A few reasons have been proposed for the unexpected increase in non-arrhythmic mortality in patients who received ICDs early post-MI. The most likely explanation is that patients post-MI are also at high risk for death from other non-arrhythmic cardiac causes; the ICD may just transform SCD to eventual death from pump failure, especially when the ventricular arrhythmia occurs in a patient with a large MI or with decompensated heart failure [4, 6]. Importantly, in an analysis of the autopsy records in a series of cases classified as sudden death events post-MI, the VALIANT investigators found that only 20% of deaths within the first month were considered presumed arrhythmic—most of these early deaths were due to recurrent MI or myocardial rupture [7]. Defibrillator therapy would not help and would possibly hurt these patients early after their event. Other reasons for the increase in overall mortality may have to do with the defibrillator itself. Although study patients did not have complications directly attributable to defibrillator implantation, the implantation surgery does incur some ongoing cardiovascular risk [7].

Defibrillator threshold testing also may cause myocardial damage in the setting of recent MI, especially when elevated levels of biomarkers associated with apoptosis are found [4, 8]. High voltage ICD shocks delivered with an electrode directly in contact with the myocardium and development of heart failure due to ventricular pacing of the ICD have been linked with increased cardiac mortality [9]. Another study showed that ICD shock voltage is proportional to the mortality rate; patients shocked for VF had higher mortality than patients shocked for slower VT [3]. Furthermore, mortality is tripled after ICD shocks in recently ischemic myocardium versus ICD shocks in nonischemic myocardium [10].

Another important factor in waiting a certain period after MI or revascularization is related to the natural history of disease following a major cardiovascular event—an often-variable process that warrants a period of risk assessment [1••, 8]. In a large multicenter observational study of patients with severe systolic dysfunction following acute MI with an EF of 35% or less, 57% had EF recovery to greater than 35% 90 days after the index event [11]. Patients with the lowest clinical risk scores for persistent LV dysfunction had 90% and 50% probability of EF recovery to > 35% and > 50%. Similar estimates have been proposed for patients with nonischemic cardiomyopathy on guideline-directed medical therapy [12]. After a 3-month waiting period of risk assessment, ICD implantation for primary prevention of SCD may no longer be indicated.

What is the rationale behind the use of LifeVest?

The WCD (LifeVest; Zoll, Pittsburgh, PA, USA) consists of a chest garment that has monitoring and defibrillation electrodes. If a shockable rhythm is detected, a vibration plate in the defibrillation electrodes provides a tactile and audible alert allowing the patient to abort the shock. If no attempt to abort is made, a shock is delivered [13, 14]. WCD therapy has a class IIb indication in the AHA/ACC/HRS guidelines in several clinical situations in which a patient's risk of SCD may resolve over time or with definitive therapy [1••].

Patients with a clear indication for an ICD who require device removal should be considered for WCD therapy [1••]. A recent retrospective analysis found that 9% of 102 patients who underwent explantation of their ICD due to cardiac device infection or device malfunction were appropriately shocked by their WCD [15].

The WCD has also been proposed as a therapeutic tool for patients with possible ion channelopathies who are being evaluated for optimal medical therapy and genetic evaluation prior to ICD placement [16].

By far the largest groups of patients for whom WCD therapy has been proposed are patients in the waiting period prior to ICD implantation for a primary prevention indication. These include patients post-MI and with severe LV dysfunction who have been recently revascularized and patients with newly diagnosed cardiomyopathy. In the former group, SCD due to ventricular arrhythmias is a major cause of mortality [17]. As noted above, the VALIANT study identified 20% of deaths within the first-month post-MI to be presumed arrhythmic [7]—a number that justifies consideration of a bridging therapy in this early period. SCD was also documented in a cohort of 373 patients with recent onset nonischemic cardiomyopathy who had a LVEF of 40% less and up to 6 months of symptoms [18], although this cohort was underpowered to evaluate the impact of early ICD implantation because only six patients had sudden death [18]. In order to protect these patients who are not yet ICD candidates, options include an external defibrillator, WCD, or antiarrhythmic medication [19]. The external defibrillator presents significant feasibility issues [20, 21]. Antiarrhythmic medications do not significantly differ from placebo for prevention of sudden cardiac death [2, 20–22]. These patients are therefore considered candidates for WCD [14, 23, 24].

Initial data suggesting efficacy of WCD therapy is derived from patients with congestive heart failure in the WEAR-IT (wearable cardioverter defibrillator investigational trial) and patients post-MI or CABG at high risk for SCD in the BIRAOD (bridge to ICD in patients at risk of arrhythmic death) studies [23]. In these cohorts, 75% of defibrillation attempts were successful, and the only SCD events occurred in patients who were not wearing the WCD or who had it on incorrectly (REF). The subsequent WEARIT-II (prospective registry of patients using the wearable defibrillator) identified a total of 120 sustained ventricular tachyarrhythmias in 41 patients of a group of 2000 patients with various types of cardiomyopathies; 54% of these patients received appropriate WCD shock [22]. The registry suggested the potential role of the WCD as a tool to protect patients from ventricular tachyarrhythmias during the period of risk assessment.

Patient compliance and its relation to effectiveness of treatment have also been demonstrated. In a nationwide registry analysis of WCD use, Chung et al. found that > 50% of patients wore the WCD 90% of the time. Fifty-nine (1.7%) of the 3569 patients in the registry had at least one sustained VT/VF event, and all WCD shocks except one were successful in restoring sinus rhythm [19]. Importantly, in this registry, eight patients died after successful conversion of unconscious VT/VF—survival occurred in only 89.5% of events—suggesting that treatment of arrhythmia in these high-risk patients is not predictive of non-arrhythmic mortality [19].

Other data highlight other potential benefits of the WCD. A retrospective analysis examining the asystole alarm of patients with WCD identified 257 out of almost 52,000 patients who had at least one episode of asystole considered as either serious (resulted in unconsciousness, hospital transfer, or death) or non-serious (not fitting the definition of serious asystole) [25]. Serious asystole episodes were experienced by 201 patients with a 26% survival rate; the remaining 56 patients experienced non-serious asystole, and those patients had a 100% survival rate. According to this study, survival rates after asystole in patients with WCD are significantly higher than historically reported survival rates in non-shockable cardiac arrest [25].

WCD may also promote patient compliance. In an observational study of 1289 of patients with heart failure with reduced EF, Mirro et al. found that WCD use was significantly associated with prescribing adherence to GDMT and with recommendations for follow-up echocardiographic study. Patients treated with WCD were more likely to receive appropriately used primary prevention ICDs [26].

The VEST trial

The vest prevention of early sudden death trial (VEST) was the first randomized controlled trial to determine the efficacy of WCD therapy during the period before ICDs are indicated in patients post-MI [27]. In this landmark multicenter study, Olgin et al. enrolled 2302 patients who had been hospitalized with an acute MI and who had an EF of 35% or less, whether or not they had also undergone revascularization. Eligible participants were randomly assigned in a 2:1 ratio to receive a WCD plus GDMT or to receive GDMT alone. Baseline characteristics were balanced regarding demographics, medical history, and clinical course post-MI—with a mean EF of 28%, an 83.6% rate of PCI, and similar New York Heart Association functional class statuses in both groups. There were no significant differences in medication use of GDMT, except for other antiplatelet agents.

VEST investigators found that WCD therapy did not lead to a reduced rate of arrhythmic death during the first 90-day post-MI. After a mean follow-up of 84.3 ± 15.6 days, there was no significant difference between the two groups in the primary outcome of arrhythmic death (1.6% in the device group and 2.4% in the control group; $P = 0.18$). Importantly, total mortality was 3.1% in the device group, as compared with 4.9% in the control group (uncorrected $P = 0.04$) [27]. However, the rate of non-arrhythmic death between the two groups was not statistically different (1.4% in the device group and 2.2% in the control group; $P = 0.15$). Furthermore, with most approaches to correction for multiple testing, the P value for the analysis of total mortality was not significant [27].

The authors of that study have pointed out a number of study limitations that warrant emphasis. The trial may have been underpowered to detect a benefit of the WCD on arrhythmic mortality. With an event rate (arrhythmic death) that is rare to begin with, misclassification of just a number of these deaths as non-arrhythmic deaths or adjudication of just a number of these deaths as being of indeterminate cause may have changed the entire outcome of the study. Misclassification was highly possible as it is very difficult to determine an arrhythmic cause of death accurately. Indeed, five of the nine VEST participants with adjudicated arrhythmic death who were wearing the WCD during the event had no ventricular tachyarrhythmias [27]. Some of the patients who had SCD may have actually had non-arrhythmic etiologies such as recurrent MI or ventricular rupture [27].

Nonadherence in the WCD group may have reduced the power of the trial to demonstrate reduction in arrhythmic death with the WCD. Device adherence rates waned over time, well below the device adherence rate of 70% that was assumed in the power calculation of the study [27]. Furthermore, in an as-treated analysis, a lower percentage of patients died when they were wearing the WCD than when they were not, suggesting that the patients randomized to the WCD arm and the patients who actually wore the device were different populations [26, 27].

Conclusions from VEST and recommendations for use of WCD

Although the VEST trial identified no significant difference in the primary outcome of arrhythmic death in patients randomized to WCD therapy, the trend toward benefit cannot be ignored [27]. Based on previous data, it is quite possible that some patients who really had ventricular tachyarrhythmic SCD had been misclassified as having had non-arrhythmic death or an indeterminate cause of death [7, 14, 21]. The study was not powered enough to overcome even a few of these potentially misclassified patients [27].

Furthermore, patients were less likely to die if they were actually wearing the WCD, highlighting the efficacy of an intervention that, when used properly, might really work. Indeed, 75% of the deaths in the WCD group occurred in patients who were not wearing the device. A recent metanalysis comparing 27 observational studies to the WCD arm of VEST trial showed that in the ischemic cardiomyopathy group, the appropriately used WCD device for 90 days was about 11% in the observational studies versus 1% in the VEST trial where the appropriately used WCD was only 1% [28].

This is not dissimilar to other cardiovascular therapies such as dual antiplatelet therapy after percutaneous coronary intervention or beta-blocker therapy following MI. With the right systems-based infrastructure—one that includes on the ground clinical support and teaching, phone reminders to the patients, and/or alerts when the device is not being worn—adherence could be improved, and more consistent mortality endpoints may be met. To say that the WCD does not work in noncompliant patients is akin to saying that dual antiplatelet therapy does not prevent in-stent thrombosis in patients who do not take their medications.

ICDs are not indicated in the first 40-day post-MI and first 90 days after revascularization. However, the risk of arrhythmic mortality is not insignificant during this time. Furthermore, unlike ICDs—which are associated with increased risk of non-arrhythmic mortality when used early post-MI—WCD have not been implicated in non-arrhythmic mortality risk for reasons proposed above. Just as the COURAGE experience warranted further analysis of acute coronary syndrome patients prior to concluding that medical management is better than PCI [29], we feel that further data and clinical follow-up is warranted before making blanket conclusions about a safe therapy that may be effective when used properly.

Additional data that includes higher rates of adherence with the WCD is needed. Moreover, cost-effectiveness and quality of life subgroup analyses should be considered in future studies [30]. Finally, the VEST trial suggested the possibility of non-arrhythmic benefits of the WCD, such as monitoring for other arrhythmias like asystole or atrial fibrillation, which would reduce the risk of stroke. The uncorrected *P* value of 0.04 that favored the WCD in reducing the risk of total mortality was not corrected for multiple testing and may have been a chance finding in the study [27]. Subgroup analysis of the data regarding total mortality is needed to more clearly define the benefit of the WCD on non-arrhythmic death.

Conclusion

Due to the lack of certainty of data regarding the use of WCD therapy, we recommend that all post-MI patients with impaired LV systolic function (EF 35% or less) should be considered possible candidates for the WCD as suggested by the AHA/ACC guidelines recommendations. However, this should be a shared decision process between healthcare providers and patients. Higher rates of adherence are needed to ensure efficacy. Well-designed future studies with appropriate cost-effectiveness analyses are indicated to define the clinical value of WCD therapy in decreasing arrhythmic and non-arrhythmic morbidity and mortality in patients who are not yet candidates for ICDs.

Compliance with Ethical Standards

Conflict of Interest

The authors declare that they have no conflicts of interest.

Human and Animal Rights and Informed Consent

This article does not contain any studies with human or animal subjects performed by any of the authors.

References and Recommended Reading

Papers of particular interest, published recently, have been highlighted as:

- • Of importance
- •• Of major importance

1.•• Al-Khatib SM, Stevenson WG, Ackerman MJ, Bryant WJ, Callans DJ, Curtis AB, et al. 2017 AHA/ACC/HRS guideline for management of patients with ventricular arrhythmias and the prevention of sudden cardiac death. Circulation. 2018;138(13):e272–391. https://doi.org/10.1161/CIR.0000000000000549.

Current AHA/ACC guidelines supporting use of WCDs in post MI patients.

2. Weinstock J. Use of the wearable cardioverter defibrillator as a bridge to implantable cardioverter defibrillator. Cardiac Electrophysiology Clinics. 2018;10(1):11–6. https://doi.org/10.1016/j.ccep.2017.11.002.

3. Elayi CS, Charnigo RJ, Heron PM, Lee BK, Olgin JE. Primary prevention of sudden cardiac death early post-myocardial infarction: root cause analysis for implantable cardioverter-defibrillator failure and currently available options. Circ Arrhythm Electrophysiol 2017;10(6). doi: https://doi.org/10.1161/CIRCEP.117.005194.

4. Hohnloser SH, Kuck KH, Dorian P, Roberts RS, Hampton JR, Hatala R, et al. Prophylactic use of an implantable cardioverter-defibrillator after acute myocardial infarction. N Engl J Med. 2004;351(24):2481–8.

5. Steinbeck G, Andresen D, Seidl K, Brachmann J, Hoffmann E, Wojciechowski D, et al. Defibrillator implantation early after myocardial infarction. N Engl J Med. 2009;361:1427–36. https://doi.org/10.1056/NEJMoa0901889.
6. Bigger JT. Prophylactic use of implanted cardiac defibrillators in patients at high risk for ventricular arrhythmias after coronary-artery bypass graft surgery. Coronary Artery Bypass Graft (CABG) Patch Trial Investigators. N Engl J Med. 1997;337:1569–75.
7. Solomon SD, Zelenkofske S, McMurray JJ, Finn PV, Velazquez E, Ertl G, et al. Sudden death in patients with myocardial infarction and left ventricular dysfunction, heart failure, or both. N Engl J Med. 2005;352(25):2581–8 Erratum in: N Engl J Med. 2005 Aug 18;353(7):744.
8. Brewster J, Sexton T, Dhaliwal G, Charnigo R, Morales G, Parrott K, et al. Acute effects of implantable cardioverter-defibrillator shocks on biomarkers of myocardial injury, apoptosis, heart failure, and systemic inflammation. Pacing Clin Electrophysiol. 2017;40(4):344–52. https://doi.org/10.1111/pace.13037.
9. Nikolski VP, Efimov IR. Electroporation of the heart. Europace. 2005;7(Suppl 2):146–54.
10. Poole JE, Johnson GW, Hellkamp AS, Anderson J, Callans DJ, Raitt MH, et al. Prognostic importance of defibrillator shocks in patients with heart failure. N Engl J Med. 2008;359(10):1009–17. https://doi.org/10.1056/NEJMoa071098.
11. Brooks GC, Lee BK, Rao R, Lin F, Morin DP, Zweibel SL, et al. Predicting persistent left ventricular dysfunction following myocardial infarction: the PREDICTS Study. J Am Coll Cardiol. 2016;67(10):1186–96. https://doi.org/10.1016/j.jacc.2015.12.042.
12. Swat SA, Cohen D, Shah SJ, Lloyd-Jones DM, Baldridge AS, Freed BH, et al. Baseline longitudinal strain predicts recovery of left ventricular ejection fraction in hospitalized patients with nonischemic cardiomyopathy. J Am Heart Assoc. 2018;7(20):e09841. https://doi.org/10.1161/JAHA.118.009841.
13. Chieng D, Paul V, Denman R. Current device therapies for sudden cardiac death prevention - the ICD, subcutaneous ICD and wearable ICD. Heart, Lung and Circulation. 2019;28(1):65–75. https://doi.org/10.1016/j.hlc.2018.09.011.
14. Piccini JP Sr, Allen LA, Kudenchuk PJ, Page RL, Patel MR, Turakhia MP, et al. Wearable cardioverter-defibrillator therapy for the prevention of sudden cardiac death: a science advisory from the American Heart Association. Circulation. 2016;133(17):1715–27. https://doi.org/10.1161/CIR.0000000000000394.
15. Kaspar G, Sanam K, Gholkar G, Bianco NR, Szymkiewicz S, Shah D. Long-term use of the wearable cardioverter defibrillator in patients with explanted ICD. Int J Cardiol. 2018;272:179–84. https://doi.org/10.1016/j.ijcard.2018.08.017.
16. Owen HJ, Bos JM, Ackerman MJ. Wearable cardioverter defibrillators for patients with long QT syndrome. Int J Cardiol. 2018;268:132–6. https://doi.org/10.1016/j.ijcard.2018.04.002.
17. Berger CJ, Murabito JM, Evans JC, Anderson KM, Levy D. Prognosis after first myocardial infarction. Comparison of Q-wave and non-Q-wave myocardial infarction in the Framingham Heart Study. JAMA. 1992;268(12):1545–51.
18. Cooper LT, Mather PJ, Alexis JD, Pauly DF, Torre-Amione G, Wittstein IS, et al. Myocardial recovery in peripartum cardiomyopathy: prospective comparison with recent onset cardiomyopathy in men and nonperipartum women. J Card Fail. 2012;18(1):28–33. https://doi.org/10.1016/j.cardfail.2011.09.009.
19. Chung MK, Szymkiewicz SJ, Shao M, Zishiri E, Niebauer MJ, Lindsay BD, et al. Aggregate national experience with the wearable cardioverter-defibrillator: event rates, compliance, and survival. J Am Coll Cardiol. 2010;56(3):194–203. https://doi.org/10.1016/j.jacc.2010.04.016.
20. Antiarrhythmics versus Implantable Defibrillators (AVID) Investigators. Antiarrhythmics versus Implantable Defibrillators (AVID) Investigators. A comparison of antiarrhythmic-drug therapy with implantable defibrillators in patients resuscitated from near-fatal ventricular arrhythmias. N Engl J Med. 1997;337(22):1576–83.
21. Bardy GH, Lee KL, Mark DB, Poole JE, Packer DL, Boineau R, et al. Amiodarone or an implantable cardioverter-defibrillator for congestive heart failure. N Engl J Med. 2005;352(3):225–37 Erratum in: N Engl J Med. 2005 May 19;352(20):2146.
22. Kutyifa V, Moss AJ, Klein H, Biton Y, McNitt S, MacKecknie B, et al. Use of the wearable cardioverter defibrillator in high-risk cardiac patients: data from the Prospective Registry of Patients Using the Wearable Cardioverter Defibrillator (WEARIT-II Registry). Circulation. 2015;132(17):1613–9. https://doi.org/10.1161/CIRCULATIONAHA.115.015677.
23. Feldman AM, Klein H, Tchou P, Murali S, Hall WJ, Mancini D, et al. Use of a wearable defibrillator in terminating tachyarrhythmias in patients at high risk for sudden death: results of the WEARIT/BIROAD. Pacing Clin Electrophysiol. 2004;27(1):4–9 Erratum in: Pacing Clin Electrophysiol. 2004 May;27(5):following table of contents.
24. Niwano S, Sekiguchi Y, Ishii Y, Iwasaki Y, Kato R, Okamura H, et al. Clinical usefulness of wearable cardioverter defibrillator (WCD) and current understanding of its clinical indication in Japan. Circ J. 2018;82(6):1481–6. https://doi.org/10.1253/circj.CJ-17-1336.
25. Liang JJ, Bianco NR, Muser D, Enriquez A, Santangeli P, D'Souza BA. Outcomes after asystole events occurring during wearable defibrillator-cardioverter use. World J Cardiol. 2018;10(4):21–5. https://doi.org/10.4330/wjc.v10.i4.21.
26. Mirro MJ, Keltner EE, Roebuck AE, Sears SF. Playing it close to the VEST and the clinical guidelines: clinical guideline compliance in HFrEF patients-role of WCD.

Pacing Clin Electrophysiol. 2018;41(10):1314–20. https://doi.org/10.1111/pace.13472.

27.• Olgin JE, Pletcher MJ, Vittinghoff E, Wranicz J, Malik R, Morin DP, et al. Wearable cardioverter-defibrillator after myocardial infarction. N Engl J Med. 2018;379(13):1205–15. https://doi.org/10.1056/NEJMoa1800781.

VEST trial reference, the main study that evaluated efficacy of WCD.

28. Masri A, Altibi AM, Erqou S, Zmaili MA, Saleh A, Al-Adham R, et al. Wearable cardioverter-defibrillator therapy for the prevention of sudden cardiac death: a systematic review and meta-analysis. JACC: Clinical Electrophysiology. 2019;5(2):152–61. https://doi.org/10.1016/j.jacep.2018.11.011.

29. Boden WE, O'Rourke RA, Teo KK, Hartigan PM, Maron DJ, Kostuk WJ, et al. Optimal medical therapy with or without PCI for stable coronary disease. N Engl J Med. 2007;356:1503–16.

30. Agarwal M, Narcisse D, Khouzam N, Khouzam RN. Wearable cardioverter defibrillator "The LifeVest": device design, limitations, and areas of improvement. Curr Probl Cardiol. 2018;43(2):45–55. https://doi.org/10.1016/j.cpcardiol.2017.04.002.

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