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Editorial

Is the writing on the skull?

Peter Safar, together with others, established the basic treatment of cardiac arrest in the 1950s and 1960s by introducing the Airway, Breathing and Circulation sequence, which became the Basic Life Support algorithm.[1,2] This was later transformed into Advanced Life Support by adding drugs and early defibrillation during cardiopulmonary resuscitation (CPR). Looking back on the fundamental studies leading to these developments, they were performed in laboratory or operating room settings with invasive blood pressure monitoring.[2] If those measurements were not available, a femoral or carotid pulse was used to measure the effect of the treatment. A pulse was made palpable or improved by either moving the patient to a harder surface or by using more body weight for compressions.[3] These *adaptations* in chest compression delivery were the first steps to a patient-tailored cardiac arrest treatment. It is interesting to see that after all these years, we still cannot say that we have the next logical evolution of resuscitation, Adaptive Life Support. In such an approach, real-time analysis of the patient would actively gauge the physiologic effects of CPR in progress and give every cardiac arrest patient, regardless of their age and body constitution, the optimal treatment. Should a female, 36 year-old cardiac arrest patient receive the same treatment as a 66 year-old men with obesity? We need not reach beyond clinical intuition for the answer.

An Adaptive Life Support approach is absolutely dependent on reliable, informative physiologic signatures that associate the state of the patient with the process of treatment. While there is little doubt that monitoring technology has evolved substantially over the past 2 decades and many candidate signatures for guiding resuscitation have persisted in the basic and clinical observational literature, the successful translation of real-time physiologic analysis into resuscitation has not happened yet. This is clear enough in the fact that the paragraph about monitoring during cardiopulmonary resuscitation (CPR) disappeared in the most recent 2021 ALS guidelines.[4,5] And yet, it is likely only a matter of time before we begin to use the wealth of data at our fingertips to net better resuscitation outcomes.

Near infrared cerebral oxygen saturation (rSO_2) measurement is a technology that has the potential to fill this role in a way that gets to the core mission directive of CPR: prioritization of the brain. rSO_2 measured during resuscitation may inform the effects of ongoing CPR toward delivering oxygenated blood to the brain, and while there is debate about the extent to which the rSO_2 signal actually reflects true cerebral saturation, numerous studies support the connection between this measure and some aspect of resuscitation.[6–11] For the moment, the primary utility for rSO_2 maybe be prognostic, although the time may come when its application more immediately governs resuscitation process.[12] Contemporary studies, including one in this issue of the journal, attempt to approach this goal.

In this study by Takegawa et al. out-of hospital cardiac arrest (OHCA) patients presenting with non-shockable rhythms were resuscitated according the TripleCPR 16 protocol.[13] At arrival at the emergency department (ED), rSO_2 monitoring was initiated and continuous mechanical chest compression was conducted for 16 minutes or until a prespecified increase in rSO_2 was achieved. This increase was based on initial rSO_2 values measured upon ED arrival. During this initial period no rhythm checks were performed, and then thereafter a general resuscitation protocol was started with rhythm controls every two minutes.

In total, 225 patients were included in the interventional protocol and were compared to a historical cohort of 86 OHCA patients by the outcome of ROSC and the occurrence of serious adverse events. ROSC rate was 39.5% in the control cohort group and 33.8% in the TripleCPR 16 group, which did not amount to a statistically significant difference. After two kinds of sensitivity analyses were performed to account for the confounding effect of type A aortic dissection (A-AD), a tendency and a significant difference in favour of the TripleCPR 16 protocol were noted, depending on.

With some promising results, it is worth briefly considering both how this rSO2 guided approach fits into current resuscitation strategies and where to go from here. The guidelines recommend a rhythm check every two minutes, however they also emphasize the importance of minimizing interruptions during chest compressions.[4] By prolonging this interval in their TripleCPR 16 protocol, the periods with no or less chest compressions will be minimised, with longer periods of circulating blood. Here was have to remember the present study included only patients with non-shockable rhythms, an essential condition given the normal prioritization of early defibrillation. Even so, no interventions were performed to increase rSO_2 during the 16 min interval besides standard advanced life support. If rSO_2 is a predictor of ROSC and is a derivate of the physiological state of the patient, one might assume that an increase in rSO_2 would result in a higher ROSC rate. Then the next hurdle to overcome presents itself: which intervention increases rSO_2? The literature has some suggestions – some successful, some not. Higher dose of epinephrine does seem to result in higher rSO_2 values, probably due to

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its cerebral vasoconstrictive effect and short acting effect on coronary perfusion pressure.[11,14,15] Two sided and three sided chest compressions may increase rSO_2 compared to one sided chest compressions in a rat cardiac arrest model.[16] Also a change from manual chest compression to load distributed chest compressions may also increase rSO_2.[17] This is not to say the possibilities have been exhausted, only to demonstrate that Takegawa et al are not alone in pursuing the potential of rSO_2.

The study was not without its limitations, however, and therein lie some opportunities for future work. Unfortunately, no data and details were given about patients achieving the prespecified increase in rSO_2 and ROSC rate in this group. This information could have given some insight in the dynamics of rSO_2 under these resuscitation conditions, as well as to see how those dynamics correlated with outcomes. Also, the presence of continuous capnography would have been very interesting, as the authors would have been able to compare and potentially synergize information from both signals, including their relative utility for determining the appropriate time for rhythm checks. Lastly and most obviously, the study design leaves open the need for a completely prospective study, whereas the present study utilized historical controls.

The TripleCPR 16 protocol is a step in the direction of an Adaptive Life Support approach, however some essential pieces are still missing to make a firm conclusion about its potential. Likewise for rSO_2 in general, which remains a potential but not certain guide for optimizing care.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Cornelia Genbrugge
Emergency Department, University Hospitals Saint-Luc, Brussels, Belgium
Acute Medicine Research Pole, Institute of Experimental and Clinical Research (IREC) Université Catholique de Louvain, Belgium
E-mail address: cornelia.genbrugge@saintluc.uclouvain.be,

David D Salcido
Department of Emergency Medicine, University of Pittsburgh School of Medicine, Pittsburgh, PA, United States
School of Medicine, University of Pittsburgh, Pittsburgh, PA, United States

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