Heartbeat: weather, air pollution and cardiac arrest

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Outcomes of patients with an out-of-hospital cardiac arrest (OHCA) remain poor despite considerable efforts in many countries directed towards rapid access defibrillation, emergency medical services and advanced supportive care in those who survive to reach the hospital. Clearly, our long-term goal should be prevention of OHCA which requires an understanding of the environmental factors contributing to this condition, as well as prevention at the individual patient level. In a study from Korea of 38 928 OHCA due to cardiac disease, Kim and colleagues¹ found significant association between OHCA and average temperature in the summer, temperature range in the winter and particulate matter (PM) ≤ 2.5 μm (PM_{2.5}) air pollution levels. However, only PM_{2.5} was independently associated with the risk of OHCA regardless of seasonal changes (figure 1).

In an editorial, Chatterjee² puts this data in the context that air pollution and meteorological factors have previously been shown to be associated with cardiovascular mortality and morbidity, including arrhythmias and heart failure. The current study provides robust data that OHCA also is affected by these environmental conditions, although data on the specific underlying arrhythmic mechanism was not available in most cases. Looking forward, 'Studies such as this one¹ emphasise that meaningful reductions in PM_{2.5} use would be predicted to substantially reduce cardiovascular mortality generally and OHCA risk specifically worldwide.' This study 'additionally emphasises the potential implications of climate change on the epidemiology and risk of OHCA. To that end, public health education campaigns and patient-level encounters are opportunities to emphasise the potential health risks of air pollution and temperature extremes, anticipating that these are likely to be most deleterious for patients with underlying cardiopulmonary disease.'

The role of early aortic valve replacement (AVR) for asymptomatic patients with severe aortic stenosis (AS) is the subject of several ongoing randomised controlled clinical trials. One of the

Figure 1 Generalised additive model with cubic splines for the effects of selected meteorological factors on the number of out-of-hospital cardiac arrests (OHCA). The BOLD line estimates the relative effect sizes for OHCA, and the blue area estimates 95% CIs. The X-axis represents selected meteorological factors. The Y-axis shows the relative effect sizes for OHCA. PM_{2.5}, particulate matter ≤ 2.5 μm .

rationales for early AVR is to prevent adverse changes to the left ventricle (LV) that can occur even with a normal ejection fraction (EF). In this issue of *Heart*, Bing and colleagues³ looked at the association between first-phase EF (EF1), a proposed marker of early LV systolic dysfunction, and clinical outcomes in 149 adults with at least mild AS (figure 2). EF1 reflects the relative volume of blood ejected during early systole, rather than over the entire

systolic ejection fraction, and is calculated as the percent change in LV volumes from end-diastole to volume at the time of the peak systolic flow velocity. Overall a low baseline EF1 was independently associated with a higher risk of AVR (n=83) or death (n=24) with a HR of 5.6 (95% CI 3.4 to 9.4).

Chahal and Senior⁴ comment that 'EF1 deserves closer attention and also validation by other groups. Although simple

Figure 2 Distribution of EF1 and ejection fraction by aortic stenosis severity box plot demonstrates EF1 according to mean gradient (<20 mmHg: 30 (27–33)%, 20–39 mmHg: 26 (20–30)%, ≥ 40 mmHg: 15 (12–25)%). Density plots demonstrate the distribution of EF1 and ejection fraction among patients with aortic stenosis stratified by mean gradient. The dashed reference lines denote 25% and 50% for EF1 and ejection fraction, respectively. EF1, first-phase ejection fraction.

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Figure 3 A scheme depicting the main study design and key outcomes. CV, cardiovascular disease; FU, follow-up; Lp(a), lipoprotein(a); MI, myocardial infarction; RCVE, recurrent CV event.

to acquire, general echocardiographic issues of image quality, endocardial border detection and reproducibility apply. At present, it seems unlikely that symptomatic patients with moderate AS will ever be offered valve replacement procedures on the basis of adverse prognostic variables such as EF1, global longitudinal strain, valvuloarterial impedance or flow rate. However, there seems to be an impetus to offer early surgery to patients with

asymptomatic severe AS, and these variables all require prospective evaluation to refine this decision-making process.'

Lipoprotein(a) (Lp(a)) levels are associated with incident cardiovascular disease but there is less data on the risk of recurrent cardiovascular events in patients with elevated Lp(a) levels. In a prospective multicenter study of 7562 patients with a first cardiovascular event and angiographically documented coronary artery

disease, Liu and colleagues⁵ found that higher Lp(a) levels were associated with an increased risk of recurrent events with an HR of 2.01 (95% CI: 1.44 to 2.80, $p < 0.001$) on multivariable analysis.

Borovac⁶ commends the authors for this study which provides 'important insights regarding the impact of Lp(a) levels on recurrent events in patients suffering from the first CV event' (figure 3). He concludes 'These findings confirm the notion that reduction in Lp(a) levels, beyond conventional lipid indices, might represent a viable strategy in the secondary prevention setting and such interventions could translate to improved clinical outcomes.'

The *Education in Heart* article in this issue⁷ summarises the role of cardiovascular imaging in primary risk reduction, starting with a summary of the history and evidence base for current clinical risk prediction scores. Imaging approaches that provide additive value to conventional prediction scores include carotid ultrasound, cardiac computed (CT) tomographic calcium quantitation, and CT coronary angiography. As the authors point out: 'Prevention of cardiovascular disease is currently guided by probabilistic risk scores that both overtreat and undertreat individuals, commit most middle-aged people to pharmacotherapy and have little evidence base. Fundamentally, imaging in asymptomatic people can prevent overmedicalisation of the truly healthy and promote treatment and risk factor modification in those with subclinical disease.'

A short *Cardiology in Focus* article in this issue⁸ discusses what is meant by work-life balance and how to maintain this balance in the context of a busy job and worldwide pandemic. Prominent clinical cardiologists provide their own leaders in cardiology provide some quick pointers of their own that you may find helpful.

Cardiac paragangliomas are rare neuroendocrine tumours that often present with cardiac symptoms of hypertension, stroke, palpitations, tachyarrhythmias and syncope. The evaluation and management of these tumours is discussed in a review article in this issue of *Heart* by Tella and colleagues.⁹ Cardiac paragangliomas might be seen on cardiac imaging in the aorto-pulmonary window or atrioventricular groove, as well as other locations (figure 4).

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Figure 4 The axial (A), coronal (B), sagittal (C) and reformatted three-dimensional images (D) of a contrast-enhanced cardiac-gated CT of a woman aged 50 years without mutation in genes encoding subunits of succinate dehydrogenase enzyme demonstrates a well-circumscribed cardiac mass (arrows) measuring 3×2×2 cm. This mass is located superior to left atrium (B, C) with the inferior border extending to the left atrioventricular groove. The mass is bordered laterally by the left atrial appendage (C) and medially by the main pulmonary artery (superiorly, (B, C)) and proximal left anterior descending artery (*, (C)). The proximal left circumflex courses just inferior to the mass (+, (D)). There is no evidence of luminal compression in the left anterior descending or left circumflex arteries by the mass. AO, aortic root; LA, left atrium; LV, left ventricle; PA, pulmonary artery; PV, pulmonary vein; RVOT, right ventricular outflow tract; asterisk (*), left anterior descending artery; plus (+), left circumflex.

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REFERENCES

- 1 Kim J-H, Hong J, Jung J, *et al*. Effect of meteorological factors and air pollutants on out-of-hospital cardiac arrests: a time series analysis. *Heart* 2020;106:1218–27.
- 2 Chatterjee N. Air pollution, climate and cardiac arrest. *Heart* 2020;106:1196–7.
- 3 Bing R, Gu H, Chin C, *et al*. Determinants and prognostic value of echocardiographic first-phase ejection fraction in aortic stenosis. *Heart* 2020;106:1236–43.
- 4 Chahal N, Senior R. Assessing systolic function in aortic stenosis: the earlier the better? *Heart* 2020;106:1200–1.
- 5 Liu H-H, Cao Y-X, Jin J-L, *et al*. Association of lipoprotein(a) levels with recurrent events in patients with coronary artery disease. *Heart* 2020;106:1228–35.
- 6 Borovac JA. Lipoprotein(a), a moving target: from the primary to secondary prevention of atherothrombotic events. *Heart* 2020;106:1198–9.
- 7 Meah MN, Dweck MR, Newby DE. Cardiovascular imaging to guide primary prevention. *Heart* 2020;106:1267–75.
- 8 Wilcox J. Work-Life balance. *Heart* 2020;106:1276–7.
- 9 Tella SH, Jha A, Taïeb D, *et al*. Comprehensive review of evaluation and management of cardiac paragangliomas. *Heart* 2020;106:1202–10.