Response to Laden et al.

We are grateful to Laden et al. for their response[1] to our article,[2] which is part of a work package with the overall objective of developing an evidence-based approach to the management of cardiac arrest in a diving bell.[2,3] Currently taught techniques lacked any supporting data.

The first article[3] in this work package evaluates commonly taught approaches to manual chest compression delivery. The article referenced by Laden et al. presents the first efficacy evaluation of the only mechanical cardiopulmonary resuscitation (mCPR) device suitable for this environment.[2] Ongoing work addresses the overall approach to cardiac arrest management, including a discussion of the optimal order of events when resuscitating a casualty.

Laden et al. are concerned regarding the lack of discussion of defibrillation; defibrillation in a diving bell is neither the focus of this article nor currently possible. We therefore disagree with the suggestion that a "*significant educational opportunity*" has been missed.

It is irrefutable that defibrillation of shockable rhythms is a vital, well-evidenced component in the effective management of cardiac arrests, and increasing time to defibrillation is associated with progressively poor outcomes. Equally, a focus on defibrillation to the exclusion of effective chest compression delivery in this scenario is unlikely to be effective; every minute without CPR, even for casualties in a shockable rhythm, reduces survival by 7–10%.[4] Even when a defibrillator is available, chest compressions between shocks are essential; the potential lack of a flat surface on which to deliver chest compressions may render CPR without an mCPR device impossible in a diving bell. We have presented an evaluation of alternative approaches,[3] but suffice to say none are as effective as either conventional or mCPR, and head-to-chest CPR should no longer be taught or practiced.

Delays in the recognition and management of cardiac arrest in this setting are likely. Delays in the provision of effective CPR reduce the amplitude of ventricular fibrillation (VF);[5] good quality chest compressions are thought to increase the amplitude of VF and improve the likelihood of conversion to a perfusing rhythm[6] and it has been hypothesised that CPR prior to defibrillation may improve outcomes.

There are currently no defibrillators that can be deployed in a diving bell. Whilst a device may survive a slow compression process, there are no data suggesting that repeated pressurisation/depressurisation cycles, coupled with the corrosive effects of the environment, are tenable for existing devices. There are also logistical challenges to safe defibrillation in a wet, confined, metal environment. This is not to say that overcoming the technical and logistical challenges to safe provision of defibrillation in a diving bell should not be a target for future work; we endorse this goal wholeheartedly, and it would undoubtedly be the 'best next step' in improving the effectiveness of resuscitation in this challenging environment.

Laden et al. have questioned whether the provision of chest compressions without defibrillation would be futile. We agree that the outcome of a cardiac arrest in a saturation diver is unfortunately likely to be poor irrespective of their management. Cardiac arrest in the general population has a poor prognosis, and the saturation diving setting presents myriad additional challenges. Nevertheless, an evidence-based approach to management is vital, both to ensure the best possible chance of survival for the casualty in case of an immediately reversible pathology (e.g., hypoxia[7]) and to minimise the long-term psychological trauma (i.e., 'second victim syndrome') caused to fellow divers (and often friends) who are forced to act in the role of rescuer. The alternative, that they sit next to their deceased colleague throughout their ascent to the surface without providing aid of any sort, is unthinkable.

References

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