Code Blue Simulation Curriculum

Stable Ventricular Tachycardia with deterioration to Pulseless VT/VF Cardiac Arrest

Project Goals

Primary Goal: To improve the ACLS algorithm adherence and leadership skills of medicine residents when responding to in-hospital cardiac arrest (IHCA) in the ICU.

Secondary Goal: To improve inter-professional communication, leadership, and teamwork during code blue (including RN, RT, and pharmacy) in the ICU.

Objectives

Upon completion of this curriculum, participants will:

- Adhere to ACLS algorithms and AHA/ACCF guidelines when leading resuscitation efforts during code blue.
- 2. Demonstrate awareness and management of practical factors that contribute to success of resuscitation efforts.
- 3. Demonstrate effective leadership, communication, and teamwork skills during code
- 4. Physician participants will increase confidence and preparedness for leading real-world code blue.

Participants

ICU MD interns, residents, and fellows **ICU RN Respiratory Therapist Pharmacist**

Schedule

Ideally, this curriculum is implemented on a recurring basis based upon trainee rotation schedule. Each month prior to trainee intensive care unit (ICU) rotation, an interprofessional team as described above will be invited to participate in a 90-minute simulation session. The ICU is an ideal setting in which to implement this interprofessional curriculum, as it has an existing interprofessional team structure and often has a higher rate of code blue than a typical medical/surgical unit.

Representatives from each of the above professions (RT, pharmacy, chief resident, ICU RN manager) will help to find a mutually agreeable time to schedule the simulation each month to maximize interprofessional participation.

Curriculum Components

The curriculum consists of three components: simulation exercise of stable VT which deteriorates into pulseless VT/VF, interactive group session with debriefing and review of relevant communication as well as medical factors, and an unannounced in-unit mock code blue. The simulation exercise (see Instructor guide for full details) and interactive group activity will occur during a 90-minute session in the weeks prior to the residents' ICU rotation start date. The unannounced in-unit mock code blue (identical scenario to the simulation exercises) will occur once during the month-long ICU rotation (if possible to also do a mock code during night shift, this is of great utility for night RN).

The clinical simulation scenario (further described in simulation script) consists of the following: Stable VT (5 min) \rightarrow Pulseless VT (2.5 min) \rightarrow VF (7 min) \rightarrow Asystole

Successful resuscitation requires:

- ✓ 2 min effective ventilation
- ✓ 2 min (at least) of high-quality CPR
- ✓ 2 defibrillations
- √ 1 dose vasoconstrictor
- √ 1 dose antiarrhythmic (amiodarone)

Outcomes

Anticipated outcomes align with the goals and objectives for this curriculum.

Primary outcome: Improvement in ACLS algorithm adherence and leadership skills of medicine residents when responding to IHCA in the MICU, as measured by direct observation of simulated code blue exercises before v. after curriculum implementation.

Secondary outcome: Improvement in perceptions of communication, leadership, and teamwork by the inter-professional code team in the MICU, as measured by survey responses before v. after curriculum implementation.

Evaluation

Evaluation of the curriculum's impact and effectiveness can occur via surveys of residents and ICU staff, direct observation of skills during simulation, and clinical outcomes.

Surveys

1. ICU Residents/Interns and ICU Staff

At the beginning of the simulation session, MD participants complete a survey (see attached) evaluating comfort with practical skills in code blue, self-assessment and experience with IHCA, and preparation for IHCA leadership. This survey is a compilation of previously published surveys. MD participants will respond to a similar cross-sectional survey after 6 months and 12 months of curriculum implementation.

ICU staff will complete a short survey prior to the simulation session, and asked to complete a follow-up cross-sectional survey 6 and 12 months after curriculum implementation.

Direct Observation

1. Simulation Exercise

Simulation exercises are scored utilizing a checklist (see attached) that has been modified from a previously-validated checklist (updated for 2015 ACLS guidelines).

2. Unit-based Mock Code

Unit-based mock codes can be scored utilizing the same checklist as above.

Code Blue Simulation Curriculum

Stable Ventricular Tachycardia with deterioration to Pulseless VT/VF Cardiac Arrest Case Description and Instructor Guide

Participants:

ICU MD interns, residents, and fellows **ICU RN Respiratory Therapist** Pharmacist

Case Set-up:

- 1. ICU RN should be in the simulation room at the start of the scenario. ICU RN given the case information (below) and instructed to call the MD due to abnormal vital signs.
- 2. ICU MD should be given the case information (below). When the simulation is set to begin, ICU RN call the MD for abnormal vital signs, at which point the MD team enters the room and begins assessment.
- 3. Respiratory Therapist and Pharmacist are available but not in the room until the MD and/or RN call "code blue," at which time they respond as part of the Code Blue team.

Required Materials:

- Human Simulator with IV access and drainage system set up
- 1-2L NS with IV tubing
- Nasal cannula
- Nonrebreather mask
- Ambu bag
- Oral airway
- Nasal airway
- Laryngoscope handle and blade
- Endotracheal tube and stylet
- 10cc syringe for cuff inflation
- Backboard (or crash cart with removable front)
- CPR stool
- Defibrillator
- (Electrogel)
- Labeled syringes with fake medicines (3-5 of each):
 - Epinephrine 1:10,000 1mg
 - o Vasopressin 40 IU
 - o Atropine 1mg
 - o Amiodarone 150mg
 - o Amiodarone 300 mg
 - o NaHCO3 one ampule
 - o Calcium chloride one ampule
 - o D-50 one ampule
 - o Metoprolol 5mg
 - Adenosine 12mg
 - Diltiazem 5mg

- o Magnesium 1g
- o Fentanyl 50mcg
- o Versed 5mg

Case Information – Provided to MD and RN participants prior to start of case

Scenario: Ms. Granger, a floor patient, has a heart rate of 160 detected on routine vital sign assessment. She presented to the ED late last night with chest pain, and was admitted by the night float resident for unstable angina. She was transferred to the floor early this morning. Her admission note from the night float resident is below.

Admission H&P: Tina Granger

HPI: 61 year old woman to the ED with 2 week history of worsening chest pain. Initially she just had L-sided chest "pressure" accompanied by mild dyspnea when she was climbing stairs or carrying heavy objects, but over past 2 weeks, she has developed more severe substernal chest pain with progressively less exertion. Now gets pain while walking on level surfaces, but no pain at rest. She had scheduled an appointment with her PMD, but husband insisted that she come to the hospital. No pain on arrival in the ED or now.

PMH: HTN, DM

Meds: Norvasc, HCTZ, Actos

Allergies: NKDA

SH: Works as a bank executive. Married, no kids. Former smoker, occasional EtOH, no drugs.

VS: T-98.2 P-160 R-22 BP-168/80 SpO2-95% on room air

Exam: Unremarkable

EKG: No acute ischemic changes

Chest X-ray: Normal

Labs: Troponin < 0.06, CK 185, MB 5, others unremarkable

Assessment/plan: Diagnosed with unstable angina in ED, given aspirin and started on heparin drip. Will admit to monitored floor, r/o MI, consult cardiology re stress test vs cath. No active ischemia at present.

Instructor Guide – NOT Provided to Students

Objectives

By the end of this case the learners will:

- Correctly identify ventricular tachycardia and provide appropriate pharmacologic therapy for stable, unstable, and pulseless ventricular tachycardia
- Demonstrate continuous, high-quality cardiopulmonary resuscitation
- Correctly perform defibrillation/cardioversion
- Demonstrate understanding of basic crisis resource management principles

Setup: Simulator Mannequin lying in bed with IV in place, attached to heparin drip, head of bed elevated to 30 degrees. Not attached to monitor/telemetry. 2L NC oxygen in place.

Instructor Role:

A simulation staff member will ideally be available to run the simulator, with your guidance. Your main job during the simulation is to bring the case to life. You will introduce the case. You will portray the voices of the patient, the nurse, and any consultants that your students may call (if simulation center has this capability). You will take the students any imaging results or medications they request, and generally keep the case moving. You will also watch carefully during the simulation and keep notes for debriefing at the end. Please give learners specific feedback on what they did well and what they need to improve upon.

Pre-case orientation:

Your learners should receive a brief orientation to simulation, depending upon their familiarity, including the following:

- Simulator features and limitations
- Preceptor roles
 - Voice of patient students should talk to patient normally
 - Voice of "InvisiNurse" serves as link to outside world, provides test results, contacts consultants, can answer questions about equipment, drugs, etc.
 - Voice of Reason can clarify whether a "finding" is really a finding or some artifact of the simulator
- Availability of clinical data labs, EKG, radiology studies, consults all available in roughly real time
- Availability of equipment or drugs can ask for anything, but will only get what would realistically be available at the patient's level of care

Before they enter the room, please provide learners with the H&P for their case, and give them a few minutes to read over it.

Scenario:

Patient is not monitored when students enter room, and monitor data should not be displayed until such time as students request it. If students ask why no monitor, tell them that patient had been on monitor previously and must have disconnected herself by accident.

When students enter room, patient is lying in stretcher as above. She is feeling a bit lightheaded and dyspneic, but denies chest pain at present. The fast heart rate was detected on routine vital sign check.

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At this point, students will likely take a brief history. The patient is having palpitations, and feels like her heart is racing. She gives a recent history consistent with unstable angina, but denies chest pain currently, though if pressed will indicated that she has a bit of pressure. She is reasonably comfortable at the beginning of the case.

When students attach the patient to the monitor, she will be in VT. She is initially hemodynamically stable, and will remain so for 5 minutes, at which point she will deteriorate into pulseless VT, regardless of student actions or lack thereof.

Possible Student Actions and Consequences:

- At any point, if students call for help, tell them that the rapid response/code blue team has been called (at this point, RT and Pharmacy can enter the room)
- If students call cardiology consult, call back as the cardiology consultant and promise to come see the patient shortly. Do not give them any direction over the phone, as the goal is for them to manage the patient themselves.
- **During STABLE VT:**
 - o If oxygen is given, there is no response, though this is a desirable action
 - o If fluids are given, there is no response this is not a desirable action
 - o If an EKG is requested, provide the VT EKG
 - o If labs are requested, agree to draw them no results will come back during the course of the simulation however
 - If an AV-nodal blocker is given (adenosine, diltiazem, metoprolol, etc), there is no response, though adenosine would be a reasonable initial drug
 - If an APPROPRIATE dose of a nonselective antiarrhythmic is given (amiodarone 150 mg over 10 minutes, or procainamide drip at 20-50 mg/min, or sotalol 100 mg over 5 minutes, NOT code-dose amiodarone), then VT terminates transiently (Patient goes to a sinus rhythm with HR 92 and BP 96/73 temporarily. VT returns after 20 seconds)
 - If code dose amiodarone is given, the patient goes into a slow junctional rhythm with HR 62 and BP 78/55
 - If the patient is shocked, she yells at the students, screaming "My chest! My chest!!!" and using any colorful language that seems useful for making the point that awake people just HATE to be shocked without sedation
 - No matter what is done during this period, the patient will deteriorate into pulseless VT after 5 min
- During PULSELESS VT: HR goes to 170, pulse absent, BP 6/6 (if they attempt to cycle the BP cuff), SpO2 absent as patient is pulseless, RR 0, eyes close, crackles in lungs, and patient unresponsive.
- Pulseless VT will deteriorate into VF after 2.5 min if the correct actions are not completed.
 - No student actions have immediate consequences, but they must perform all critical actions **CORRECTLY** to make recovery possible
 - Students may intubate this is acceptable, although they should only intubate after thoroughly troubleshooting BVM. If BVM is working appropriately, intubation should not be attempted.

- o CPR is **NOT** considered effective until students use a backboard, a stool, and proper technique (as allowed by stiffness of mannequin)
- In order for VT to terminate, students have to complete **ALL** of these actions:
 - 2 minutes of effective ventilation (via proper BVM technique and/or intubation)
 - 2 minutes of effective CPR
 - 2 defibrillations
 - 1 dose of vasoconstrictor (epinephrine 1mg according to 2015 ACLS guidelines – vasopressin no longer in algorithm)
 - 1 dose amiodarone (code dose 300mg)
- Students have 7 minutes to perform these interventions if this deadline is not met, patient will become asystolic and unrecoverable
- Students may perform additional interventions before these criteria are met these will not have any effect

Ending the Case:

- If the case ends well (i.e., students have met above criteria and VF has been terminated), give them several minutes to reassess the patient (check pulse, blood pressure) and initiate appropriate post-arrest care.
 - Students should perform appropriate stabilization including:
 - Consider intubation as patient is unresponsive/unconscious
 - Consider access (do not ask them to simulate central line placement during this simulation, but note their request)
 - Labs
 - Transfer to ICU
 - Obtain labs
 - Adequate post-arrest care MUST include the following:
 - 12-lead EKG (which will show NSR with anterior STEMI)
 - Recognize STEMI and/or call cardiology to consider urgent revascularization
 - Consider hypothermia
- Give the learners approximately 3 minutes to consider the three highlighted items of post-arrest care (emphasized in the "links in the chain of survival" for In-Hospital Cardiac Arrest). After 3 minutes, enter the room in the role of the cardiologist, and congratulate them on stabilizing the patient.
- If they have not fulfilled the 3 highlighted post-arrest care steps, emphasize the appropriateness of EKG, cardiology consultation, and hypothermia.
- If the case does not end well (i.e., patient has become asystolic), give them about a minute to continue the asystole protocol, then go in and debrief.

Critical Actions for Students:

- **During STABLE VT:**
 - o Attach monitor, BP, pulse ox
 - Administer oxygen
 - o Call for help (attempts to get attending, code team, etc.)

- Antiarrhythmic drug treatment for stable VT (amiodarone 150mg, procainamide, sotalol all acceptable)
- **During PULSELESS VT:**
 - Assess C-A-B (Circulation-Airway-Breathing) and recognize arrest
 - o **Effective** CPR (backboard, stool, positioning)
 - o **Effective** BVM (vs intubation)
 - o Defibrillation this should be done as soon as the defibrillator is attached to the patient. If the group waits a full 2 minutes prior to shocking, this should be addressed during debriefing.
 - Vasoconstrictor administration (epi only per 2015 ACLS Guidelines) according to ACLS algorithm, this should only be done after 2 shocks are administered. If it is given earlier, cover during debriefing.
 - Amiodarone administration
- After Recovery:
 - o Check pulse, BP, SpO2, and mental status
 - Antiarrhythmic infusion consider given risk of recurrent VT
 - o 12 Lead EKG to evaluate for ischemia/infarction
 - Cardiology consultation
 - Consider hypothermia

Key Teaching Points:

- **Rhythm Recognition**
 - Review features of VT fast, wide, regular
 - o ALL WIDE COMPLEX TACHYCARDIA in an unstable patient IS VT UNTIL PROVEN **OTHERWISE**
 - o Importance of identifying the rhythm OUT LOUD for entire group to hear (not everyone in the room can read an EKG)
- Management of VT WITH PULSE
 - Emergent cardioversion indicated for **UNSTABLE** VT:
 - Significant hypotension (systemic hypoperfusion)
 - Ischemic chest pain (coronary hypoperfusion)
 - Acutely altered mental status (cerebral hypoperfusion)
 - Signs of shock
 - Signs of decompensated heart failure (pulmonary edema due to poor CO)
 - Cardioversion:
 - If emergent cardioversion is required in a conscious patient, sedation should be strongly considered – shocks are painful and disturbing to
 - Patients with pulses receive SYNCHRONIZED cardioversion, as an unsynchronized shock could preciptate VF – demonstrate this function on defibrillator
 - Initial dose is 100J, can increase to 200J if needed
 - o Our patient was **STABLE**, therefore initial treatment is *pharmacologic*
 - Treatment options:

- Amiodarone: 150mg in 100cc D5W over 10 min do NOT confuse with code dose. Give 1mg/min infusion for 6 hours after loading dose. This is by far the most commonly used drug for VT.
- Adenosine: While many learners will consider adenosine, it's only real role is to cause AV nodal blockade and reveal underlying rhythm IF it is a supraventricular tachycardia with aberrant (wide) conduction. Steer them away from using this routinely for wide complex tachycardias, unless they have a high suspicion of SVT with aberrancy. Amiodarone will also be treatment for SVT.
- Lidocaine, Procainamide, or Sotalol can be considered, but for simplicity sake, emphasize amiodarone (lidocaine for ischemic VT).

Management of VT WITHOUT PULSE

- CPR!!! Immediate, continuous and high quality (see below). Should start within 10sec of arrest.
 - Good CPR technique is ESSENTIAL FOR INTACT SURVIVAL
 - Minimize interruptions the only time CPR should be stopped is for scheduled rhythm checks (every 5 cycles or 2 minutes). ACLS algorithm allows for either 30:2 compressions to breaths (interrupted), or 1 breath every 8-10 seconds (uninterrupted). We prefer uninterrupted for professional rescuers in the hospital.
 - Switch personnel every 2 minutes during rhythm checks good CPR is exhausting, and can't be maintained for long
 - Use a stool for optimal body position
 - Use a backboard to optimize efficacy of each compression

Defibrillation 0

- SINGLE MOST IMPORTANT DETERMINANT OF OUTCOME!
- Make sure rhythm is shockable before shocking (VF or pulseless VT on visual inspection)
- Do not need to synchronize as for VT with pulse
- Repeated every 2 min for as long as patient remains in shockable rhythm
- More important than any other intervention aside from high-quality CPR – perform defibrillation as soon as the defibrillator arrives – do not delay for airway management, or IV access. Should occur within 2 min of cardiac arrest, sooner if possible. For every 1 minute delay in defibrillation, survival decreases by 10%!! This means if they delay for a full 2 minutes of CPR prior to shocking, they have decreased chances of survival by 20%.
- Continue CPR while defibrillator is charging, minimize pauses in CPR.
- After each shock, RESUME CPR IMMEDIATELY you don't get to assess the effect of a shock until the next scheduled rhythm check (unless of course patient shows clinically obvious signs of life)

Drugs

Compared to CPR and defibrillation, which are the most important interventions, medications play a small role in resuscitation and have no evidence for improved mortality

- Vasoconstrictors: optimize perfusion to heart and brain this increases the likelihood of return of spontaneous circulation, but do not have long-term mortality benefit in shockable rhythms.
 - Epinephrine 1mg 1:10,000 solution, Q3-5 min (evidence that less frequent epi administration improves outcomes)
 - Vasopressin removed from 2015 ACLS algorithm due to no evidence of superiority in head to head trials with epinephrine, and for ease of administration
- Antiarrhythmics: no evidence that they change long-term outcomes. Should be considered for VF/VT, but not a mandatory intervention. Do NOT need to wait between administration of vasopressor and antiarrhythmic (i.e. the 3-5 minutes between epi doses)
 - Amiodarone is the antiarrhythmic of choice for VF/VT arrest has been shown to improve short-term outcomes, though no evidence of long-term survival benefit
 - Dose is 300mg IV push, 2nd Dose of 150 mg IV push if needed
- Airway/Breathing
 - LESS IMPORTANT THAN COMPRESSIONS!!! No clear benefit for respiratory support during initial phase of resuscitation
 - **BVM**
 - Must use good technique for success, only measurement of success is chest rise (pulse ox not available in shock or cardiac arrest)
 - One-person BVM is often not successful use two-person BVM with oral airway to optimize
 - Respiratory rate often is high (as high as 30 breaths per minute) - with every breath, positive pressure is introduced into chest, raising intrathoracic pressure and decreasing preload, as well as decreasing coronary perfusion pressure. Therefore, need appropriate frequency (30:2 OR once every 6-10 seconds) and appropriate length (NOT prolonged breath delivery)
 - Review BVM technique as needed
 - Jaw thrust with two hand mask seal
 - Second person bags
 - Oral airway placement required
 - o Check for chest rise with each and every breath
 - Intubation
 - The optimal time for intubation is unknown as interns, don't do it in the early stages of resuscitation unless you are absolutely unable to achieve success with BVM
 - Oxygen
 - O2 at 15L/min failing to attach the ambu bag to anything is a disturbingly common mistake
- Crisis resource management/Team and Leadership Skills:
 - CODE STATUS: Common mistake in simulation to not clarify code status (as they are prepared to perform CPR so do not think the patient might be DNR).

- Support CALL FOR HELP EARLY
- o Team Leader: a single leader delegates roles to other team members. Common mistake is leader starts performing resuscitation maneuvers (CPR, defib, etc.) and loses focus as leader
- Team Roles: 5 essential roles to fulfill
 - Leader
 - Defibrillation
 - CPR (with several on back-up)
 - Airway (BVM, intubation)
 - Drug administration/access
- Communication: close the loop!
 - Leader gives an order
 - Team member acknowledges hearing the order
 - Team member informs the leader when the order is complete
 - Recorder to document
- Resources:
 - Ask clearly for what you need
 - Know your environment, including where things are kept and what is available on your crash cart

Code Blue Simulation Curriculum Admission H&P: Tina Granger

HPI: 61 year old woman to the ED with 2 week history of worsening chest pain. Initially she just had L-sided chest "pressure" accompanied by mild dyspnea when she was climbing stairs or carrying heavy objects, but over past 2 weeks, she has developed more severe substernal chest pain with progressively less exertion. Now gets pain while walking on level surfaces, but no pain at rest. She had scheduled an appointment with her PMD, but husband insisted that she come to the hospital. No pain on arrival in the ED or now.

PMH: HTN, DM

Meds: Norvasc, HCTZ, Actos

Allergies: NKDA

SH: Works as a bank executive. Married, no kids. Former smoker, occasional EtOH, no drugs.

VS: T-98.2 P-160 R-22 BP-168/80 SpO2-95% on room air

Exam: Unremarkable

EKG: No acute ischemic changes

Chest X-ray: Normal

Labs: Troponin < 0.06, CK 185, MB 5, others unremarkable

Assessment/plan: Diagnosed with unstable angina in ED, given aspirin and started on heparin drip. Will admit to monitored floor, r/o MI, consult cardiology re stress test vs cath. No active ischemia at present.

CODE BLUE RESUSCITATION SIMULATION CHECKLIST

Unique ID #			
Date	Evaluator		

Pulseless VT/VF, Refractory

Skill Key: A = Done Correctly B = Done Incorrectly C = Not Done

		-		
Recognize pulseless patient within 10 seconds	Α	В	С	n/a
Check responsiveness		В	С	n/a
Confirm patient code status		В	С	n/a
Get Help – Call Code		В	С	n/a
Assign roles – verbal or understood	Α	В	С	n/a
Call for defibrillator	Α	В	С	n/a
Initiate CPR within 10 seconds of recognizing pulseless		В	С	n/a
Adequate rate >100/min		В	С	n/a
Give oxygen.	Α	В	С	n/a
Give respirations at rate of 8-10/min via bag-mask		В	С	n/a
Attach monitor/defibrillator and plug in/turn on	Α	В	С	n/a
Check/Identify rhythm on monitor <10 sec	Α	В	С	n/a
Charge while continuing CPR	Α	В	С	n/a
Clear	Α	В	С	n/a
Defibrillate #1 as soon as defibrillator is attached to	Α	В	С	n/a
patient and shockable rhythm identified				
Immediately resume CPR		В	С	n/a
CPR 2 minutes		В	С	n/a
Adequate rate >100/min		В	С	n/a
Pulse/rhythm check <10 sec		В	С	n/a
Charge while continuing CPR	Α	В	С	n/a
Clear		В	С	n/a
Defibrillate #2	Α	В	С	n/a
Search 5H/5T	Α	В	С	n/a
Change compressor every 2 minutes OR as needed	Α	В	С	n/a
Immediately resume CPR		В	С	n/a
CPR 2 minutes – do not stop for meds		В	С	n/a
Adequate rate >100/min		В	С	n/a
Epinephrine 1mg IV push, repeat every 3-5 minutes OR		В	С	n/a
Vasopressin 40 U IV single dose to replace 1 st or 2 nd				
dose of Epi				
Full credit only if give Epi AFTER Defib #2				
Pulse/rhythm check <10 sec		В	С	n/a

5 H 1 hypovolemia 2 hypoxia 3 hydrogen ions (acidosis) 4 hyper/hypokalemia
5 hypothermia
5 T
1 toxins
2 tamponade
3 tension pneumothorax
4 thrombosis coronary
5 thrombosis pulmonary

Charge while continuing CPR		В	С	n/a
Clear		В	С	n/a
Defibrillate		В	С	n/a
CPR 2 minutes, do not stop for meds		В	С	n/a
Adequate rate >100/min		В	С	n/a
Amiodarone 300mg IVP +/- 150mg, ok to repeat x1	Α	В	С	n/a
Ok to give at any point during code blue				
Pulse/rhythm check <10 sec		В	С	n/a
Charge		В	С	n/a
Clear	Α	В	С	n/a
Defibrillate		В	С	n/a
Post-arrest: Obtain EKG		В	С	n/a
Post-arrest: Identify STEMI OR call cardiology		В	С	n/a
Post-arrest: Consider hypothermia		В	С	n/a