Vital signs: vital for surviving in-hospital cardiac arrest?

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The measurement of vital signs (e.g., blood pressure, pulse rate) is a ubiquitous activity in hospital, being important for determining a patient's severity of illness and/or diagnosis. Vital sign monitoring forms part of the 'chain of prevention'[1] and nurses often use vital sign measurements to confirm their intuition or 'gut feeling' that a patient is unwell or deteriorating.[2] The rationale for the regular measurement of vital signs is that measured physiological values, which deviate from normal, are accompanied by an increased risk of adverse clinical events. The early identification of such abnormalities provides the opportunity to intervene, thereby halting and reversing deterioration.[3]

Large single-centre studies have demonstrated relationships between abnormalities in routinely measured vital signs and serious outcomes including death, unanticipated ICU admission and in-hospital cardiac arrest (IHCA).[4,5] Abnormal vital signs are common before in-hospital cardiac arrest (IHCA)[6-8] and appear to predict progression to IHCA.[9,10]

Research reported by Andersen and colleagues in this issue of *Resuscitation* adds to our understanding of the relationship between vital signs and outcomes.[11] Anderson et al. report a strong 'exposure-response' relationship between pre-arrest vital sign abnormalities and post-arrest outcomes in ward patients in a large multicentre study. Using a priori definitions of vital sign abnormality (e.g., heart rate ≤60 or ≥100 min^{-1}), they performed a post hoc analysis of data from 7851 patients in 300 hospitals in the US' Get With The Guidelines –Resuscitation (GWTG-R) registry of IHCAs.[12] Only vital signs sets with at least heart rate, respiratory rate and systolic BP were included, and only the earliest set in the 4 hours prior to the IHCA were used. All patients studied had received treatment for cardiac arrest. They found strong relationships between the pre-IHCA measured values of individual vital sign parameters and post-IHCA mortality. Additionally, they report a step-wise increase in mortality in association with increasing numbers of abnormal vital signs. The observation by Andersen et al. that 40.6% of adult IHCA patients in the study database had no recorded vital sign abnormality before arrest resonates with recent findings from South Korea that 45% of patients had a low early warning score (EWS) value 8

hours before cardiac arrest and that an increasing EWS value occurred before only 47% of arrests.[13] However, the ability to detect either vita signs abnormalities or associated changes in a timely fashion will be closely related to the frequency of vital signs monitoring, which may be variable or inadequate.[14,15]

That vital signs abnormalities are predictive of IHCA outcome is not surprising, given that research has already established the strong relationship between such abnormalities and death,[4,5,18] and that the majority of patients having an IHCA die prior to hospital discharge.[12,17] However, the current research builds upon findings from single-site studies from Finland and the UK, where cardiac arrests with no pre-arrest vital sign abnormalities were associated with better survival than those where they were present.[18,19] All these publications underscore a generally held belief that early identification of deterioration, i.e. before several organ systems become affected, is needed to avoid cardiac arrest and also provide evidence upon which assessments of post-arrest prognosis may be based.

There are a number of obvious limitations to the study by Andersen et al., most of them acknowledged in their publication.[11] Notably the degree to which the findings are generalisable is unknown, as participation in the GWTG-R registry is voluntary, and participating hospitals may differ in resources and clinical practice from non-participating sites. Differences in the number of available ICU beds, degree of continuous monitoring and telemetry, and staffing levels are all likely to impact upon the degree of monitoring and the ability to detect deterioration. The study reports the mortality associated with incremental values for only heart rate, respiratory rate and systolic blood pressure, whereas it is known that the values of diastolic blood pressure, S_pO_2, conscious level and temperature also influence outcome.[4,5,9,10,16] Importantly, the study provides no information about responses to the abnormal vital signs; nor does it gives details of intra-arrest interventions or decision-making, both of which may influence the relationship between pre-arrest vital signs and post-arrest outcome. These omissions pose a number of interesting questions: Was pre-arrest management of the deteriorating patient adequate? Were intra-arrest

interventions more or less likely to be employed in patients with multiple vital signs abnormalities? Did the duration of arrest differ between patients with low versus high number of abnormalities? Were decisions to cease CPR predicated on the number of vital signs abnormalities present before arrest?

One worrying finding from this study, and one that has the potential to influence the significance of the results, is that 55% of patients having an IHCA had no documented vital signs recordings in the 4 hours prior to the arrest.[11] Why is this the case, given that supplementary data provided with the paper shows that many of these patients were monitored [defined as the presence of electrocardiography, pulse oximetry, and/or apnea monitor] at the time of the arrest (65%) and/or nursed in areas with telemetry (43%)? Does this represent a quality of care issue that requires investigation and remedy by the participating hospitals? It is possible that some of the excluded patients had arrived on the ward immediately before the arrest, thereby reducing the opportunity for vital signs to be measured or documented, but if so, does this not suggest that the choice of location for the patient (i.e., a ward rather than an ICU) could have been better? Or do the findings suggest that ward staff elected not to monitor the patents' vital signs for some unspecified reason?

It is striking that the characteristics and mortality of those with and without recorded vital signs were similar.[11] Even amongst patients that had documented vital signs, 72% of arrests occurred in monitored patients, 52% occurred in areas with telemetry and 63% were witnessed. Nevertheless, only 16% of arrest had an initial cardiac rhythm that was shockable, suggesting that the majority of IHCAs were due to gradual deterioration rather than myocardial ischaemia. This raises questions about whether deterioration was recognised or if the quality of the response to deterioration was adequate. Is it the case that despite continuous monitoring, no one noticed or responded to alarms or obvious deviations in physiological values? Alternatively, is it the case that deterioration was adequately identified and appropriately treated, but that many patients in the study were dying and that cardiac arrest might have been avoided with greater use of

treatment limitation and/or do-not-attempt cardiopulmonary resuscitation decisions?[20]

The results of the research by Andersen et al. provide another small piece of the jigsaw in our understanding of the potential to prevent and/or reverse deterioration, and the relationship between vital signs and outcome. As with the other published studies on this subject, [18,19] missing or incomplete information regarding the clinical practice underlying the results prevents a full understanding of the data's significance. There are pointers that suggest room for improvement in the clinical practice underlying the results in Andersen's publication. Whether we would find the same relationship between pre-arrest vital signs and post-arrest outcome, if all aspects of the chain of prevention[1] - education, monitoring, recognition, call for help and response – were optimal, is unknown.

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