Canadian Journal of Cardiology 34 (2018) 1079–1082

Training/Practice
Contemporary Issues in Cardiology Practice

Out-of-Hospital Cardiac Arrest in the Presence of Ischemic Heart Disease: What Is the Long-term Arrhythmic Risk After Revascularization?

Nigel S. Tan, MD,[a,b] and Paul Dorian, MD, MSc[a,b]

[a] *Department of Medicine, University of Toronto, Toronto, Ontario, Canada*

[b] *Division of Cardiology, St Michael's Hospital, Toronto, Ontario, Canada*

ABSTRACT

Patients resuscitated from out-of-hospital cardiac arrest (OHCA) frequently have underlying coronary artery disease (CAD), but the relationship between the arrest and myocardial ischemia or infarction due to CAD can be difficult to discern in clinical practice. Patients often present with clinical profiles that guideline recommendations for appropriate implantable cardioverter-defibrillator use do not address. In cases of incomplete revascularization or mild but sustained impairment of ventricular function, it is not clear if the cause of the cardiac arrest is completely "reversible." We describe distinct phenotypes of patients with OHCA and concomitant CAD and highlight current knowledge gaps in their management and outcomes.

RÉSUMÉ

Les patients réanimés après un arrêt cardiaque hors de l'hôpital (ACHH) ont souvent une coronaropathie sous-jacente, mais le lien entre l'arrêt et l'ischémie ou l'infarctus du myocarde en raison de la coronaropathie peut être difficile à reconnaître dans la pratique clinique. Les patients présentent souvent des profils cliniques pour lesquels les recommandations des lignes directrices sur l'utilisation appropriée des défibrillateurs cardioverteurs implantables ne sont pas formulées. Dans les cas de revascularisation incomplète ou de détérioration faible, mais prolongée, de la fonction ventriculaire, on ignore si la cause de l'arrêt cardiaque est complètement « réversible ». Nous décrivons les différents phénotypes des patients atteints d'une coronaropathie qui subissent un ACHH et démontrons les lacunes courantes en matière de connaissances sur leur prise en charge et leur issue.

A 68-year-old man with a past medical history of coronary artery disease (CAD) and 3-vessel coronary artery bypass graft (CABG) surgery performed 10 years ago sustains a witnessed out-of-hospital cardiac arrest (OHCA) while purchasing a lottery ticket. This followed a recent onset of intermittent exertional angina relieved with nitroglycerin over the past week; he was previously asymptomatic since his cardiac surgery. He has multiple cardiovascular risk factors that have been well controlled with medical therapy. He received immediate bystander cardiopulmonary resuscitation (CPR) and is successfully defibrillated by paramedics at the scene from an initial rhythm of ventricular fibrillation. After return of spontaneous circulation, the post-resuscitation 12-lead electrocardiogram (ECG) shows ischemic-appearing ST-segment changes in the lateral leads (I and aVL) but no clear ST-segment elevation myocardial infarction (STEMI). Troponin I peaks at 415 ng/L (upper reference limit ≤40 ng/L).

He is emergently brought to the cardiac catheterization laboratory and undergoes percutaneous coronary intervention (PCI) of the saphenous vein graft to an obtuse marginal artery, which is found to be subtotally occluded. He has non–flow-limiting disease of his other grafts that are not treated. Left ventricular (LV) systolic function is mildly reduced (left ventricular ejection fraction [LVEF] measures 49% by echocardiography) with lateral-wall hypokinesis, measured 2 days later. He makes a full neurological recovery and is ready to be discharged from the coronary care unit. Should this man receive an ICD? What is the evidence to base our recommendation upon?

Sudden Cardiac Arrest and CAD

Rates for cardiovascular mortality and sudden death have declined in industrialized nations over the past several decades, owing to important progress in therapies for heart disease. However, the burden of cardiovascular disease remains

Received for publication February 16, 2018. Accepted April 2, 2018.

Corresponding author: Dr Paul Dorian, St. Michael's Hospital, 30 Bond Street, 6-050, Toronto, Ontario M5B 1W8, Canada. Tel.: +1-416-864-5104. Fax: +1-416-864-5849.

E-mail: dorianp@smh.ca

See page 1082 for disclosure information.

https://doi.org/10.1016/j.cjca.2018.04.001

substantial, and approximately 1 in 4 cardiovascular deaths are still attributable to sudden cardiac death (SCD). OHCAs continue to have substantial impact on the global population, with more than 3.5 million annual events worldwide, and more than 400,000 events in North America.[1] Approximately 20% to 25% of patients treated by emergency first responders—and 65% of those who arrest in public places—have initial shockable rhythm of ventricular fibrillation or ventricular tachycardia (VT), of whom 30% survive to hospital discharge.[2]

An estimated 50% of cardiac arrests occur in patients with underlying CAD, which is often unrecognized before the index event. Following an OHCA, routine evaluation for ischemic heart disease and appropriate revascularization is recommended in contemporary guidelines, in the absence of an obvious noncoronary cause or contraindications. Clinicians are frequently presented with the challenge of identifying whether an arrest occurred because of transient ischemia, acute infarction, or pre-existing CAD with subacute or remote myocardial necrosis. It is believed that the risk of recurrence of arrhythmia is different in each of these settings, but this risk is incompletely understood.

Phenotypes of OHCA in Relation to Ischemic Heart Disease

Patients who experience OHCA in the context of ischemic heart disease can broadly be grouped into 3 phenotypes (Fig. 1). The first is due to a fixed arrhythmia substrate: most commonly, a region of scar from previous myocardial infarction (MI), which predisposes to heterogeneous conduction and sustained ventricular arrhythmias through a re-entry mechanism. The initial rhythm is a monomorphic VT, and the post-defibrillation ECG will have minimal ST-segment deviation unless an aneurysm or pre-existing conduction abnormality is present. The second phenotype is due to an acutely occluded coronary artery, resulting in transmural ischemia ("MI in evolution"), which manifests as ST-segment elevation following defibrillation. The third phenotype is due to ischemia from either an unstable coronary plaque or supply-demand mismatch, possibly destined to progress to a non-ST-segment elevation acute coronary syndrome until ventricular fibrillation alters the presentation. In all phenotypes, the degree of biomarker elevation will depend on the extent and duration of ischemia, which also depends on the extent of coronary disease and pre-existing cardiomyopathy and the duration of the "low flow" state before resuscitation. Therefore, it may be impossible prospectively to classify which phenotype a given patient belongs to from noninvasive investigations including bloodwork and ECGs performed immediately post-OHCA.

Routine Coronary Angiography in OHCA

Although the ECG in OHCA to identify acute coronary occlusion is imperfect, the presence of ST-segment elevation on the post-resuscitation ECG remains an important discriminating factor in clinical practice. Randomized controlled trials examining the efficacy of emergency reperfusion strategies in OHCA are lacking. However, observational studies have described favourable neurological or functional outcomes with primary PCI for patients who obtain return of spontaneous circulation. The primary limitation of these data is potential confounding by indication, as patients deemed suitable for coronary angiography may have other favourable prognostic clinical factors not adjusted for in multivariable analyses. A recent meta-analysis highlighted significant risk of bias in the majority of published studies as well as lack of reported long-term outcomes.[3] Knowledge of the coronary anatomy post-arrest can nevertheless often help to identify the possible relationship between ischemic heart disease and the arrhythmic event.

ICDs Following Revascularization

The prevention of future arrhythmic events in patients who have sustained OHCA due to ischemic heart disease has been a focus of intensive study and has given rise to evidence-based recommendations regarding the use of ICDs as secondary prevention. Among patients with previous cardiac arrest "in the absence of a reversible cause" (which is stated or implied to include acute cardiac ischemia), multiple randomized controlled trials including the **A**ntiarrhythmics **V**ersus **I**mplantable **D**efibrillators (AVID) trial, **C**anadian **I**mplantable **D**efibrillator **S**tudy (CIDS), and **C**ardiac **A**rrest **S**tudy **H**amburg (CASH) have demonstrated that use of ICDs unequivocally reduces mortality compared with antiarrhythmic drug therapy. These seminal trials excluded patients diagnosed with MI within 72 hours of index arrhythmia. Most of these patients had significant structural heart disease including scar, LV dysfunction, residual coronary disease, or inherited arrhythmia.

The practical difficulty in extrapolating this evidence to a given patient results from the challenge in establishing whether the OHCA was from a "reversible cause," even if myocardial ischemia is known or suspected, as not all ischemia is "reversible" or preventable. It is widely assumed that future arrhythmic risk is low among patients resuscitated from ventricular fibrillation who undergo complete revascularization and have normal LV function. This notion is based on observational studies conducted before the era of routine PCI for acute coronary syndrome (ACS), suggesting that ventricular arrhythmias occurring within 24 to 48 hours of MI did not confer an increased long-term risk of sudden death.[4] There is a paucity of evidence demonstrating this to be true in the contemporary era of management of CAD. Data from the AVID registry demonstrated that patients with ventricular arrhythmic arrests secondary to transient or correctable causes (including acute MI) remain at high risk of death in follow-up, comparable to "primary" unprovoked arrhythmic arrests, in spite of higher rates of revascularization and favourable baseline characteristics.[5]

Even greater clinical equipoise may exist for the group of patients who are incompletely revascularized or have mild residual LV dysfunction (Fig. 2). Predicting the risk of recurrent arrest in such patients can be extremely challenging, and, given an implied threshold for ICD placement of >1% annual risk of sudden death, it is not known who among them should receive devices. This is especially true when the relationship between the cardiac arrest and the presence and extent of myocardial ischemia remains ambiguous despite the information from the ECG, biomarkers, cardiac catheterization, and assessment of ventricular function. Evaluation of the