HUMAN FACTORS IN ADVANCED CARDIAC LIFE SUPPORT

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Human factors is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the design of the system in order to optimize human well-being and overall system performance. As a medical specialty, anaesthesia has lead the way, by incorporating human factors principles into our training and our clinical practice. Simulation-based crisis management training is now a standard part of anaesthesia education in many parts of the world. The universal ACLS guidelines place emphasis on technical and medical aspects of patient care, whereas the non-technical aspects receive scant attention. This is a flaw in traditional teaching, because effective teamwork that includes leadership, delegation of areas of responsibility, communication, and the recognition and management of errors, are essential to the solution of most life-threatening problems faced by anaesthetists and other acute care specialists.

The technical aspects of the most recent ACLS guidelines are an evidence-based, common sense modification of pre-existing guidelines with refocusing on the provision of uninterrupted and good quality CPR [1]. An easily digested summary was published in Australasian Anaesthesia 2007 [2] The Universal ACLS Algorithm, as approved by the International Liaison Committee on Resuscitation (ILCOR) has only two possible treatment pathways based upon the cardiac rhythm:

- The VF/VT path requires immediate defibrillation.
- The PEA/Asystole path requires immediate thought about the cause of the cardiac arrest. This is the usual path during anaesthesia.

Perioperative cardiac arrest is usually attributed to a specific cause which must be remedied for resuscitation to be successful. This is in contrast to out-of-hospital cardiac arrest where the usual cause is VF/VT (82% of cases), secondary to heart disease, and the treatment is early defibrillation [3]. Hence in our practice, it is important to search for the cause while administering supportive treatment. The common causes are:

- Pre-existing cardiac, respiratory or renal disease.
- Drug-induced problems such as overdose, suxamethonium induced bradycardia, and anaphylaxis caused by any of the chemicals to which the patient is exposed (drugs, chlorhexidine, latex, etc).
- Error or fault with the anaesthetic technique such as problems with ventilation and oxygenation.
- Problems with the surgical technique (e.g. vagal stimulation, carbon dioxide insufflation or insertion of femoral prosthesis).
- Haemorrhage and hypovolaemia.
- Sepsis.
- Embolic phenomena (thrombi, fat, air).

While it is sensible and natural to treat the obvious, failure to respond to treatment should trigger a search for a thorough differential diagnosis using the 4 H's and 4 T's:

- Hypovolaemia (the most common cause).
- Hypoxaemia.
- Hypo/or/hyperkalaemia; hypomagnesaemia; hypercalcaemia.
- Hypo/or/hyperthermia.
- Tension pneumothorax.
- Tamponade (trauma, renal failure, thoracic malignancy).
- Thromboembolus/ pulmonary embolus.
- Toxicity (including anaphylaxis and overdoses – tricyclics, β-blockers, Ca^{++} channel blockers).

Management of Perioperative Cardiac Arrest [4]

Optimising the human factors is essential, because key issues are team functioning, with appropriate differential diagnoses, decision making, and error management:

- Declare a crisis.
- Notify the surgeon/stop surgery and pack wound.
- Call for help and a defibrillator.
- Place patient supine and expose the chest.
- Discontinue anaesthetic agents (infusions and vaporisers).
- Administer 100% oxygen and verify gas composition.
- Institute CPR "Push hard, push fast, allow full chest recoil, minimize interruptions in compressions, and defibrillate promptly when appropriate."[5]
- Search for a cause and undertake rapid and complete systematic assessment of the patient, the equipment and drugs, even if the cause is thought to be identified.
- Vocalise and actively pursue those things that don't make sense or that contradict the dominant diagnosis. This approach may uncover fixation errors, that can then be remedied.
- Search for and manage errors. Common errors seen during simulation are failure to discontinue anaesthetic agents and failure to administer 100 % oxygen - check these when you go to help someone else. In the anaesthetised patient, cardiac arrest is usually first indicated by the physiological monitors, and it can be difficult to decide when to start chest compressions in a monitored hypotensive patient.

Leader Delegates Areas of Responsibility

In perioperative cardiac arrest there are several skilled individuals in the room or vicinity, and so single or two-person CPR is uncommon. In EMAC we suggest delegation of the following areas of responsibility:

- Airway/intubation/ventilation.
- Chest compression - change person doing compressions every 2 minutes [1]. If perfusing rhythm is restored this person can keep a finger on femoral pulse.
- Monitor and defibrillation.
- IV access and drugs.
- Search for cause i.e. exclude H's and T's. If the initial rhythm is not VF/VT, then immediately search for a cause…do not assume a myocardial ischaemic aetiology.
- Support the leader with the decision making and delegation.

Post Resuscitation Care and Peri-arrest Conditions [1,6]

- Optimise cardiopulmonary function and systemic perfusion, especially to the brain.
- Identify precipitating causes.
- Institute measures to prevent recurrence.
- Institute measures that may improve long-term, neurologically intact survival.

Global Review

Repeated re-evaluation should be undertaken. Hypoxia, hypercarbia and hypotension all increase the risk of further cardiac arrest, and contribute to secondary brain injury. Post-arrest patients will frequently have haemodynamic instability with:

- Bradycardia or tachycardia. Search for and treat life threatening cardiac rhythms. [1]
- Myocardial depression/stunning with systolic and diastolic dysfunction.
- Cerebral dysfunction and loss of cerebral autoregulation. This will result in pressure dependent cerebral blood flow, and so hypotension should be aggressively treated. Seizures occur in 5-15%.
- Patients may sustain fractured ribs and pneumothorax from compressions.

These are the leading causes of post-resuscitation mortality and should be treated aggressively. ABCD problems are a common cause of post-resuscitation hypotension and arrhythmia.

Secondary Survey

Airway	Ventilation – right equals left.
Breathing	SpO_2, paralyse, sedate.
Circulation	IV access, monitoring (vital signs, urine output, invasive monitoring). Verify placement of all catheters and cannulae.
Diagnose Cause & Complications	12 lead ECG, electrolytes (Na^+,K^+,Ca^{2+},Mg^{2+}, blood gases), drug screen, glucose CXR (fractured ribs, pneumothorax, tracheal tube), consider tamponade.

The severity of myocardial dysfunction in the post-resuscitation period is related to the duration of global myocardial ischaemia. Inotropes or vasopressors may be needed to treat the hypotension from systolic dysfunction. Volume loading may be needed to optimise preload in context of impaired diastolic relaxation.

The patient may be hypoxaemic secondary to gross V/Q mismatching and should be ventilated with 100% oxygen until oxygenation is stable.

Early neurologic assessment is an unreliable indicator of ultimate recovery of cerebral function. Assessment at 72 hours is more reliable. Up to 20% of initially comatose survivors of cardiac arrest may have good 1-year neurologic outcome [6]. Hyperventilation may worsen neurologic outcome, and normocarbia is recommended. Mild induced hypothermia (32°-34°C) improves neurologic outcome among initially comatose survivors, but its practical application may be difficult. Patients should not be rewarmed from mild spontaneous hypothermia (>33°C), and hyperthermia should be avoided because it increases cerebral metabolic rate and is associated with a worse neurologic outcome [6]. Tight glycaemic control is recommended.

Conclusion

The successful management of perioperative cardiac arrest is a crisis where effective teamwork is needed because there are numerous tasks to be undertaken in a short period of time, where errors are to be expected and where the correct mix of technical and non-technical skills needs to be deployed without delay.

References

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