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Editorial

Can computed tomography predict neurological outcomes after cardiac arrest?

Inamasu and colleagues should be congratulated for producing their manuscript, which is an important paper on the use of neuroimaging to help prognosticate out of hospital cardiac arrests patients (OHCA).[1] The authors used early computed tomography (CT) signs in 75 consecutive survivors of witnessed-OHCA as a temporal profile and prognostic marker for 6-month neurological outcomes. Every effort was made to include only cardiac arrests from a cardiac etiology and 'early' CT was performed immediately after successful resuscitation of the patients, often within the first hour of hospital admission. The aim was to identify patients who sustained irreversible brain damage as early as possible, and to delineate a temporal profile of ischaemic CT signs and their potential role as a prognostic marker for neurological outcomes at 6 months.

To clarify the temporal profile of the CT signs, patients were divided into two groups depending on the time from cardiac arrest to return of spontaneous circulation (CA-ROSC) of more or less than 20 min – a duration previously shown to be predictive of neurological outcomes in OHCA patients with ventricular fibrillation.[2]

The CT scan was interpreted by two independent experts examining the loss of barrier (LOB) between the gray and white matter at the level of the basal ganglia, and the presence of sulcal effacement (SE) at the level of the centrum semiovale as with previous studies –two specific areas previously shown to be vulnerable to ischaemic insults in comatose patients after cardiac arrests.[3-5]

This is an important trial for several reasons. It is the largest trial to date using CT scans in early OHCA patients, and every effort has been made to exclude extrinsic causes of cardiac arrest (trauma, asphyxia, and near drowning) to better characterize the typical patients seen in the emergency departments (ED). As such, it is generalisable to most institutions' patient demographics. In addition, the use of CT scans is widely available in most EDs and is a viable and attainable first line modality of neuroimaging, especially if performed immediately after successful cardiac resuscitation, where there is less time and hemodynamic stability to organize potentially more detailed modes of neuroimaging. As a first line modality, CT is relatively easy to undertake and can provide useful diagnostic information. With this current trial, an argument is made for CT yielding important prognostic information as well.

The results are useful for several reasons. The first is the plausibility of the findings; patients who were more likely to have good neurological outcomes at 6 months were younger (59.3 vs 70.0 years), had a higher percentage of ventricular fibrillation (VF) as the initial rhythm (83% vs 29%), and had lower CA-ROSC times (22.7 min vs 35.0 min). The second is the significant difference in the CT signs and unfavorable outcome rate in patients with CA-ROSC interval ≤20 min and >20 min, which would also be expected. The imaging correlations of different CA-ROSC cut-off thresholds would have been interesting, but are not addressed. However, to be fair to the authors, the relative prognostic merits of varying CA-ROSC thresholds are poorly addressed in the literature.

The most important finding is calculated from the LOB and SE sensitivity and specificity tables. Although a positive LOB sign, which carries an 81% sensitivity and 92% specificity for unfavorable outcomes, has been argued by the authors to be a useful prognosticator, it is still difficult to change practice using these numbers. Would a physician quote these numbers to a patient's family members in a discussion about prognosis after a cardiac arrest? What is of crucial importance, however, is the SE sign carrying a weak sensitivity of 32% but a specificity of 100% for unfavorable outcome. This implies that all patients with a positive SE sign on the initial early CT scan will have unfavorable outcomes with a CPC of 3-5. Theoretically, a physician could explain to family members that the current evidence, albeit relatively new and not yet reproduced by larger trials, suggest that all patients with positive SE signs will have severe disability, coma, or ultimate progression to brain death. This then, represents useful additional information regarding neuroprognostication after OHCA. Regardless of the impact of these findings on decision making in individual patients, it seems very likely they may provide a valuable means of stratifying patients in future clinical trials.

There are several limitations to the study. It is not clear what percentage of patients received therapeutic hypothermia as standard treatment after successful resuscitation given the accepted neurological benefits in OHCA survivors, particularly with the large percentage of VF survivors in the group.[6,7] Additionally, the poor kappa coefficients for both the LOB and SE signs should make readers cautious about whether these findings can be easily translated to other centres, since they are clearly observer dependent. Given this, it was a little disappointing not to have a fuller analysis of the quantitative measurement of grey to white matter densities, since this would provide a more objective (and perhaps more easily generalisable) counterpart of the LOB sign.

It is also interesting to note that the authors elected to evaluate outcomes at 6 months after cardiac arrest for long-term survivors with a Pittsburgh cerebral performance category (CPC) as the neurological scoring system of choice. Although it has been demonstrated to be useful for predicting outcomes at 1 year after cardiac arrests it would have been interesting to also view the Health Utilities Index scale – a validated but more complex scale for OHCA survivors to assess for neurological outcomes at 6 months.[8] It is likely that the authors decided to use the CPC score for its rel-

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ative ease of use, but it is an unvalidated scoring system which potentially limits the interpretation of the functional outcomes results.

With regards to prognostication, it remains unclear what is the best imaging modality to investigate for early signs of irreversible cerebral ischemia in OHCA survivors. In similar forms of severe brain injury from trauma and stroke patients, diffusion-weighted MRI images appear to yield the most information regarding neuroprognostication.[9–13] Initial studies are beginning to show the utility of MRI (particularly with diffusion tensor imaging) in patients who survive a cardiac arrest, but data are still limited in this context.[14,15] However, the sensitivity of MRI in other settings suggests that it may well be able to detect early markers of irreversible ischaemic injury.

Despite this potential for MR imaging, from a practical point of view, as well from a hemodynamic perspective, it is much more difficult to arrange for an MRI immediately after successful resuscitation of OHCA patients, and CT seems to be the appropriate first line imaging modality. The authors should be credited for being able to discriminate between the groups using CT scanning and for being able to shed light on a potential role for a positive SE sign in neuroprognostication. Future studies are required to better discriminate between groups of survivors of OHCA. It would be interesting to perform sequential MRI imaging at different time periods post-resuscitation to better discriminate between the groups. A multicenter, prospective trial with an initial CT scan and subsequent subacute diffusion-weighted MRI imaging within 24 hours, post hypothermia, and at 72 hours would be a next possible step in the evaluation of the OHCA survivor for using imaging modality as a neuroprognostic marker.

Conflict of interest

No conflict of interest declared.

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