King's Clinical Training

IN SITU SIMULATION TEAM TRAINING FOR THE MANAGEMENT OF MEDICAL EMERGENCIES OCCURRING ON HAEMODIALYSIS

A practical guide

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Contents

Abbreviations and Acronyms

ABG	Arterial blood gas
AED	Automated external defibrillator
AF	Atrial fibrillation
AV	Arterio-venous
AVPU scale	Alert, Voice, Pain, Unresponsive
BM	Blood glucose
BP	Blood pressure
BVM	Bag valve mask
CPR	Cardiopulmonary resuscitation
EF	Ejection fraction
ESRF	End stage renal failure
GCS	Glasgow Coma Score
GI	Gastro-intestinal
HCA	Health care assistant
HD	Haemodialysis
HR	Heart Rate
HTN	Hypertension
IHD	Ischaemic heart disease
IV	Intravenous
LMWH	Low molecular weight heparin
LV	Left ventricle
MDT	Multidisciplinary team
MI	Myocardial infarction
MVR	Mitral valve replacement
NKDA	No known drug allergies
NRBM	Non rebreathe mask
O_2	Oxygen
OA	On air
OGD	Oesophago-gastroduodenoscopy
PEA	Pulseless electrical activity
PGD	Patient Group Direction
PPI	Proton pump inhibitor
PR	Per rectum
ROSC	Return of spontaneous circulation
RR	Respiratory rate
SBAR	Situation, Background, Assessment, Recommendations
SHO	Senior house officer/ core medical trainee
SpR	Registrar
T2DM	Type 2 diabetes mellitus
TW	Target weight
UF	Ultrafiltration
VT	Ventricular tachycardia

Introduction

Simulation is an educational tool that enables individuals to learn through experiencing an artificial representation of a real-life situation. High fidelity simulation is a type of simulation where the aim is to resemble real life as much as possible, e.g. a plastic manikin that speaks with heart, breath, abdominal sounds and pulses.

Simulation scenarios provide an opportunity for a team to practice the clinical management of a patient in a risk-free controlled manner. In addition, human factors such as teamwork, communication and leadership skills can be developed.

In situ simulation takes place in the actual workplace rather than in an education centre. The additional benefits of this include improving the team's appreciation of the local environment and resources; it requires less time away from clinical duties thereby enabling more members of the multidisciplinary team to attend; furthermore, it may identify latent safety threats, clinical error waiting to happen, highlight areas for service improvement, and can lead to the generation of quality improvement projects.

Participants in in situ simulation training include those taking part in the scenario and also observers. Those observing the simulation can have as useful a learning experience as those individuals participating directly in the scenario. A structured debrief of the scenario in a safe environment can help maximise the learning and encourage the group to reflect on the event. It is important that a member of the faculty involved in the simulation is trained to provide a structured debrief using validated models such as the "DAA" or "Modified Plus/Delta (Miller)".

This resource is designed to provide support for the set-up of an in situ simulation training programme for the management of medical emergencies on haemodialysis (HD) based on our experiences at King's College Hospital. However the nature of simulation training dictates that the debrief is based on the actual events that occur in the scenario. To this end, some of the material presented here may not be required in the scenario and the learning outcomes may be different to those anticipated.

We have found that in situ simulation training has been of great value in our unit (Watson et al, 2017) and hope other units can benefit from this innovative training exercise.

Setting up an in situ haemodialysis simulation training programme: The King's College Hospital model

Aim: To create a regular training session for the management of acute medical emergencies in the patient on haemodialysis for the renal multidisciplinary team (MDT).

Target audience: Renal MDT- dialysis nurses and healthcare assistants, renal SHOs, renal registrars.

Frequency: Monthly, 75 minutes duration; faculty meet 15 minutes beforehand.

Location: Technician's room on the haemodialysis unit; a dialysis bay is also possible.

Participants: Rostered to attend and to include a minimum of x2 renal nurses and x2 doctors (suggest an SHO and renal registrar; we average 8 attendees with 4-5 participating directly in the scenario); those rostered have bleep free protected teaching. Our training has so far focused on renal nurses and doctors, but training could be extended to other junior doctors within the hospital.

Equipment: High fidelity manikin, Susie-Gaumard® or (low fidelity manikin with SimMon® if no access to higher fidelity manikin), with fistula arm, dialysis chair/bed, dialysis machine, cardiac monitoring and observation monitoring equipment, simulated crash trolley (replicating actual crash trolley), oxygen, ECG machine, defibrillator (either manual or automated external defibrillator, based on what is present in the unit), simulated telephone, simulated emergency alarm buzzer, and screen (to obscure technician operating manikin and faculty member being the patient voice). Attention needs to be given to ensure simulation equipment e.g. drugs, airway adjuncts etc. are kept separate and removed after the training, to ensure out of date medications and non-sterile kit are not used in clinical practice.

To create a simulated fistula on the manikin a rubber loop of tubing with a bung port at each end was created and put underneath the plastic manikin skin; the arterial and venous dialysis needles can then be connected to the ports. The tunnelled line was simulated by tying off the distal part of a tunnelled line and then positioning the catheter underneath the breast of the manikin. Both these designs allow a circuit to be set up for the dialysate to flow around.

Faculty: Scenarios run with a minimum of three faculty members: 1) An embedded practitioner- this is a member of the faculty who usually plays the role of a junior dialysis nurse; they also have a role in clarifying any aspects of the scenario which may not be clearly simulated by the plastic manikin ("reality gaps"); 2) Simulation technician- operates the manikin and plays the patient voice; 3) Control room lead- instructs the simulation technician when to change the manikin's observations, gives specialty advice when called for by participants by answering the mock-up telephone, provides investigation results, introduces further participants to the scenario, and ends scenario at an appropriate time.

A member of the faculty must have educational training to deliver a structured debrief, and a member of the faculty with expert knowledge must also be present (for example, a consultant nephrologist, consultant nurse or senior renal registrar).

Set up: Participants are rostered to take part in the simulation training and are sent an email invite which contains a video link providing them with an introduction to simulation (see supplementary material, email invite). Sessions last 75 minutes; the first 15 minutes is used for introducing the members of faculty and participants, and orientating the participants to the manikin and the local

environment. The scenario then runs in real time for around 15 minutes with the embedded practitioner playing the role of the junior dialysis nurse to help with limitations of fidelity of the manikin and reality gaps. Trainees not involved in the scenario watch but do not get involved in the scenario; they do however contribute to the debrief. The debrief runs for around 45 minutes in a separate seminar room on the dialysis unit and provides a safe learning forum (a separate room is preferable, but not essential). We used the diamond model to structure the debrief (see additional resources) which consists of 4 phases:

1) A description phase (recounting an objective time line of what happened in the scenario)
2) A transition phase (covering the technical medical management of the condition)
3) An analysis phase (looking at behaviour, what was done well and why)
4) An application phase (how the training will lead the participants to change their future practice).

Sustainability: Availability of a scenario bank (additional scenarios can be added based on local requirements); provision of a core faculty who are trained in simulation debriefing; and training a "bank" of renal simulation technicians to operate the manikin. The simulation technician from the postgraduate education department trained our local renal technicians to operate the manikin which created a "bank" of renal simulation technicians.

Example timetable

Simulation training runs for 75 minutes

12:30 Education team set up room

13:00 Faculty arrive with scenario brief; role allocation of faculty and participants

13:15 Participants arrive

13:15 Introduction – objectives of session, orientation to manikin, simulation set up and the local resources

13:30 Scenario

13:45 Structured debrief

14:30 End

Part 1. Case Scenarios for the Main Haemodialysis Unit

King's Clinical Training

In Situ Dialysis Simulation Scenarios

Scenario: Victoria Hugo; Septic Shock - Tunnelled line sepsis

Scenario Quick Notes

Patient name:
Victoria Hugo

Age: 67 years

Clinical Headline:
Sepsis, infected tunnelled line

Haemodialysis since 2000 via tunnelled line, x3/wk, TW 75 kg

PMH: Warfarin for metallic mitral valve replacement 20 year ago, type 2 diabetes, IHD, poor access- failed fistulas and no further fistula options; unfit for transplantation

DH: warfarin, ramipril, calcium acetate, alfacalcidol, neorecormon

SH: Lives alone in flat, family support for shopping, washing and transport to haemodialysis

Clinical learning objectives:
Recognition of acutely unwell patient
Recognition and management of septic shock
Administering fluid boluses for hypotension
Need for inotropes if ongoing hypotension
Planning of safe line removal and temporary line insertion
Consideration of anticoagulation bridging for metallic mitral valve
Discussion of how to deliver ongoing dialysis/filtration and need for intensive care

Anticipated human factor objectives:
Communication
Leadership
Teamwork
Escalation
SBAR handover

Added complexity:
Hyperkalaemia on spot venous gas
Ongoing hypotension despite fluids – need for inotropic support & setting ceilings of care

Expected scenario progression:
The haemodialysis nurse attends to Victoria whose dialysis machine is alarming because of poor flows. She is 1 hour into her dialysis session. Victoria is currently on a course of flucloxacillin for an exit site infection. The nurse should assess the patient and perform an A to E assessment: the patient is confused on talking, has a high respiratory rate, low blood pressure, and a normal blood glucose; She is delirious, GCS 13-14, and has a fever 39^{0}C. The doctor should be called. The doctor is expected to assess and treat using a systematic A to E approach including provision of high flow oxygen and they should establish intravenous access. They should recognise that the patient is septic and identify the likely source to be the tunnelled line, with a mucky, oozy tunnelled line site. Dialysis

should be stopped and sepsis treated using the "sepsis 6 bundle"*(ignoring urine output measurement)*. Central and peripheral blood cultures are required as well as a blood gas including a spot potassium and lactate. Fluid boluses for hypotension via the peripheral cannula should be given and antibiotics started within the timing of the scenario, following local microbiology guidelines. The patient should be admitted with a plan to remove the tunnelled line post coagulation factor replacement. The patient's blood pressure will remain low despite above treatment, and the team should involve intensive care for consideration of inotropes and haemofiltration.

Faculty and participants

Faculty: minimum of three
Sim technician and patient voice, control room lead, embedded practitioner

Member of faculty trained for structured debrief plus a senior member of renal team

Participants:
2 nurses

2/3 doctors

Sim Set Up

Extra Props and Settings:

ECG: sinus tachycardia /atrial fibrillation with fast ventricular response
Drug Chart
Bandage covering "oozing red tunnelled line exit"

Crash trolley accessible with :Training AED/manual defibrillator, Emergency drugs/O2/airway adjuncts/kit for intubation

Manikin Settings:

Equal air entry bilaterally

Initial Observations:

Sats	90% OA
RR	24
HR	130
BP	80/50
Temp	39

Non Manikin Observations:
Cap Refill: 3s
BM 6.8
GCS: 13 (E3, V4, M6)

HD Settings:

Dry weight 75kg, planned ultrafiltration 2L over 4 hours
FX80 A7
Blood flow 300ml/min
UF 500ml/hr
Observations on arrival at HD: BP 110/50, HR 90, 77kg

Deteriorating Observations

Sats	94% on 15L
RR	28
HR	140
BP	70/42
Temp	38.8
GCS	12
BM	6

Improving Observations (post correct choice of antibiotics and fluid bolus)

Sats	98% on 15L
RR	20
HR	110
BP	90/50
Temp	37.6
GCS	14
BM	6

Peri-arrest Observations

Sats	90% on 15L
RR	40
HR	32
BP	65/40
Temp	38.8
GCS	9
BM	6

Participant Briefing: to Dialysis Nurse
You are the dialysis nurse. You are looking after Victoria, a 67-year-old woman attending her routine dialysis session. She is above her target weight and is having a 4 hour session with 2 Litre removal on UF on a standard low K bath. She has been receiving oral flucloxacillin for an exit site infection. The dialysis machine is alarming with poor flows.

Control Room Lead Briefing
This scenario is to practise the management of septic shock in a patient on haemodialysis. The team should manage sepsis as per sepsis 6 *(not including urine output)*, taking central and peripheral cultures. Added complexity includes hyperkalaemia, and safe removal of her tunnelled line given the need for anticoagulation with a metallic mitral valve replacement. If managed correctly the patient will stabilise and a plan should be made for ongoing care in a high dependency care setting or transfer to intensive care.

Patient Voice Briefing
You are confused; you are feeling cold and dizzy. If not managed appropriately you will become increasingly unwell and unresponsive.

Embedded Practitioner Briefing
You are the junior dialysis nurse; you can point out any reality gaps and direct the participants to the whereabouts of the local resources.

Technical Points for discussion
Fluid management
Line sepsis- salvage antibiotics
Site for microbiology cultures and appropriate antimicrobials
Consideration of seeding of infection- endocarditis, discitis
Removal of line safely in the context of abnormal clotting
Management of anticoagulation
Management of hyperkalaemia
Suitability for escalation to Intensive care; discussion with long-term haemodialysis consultant

BLOOD RESULTS

Victoria Hugo

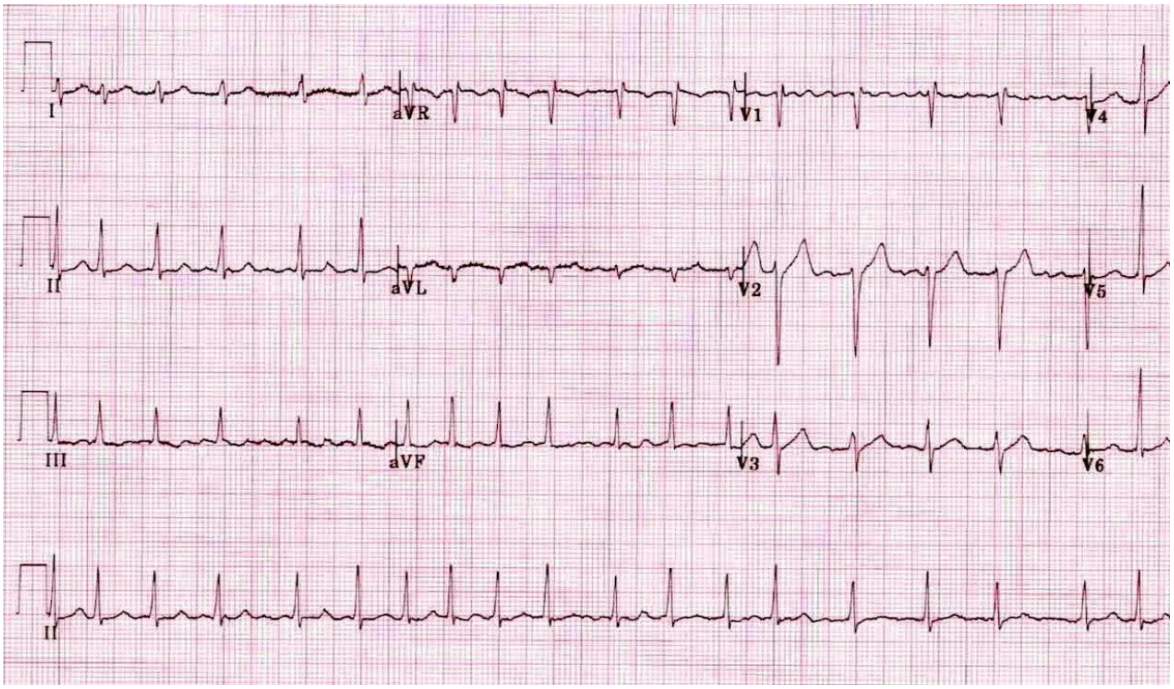
Hb	100	g/L	(130-180)
WCC	20	$x10^9$/L	(3.6-11.0)
Plt	80	$x10^9$/L	(140-400)
Na^+	136	mmol/L	(135-145)
K^+	6.2	mmol/L	(3.5-5.0)
CRP	300	mg/L	(<5)
ALT	45	U/L	(<41)
Bil	7	µmol/L	(5-21)
GGT	34	U/L	(<60)
ALP	140	U/L	(30-130)
Alb	35	g/L	(35-50)
adjusted Ca^{2+}	2.3	mmol/L	(2.2-2.6)
Phos	1.1	mmol/L	(0.8-1.5)
INR	2.7		(0.8-1.2)

Patient: Victoria Hugo
FiO_2: 21%
Sample: Arterial

Blood Gas Values						
pH	**7.350**		[	7.350 - 7.450	]	
pCO_2	**4.30**	kPa	[	4.00 - 6.50	]	
pO_2	**9.0**	kPa	[	12.0 - 15.0	]	
Acid Base Status						
HCO_3^-	**19**	mmol/L	[	22 - 28	]	
BE	**-5.0**	mmol/L	[	-3.0 - 3.0	]	
Oximetry Values						
Hb	**98**	g/L	[	135 - 175	]	
SaO_2	**90.9**	%	[	95.0 - 100.0	]	
Electrolyte Values						
K^+	**6.0**	mmol/L	[	3.5 - 5.0	]	
Na^+	**140**	mmol/L	[	135 - 145	]	
ion Ca^{2+}	**1.15**	mmol/L	[	1.10 - 1.35	]	
Cl^-	**102**	mmol/L	[	96 - 106	]	
Anion Gap	**18.0**	mmol/L	[	8.0 - 16.0	]	
Metabolic Values						
Lact	**3.0**	mmol/L	[	0.5 - 2.0	]	
Bili	**6**	µmol/L	[	-	]	

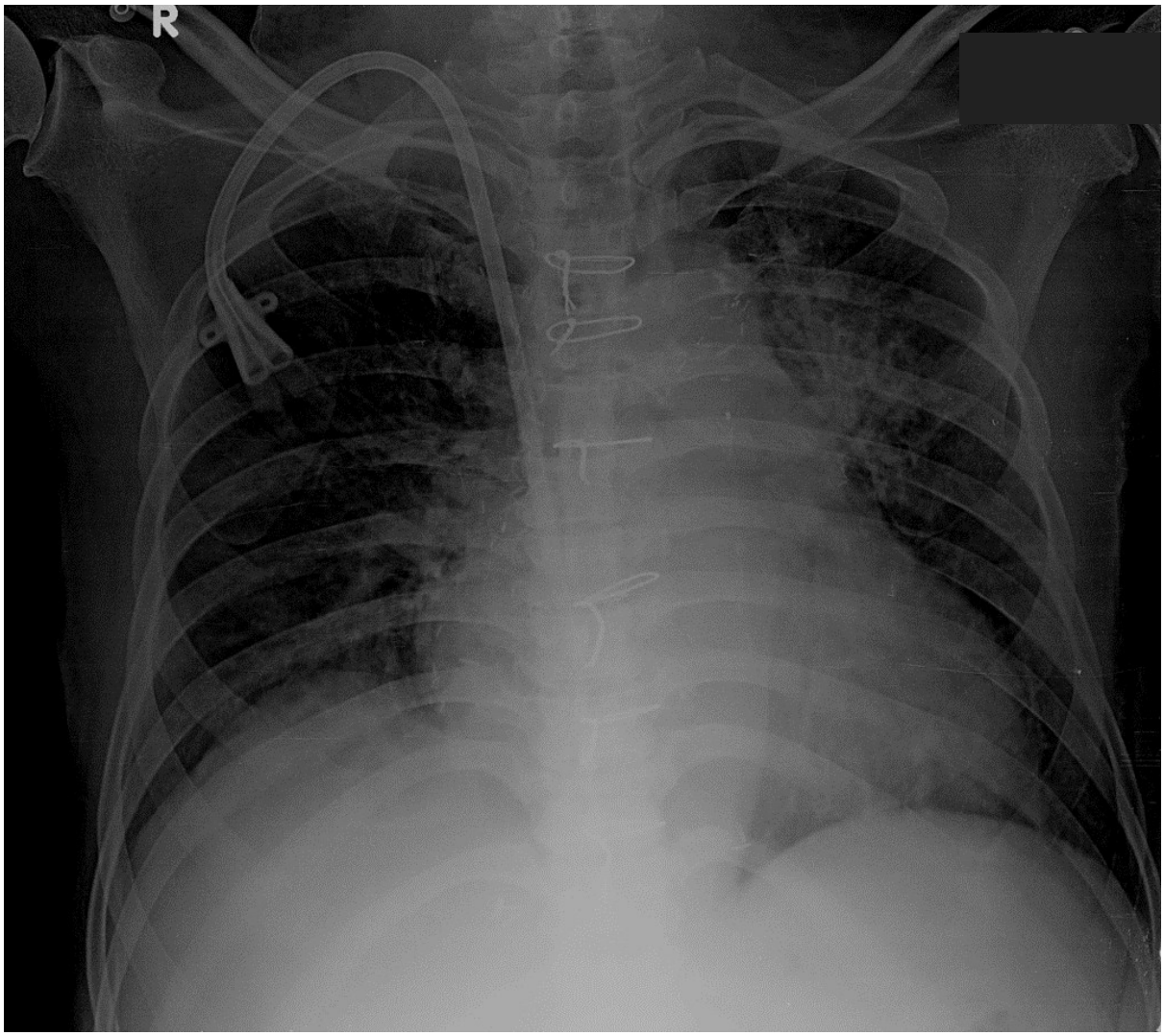
Victoria Hugo

ECG



Victoria Hugo

Chest X-ray



Clinic Letter

Victoria Hugo

67 -year-old lady

Problem list

HD since 2000, Main unit M/W/F

Failed fistula and grafts- no further fistula options

Tunnelled line since 2015

Metallic MVR- warfarin; target INR 2.5

IHD

T2DM

Lives alone, carer x1 day

DH

Warfarin

Ramipril 2.5mg od

Calcium acetate Ŧ tds

Alfacalcidol 0.25mcg

Neorecormon 2000IU twice week

NKDA

Victoria is continuing to dialyse on our main HD unit through her tunnelled line. Her interdialytic weight gain is around 2-3kg. Her blood pressures are around 130-110/90-70 on the dialysis machine, with no reports of hypotension on dialysis.

She is living alone, has a good family support and a carer once per day. She rarely leaves the house other than to attend dialysis.

Her exit site looked a little inflamed today in clinic, I have given her a 7-day course of flucloxacillin, but this needs monitoring.

Yours sincerely

Dr Sharma

Learning Points

This scenario demonstrates septic shock from line sepsis in a 67-year-old lady with difficult vascular access & no further fistula options; the scenario is further complicated as the patient is anticoagulated for a metallic mitral valve replacement.

The technical learning points from our experience were:

- Use an A to E systematic approach to structure the assessment of the acutely unwell patient. Give high flow oxygen and obtain peripheral IV access.
- Stop ultrafiltration in the presence of hypotension and give a fluid bolus on haemodialysis.
- Once sepsis has been identified, follow the sepsis 6 bundle; take central and peripheral blood cultures, a venous lactate, and ensure high flow oxygen, fluid boluses for hypotension and antibiotics in accordance with local antimicrobial guidelines are given quickly.
- Take a blood gas to ascertain potassium, bicarbonate and lactate. In this scenario the potassium was 6.2mmol/L.
- Monitor potassium levels carefully and consider giving medical treatment of hyperkalaemia as a holding measure, as the patient is too haemodynamically unstable to continue with haemodialysis.
- Involve intensive care for consideration of inotropes and haemofiltration.
- Involve the consultant nephrologist for decisions regarding timing of tunnelled line removal and discussions of ceiling of care.
- Consider coagulation with regards to removal of tunnelled line and insertion of temporary haemodialysis catheter given presence of metallic mitral valve.
- Investigate for secondary seeding, infective endocarditis (native or prosthetic), discitis, osteomyelitis.

Human factors we discussed when running this scenario:
- Professional learning/ expertise: We found that the haemodialysis nurses focused on the haemodialysis machine. They were quick to stop ultrafiltration, give fluid back, and send a spot potassium level. The doctors focused on the patient, with less attention to what was happening with respect to haemodialysis. This highlights the merit of sharing expertise in the team.
- Effective team-working: This was facilitated through the calm approach of the team, with logical thought processes & clear handovers. Expertise in the group & previous experience of this scenario made this easier.
-Suggestions were made to state aloud "we are dealing with septic shock from presumed line sepsis" to make sure everyone is clear what is happening in the scenario.

Feedback from the group was that this training scenario improved their confidence in managing septic shock on dialysis and their understanding of the skill set of their colleagues in the team.

King's Clinical Training

In Situ Dialysis Simulation Scenario

Scenario: Betty Marshall; Acute Gastrointestinal Bleed

Scenario Quick Notes

Patient name:
Betty Marshall

Clinical Headline:
Hypotension on HD

Age: 60 years

Haemodialysis since 2010 via AV graft, x3/week
TW 65kg

PMH: ESRF secondary to hypertension, myocardial infarction 6 months ago with drug eluting stent, suspended from transplant waiting list, difficult intravenous access.

DH: aspirin, clopidogrel, bisoprolol, ramipril, calcium acetate, alfacalcidol, neorecormon

SH: independent, lives with husband

Clinical learning objectives

Recognition of acutely unwell patient
Differential diagnosis of breathlessness
Acute management of major GI bleed on HD
Requests relevant investigations
Prescribes safely
Activates major haemorrhage protocol

Anticipated human factor objectives:

Communication
Effective teamwork
Leadership skills
Recognises and works within limits of personal competence

Added complexity/discussion points:

Difficult IV access, use of AV graft as access
Choice of blood products and risk of hyperkalaemia
Review of antiplatelet therapy

Expected scenario progression:

Betty Marshall is 60 years old, and has been dialysis dependent for 6 yrs. She had a myocardial infarction 6 months ago and was treated with a drug eluting stent and is currently taking dual antiplatelet therapy. She attends dialysis with shortness of breath. She thinks that she is fluid overloaded and asks the nurse to take 3 litres off.

The scenario starts one hour into haemodialysis with Betty reporting feeling breathless and anxious, with chest tightness. She is anxious something is not right. Her abdomen is feeling tender. She is

troubled by the breathlessness and dizziness, and worries she is having another heart attack. She mentions needing to open her bowels; if exposed, melaena can be seen on the sheets.

- Expect the nurse to perform an A to E assessment and administer oxygen

The machine alarms, she suddenly drops her blood pressure and has a short syncopal episode.

- The nurse should lie the patient head down, stop ultrafiltration, and give a fluid bolus "flush back" via HD. She should perform an urgent set of patient observations, fast bleep the doctor and handover using a SBAR format.
- The Doctor arrives and receives handover, then is expected to take a focused history, complete an A to E assessment, ensure the patient is receiving high flow oxygen, secure IV access, give IV fluids, and get baseline investigations (ECG/CXR/bloods). Once melaena has been identified on sheets or through the history, the doctor should identify this as hypovolemic shock from major haemorrhage, activate the major haemorrhage protocol, and refer to intensive care and the acute bleed endoscopist. Note should be taken that the patient has received LMWH heparin on dialysis and will have uraemic platelet dysfunction, therefore additional blood products should be considered, e.g. tranexamic acid/ DDAVP (desmopressin); the patient should commence an IV proton pump inhibitor (consult trust specific guidelines)
- If unable to secure other wide bore access, the graft should be used.

Faculty and participants

Faculty: minimum of three
Sim technician and patient voice, control room lead, embedded practitioner

Member of faculty trained for structured debrief plus a senior member of renal team

Participants:
2 dialysis nurses

2 doctors

Sim Set Up

Extra Props and Settings:

ECG – sinus tachycardia
Melaena on bed *(hidden under sheet)*
Drug Chart
Radiology- CXR normal

Training AED/manual defibrillator, emergency drugs, O_2, airway adjuncts/kit for intubation

Manikin Settings:

Chest equal air entry bilaterally

Initial observations 1hr into HD:

Sats	95% OA
RR	28
HR	110
BP	100/65
Temp	36.5

Non Manikin Observations:
Cap Refill: 3s
GCS: 15
BM 6.0

HD settings:

Dry weight 65kg, planned UF 3L over 4 hours
FX80 A7
Blood flow rate 300ml/min
UF 750ml/hr
Enoxaparin 20mg
Observations on arrival at HD: BP 120/80, PR 90, 66kg

Deteriorating Observations

Sats	90% OA
RR	40
HR	140
BP	80/52
Temp	36.5
GCS	13

Improving Observations

Sats	98% 15L
RR	24
HR	100
BP	110/70
Temp	36.5
GCS	15

Peri-arrest Observations

Sats	90% 15L
RR	15
HR	150
BP	75/40
Temp	37
GCS	11

Participant Briefing: to Dialysis Nurse

You are called to see Betty on haemodialysis to give assistance to the junior dialysis nurse as Betty is breathless with chest tightness. Betty attended her routine dialysis 1kg above her dry weight and was very breathless. She thought it was fluid overload (as she has been trying to lose weight); she is having 3 litres removed over her 4 hour HD session.

Control Room Lead Briefing

The aim of this scenario is to identify a large GI bleed in a patient who presents with symptoms of breathlessness and chest tightness. The patient attributes her symptoms to being "fluid overloaded", she is later concerned she is having another heart attack, although she says, "it feels different to my last heart attack". She has been having some dyspepsia & dark, tarry stool but will only admit this if asked about eating or her bowel habit.

The patient goes on to have a further large upper GI bleed with associated hypotension and a short syncopal episode. The team should treat in a systematic A to E approach, and administer high flow oxygen and intravenous fluid until blood is available. The haemodynamic instability and melaena should prompt the participant to organise emergency blood, activate the major haemorrhage protocol and contact the haematology/transfusion team to discuss the need for other blood products. HD should be stopped, although blood can be given via the needle in her graft. Care should be escalated to intensive care and an OGD performed when the patient is haemodynamically stable. Intravenous PPI may be considered, refer to specific trust guidelines and likely timing of OGD. If treated appropriately, the patient will stabilise (and clinical observations, heart rate and blood pressure will improve). If not treated appropriately, the patient will continue to deteriorate and have a PEA cardiac arrest.

Patient Voice Briefing

You are breathless- you had asked for fluid to be removed as you thought you were fluid overloaded. You say you have been losing flesh weight.

You complain of feeling dizzy and light headed. Your chest is feeling tight and you are worried you are having another heart attack, but it feels different to your previous heart attack. You are very anxious.

If asked about your bowels- you have been getting some indigestion and your bowels have been loose, dark and offensive, your abdomen has been bloated.

When asked about medication you should inform the team that you are taking aspirin and clopidogrel. You have been on it since your heart attack and stent insertion 6 months ago. You were told you needed to continue both these drugs for a year.

You then have a large rectal bleed, with fresh melaena- you say you need to open your bowels and can't control it, and have a syncopal episode; you regain consciousness following a fluid challenge but you remain hypotensive and drowsy.

Embedded Practitioner Briefing

You are the junior dialysis nurse. Betty came to haemodialysis a bit breathless. She was 1kg above her dry weight, and you are in the process of removing 3L UF as Betty directed. Her pre dialysis blood pressure was 120/80. One hour into Betty's dialysis you call the team for assistance as Betty is complaining of feeling dizzy and breathless.

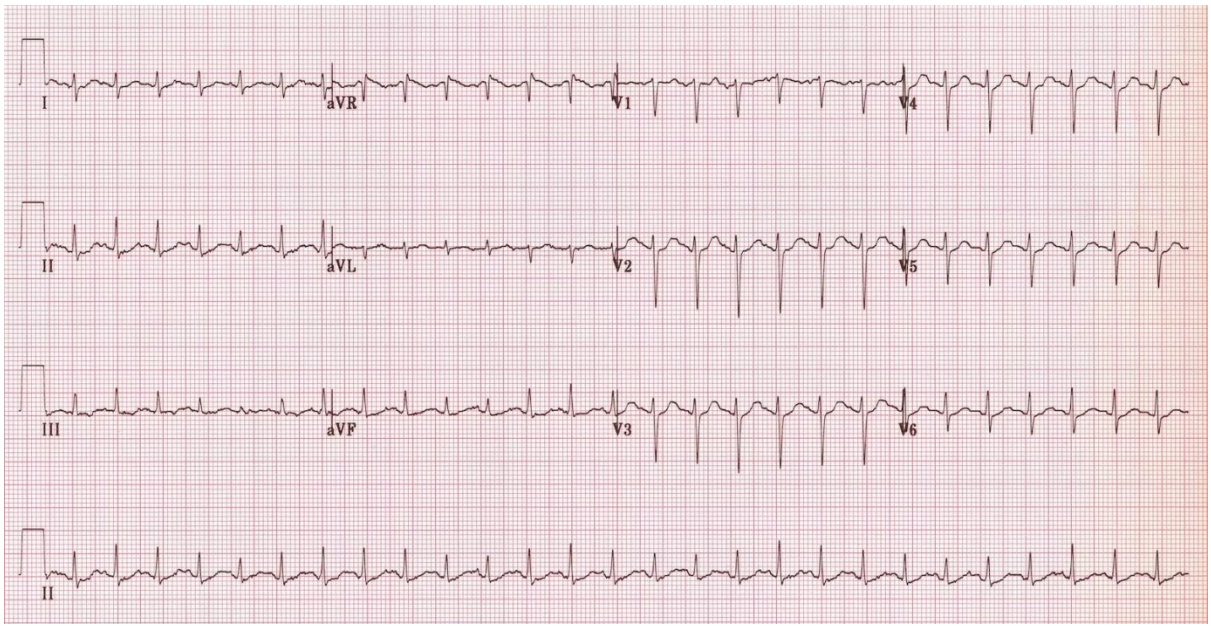
Patient: Betty Marshall
FiO_2: 21%
Sample: Arterial

Blood Gas Values						
pH	**7.431**		[7.350	-	7.450	]
pCO_2	**4.30**	kPa	[4.00	-	6.50	]
pO_2	**12.0**	kPa	[12.0	-	15.0	]
Acid Base Status						
HCO_3^-	**21**	mmol/L	[22	-	28	]
BE	**-4.3**	mmol/L	[-3.0	-	3.0	]
Oximetry Values						
Hb	**50**	g/L	[135	-	175	]
SaO_2	**98.9**	%	[95.0	-	100.0	]
Electrolyte Values						
K^+	**5.6**	mmol/L	[3.5	-	5.0	]
Na^+	**140**	mmol/L	[135	-	145	]
ion Ca^{2+}	**1.15**	mmol/L	[1.10	-	1.35	]
Cl^-	**102**	mmol/L	[96	-	106	]
Anion Gap	**17.0**	mmol/L	[8.0	-	16.0	]
Metabolic Values						
Lact	**2.0**	mmol/L	[0.5	-	2.0	]
Bili	**6**	µmol/L	[	-		]

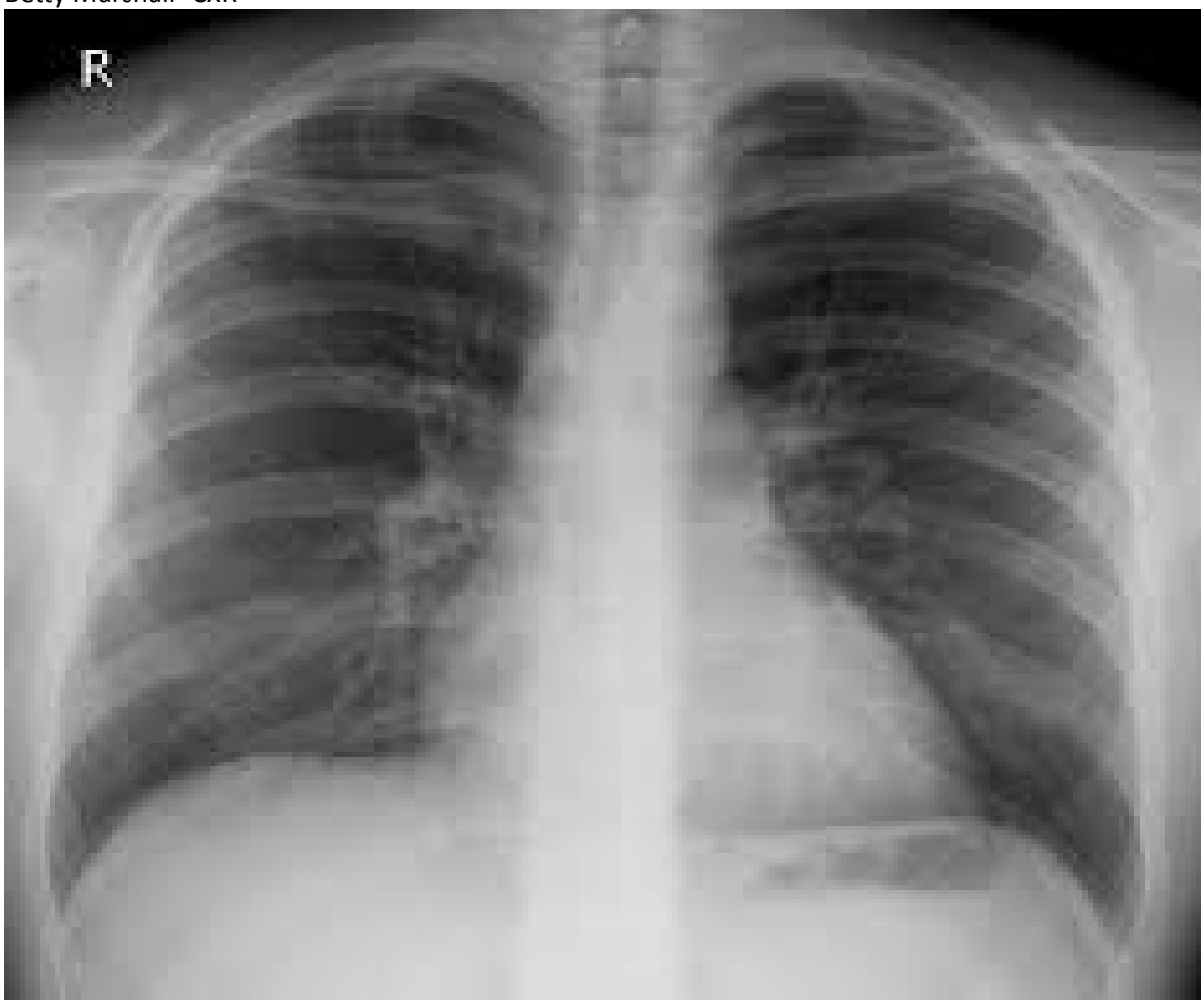
Patient: Betty Marshall
FiO_2: 90%
Sample: Arterial

Blood Gas Values						
pH	**7.431**		[	7.350	- 7.450	]
pCO_2	**4.30**	kPa	[	4.00	- 6.50	]
pO_2	**20.0**	kPa	[	12.0	- 15.0	]
Acid Base Status						
HCO_3^-	**21**	mmol/L	[	22	- 28	]
BE	**-4.3**	mmol/L	[	-3.0	- 3.0	]
Oximetry Values						
Hb	**50**	g/L	[	135	- 175	]
SaO_2	**99.0**	%	[	95.0	- 100.0	]
Electrolyte Values						
K^+	**5.6**	mmol/L	[	3.5	- 5.0	]
Na^+	**140**	mmol/L	[	135	- 145	]
ion Ca^{2+}	**1.15**	mmol/L	[	1.10	- 1.35	]
Cl^-	**102**	mmol/L	[	96	- 106	]
Anion Gap	**17.0**	mmol/L	[	8.0	- 16.0	]
Metabolic Values						
Lact	**2.0**	mmol/L	[	0.5	- 2.0	]
Bili	**6**	µmol/L	[		-	]

Betty Marshall
ECG



Betty Marshall- CXR



Clinic Letter

Betty Marshall

60 -year-old lady

Problem list

HD since 2010, Main unit M/W/F via AV graft, TW 65 kg

ESRF secondary to HTN

MI 6 months ago- primary PCI with drug eluting stent

Difficult IV access

Suspended on transplant waiting list

DH

Aspirin 75mg od

Clopidogrel 75mg od

Bisoprolol 5mg od

Ramipril 2.5mg od

Calcium acetate Ṫ tds

Alfacalcidol 0.25mcg od

Neorecormon 2000 IU three times week

Betty continues to have dialysis on our main HD unit via her graft. Interdialytic weight gain is generally less than 1kg. Her blood pressure has been well controlled, haemoglobin, potassium and phosphate control are on target and dialysis is uneventful.

Unfortunately, we have had to suspend Betty from the transplant waiting list following her myocardial infarction 6 months ago, for which she is on dual antiplatelet therapy following her drug eluting stent, but we can review this in 6 months' time when we can cut down to a single antiplatelet drug.

We will review her in 2 months' time.

Yours sincerely

Dr Sharma

Learning Points

This scenario depicts an acute GI bleed in a 60-year-old lady, which masquerades as angina with symptoms of chest tightness and breathlessness. Only on full exposure is PR blood loss seen.

The technical learning points are:
- Dialysis nurses do routinely ask about occult blood loss prior to starting HD and using heparin in the circuit. This may have triggered the history of melaena that Betty only reports on direct questioning.
- Management of a GI bleed in a patient on HD (note she is on dual antiplatelet therapy with drug eluting stent) and haemodynamically unstable:
    -Give high flow oxygen, 15L
    -Give IV fluid while organising emergency blood. Flying squad O negative blood is found in the fridge in the emergency department, theatres and maternity. Activate the Code red (massive haemorrhage protocol) by calling 2222 and ask for code red giving your location. This will bring a porter. Code red brings 4 units of O negative blood and 4 units FFP, blood from this point on will be cross matched. *Consult local trust guidelines as this varies across trusts.*
- Discuss the scenario with haematology- consider transfusion of platelets, cryoprecipitate, tranexamic acid and DDAVP in addition to blood and coagulation factor replacement. Platelets and cryoprecipitate will need to be specifically requested (platelets likely to be dysfunctional given uraemia and dual antiplatelet use)
- Monitor fluid balance and potassium levels carefully with the large transfusions of blood products
- Start an intravenous proton pump inhibitor
- Involve intensive care for haemodynamic support, transfer for endoscopy and admission to the intensive care unit.
- Future discussions will be needed with cardiology for advice on whether antiplatelet therapy can be reduced. Normally only a single antiplatelet agent is used from 6 months.

Human factors: *From our experience running this scenario*
- We discussed cognitive bias: in this lady, with recent MI complaining of breathlessness and chest tightness, immediate thoughts were that this was an MI or pulmonary oedema. There is a risk of trying to fit the examination findings and investigations to confirm this picture. When we ran this scenario, it was only when the patient did not respond to initial treatment for pulmonary oedema/MI and the normal ECG and CXR appearance were noted, that the low haemoglobin on the blood gas (Hb 50g/L) was identified. This then prompted full exposure of the patient revealing melaena on the sheets.
- Dealing with stress: doctors were less familiar with the environment on the haemodialysis unit, how to manage emergencies in a patient on haemodialysis and where to find emergency equipment. This increased stress. Strategies to help were to go back to a systematic A to E approach, and to voice thought processes to engage the help of the MDT, some of whom are more familiar with the local environment and managing a patient on HD.
- Communication and diagnostic uncertainty: we discussed the benefits of thinking aloud and summarising information gathered at appropriate time points. We discussed how it can be easier to manage the arrested patient, as there is a clear protocol that everyone is aware of. When this doesn't exist, “thinking aloud” ensures all the team know what is going on and it makes it easier for other team members to feel empowered to add any relevant information.
- Importance of A to E assessment to ensure that a full assessment is carried out. In the situation where the focus is on treating “C” (circulation), completing the rest of the A to E assessment can be delegated to another team member. If this had been performed earlier in the scenario, the PR bleed may have been picked up sooner.

Feedback from the group was that the training increased their confidence of managing an acute GI

bleed on haemodialysis, increased their understanding of the skill set of their colleagues and improved their knowledge of the location of emergency equipment on the haemodialysis unit.

King's Clinical Training

In Situ Dialysis Simulation Scenarios

Scenario: Carla Williams; Anaphylaxis

Scenario Quick Notes

Patient name:
Carla Williams

Clinical Headline:
Anaphylactic reaction secondary to dialysis membrane

Age: 28 years

Background:
Haemodialysis since 2015 via AVF x3/week, TW 60kg

PMH*:* ESRF secondary to anti GBM disease 2015, asthma, active on the transplant waiting list

DH: ramipril, calcium acetate, IV iron, salbutamol inhaler prn, NKDA

SH: Hairdresser, lives with fiancée, recent ex-smoker

Clinical learning objectives:
Recognition of acutely unwell patient
Recognition of anaphylaxis
Recognition of cause of anaphylaxis likely to be the dialysis membrane; relevance of cause
Treatment of anaphylaxis
Management of respiratory/cardiac peri-arrest
Early intensive care involvement

Anticipated human factor objectives:
Communicates clearly in a variety of settings
Works effectively as a team member
Demonstrates leadership skills
Forward planning and escalation

Expected scenario progression:
Carla, a 28-year-woman, is well on arrival to her routine haemodialysis session. She is 2 kg above her target weight and a 2L UF is planned. She has been attached to a new dialysis machine. 5 minutes into dialysis she feels flushed, breathless, and rapidly progresses to stridor, has difficulty breathing, and desaturates with cardiovascular collapse. The participants should identify this as anaphylaxis, stop dialysis and disconnect her from the machine; no flush back should be given through the machine; however the arterial needle can be used for access. If a fluid bolus is administered through the dialysis machine, or if the venous needles are used at any point during the scenario she will deteriorate further. An A to E assessment should be done and 500 mcg 1:1000 intramuscular adrenaline should be given at the earliest opportunity and without delay if anaphylaxis is suspected; high flow 15L oxygen should also be administered, as well as intravenous fluid (through different access or through arterial needle only), 10mg chlorphenamine and 200mg IV hydrocortisone. A repeat dose of adrenaline 500mcg IM can be given after 5 minutes. Clinical improvement only occurs with delivery of the adrenaline and the scenario proceeds to PEA cardiac arrest if adrenaline is not initiated.

Faculty and participants

Faculty: minimum of three	*Participants:*
Sim technician and patient voice, control room lead, embedded practitioner	2 dialysis nurses
Member of faculty trained for structured debrief plus a senior member of renal team	2 doctors

Sim Set Up

Extra Props and Settings

ECG: Sinus tachycardia
Drug chart
ABG
Clinic Letter

Training AED/manual defibrillator Emergency drugs/O_2/kit for intubation and airway adjuncts

Manikin Settings

Chest: initially has a wheeze bilaterally

Initial Observations:

Sats	98% room air
RR	20
HR	90
BP	125/75
Temp	36.5

Non Manikin Observations:
Cap Refill: <2s
GCS: E4V5M6
BM 6.0

HD settings:

Dry weight 60 kg, planned 2L UF over 4 hours
FX80 A7
Blood flow rate 300ml/min
UF 500ml/hr
Enoxaparin 20mg
Observations on arrival at HD: BP 130/80, HR 60, 62kg

Participant Briefing: to Dialysis Nurse

Carla is well on attending her routine dialysis. She is using a new dialysis machine. A few minutes into her session she complains of feeling dizzy and breathless. You are called by the junior dialysis nurse to help.

Control Room Lead Briefing: Up to 10 minute scenario.

1-2mins: Initial observations normal (see above).

2-5mins:
A – Worsening stridor
B - RR increases to 26, bilateral wheeze, SaO_2 reduced to 92%
C – HR increases to 130, BP initially maintained
D – GCS 15/15
E – Nil

5-7mins: ***If IM 500mcg of 1:1000 adrenaline, high flow oxygen, hydrocortisone and chlorphenamine administered, and the patient taken off dialysis***
A – Improving stridor
B – Improving wheeze. RR 20-25. SaO2 98% if on O_2 via a non rebreathe mask (NRBM)
C – HR 140, No change in BP.
D – GCS 15/15
E – Nil

5-7mins: ***If adrenaline not administered, or fluid bolus given from dialysis machine:***
A – Apnoea
B – Apnoea, SaO_2 reduced to 30% despite O_2, (if the patient is manually ventilated, SaO_2 will increase to maximum of 85% but chest compliance is poor).
Chest compliance improves and SaO_2 increases to 95% only if anaphylaxis protocol drugs given
C – HR140, BP 60/20,
D – GCS E1V1m1, Pupils 3+/3+
E – Nil

7-10mins: ***if medications for anaphylaxis given correctly, and iv fluid boluses given not via dialysis membrane or venous needle:***
A – Stridor resolves
B – Breathing improves, RR 20, SaO_2 99% on O_2, (Wheeze resolves if bronchodilator given)
C – HR 100, BP 130/70, Normal cap refill
D – GCS 15/15, calm
E – Nil

7-10mins: ***If adrenaline not administered or fluid bolus given via dialysis machine:***
A – Apnoea
B – Apnoea, No SaO_2 monitor pick up
C – Bradycardia leading to PEA cardiac arrest
D – GCS 3/15, pupils 3+/3+
E – Nil

8-10mins: ***If cardiac arrest appropriately managed (i.e. CPR + IV 1mg 1:10000 adrenaline)***
A – Apnoea
B – Apnoea, SaO_2 92% if bag valve mask (BVM) ventilation with O_2
C – ROSC with HR 120, BP 110/70
D – GCS 3/15 Pupils 4+/4+
E – Nil

Patient Voice Briefing
Initially:
A – Itchy throat, able to speak in full sentences
B – No difficulty in breathing
C – N/A
D – GCS 15/15, but frightened- is this her asthma? If asked, she has taken all her normal medications. She didn't have IV iron today. The participants are able to take a brief history from her.

2-3 mins
A – Stridor
B – Difficulty in breathing and speaking
C – N/A
D – GCS 15/15, increasingly agitated
E – Nil

3-5mins
A – Increasing stridor, unable to verbalise
B – N/A
C – N/A
D – E4V2M6, only able to make incomprehensible sounds
E – Nil

5-7mins: ***If adrenaline, high flow oxygen, hydrocortisone and chlorphenamine administered :***
A – Improving stridor
B – Able to speak single words
C – N/A
D – E4V5M6, able to speak single words only
E – Nil

5-10mins: ***If adrenaline not administered:***
A – Apnoea
B – Apnoea
C – N/A
D – GCS E1V1M1
E – Nil

Embedded Practitioner Briefing
You are a junior nurse and you call your nursing colleagues for help. Carla was well before commencing HD but a few minutes into the session she started to complain of feeling breathless and dizzy. It is a new dialysis machine.
If asked, there have been no recent changes to her medications; she has no known allergies.
You are helpful and competent in following instructions, e.g. to stop dialysis, provide oxygen (they should specify the delivery device), retrieve drugs and deliver chest compressions.

Further Reading

Ebo D G, et al. "Haemodialysis-associated anaphylactic and anaphylactoid reactions." *Allergy* 61.2 (2006): 211-220.
https://www.resus.org.uk/EasySiteWeb/GatewayLink.aspx?alId=824

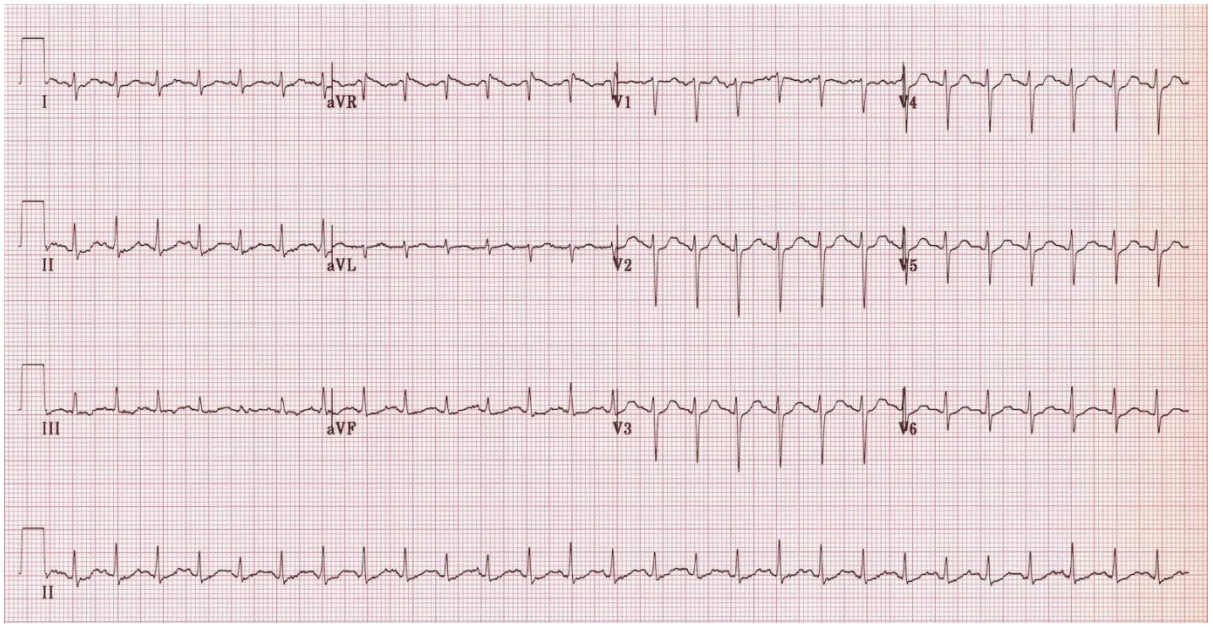
Patient: Carla Williams
90%
Sample: Arterial

Blood Gas Values						
pH	**7.344**		[	7.350 - 7.450		]
pCO_2	**5.50**	kPa	[	4.00 - 6.50		]
pO_2	**12.0**	kPa	[	12.0 - 15.0		]
Acid Base Status						
HCO_3^-	**22**	mmol/L	[	22 - 28		]
BE	**-1.9**	mmol/L	[	-3.0 - 3.0		]
Oximetry Values						
Hb	**100**	g/L	[	135 - 175		]
SaO_2	**98.2**	%	[	95.0 - 100.0		]
Electrolyte Values						
K^+	**4.2**	mmol/L	[	3.5 - 5.0		]
Na^+	**140**	mmol/L	[	135 - 145		]
ion Ca^{2+}	**1.15**	mmol/L	[	1.10 - 1.35		]
Cl^-	**102**	mmol/L	[	96 - 106		]
Anion Gap	**16.0**	mmol/L	[	8.0 - 16.0		]
Metabolic Values						
Lact	**2.3**	mmol/L	[	0.5 - 2.0		]
Bili	**6**	µmol/L	[	-		]

Patient:	Carla Williams
	90%
	CARDIAC
	ARREST
Sample:	Arterial

Blood Gas Values						
pH	**7.204**		[	7.350 - 7.450	]	
pCO_2	**7.60**	kPa	[	4.00 - 6.50	]	
pO_2	**6.0**	kPa	[	12.0 - 15.0	]	
Acid Base Status						
HCO_3^-	**14**	mmol/L	[	22 - 28	]	
BE	**-4.3**	mmol/L	[	-3.0 - 3.0	]	
Oximetry Values						
Hb	**100**	g/L	[	135 - 175	]	
SaO_2	**62.2**	%	[	95.0 - 100.0	]	
Electrolyte Values						
K^+	**4.2**	mmol/L	[	3.5 - 5.0	]	
Na^+	**140**	mmol/L	[	135 - 145	]	
ion Ca^{2+}	**1.15**	mmol/L	[	1.10 - 1.35	]	
Cl^-	**102**	mmol/L	[	96 - 106	]	
Anion Gap	**16.0**	mmol/L	[	8.0 - 16.0	]	
Metabolic Values						
Lact	**4.3**	mmol/L	[	0.5 - 2.0	]	
Bili	**6**	µmol/L	[	-	]	

Carla Williams
ECG



Clinic Letter

Carla Williams

28-year-old lady

DH

Ramipril 2.5mg od

Calcium acetate ŧ tds

Alfacalcidol 0.25mcg

IV iron

Salbutamol inhaler

NKDA

Problem list

HD since 2015 on main unit M/W/F via AVF, TW 60 kg

ESRF secondary to anti GBM disease

Asthma

Active on transplant waiting list

Carla is continuing to have dialysis on our main dialysis unit through her fistula. She is doing well. Her blood pressure is well controlled, and she has minimal interdialytic weight gain. Her haemoglobin and phosphate / PTH are all within target range and potassium well controlled.

She is working as a hairdresser and is active on the transplant waiting list.

We will review her in 2 months' time.

Yours sincerely

Dr Scott

Learning Points

Anaphylaxis on dialysis is a rare but life-threatening event, quoted as occurring in around 1 in 12000 dialysis sessions (Ebo DG et al, 2006). Recognised culprits include chemicals used to sterilise the dialysis membranes (particularly ethylene oxide), the dialysis membrane itself (particularly the high flux polyacylnitrile membrane), or reaction to heparin or iron if given on dialysis.

If suspecting anaphylaxis, stop HD and do not give fluid back from the dialysis machine. Treatment initiated early with adrenaline is imperative (IM 1:1000 0.5mg), and IV hydrocortisone and chlorphenamine as well as high flow oxygen should also be given.

The learning points were:

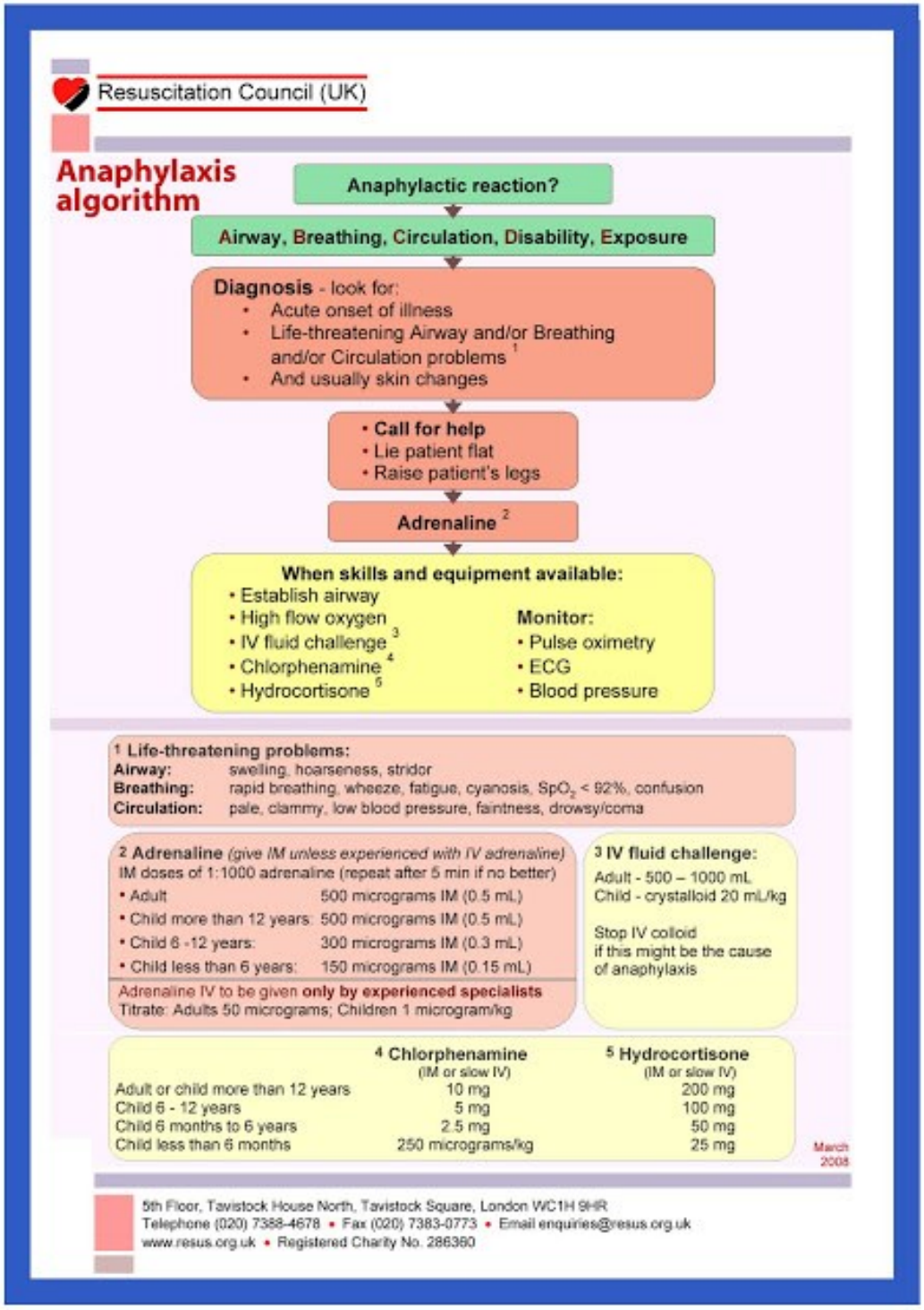
- Consider the time frame: in this scenario the patient was entirely well on starting her routine HD using a new dialysis membrane and became symptomatic soon after starting dialysis. When we ran this scenario, when fluid was given back from the dialysis machine in response to hypotension, there was a sudden further deterioration with hypoxia and worsening hypotension leading to cardiac arrest. Here, attention to the time line of events is key to making the diagnosis; it is this sequence of events which is often missed when teams arrive later in the emergency and it highlights the importance of clearly communicating this information.

- Information is often not taken on board when in a stressed, high pressured situation. Appreciate the fact that whoever has joined the team will be making a visual assessment at the same time as listening to the verbal handover, so key information may need to be repeated. Try and make the handover succinct and headline the most important information.

- Supporting the leader was discussed. This may be through empowering them to lead; this was seen during our scenario with “let me perform chest compressions so you can stand at the end of the bed”, and members of the team volunteering “I am bringing the crash trolley”, “I will call the arrest team”.

- How to make best use of the team was discussed, for example by allocating people according to their skills, which can free up the team leader to stand back and have an overview of the situation.

Feedback from the group was that everyone found it very helpful. Comments included: “A very realistic scenario”; “Good to have practise in managing a stressful, time pressured situation”; “Good to learn with the multidisciplinary team”.



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King's Clinical Training

In Situ Dialysis Simulation Scenario

Scenario: Evelyn Reid; Cardiogenic Shock

Scenario Quick Notes

Patient name:
Evelyn Reid

Age: 67 years

Clinical Headline:
Cardiogenic shock, ventricular tachycardia with haemodynamic compromise leading to cardiac arrest

Background:
Haemodialysis since 2005 via AVF x3/week, TW 45 kg

PMH: ESRF secondary to HTN,
IHD, previous myocardial infarction,
poor LV function & diastolic dysfunction, EF 30%

DH: aspirin, bisoprolol, ramipril, calcium acetate, alfacalcidol, neorecormon

SH: Lives in a warden controlled retirement home with husband, husband main carer, only leaves flat for dialysis.

Clinical learning objectives:

Recognition of the acutely unwell patient
Recognition of haemodynamically unstable ventricular tachycardia & cardiogenic shock
Identification of need for cardioversion, with synchronised DC cardioversion and gives IV amiodarone, corrects electrolyte abnormalities such as hyperkalaemia.
Treats cardiac arrest as per shockable rhythm

Anticipated human factor objectives:

Communication
Teamwork
Leadership
Escalation
SBAR handover
Knowledge of location of emergency resources

Expected scenario progression:

Evelyn has come for haemodialysis; she arrives 3kg above her TW and is breathless. The junior dialysis nurse plans to remove 3L over the 4 hour session. Evelyn's blood pressure is 95/50 on arrival, within her normal range.
The scenario starts ½ hr into her dialysis session; Evelyn complains of feeling dizzy and tired and the machine alarms due to low blood flows. Her blood pressure drops further, and she is tachycardic at a rate of 180.
Nurse expected to perform A to E assessment, give high flow oxygen, put the bed head down, stop

UF and administer a fluid bolus on dialysis; she should press the emergency alarm/ call for help. Nurse 2 arrives and should be instructed to fast bleep the doctor (or put out a cardiac arrest call); she, in partnership with nurse 1, is expected to bring the crash trolley and attach the patient to the defibrillator.
The doctor arrives (cardiac arrest team, if requested, do not come at this point); the doctor should repeat an A to E assessment, and ensure the patient is on high flow oxygen. The patient will have normal saturations on high flow oxygen but is tachycardic, hypotensive and confused, GCS 13, with normal blood sugars. Bilateral crackles are found on chest auscultation. A broad complex tachycardia will be seen on the cardiac monitor. IV access should be secured and an ABG should be taken which shows she is hyperkalaemic. Medical treatment for hyperkalaemia should be given: calcium gluconate and iv insulin/ dextrose. The team should recognise that this is haemodynamically unstable VT and call the anaesthetist/cardiac arrest team to perform synchronised cardioversion. If a manual defibrillator is available, then the team should proceed to perform 3 synchronised shocks as the patient is peri-arrest with reduced consciousness and is too unstable to warrant delay for sedation. Alternatively, whilst waiting for the anaesthetist/cardiac arrest team, amiodarone should be administered through a wide bore cannula or through the needled fistula. Prior to the anaesthetist or the cardiac arrest team arriving, the patient arrests. The shockable arm of the cardiac arrest algorithm should be followed. If the cardiac arrest is well managed, after x3 cycles with shock and administration of IV adrenaline, the patient will achieve return of spontaneous circulation (ROSC). The scenario ends with the arrival of the crash team.

Faculty and participants

Faculty: minimum of three	*Participants:*
Sim technician and patient voice, control room lead, embedded practitioner	2 nurses
Member of faculty trained for structured debrief plus a senior member of renal team	2 doctors: preferably 1 SHO and 1 registrar

Sim Set Up

Extra Props and Settings:

ECG: broad complex tachycardia
Radiology: CXR shows cardiomegaly/pulmonary oedema
ABG
Clinic letter/ Echo result

Training AED/manual defibrillator
Emergency drugs/O2/ kit for intubation

Manikin Settings:

Chest: bilateral crackles
Initial Observations
½ hour into dialysis:

Sats	92%
RR	26
HR	180-200
BP	80/50
Temp	37.0

Non Manikin Observations:
Cap Refill: 3s
GCS: 13 (E3, V4, M6)
BM 6

HD Settings:

Dry weight 45kg, planned UF 3L over 4 hours
FX80 A7
Blood flow rate 300ml/min
UF 750ml/hr
Enoxaparin 20mg
Observations on arrival at HD: BP 95/50, HR 90, weight 48kg

Initial observations ½ hour into dialysis

Sats	92% (On air)
RR	26
HR	180-200
BP	80/50
Temp	37.0
GCS	13
BM	6

Observations post 250 ml fluid

Sats	98% (15 L)
RR	28
HR	180
BP	85/50
Temp	37
GCS	12
BM	6

Peri-arrest Observations

Sats	98% (15L)
RR	40
HR	200
BP	65/40
Temp	37
GCS	9
BM	6

Participant Briefing: to Dialysis Nurses

You are called by the junior dialysis nurse to see Evelyn. She is a 67-year-old lady with ischaemic heart disease and has been on dialysis for 12 years. She struggles with fluid restriction, and she often drops her blood pressure on HD. She came today 3 kg above her target weight. The dialysis machine is set to remove 3L of UF over 4 hours. Evelyn is 1/2 hour into the dialysis session and you are asked to help as Evelyn is feeling dizzy.

Control Room Lead Briefing

This scenario is designed to practise the management of haemodynamically unstable ventricular tachycardia and cardiogenic shock which progresses to cardiac arrest, shockable rhythm. The scenario starts with Evelyn in extremis with ventricular tachycardia, she is hypotensive and confused. The team should recognise that this requires DC synchronised cardioversion. This requires a manual defibrillator (often only AED present on dialysis units), and likely sedation with an anaesthetist present; the fastest way of getting an anaesthetist and a manual defibrillator is by calling the cardiac arrest team. The team should administer high flow oxygen and give a fluid bolus for hypotension (cautiously as there is evidence of pulmonary oedema). She should be attached to the defibrillator for cardiac monitoring. Hyperkalaemia should be identified through an ABG/spot K and medically treated. IV amiodarone should also be given if there is a delay in synchronised cardioversion. However, before arrival of the anaesthetist or the cardiac arrest team she arrests – it is a shockable rhythm. Treat as per shockable rhythm and, if successfully managed, return of spontaneous circulation, (ROSC) is achieved after 3 cycles.

Patient Voice Briefing

You are confused and feel dizzy, tired and breathless. You speak only on direct questioning, managing a few words at a time. Later in the scenario you become unresponsive.

Embedded Practitioner Briefing

You are the junior dialysis nurse. You are helpful but not experienced. Evelyn came to dialysis with a BP 95/50 (her normal blood pressure), HR 90, sats 94% OA. She was a bit dizzy and breathless on arrival. She is 3 kg above her target weight and you plan to remove 3L over her 4 hour session. The scenario starts ½ hour into Evelyn's dialysis with the machine alarming and the patient reporting dizziness.

Technical Points for discussion:

- Approach to intradialytic hypotension, how to safely provide UF in a patient with hypotension
- Management of arrhythmias and risk factors for arrhythmias on HD
- Discussion with cardiology team regarding further management including consideration of implantable cardioverter-defibrillator (ICD)
- Suitability for long term HD/RRT

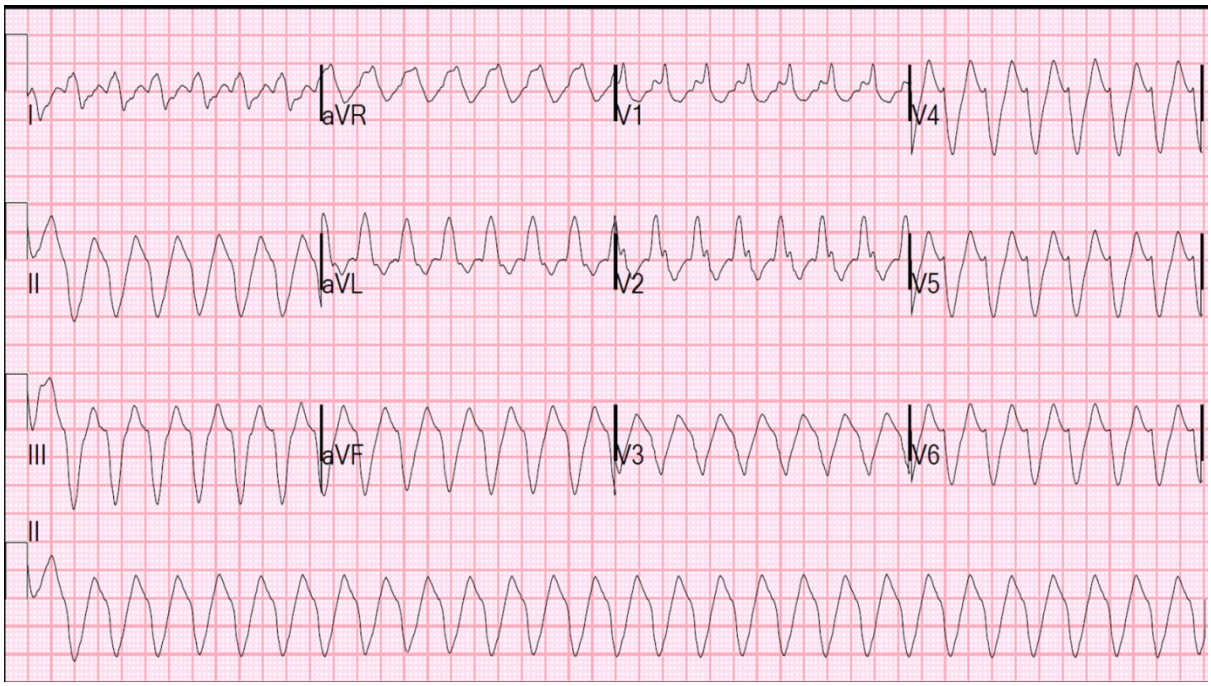
Patient: Evelyn Reid
FiO_2: 21%
Sample: Arterial

Blood Gas Values						
pH	**7.431**		[	7.350 -	7.450	]
pCO_2	**4.30**	kPa	[	4.00 -	6.50	]
pO_2	**7.5**	kPa	[	12.0 -	15.0	]
Acid Base Status						
HCO_3^-	**21**	mmol/L	[	22 -	28	]
BE	**-4.3**	mmol/L	[	-3.0 -	3.0	]
Oximetry Values						
Hb	**95**	g/L	[	135 -	175	]
SaO_2	**91.7**	%	[	95.0 -	100.0	]
Electrolyte Values						
K^+	**6.9**	mmol/L	[	3.5 -	5.0	]
Na^+	**140**	mmol/L	[	135 -	145	]
ion Ca^{2+}	**1.15**	mmol/L	[	1.10 -	1.35	]
Cl^-	**102**	mmol/L	[	96 -	106	]
Anion Gap	**17.0**	mmol/L	[	8.0 -	16.0	]
Metabolic Values						
Lact	**4.0**	mmol/L	[	0.5 -	2.0	]
Bili	**6**	µmol/L	[	-		]

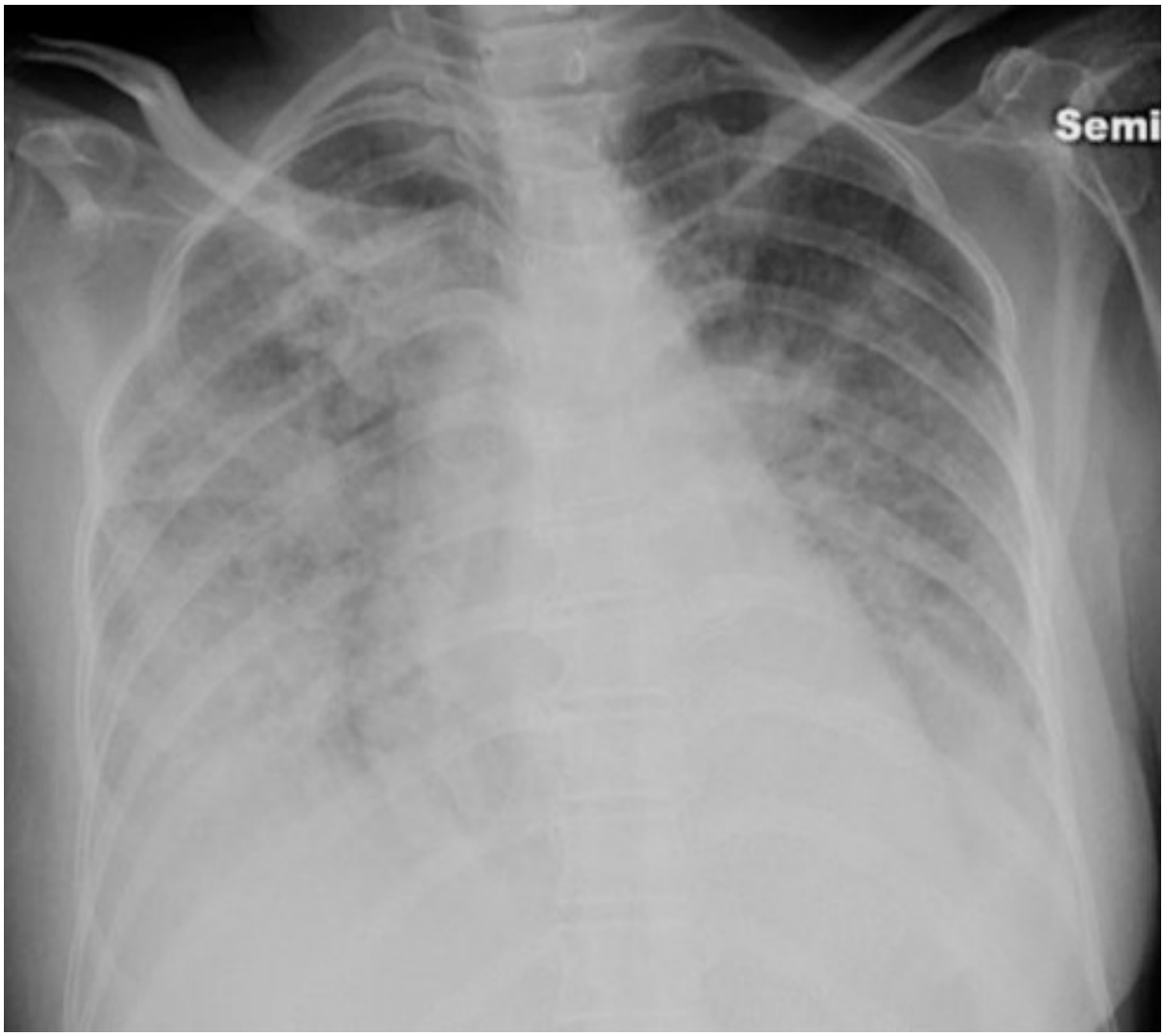
Patient: Evelyn Reid
FiO_2: 90%
Sample: Arterial

Blood Gas Values						
pH	**7.431**		[	7.350 -	7.450	]
pCO_2	**4.30**	kPa	[	4.00 -	6.50	]
pO_2	**10.0**	kPa	[	12.0 -	15.0	]
Acid Base Status						
HCO_3^-	**21**	mmol/L	[	22 -	28	]
BE	**-4.3**	mmol/L	[	-3.0 -	3.0	]
Oximetry Values						
Hb	**95**	g/L	[	135 -	175	]
SaO_2	**98.0**	%	[	95.0 -	100.0	]
Electrolyte Values						
K^+	**6.9**	mmol/L	[	3.5 -	5.0	]
Na^+	**140**	mmol/L	[	135 -	145	]
ion Ca^{2+}	**1.15**	mmol/L	[	1.10 -	1.35	]
Cl^-	**102**	mmol/L	[	96 -	106	]
Anion Gap	**17.0**	mmol/L	[	8.0 -	16.0	]
Metabolic Values						
Lact	**4.0**	mmol/L	[	0.5 -	2.0	]
Bili	**6**	µmol/L	[	-		]

Evelyn Reid
ECG



Evelyn Reid- Chest X-ray



Clinic Letter

Evelyn Reid

67-year-old lady

Problem list

HD since 2005 on main unit M/W/F via AVF, TW 45 kg

ESRF secondary to HTN

IHD, previous MI

Poor LV function EF 30%, diastolic dysfunction

Lives in warden controlled flat

DH

Aspirin 75mg od

Bisoprolol 1.25mg od

Ramipril 2.5mg od

Calcium acetate † tds

Alfacalcidol 0.25mcg od

Neorecormon 2000 IU three times week

NKDA

Evelyn is continuing to have dialysis on our main haemodialysis unit via her fistula. Her interdialytic weight gain is around 2-3kg. Her blood pressures are generally low, around 100-90/50-40, with syncopal episodes reported around once a month on haemodialysis. Her pre-dialysis potassium have been high at 6.
She lives with her husband, her main carer. She can walk around 10-20 m on the flat. She rarely leaves her flat other than to attend dialysis.
We talked today about the importance of reducing her weight gain in between dialysis sessions, tightly restricting her fluid intake, and complying with her low potassium diet.
Her recent echo result showed a functional MR, with dilated LV and EF 30%, and diastolic dysfunction.
We are unable to increase her cardiac medications further given her low blood pressures.
We will review her in 2 months' time.

Yours sincerely

Dr Sharma

Learning Points

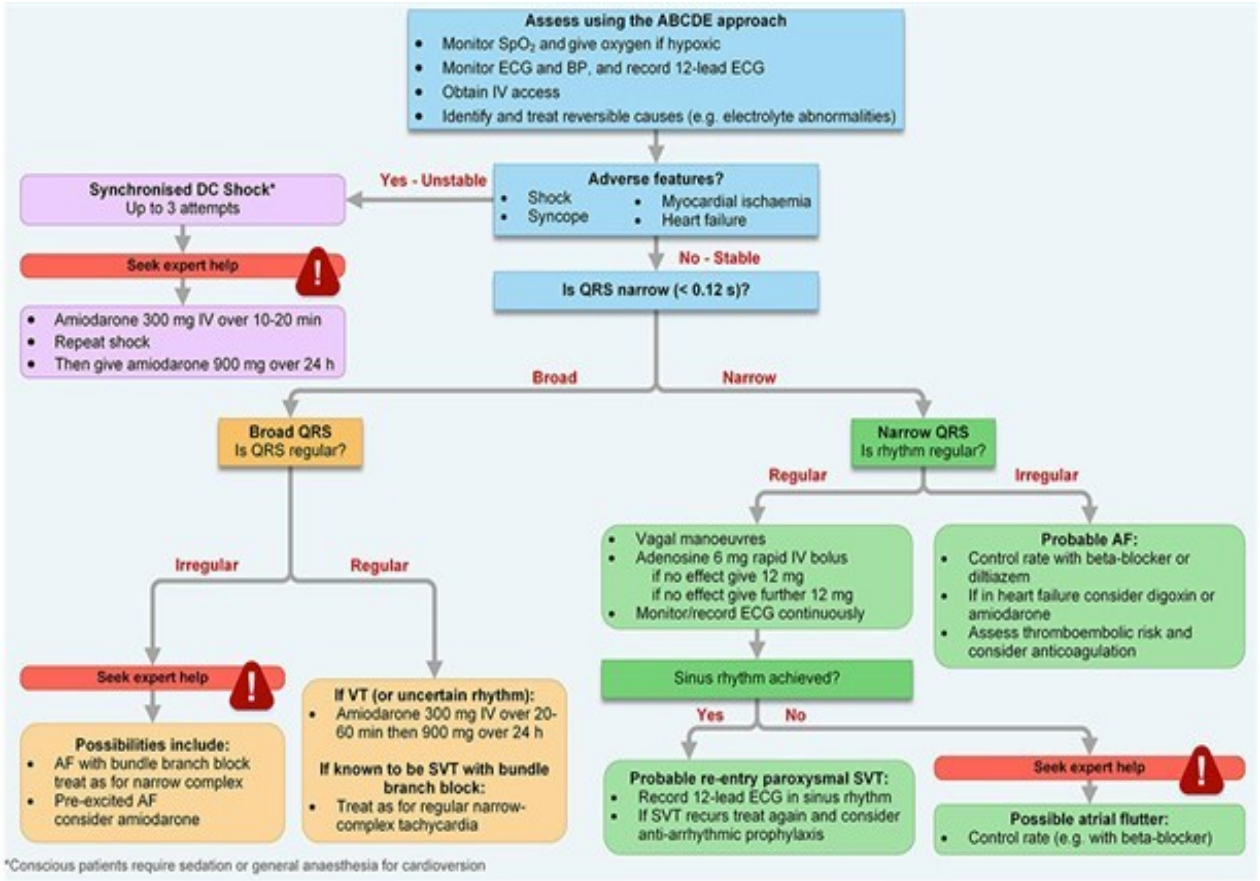
This scenario demonstrates management of haemodynamically unstable ventricular tachycardia (VT) and cardiogenic shock in a 67- year- old lady on HD with known severe cardiac dysfunction.

The technical learning points were:
Prevention of the scenario occurring in first instance:
- Consider the appropriateness of large UF volumes in a hypotensive patient with a cardiac background; consider whether additional HD sessions for isolated UF should be scheduled. The importance of fluid restriction should be discussed with the patient, to reduce the need for large volume UF. A change in dialysis modality to peritoneal dialysis should be discussed with the patient, as this may be better tolerated, as well as exploring their wishes to continue with renal replacement therapy.

Management in this scenario:
- Use a systematic A to E approach, give high flow oxygen, stop dialysis, secure IV access and give a cautious fluid bolus for hypotension. Get crash trolley and attach patient to defibrillator
- Look for electrolyte disturbances and treat these promptly
- Situational planning: in VT with haemodynamic comprise call the crash team early. This will bring an anaesthetist, a manual defibrillator, and allow for discussion about the best location to perform synchronised cardioversion and whether there is time to perform this under sedation. Calling the crash team will bring the manual defibrillator quickly, and this is safer than trying to deliver an unsynchronised shock with the AED (AED defibrillators are commonly found on dialysis units).
- Give amiodarone either following 3 shocks of synchronised cardioversion or whilst waiting for the anaesthetist/cardiac arrest team. This should be given via a wide bore cannula, the needled fistula can be used for this emergency.
- Once in cardiac arrest, a defibrillator, manual or automated, can be used to give an early shock; the shockable side of the cardiac arrest algorithm should be followed.

Human factors: *From our experience running this scenario*
- This scenario highlighted the importance of clear communication, and how this can be achieved by using the "closed loop communication" model. This is where clear instructions are given to a named individual; the individual then accepts the task and feeds back when the task has been performed or if they are unable to perform it.
- Leadership was discussed and the importance of allocating a leader in an emergency scenario, with team members having a role to support that leader, give advice and volunteer to take on specific tasks. The individual with the most experience of the situation was deemed to be the best person to be the leader, not necessarily the most senior member of the team.
- Role allocation was discussed and the challenges of leaving the bedside to call for senior/expert help. Strategies identified were: a) Any member of the team can put out an arrest call; b) If emergency help is needed, e.g. calling for an anaesthetist, a clear headline should be sufficient to get help; this can be clearly communicated by the leader and delegated to another member of the team; c) Where more detailed information is required then requesting another team member to contact the specialist and once they are available, the "leader" can step away from the bedside to discuss the case thereby minimising time away from the patient.

Feedback from the group was that everyone found it very helpful. They reported increased confidence in managing a cardiac arrest on haemodialysis, increased understanding of the skill set of their colleagues and knowledge of the location of emergency equipment on the dialysis unit. They appreciated having the opportunity to practice the management of an emergency with the multi-professional team.



Broad complex tachycardia: Resuscitation Council UK 2015

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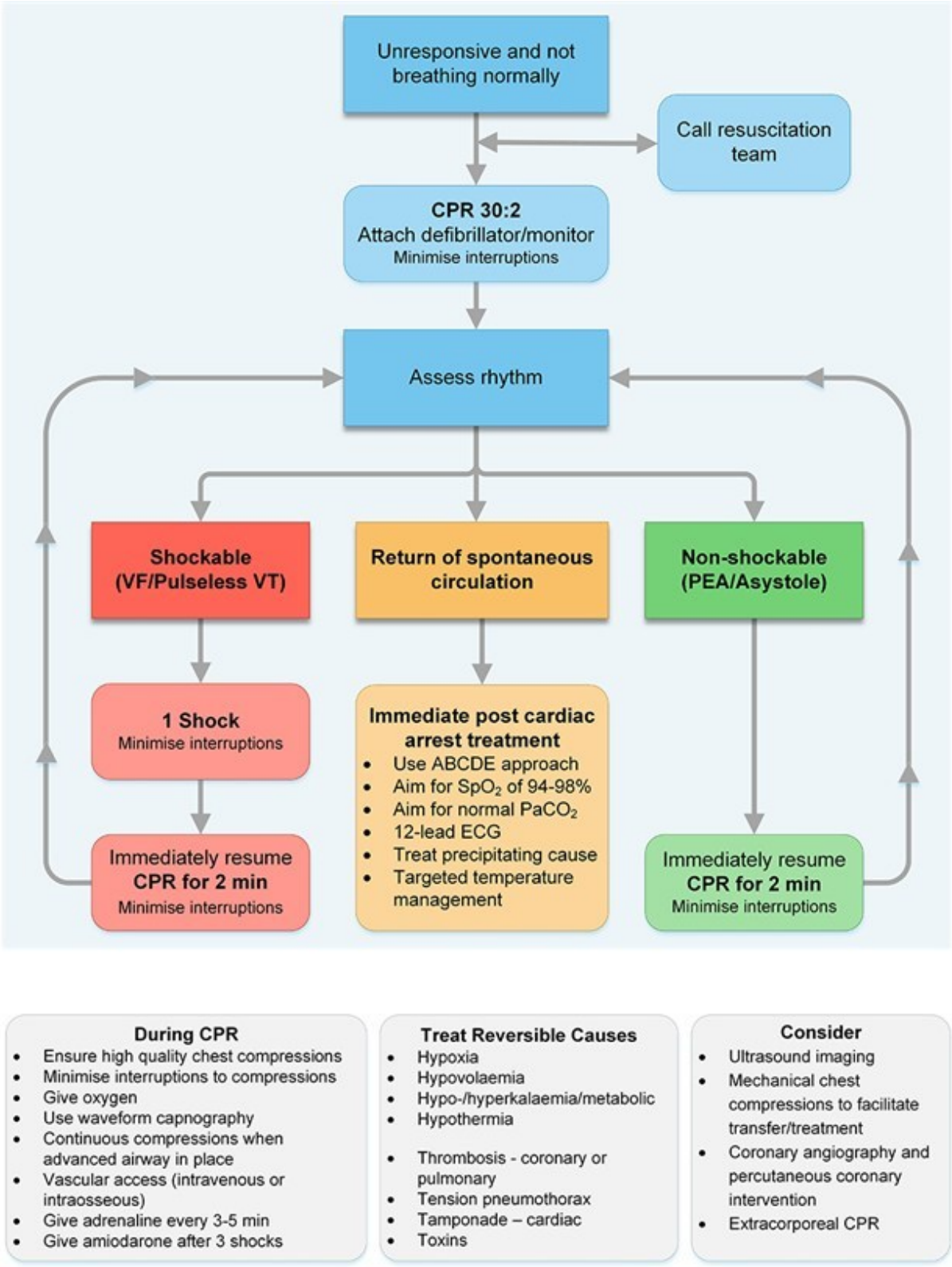

Cardiac Arrest Algorithm, Resuscitation Council UK 2015

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King's Clinical Training

In Situ Dialysis Simulation Scenarios

Scenario: Isobella Split; Air Embolus

Scenario Quick Notes

Patient name:
Isobella Split

Age: 39

Clinical Headline:
Air embolism
PEA cardiac arrest

Haemodialysis since 2013 via tunnelled line, x3/wk, TW 60kg

PMH: ESRF secondary to IgA, active on transplant waiting list

DH: ramipril, calcium acetate, alfacalcidol, neorecormon

SH: Lives with husband and children, self-employed hair dresser

Clinical learning objectives:

Recognition of acutely unwell patient
Recognition and management of life threatening air embolus
Management of cardiac arrest – PEA

Anticipated human factor objectives:

Communication with effective handovers
Teamwork
Leadership
Forward planning and escalation

Expected scenario progression:

Isobella came to her routine haemodialysis session feeling well. She dialyses via a tunnelled line and attends dialysis 2kg above her TW with a plan to remove 2L UF on dialysis. Early in the dialysis session her lines are reversed because of poor flows. Her tunnelled line is under her clothing. The junior dialysis nurse briefly leaves the room and returns to find that the venous line is disconnected; she reconnects it, but Isobella then becomes less responsive. The junior dialysis nurse presses the patient emergency alarm. The scenario starts here.

All nurse participants respond to the emergency buzzer, and on arrival the patient is groaning and breathless; the dialysis machine is alarming. The nursing team should take a history from the junior dialysis nurse (*the embedded practitioner)* who states "all was initially fine but the blood flows on dialysis were poor, so I reversed the lines. I popped out briefly and returned to see that the line had disconnected- it can't have been long and I quickly replaced it". Nurse participants should perform an A to E assessment recording the observations, give high flow oxygen, stop dialysis (if air embolism is suspected air should be aspirated from tunnelled line then venous line clamped), intravenous fluid should be given, and the patient put in the left lateral decubitus position; they should bring the cardiac arrest trolley, and put out a cardiac arrest call.

Doctors arrive prior to the cardiac arrest team. Following handover to the doctors and initial assessment, the patient arrests. The team should commence CPR and assess rhythm as soon as the patient is attached to the defibrillator- the rhythm is PEA. Cardiac arrest should be managed

according to cardiac arrest algorithm, non-shockable rhythm. The team should consider the differential diagnosis of a venous air embolism.
If well managed the patient regains return of spontaneous circulation, the scenario ends with arrival of the cardiac arrest team.
Treatment of venous air embolism includes high flow oxygen, fluid resuscitation, and positioning the patient in left lateral decubitus position (bed tilted head down and patient rolled on their left); aspiration of air from the tunnelled line can also be attempted. Early Intensive care input is required with consideration of hyperbaric oxygen treatment.
Incident reporting and route cause analysis should follow this adverse event.

Faculty and Participants

Faculty: minimum of three	*Participants:*
Sim technician and patient voice, control room lead, embedded practitioner	2 nurses
Member of faculty trained for structured debrief plus a senior member of renal team	2/ 3 doctors

Sim Set Up

Extra Props and Settings:

ECG: RBBB (S1Q3T3 pattern)
ABG
Drug chart
Clinic letter

Training AED/manual defibrillator/ Emergency drugs/O2/kit for intubation and airway adjuncts

Manikin Settings:

Tunnelled line under clothing
Chest: clear
Initial scenario observations
½ hr into dialysis session (peri-arrest)

Sats	80% OA
RR	30
HR	150
BP	80/50
Temp	36.5

Non Manikin Observations:
Cap Refill: 4s
GCS: E1V2M5
BM 6.0

HD Settings:

Dry weight 60kg, planned 2L UF over 4 hours
FX80 A7
Blood flow rate 300ml/min
UF 500ml/hr
Enoxaparin 20mg
Arrival at HD BP 125/75, HR 80
Weight 62kg

Post high flow oxygen 15L, IV fluid

Sats	85% 15L
RR	30
HR	150
BP	70/40
Temp	36.5

PEA arrest

Sats	70%
RR	-
HR	150 SR
BP	-
Temp	36.5

ROSC

Sats	90% 15L
RR	30
HR	100 SR
BP	90/50
Temp	36.5

Participant Briefing: to Dialysis Nurse

Isobella has attended her regular HD session and was well on arrival. She dialyses through a tunnelled line. She was 2kg above her TW and 2L fluid removal was planned. Since starting dialysis her flows have been poor, and the junior nurse reversed the lines. She is now 30 mins into her dialysis session. You respond to the emergency buzzer.

Control Room Lead Brief:

This scenario explores management of a venous air embolism. The history of the disconnected line should only be given in the scenario by the embedded practitioner (the junior dialysis nurse). The scenario starts with the nurses responding to the emergency buzzer finding Isobella peri-arrest. They should perform an A to E assessment, give high flow oxygen, stop haemodialysis, get the crash trolley, connect her to the defibrillator for cardiac monitoring, and call the crash team. Doctors enter the scenario prior to the crash team arriving. A few minutes after the doctors arrive the patient will have a cardiac arrest. Cardiac arrest should be confirmed, the patient will be in PEA- and the cardiac arrest algorithm followed. If the team considers an air embolism specific treatment includes positioning the patient in left lateral decubitus position (bed tilted head down and patient rolled on their left) and aspiration of air from the tunnelled line can also be attempted. The patient needs to go to intensive care for supportive care, and for the consideration of hyperbaric oxygen or ECMO. The scenario ends with arrival of the crash team.

Patient Voice Briefing
Initial grunting noises, then you become silent (cardiac arrest) a few minutes after doctor team arrive; if successfully resuscitated, you will have signs of life, and you will cough/grunt.

Embedded Practitioner Briefing
Isobella was well initially on haemodialysis and there have been no recent changes to her medications. She has no drug allergies. Her flow rates were poor, "her tunnelled line was playing up". You reversed the lines **and returned to find that the venous line had disconnected**. "It can't have been like that for long- I just left the bay for a few minutes." You immediately replaced it. You are helpful and competent in providing oxygen therapy, retrieving drugs and delivering chest compressions.

References:
https://renal.org/wp-content/uploads/2017/07/air-embolism-hd-catheter-aug-07.pdf

Further Reading:
McCarthy CJ et al. "Air embolism: practical tips for prevention and treatment." *Journal of clinical medicine* 5.11 (2016): 93.

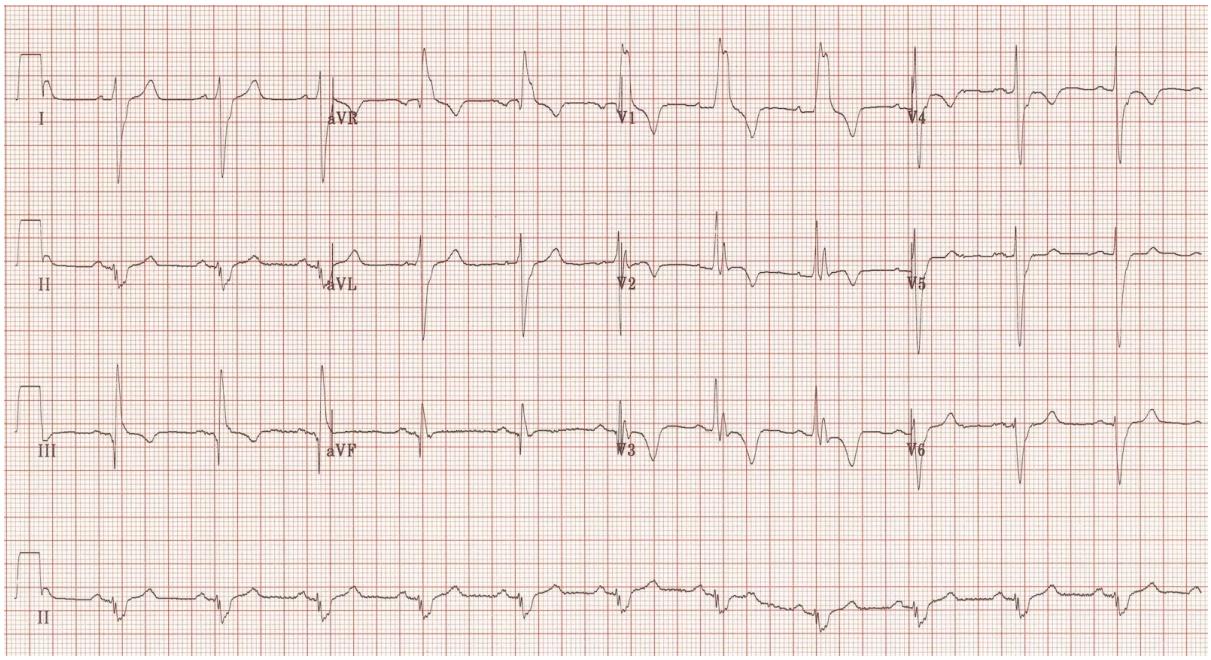
Patient: Isobella Split
FiO_2: 21% OA
Sample: Arterial

Blood Gas Values						
pH	**7.286**		[	7.350 - 7.450		]
pCO_2	**6.00**	kPa	[	4.00 - 6.50		]
pO_2	**6.5**	kPa	[	12.0 - 15.0		]
Acid Base Status						
HCO_3^-	**19**	mmol/L	[	22 - 28		]
BE	**-4.8**	mmol/L	[	-3.0 - 3.0		]
Oximetry Values						
Hb	**90**	g/L	[	135 - 175		]
SaO_2	**72.8**	%	[	95.0 - 100.0		]
Electrolyte Values						
K^+	**4.5**	mmol/L	[	3.5 - 5.0		]
Na^+	**140**	mmol/L	[	135 - 145		]
ion Ca^{2+}	**1.15**	mmol/L	[	1.10 - 1.35		]
Cl^-	**102**	mmol/L	[	96 - 106		]
Anion Gap	**17.0**	mmol/L	[	8.0 - 16.0		]
Metabolic Values						
Lact	**3.5**	mmol/L	[	0.5 - 2.0		]
Bili	**6**	µmol/L	[	-		]

Patient: Isobella Split
FiO_2: 100%
Sample: Arterial

Blood Gas Values						
pH	**7.286**		[	7.350 - 7.450	]	
pCO_2	**6.00**	kPa	[	4.00 - 6.50	]	
pO_2	**8.5**	kPa	[	12.0 - 15.0	]	
Acid Base Status						
HCO_3^-	**19**	mmol/L	[	22 - 28	]	
BE	**-4.8**	mmol/L	[	-3.0 - 3.0	]	
Oximetry Values						
Hb	**90**	g/L	[	135 - 175	]	
SaO_2	**94.4**	%	[	95.0 - 100.0	]	
Electrolyte Values						
K^+	**4.5**	mmol/L	[	3.5 - 5.0	]	
Na^+	**140**	mmol/L	[	135 - 145	]	
ion Ca^{2+}	**1.15**	mmol/L	[	1.10 - 1.35	]	
Cl^-	**102**	mmol/L	[	96 - 106	]	
Anion Gap	**17.0**	mmol/L	[	8.0 - 16.0	]	
Metabolic Values						
Lact	**3.5**	mmol/L	[	0.5 - 2.0	]	
Bili	**6**	µmol/L	[	-	]	

ECG- Isobella Split



Clinic Letter

Isobella Split

39-year-old lady

DH

Ramipril 2.5mg od

Calcium acetate † tds

Alfacalcidol 0.25mcg od

NKDA

Problem list

HD since 2013 on main unit M/W/F via tunnelled line, TW 60 kg

ESRF secondary to IgA

Active on transplant waiting list

Isobella continues to dialyse on the main HD unit through her tunnelled line. She is doing very well. Her blood pressure is well controlled, and she has minimal interdialytic weight gain. Her biochemical parameters are all within target range.

She continues to dialyse via her tunnelled line, which is her choice, and she has been free of any line infection.

She works as a hair dresser and is active on the transplant waiting list.

We will review her in 2 months' time.

Yours sincerely

Dr Scott

Learning Points

This scenario simulates cardiac arrest following an air embolus. It was based on a true case, in which the venous line of a haemodialysis catheter accidentally disconnected following reversal of the lines during a dialysis session. The incident was not immediately detected as the dialysis catheter was under the patient's clothing. This was reported by The National Patient Safety Agency, with the recommendation that the dialysis line and the connections should be visible at all times during dialysis. (https://renal.org/wp-content/uploads/2017/07/air-embolism-hd-catheter-aug-07.pdf)

The technical learning points:
- Consider air embolism with a history of disconnected haemodialysis catheter/ faulty connections. It can be avoided by ensuring good priming of extracorporeal circuit including the dialyser, by checking the dialysis machine air detector, and by ensuring good dialysis connections and clamped lines.
- Specific management of air embolus: Stop haemodialysis, clamp venous blood line and, if possible, aspirate air from the line; position the patient in the left lateral decubitus position (on left side and head down) and administer high flow oxygen and iv fluid resuscitation. If air is entrained through the venous system, then symptoms are akin to pulmonary embolism. In the presence of a patent foramen ovale, then stroke, mesenteric embolus or MI can occur. Intensive care for supportive care including high flow oxygen and ventilation may be required; treatment with hyperbaric oxygen may be considered in certain cases.

Human factors we discussed when running this scenario:
- Dealing with stressful situations, heightened by some members of the team being less familiar with the local environment and equipment e.g. use of the AED; however, different members of the team had different skill sets and knowledge of equipment, highlighting the need for good teamwork.
- Effective communication strategies using closed loop communication was discussed.

Comments from qualitative feedback post running this simulation included: "Useful realistic scenario"; " good to have a practice run of this stressful scenario- good practice"; " would be good to repeat the training exercise in the future"; " now aware that I need to have more experience using AED defibrillators"; " now more familiar with where emergency resources are kept on the dialysis unit".

In Situ Dialysis Simulation Scenario

Scenario: Ivy Shivers; Seizures

Scenario Quick Notes

Patient name:
Ivy Shivers

Age: 65

Clinical Headline:
Seizures on HD

Haemodialysis since 2016 via AV graft x3/week, TW 75Kg

PMH: ESRF secondary to diabetic nephropathy, hypertension, diverticulitis

DH: aspirin, ramipril, calcium acetate, alfacalcidol, neorecormon, levemir 6 units od, novorapid 2-4 units tds

SH: Lives with husband- independent.

Clinical learning objectives:
Recognition of the acutely unwell patient
Management of seizures; maintaining a safe airway
Differential diagnosis of seizures
Treatment of hypoglycaemia
Glucose management on haemodialysis

Anticipated human factor objectives:
Communication
Effective teamwork
Demonstrates leadership skills
Forward planning and escalation

Expected scenario progression:
Ivy attends her normal haemodialysis session. She has been diagnosed with a urinary infection and is on day 3 of ciprofloxacin. She reports being a little more muddled and forgetful over the last week. She comes to dialysis 1 kg above her target weight, BP 120/80.
The scenario starts 1 hour into Ivy's dialysis session, the nurse participants are asked to see Ivy who is complaining of feeling dizzy and tremulous. The nursing team should perform an A to E assessment and take a history; shortly after obtaining the observations / a few minutes into the scenario, Ivy starts to have a seizure. It may need to be pointed out by the embedded practitioner that she is having a seizure if it is not easily seen. Expect nurses to repeat an A to E assessment, give high flow oxygen, stop haemodialysis, secure dialysis tubing, and put the patient in the recovery position. A blood sugar level should be taken as part of the A to E assessment and identified as being very low. They should fast bleep the doctor, bring the crash trolley, consider need for airway adjunct and start timing the seizure.
Doctors arrive: If informed of low glucose level this should be treated immediately; if not informed then they should repeat an A to E assessment and escalate early putting out a peri-arrest call. Airway adjuncts: initially oropharyngeal airway will not be tolerated due to trismus but nasopharyngeal airway will be tolerated. Breathing: ensure high flow oxygen is given. Circulation: ensure IV access is secured (can use dialysis needles if necessary), urgent blood tests should be sent, and blood gas taken. Disability: Blood sugars should be taken, BM 1.7mmol/L. This should be corrected with IV dextrose solution. A benzodiazepine should be sourced and prepared e.g. IV lorazepam. The patient will stop seizing with appropriate blood sugar correction.

Faculty and Participants

Faculty: minimum of three	*Participants:*
Sim technician and patient voice, control room lead, embedded practitioner.	2 dialysis nurses
Member of faculty trained for structured debrief plus a senior member of renal team	2 Doctors

Sim Set Up

Extra Props and Settings:

ECG: None- unable to get trace
Clinic letter
Drug chart
Blood results
ABG

Training AED/manual defib Emergency drugs/O2/kit for intubation and airway adjuncts

Manikin Settings:

Chest clear
Initial observations

Sats	98%
RR	20
HR	110
BP	150/80
Temp	37.5

Non Manikin Observations:
GCS E4 V4 M6
BM 1.7 mmol/L

HD Settings:

Dry weight 75kg, planned 1 L UF over 4 hours
Fx 80 A7
Blood flow rate 300ml/min
UF 250ml/hr
Enoxaparin 20mg
Observations on arrival at HD: BP 120/80, HR 90, weight 76kg

Few minutes into scenario, patient starts to have seizures

Sats	Poor trace due to seizure
RR	18
HR	Poor trace, manual 110
BP	Unrecordable
Temp	37.5
GCS	E1, V1, M2 -All limbs seizing
BM	1.7

Post ictal observations- following correction of BM

Sats	98% 15L
RR	12
HR	110
BP	150/80
Temp	37.5
GCS	E3, V3, M6
BM	3.2

Participant Briefing: to Dialysis Nurse
Ivy has come to her regular dialysis session. She has recently been treated with ciprofloxacin for a pseudomonas UTI and has been rather muddled. She attends feeling a little dizzy. Her blood pressure is 120/80 initially; she starts HD with a plan for 1L UF to bring her to her target weight of 75 kg. You are called to see her as she is feeling dizzy….

Control Room Lead Brief:
The aim of this scenario is to safely manage seizures in a patient on haemodialysis by using an A to E approach and with a focus on securing a safe airway. The team needs to consider the differential diagnosis of seizures in a patient receiving haemodialysis.

Patient Voice Briefing
At the start of the scenario you say a few words such as " I am feeling strange"; you then start to have a seizure and you snore/grunt. Once your BM is corrected you stop fitting and you are drowsy/post ictal.

Embedded Practitioner Briefing:
You call the nurse for help as Ivy is feeling dizzy and a little tremulous. You mention she had been a little muddled since starting dialysis, that she is being treated for a urinary infection, and that her observations were all fine when she started dialysis. A few minutes into the scenario Ivy starts to have a seizure, please point this out to them if they don't recognise it.

Further points for debrief discussion:
-Differential diagnoses for seizures in a patient on haemodialysis include: cerebral causes (epilepsy, tumour, bleed, stroke, infection), systemic electrolyte imbalances, hypoglycaemia, disequilibrium syndrome, Severe hypertension and alcohol withdrawal. In this case the cause for the seizure was hypoglycaemia, likely from inappropriate insulin use. It is important to review whether a patient should be self-managing their insulin during illness especially if their cognition is impaired. She was also being treated with ciprofloxacin for her urinary infection which can reduce seizure threshold.
-Haemodialysis and the effect on blood glucose: it is important to monitor blood sugars during haemodialysis, and to reduce insulin dose pre-dialysis session.
http://www.diabetologists-abcd.org.uk/JBDS/JBDS_RenalGuide_2016.pdf

Blood results: Ivy Shivers (last HD session)

Hb	110	g/L
WCC	14	$x10^9$/L
Plt	250	$x10^9$/L
Na^+	138	mmol/L
K^+	5.5	mmol/L
CRP	80	mg/L
ALT	40	U/L
Bil	20	µmol/L
GGT	50	U/L
ALP	90	U/L
Alb	40	g/L
adjusted Ca^{2+}	2.4	mmol/L
Phos	1.2	mmol/L
INR	1.1	

Patient: Ivy Shivers
FiO_2: 21%
Sample: Arterial

Blood Gas Values						
pH	**7.272**		[	7.350 - 7.450	]	
pCO_2	**6.50**	kPa	[	4.00 - 6.50	]	
pO_2	**10.0**	kPa	[	12.0 - 15.0	]	
Acid Base Status						
HCO_3^-	**19**	mmol/L	[	22 - 28	]	
BE	**-3.5**	mmol/L	[	-3.0 - 3.0	]	
Oximetry Values						
Hb	**110**	g/L	[	135 - 175	]	
SaO_2	**98.0**	%	[	95.0 - 100.0	]	
Electrolyte Values						
K^+	**5.5**	mmol/L	[	3.5 - 5.0	]	
Na^+	**140**	mmol/L	[	135 - 145	]	
ion Ca^{2+}	**1.15**	mmol/L	[	1.10 - 1.35	]	
Cl^-	**102**	mmol/L	[	96 - 106	]	
Anion Gap	**16.0**	mmol/L	[	8.0 - 16.0	]	
Metabolic Values						
Lact	**4.0**	mmol/L	[	0.5 - 2.0	]	
Bili	**6**	µmol/L	[	-	]	

Patient: Ivy Shivers
FiO_2: 90%
Sample: Arterial

Blood Gas Values						
pH	**7.306**		[	7.350 - 7.450		]
pCO_2	**6.00**	kPa	[	4.00 - 6.50		]
pO_2	**40.0**	kPa	[	12.0 - 15.0		]
Acid Base Status						
HCO_3^-	**19**	mmol/L	[	22 - 28		]
BE	**-3.3**	mmol/L	[	-3.0 - 3.0		]
Oximetry Values						
Hb	**110**	g/L	[	135 - 175		]
SaO_2	**99.0**	%	[	95.0 - 100.0		]
Electrolyte Values						
K^+	**5.5**	mmol/L	[	3.5 - 5.0		]
Na^+	**140**	mmol/L	[	135 - 145		]
ion Ca^{2+}	**1.15**	mmol/L	[	1.10 - 1.35		]
Cl^-	**102**	mmol/L	[	96 - 106		]
Anion Gap	**16.0**	mmol/L	[	8.0 - 16.0		]
Metabolic Values						
Lact	**4.0**	mmol/L	[	0.5 - 2.0		]
Bili	**6**	µmol/L	[	-		]

Clinic Letter

Ivy Shivers

65-year-old lady

Problem list

HD since 2016 on main unit M/W/F via AV graft, TW 75 kg

ESRF secondary to diabetic nephropathy

Hypertension

Diverticulitis

Active on transplant waiting list

DH

Ramipril 2.5mg od

Calcium acetate † tds

Alfacalcidol 0.25mcg

Neorecormon 2000 IU a week

Aspirin 75mg od

Levemir 6 units ON

Novorapid 2-4 units with meals

NKDA

Ivy continues to dialyse on the main HD unit through her AV graft. She is doing very well. Her blood pressure is well controlled, and she has minimal interdialytic weight gain. Her biochemical parameters are all within target range. She has a residual urine output of 1 litre. Her blood sugars are well controlled between 6-10mmol/L.

In clinic she had symptoms of dysuria. A urine sample sent from clinic has shown a heavy growth of Ecoli sensitive to ciprofloxacin. She has been informed and will commence a five-day course of ciprofloxacin.

We will review her in 2 months' time.

Yours sincerely

Dr Scott

Learning Points

This scenario demonstrates seizures in a patient on haemodialysis secondary to hypoglycaemia.

The technical learning points are:
- Management of seizures: Consider airway patency, position patient in the recovery position, stop dialysis, and use of airway manoeuvres and airway adjuncts. Oral airway adjuncts can be difficult with jaw clenching and a nasopharyngeal airway is often required. Administer high flow oxygen. Time the seizure and call for an anaesthetist if seizures continue for more than 3 minutes.
- During seizure activity the Dynamap®, electronic blood pressure, heart rate and saturation monitor will often not work- in this case go back to clinical examination findings/ perform manual observations.
- If the seizures last over 5 minutes then the diagnosis is status epilepticus and a benzodiazepine e.g. 4mg IV lorazepam should be given. It is often difficult to find benzodiazepines quickly, so forward planning is essential- source and draw up the medication early so it is ready should it be required.
- Identify and treat factors that may reduce seizure threshold e.g. hypoglycaemia and electrolyte disturbances.
- Consider differential diagnosis of seizures on a patient receiving haemodialysis: Intracranial pathology e.g. stroke, bleed, meningitis; alcohol withdrawal; epilepsy; severe hypertension and dialysis disequilibrium syndrome.

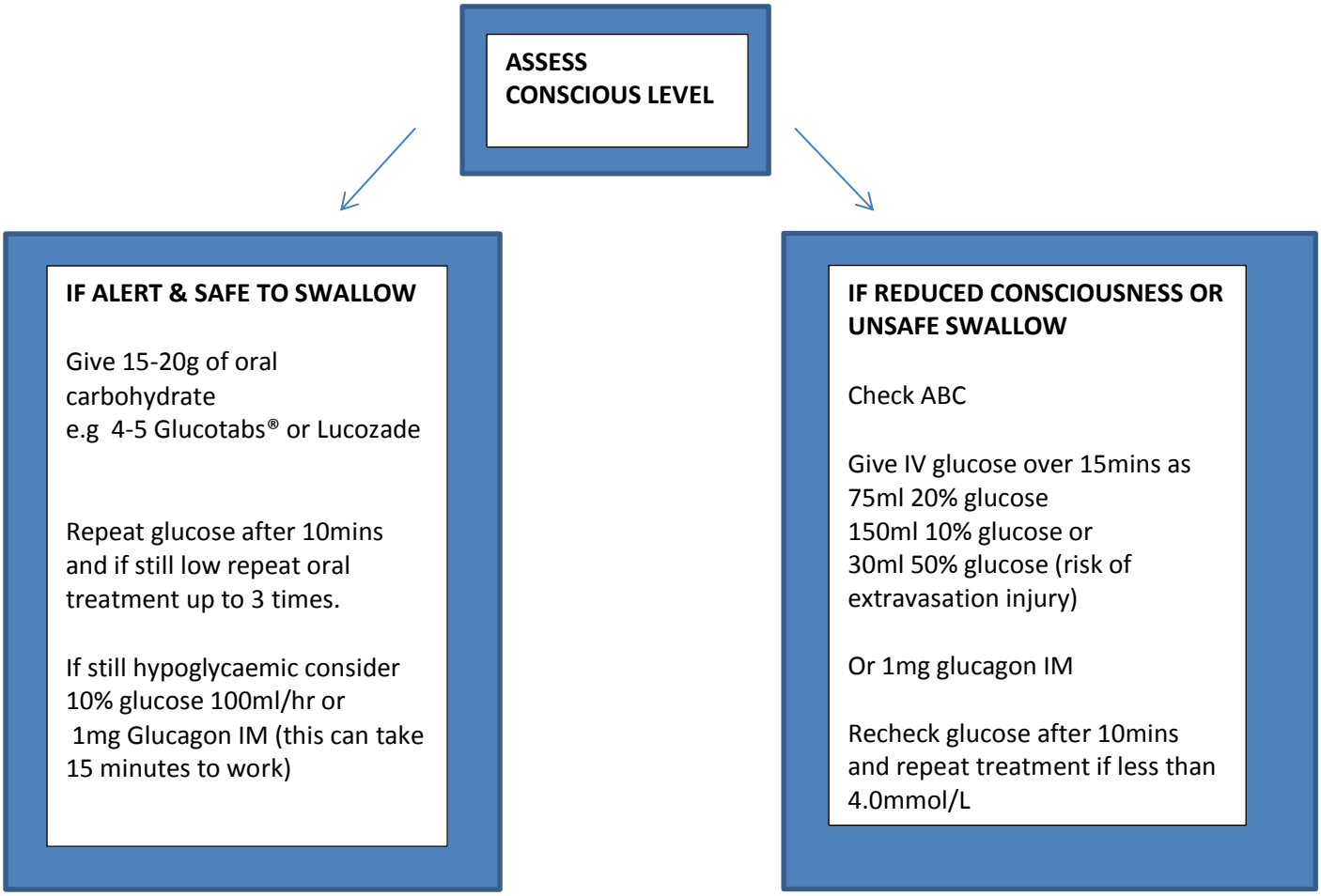
Hypoglycaemia
- Dialysis nurses routinely check blood glucose in a diabetic patient prior to haemodialysis, 3 hours into dialysis (*which is classically when blood glucose levels fall)*, and after dialysis.
-JBDS-IP guidelines for management of adults with diabetes on the haemodialysis unit suggest making a 10% reduction in the patient's regular insulin dose both before and following their dialysis session if using rapid acting insulin; a 10% dose reduction prior to dialysis if using a premixed/biphasic insulin; a 25% dose reduction prior to dialysis if using a long acting insulin. (http://www.diabetologists-abcd.org.uk/JBDS/JBDS_RenalGuide_2016.pdf.)

The human factors we discussed when running this scenario:
- "Freezing" during times of stress; coping strategies included using a systematic A to E approach, to ensure the most urgent issues are dealt with first in a structured manner.
- What to do when the situation is not improving despite treatment; strategies included standing-back and summarising with the team what the working diagnosis is and what has been done so far- this encourages others to voice their thoughts; repeat an A to E assessment; call for senior help.
- Ways to improve communication/teamwork were discussed and the importance of knowing the name and job role of members of the team- this allows appropriate instructions to be directed to a specific individual. "Closed loop communication" can then be practiced, i.e. the individual acknowledges the instruction and is told to report back when task has been done or if any problems.

Feedback from the group was that everyone found it very helpful. They reported increased confidence managing seizures on dialysis, increased understanding of the skill set of their inter-professional colleagues and consolidation of knowledge of the location of emergency equipment on the dialysis unit.

Management of Hypoglycaemia

Hypoglycaemia is defined as a blood sugar <4mmol/l. (Rajendran R et al, 2015). Treat hypoglycaemia as per algorithm below.



Algorithm for management of hypoglycaemia; adapted from Joint British Diabetes Societies for inpatient care; The Hospital Management of Hypoglycaemia in Adults with Diabetes Mellitus Revised February 2018

For full algorithm see
https://diabetes-resources-production.s3.eu-west-1.amazonaws.com/resources-s3/2018-03/JBDS_HypoGuideline.pdf%20FINAL%2008.03.18.pdf

Management of Status Epilepticus in Adults

Time 0 -10mins (1^{st} stage) Early Status	-Seizure starts- TIME IT -Protect airway, put in recovery position and secure airway -Administer high flow oxygen -Establish IV access -Assess cardiorespiratory function	Prepare benzodiazepine
0-30 mins (2^{nd} stage)	-Institute regular monitoring -Emergency antiepileptic drug therapy : Give usual antiepileptic drug if already on treatment Lorazepam 0.1 mg/kg if intravenous access established (usual 4mg bolus-repeat 10-20 mins) Or 10mg Diazepam IV Or if no IV access 10mg buccal Midazolam/ 10 mg rectal diazepam -Emergency Investigations: including blood glucose, blood gases, electrolytes, including calcium, magnesium, liver function, antiepileptic drug levels, and consider toxicology screen -Check blood glucose- administer IV glucose if < 4.0mmol/L Commence IV thiamine (pabrinex®) if suggestion of alcohol abuse or impaired nutrition -Treat acidosis if severe	Call anaesthetist if no response to first benzodiazepine dose
0-60 mins (3^{rd} stage) Established Status	-Give phenytoin infusion, Sodium Valproate or Levetiracetam. -Establish aetiology -Alert anaesthetist and ITU -Identify and treat medical complications	

Management of Status Epilepticus. Adapted from NICE guidelines: Treating convulsive status epilepticus in adults (2004)

https://www.nice.org.uk/guidance/cg137/chapter/appendix-f-protocols-for-treating-convulsive-status-epilepticus-in-adults-and-children-adults-published-in-2004-and-children-published-in-2011

In Situ Dialysis Simulation Scenarios

Scenario: Merlinda Jones; Active Psychosis with Fistula Bleed

Scenario Quick Notes

Patient name:
Merlinda Jones

Clinical Headline:
Active psychosis on HD

Age: 39 years

Haemodialysis since 2010 via AV graft, x3/wk, TW 65kg

PMH: ESRF secondary to lithium toxicity, Schizophrenia, Depression, Hypertension, Hepatitis C positive- high viral load, suspended from transplant list

DH: sodium valproate, sertraline, haloperidol PRN, ramipril, calcium acetate, alfacalcidol, neorecormon

SH: Journalist, independent with husband, currently inpatient in mental health unit

Clinical Learning Objectives:

Recognition of the acutely unwell patient
Performs capacity assessment
Restrains and gives sedation appropriately
Acute management of major haemorrhage

Anticipated human factor objectives:

Communicates clearly in a variety of settings
Works effectively as a team member
Demonstrates leadership skills
Recognises and works within limits of personal competence

Expected scenario progression:

Merlinda is an inpatient on a psychiatric ward for active psychosis. She has been refusing haemodialysis believing the machine to be a "dalek" infusing poison into her blood. She is poorly compliant with diet and fluid restriction and has high pre-dialysis potassium levels with large interdialytic weight gain. She was given haloperidol 30 mins prior to her haemodialysis session. She attended dialysis calm and compliant.
The scenario starts 2 hours into Merlinda's haemodialysis session, when she becomes highly distressed. The scenario starts with the embedded nurse practitioner pressing the emergency buzzer.
The nursing team participants respond to the alarm, on arrival Merlinda is screaming "I want to be freed from this dalek monster". The embedded practitioner confirms "Oh no, she has pulled out her needles and is bleeding out all over the floor".

- Expect the nursing team to put on goggles, apron and gloves and stop haemodialysis. They should attempt to elevate the arm and apply pressure on the graft. The patient will not

allow them to do this, and it is only possible if she is restrained. They should fast bleep the renal registrar, or, if peri-arrest, call the cardiac arrest team.

- If the team try to perform an A to E assessment or administer oxygen the patient will pull it off, unless she is restrained.
- Doctors on arrival receive handover and should give emergency sedation with haloperidol IM or lorazepam IM and fast bleep the anaesthetist. If haloperidol/ or lorazepam is given they are able to perform an A to E assessment, administer high flow oxygen, insert a wide bore cannula, fluid resuscitate and put out a major haemorrhage protocol (a CODE RED). If not sedated the patient will initially be aggressive and combative, and it will not be possible to get IV access. With further blood loss, she drops her blood pressure and then GCS and is no longer able to resist any treatment. If hypovolemic shock is not appropriately managed she will arrest, PEA cardiac arrest.
- The team should treat hypovolemia with fluids until blood products are available. Attention should be paid to potassium with blood products. She will need to go to intensive care for haemofiltration and sedation at the end of the scenario.

Faculty and participants:

Faculty: minimum of three	*Participants:*
Sim technician and patient voice, control room lead, embedded practitioner	2 dialysis nurses
Member of faculty trained for structured debrief plus a senior member of renal team	2 doctors

Sim Set Up

Extra Props and Settings:

ECG – unable, patient not allowing
Radiology: unable to perform CXR
ABG
Drug chart
Clinic letter
Training AED/manual defibrillator/ Emergency drugs/O2/kit for intubation and airway adjuncts

Red dyed "inko" pads- for blood

Manikin Settings:

Chest: clear
Initial Observations 2hr into HD (Patient refusing observations)

Sats	
RR	28
HR	
BP	
Temp	

Non Manikin Observations:
Cap Refill: does not allow
BM: does not allow
GCS: 15
Limb Movements: moving all 4 limbs, combative

HD settings:

Dry weight 65kg, planned UF 3kg over 4 hours
FX80 A7
Blood flow rate 300ml/min
UF 750ml/hr
Enoxaparin 20 mg
Observations on arrival at HD BP140/80, HR 90, 69kg

If successful sedated

Sats	98% 15L
RR	12
HR	90
BP	100/50
Temp	36.5
GCS	E3 V4 M5

Peri arrest

Sats	85% on 15L
RR	30
HR	135
BP	60/40
Temp	36.5
GCS	E1 V3 M5

ROSC

Sats	90% 15L
RR	18
HR	80
BP	70/40
Temp	36.5
GCS	E1 V3 M3

Participant Briefing: to Dialysis Nurses

Merlinda is a 39-year-old inpatient at a mental health unit for schizophrenia with active pscyhosis. She has attended for her routine haemodialysis session and is 2 hours into her 4 hour session. She is poorly compliant with fluid restriction and her diet. The junior dialysis nurse looking after Merlinda has just pulled the emergency alarm patient buzzer and you go to help.

Control Room Lead Briefing

The aim of this scenario is to practise the emergency management of acute psychosis in a patient receiving haemodialysis. In this scenario the patient's mental state worsened as her antipsychotic medication had been cleared by haemodialysis.
The team should identify that she lacks capacity and that she needs to be restrained and sedated to deliver emergency treatment. The team should first ensure their own personal safety by wearing personal protective equipment (PPE). At the start of the scenario, Merlinda pulls out the dialysis needles, so the team need to act quickly. They should stop dialysis and restrain her enough to allow them to administer emergency sedation, put pressure on the fistula to stop the bleeding and resuscitate her. If not restrained and sedated, resuscitation will not be possible, and she will have a PEA cardiac arrest. She should be treated for cardiac arrest secondary to hypovolemia, and the major haemorrhage protocol (Code Red) should be activated. The scenario ends with the arrival of the crash team.

Patient Voice Briefing

You scream “get me off this monster, it is poisoning me”. When the team arrive, you scream “I know you are going to hurt me, if you come any closer I’m pulling these needles out- got them…they’re out”. You will not let anyone get near you ….you say “get that off” if they try and give you oxygen or put on any monitoring. As you lose more blood you start slurring your words and then become unresponsive, you remain drowsy and just grunt, if not appropriately managed you go silent (cardiac arrest).

Embedded Practitioner Briefing

You are the junior HD nurse. Merlinda came to HD calm, she received haloperidol 30mins before her dialysis session, and you were able to attach her to the haemodialysis machine. She was 4 kg above her dry weight, and you planned to take off 3kg UF on a low potassium tank, she was given standard 20mg enoxaparin.

The scenario starts with Merlinda screaming “get me away from this monster it’s trying to poison me”. Merlinda threatens that she is going to pull out her needles, you confirm that she has done this….(then start putting the “inko pads” on the floor pretending to clear up the blood, the “inko pads” will be dyed red to simulate blood soaked pads). Instruct the nursing team to be careful, mention that she is Hepatitis C positive and there is blood on the floor. Tell them that Merlinda is pulling off any oxygen or monitoring that they try to put on her, and that she is kicking and punching out, and that it is hard to approach her. Explain she is 2 hours into her routine haemodialysis session and that she had haloperidol 30 min prior to starting dialysis. You can direct them to her drug chart with prn sedation written on it, and her clinical notes.

If the team restrain and sedate her they can prevent further blood loss from the graft and appropriately resuscitate her.

If not sedated, after 3-5 mins she will start getting drowsy from hypovolemic shock. She will be unable to resist any monitoring or treatment. If not resuscitated she will arrest after 6-8 mins.

Further Discussion

The reason for her acute psychosis is clearance of her antipsychotic medication by haemodialysis. To avoid this situation her antipsychotic medication needs to be adjusted around her haemodialysis, this involves careful planning with the psychiatric team and renal pharmacist.

Patient: Merlinda Jones
FiO_2: 90%
Sample: Arterial

Blood Gas Values						
pH	**7.331**		[	7.350 - 7.450		]
pCO_2	**4.30**	kPa	[	4.00 - 6.50		]
pO_2	**16.0**	kPa	[	12.0 - 15.0		]
Acid Base Status						
HCO_3^-	**20**	mmol/L	[	22 - 28		]
BE	**-4.3**	mmol/L	[	-3.0 - 3.0		]
Oximetry Values						
Hb	**50**	g/L	[	135 - 175		]
SaO_2	**98.9**	%	[	95.0 - 100.0		]
Electrolyte Values						
K^+	**5.6**	mmol/L	[	3.5 - 5.0		]
Na^+	**140**	mmol/L	[	135 - 145		]
ion Ca^{2+}	**1.15**	mmol/L	[	1.10 - 1.35		]
Cl^-	**102**	mmol/L	[	96 - 106		]
Anion Gap	**17.0**	mmol/L	[	8.0 - 16.0		]
Metabolic Values						
Lact	**2.5**	mmol/L	[	0.5 - 2.0		]
Bili	**6**	µmol/L	[	-		]

Clinic Letter

Merlinda Jones

39-year-old lady

DH

Sodium valproate

Sertraline

Haloperidol PRN

Ramipril 2.5mg

Calcium acetate † tds

Alfacalcidol 0.25mcg

Neorecormon 2000 IU three times week

NKDA

Problem list

HD since 2010 on main unit M/W/F via AV graft, TW 65 kg

ESRF secondary to lithium toxicity

Schizophrenia

Depression

Hepatitis C –high viral load, under hepatology review

Suspended from transplant waiting list

Merlinda, didn't attend clinic today. She is an inpatient at the Maudsley mental health unit, with depression and active psychosis. Her updated medication list is above. She has been running high pre-dialysis potassium, between 5.8- 6.5 mmol/L, and her interdialytic weight gains are high around 3-4 kg. She is currently suspended from the transplant waiting list until her mental health and hepatitis C are better controlled.

We will review her in 2 months' time.

Yours sincerely

Dr Sharma

Learning Points

This scenario, based on an actual case, demonstrates the management of acute psychosis on haemodialysis, complicated by hypovolemic shock from massive graft bleed, and cardiac arrest.

The technical learning points are:

Prevention:
- Have a psychiatric nurse escort to reassure, detect agitation early and administer sedative drugs. If the patients' agitation does not settle despite intervention, a decision to stop dialysis and reschedule an additional session can be taken. Ensure a comprehensive plan is in place from the psychiatric team and that the sedative medication to be used in an emergency is both prescribed and easily accessible. Sedative medications (e.g. lorazepam or haloperidol) are not stocked on most dialysis units, which would result in a delay. Note that haloperidol is partially cleared by high flux dialysis, hence expect this drug level to drop throughout the dialysis session.

Management of the psychiatric state:
- Ensure your personal safety, wear personal protective equipment (visors, gloves and apron)
- She has "a disturbance in mind" so a capacity assessment needs to be conducted. She is clearly unable to understand, retain and weigh up the risks to make a decision so she does not have capacity. You should treat her in her best interests- including restraining if necessary- to deliver lifesaving treatment.
- Aim to de-escalate situation: stop dialysis and give sedation (IM route if she is not going to take anything orally, e.g. 2mg IM lorazepam or 2.5mg IM haloperidol)

Management of massive fistula bleed:
Stop the bleed with vigorous direct pressure on the fistula/graft. This is a massive bleed, save the patient's life not the fistula. Manage the patient with an A to E approach, give high flow oxygen and secure IV access and send urgent blood tests including blood for urgent cross match. Call 2222 asking for a "code red" or to activate "the major haemorrhage protocol". This brings a porter with 4 units of O negative blood and 4 units of FFP. Further code red packs will continue to arrive until called to stop. Consider need for other blood products such as cryoprecipitate and platelets which are not included as part of this protocol (discuss with haematology).

Human Factors we discussed when running this scenario:
Communication:
- In our scenario, an instruction to put out a cardiac arrest call was given to an individual already on the phone calling for the "code red". This instruction was not heard and therefore not acted on.
- Importance of communicating if you are unclear of how to perform a task. The individual trying to call for a "code red" didn't know how to do this. Other members of the team could have assisted if asked.

Feedback from the group was that everyone found the simulation very helpful, comments included: "Good to have practise in managing this very difficult scenario", "I learnt the do's and don'ts of managing emergencies on dialysis", "It improved my understanding of capacity".

Learning Points: Handout for Participants Following Acute Psychosis Scenario

REFUSAL OF TREATMENT

Common Law

Common law can be used to treat patients in emergencies, especially when the diagnosis is unclear. It allows necessary and proportionate restraint until Mental Capacity Act (MCA) or Mental Health Act (MHA) assessments are completed. The clinician must reasonably believe that action is necessary to prevent harm to the patient (or others). Actions must be proportionate to the likelihood of the patient (or others) being harmed and the seriousness of that harm. This governs treatment in emergency situations, it enables restraint, and it can be used for both physical and mental health disorders.

Mental Capacity Act (MCA)

MCA is the legal framework for decision-making on behalf of adults who lack capacity to make decisions for themselves. It covers patient's best interests only, not the protection of others, and applies only to those aged 16 years and over.

Capacity is the ability to make a specific decision at a particular time:

1. Adults are assumed to have capacity unless shown otherwise
2. All practical steps must be taken to help an individual make a decision
3. A person is not to be treated as unable to make a decision merely because they make an unwise decision
4. An act done, or decision made, on behalf of a patient who lacks capacity must be done in their "best interests"…this must be in the least restrictive way

When should I assess capacity?

Does the individual concerned have an impairment of, or a disturbance in the functioning of, their mind or brain, whether as a result of a condition, illness, or external factors such as alcohol or drug use? Does it affect their ability to make a decision?

Capacity Assessment

1. Can the individual understand the treatment?
    - Risks and benefits of the treatment
    - The implications of not having it
    - Discuss any alternatives
    - Use a level appropriate to the individual

2. Can the individual retain information regarding treatment?
    - Observe for cognitive deficits
    - Cognitive testing may help
    - Can the patient recall or paraphrase the discussion?

3. Can the individual weigh up information regarding treatment?
    - Appreciate the wider consequences of the decision?
    - Apply the information to their own situation?
    - Weigh up the risks and benefits of options?

Help - my patient doesn't have capacity

If the individual is deemed not to have capacity – decision should be in their best interests. Treatment and care should be given using the least restrictive option.

Mental Health Act

- Regulates the treatment of mental but not unrelated physical health problems
- Patients have same rights as others regarding decisions about physical health care
- Allows medical treatment for mental disorder to alleviate or prevent a worsening of the mental disorder or one of its manifestations, for instance the physical consequences of self-harm.

	Section 5,2	**Sections 2**	**Section 3**
Why?	"Doctors holding power" To stop the individual from leaving hospital if deemed to be at a risk to themselves or others due to a mental disorder. Can be used in a general or psychiatric hospital	For assessment and treatment of a mental disorder if the individual is a risk to themselves or others	For treatment of a mental disorder. Established mental illness.
Who?	The doctor in charge of patient's care at the time	AMHP* 2 doctors (usually psychiatrists), 1 doctor must be Section 12 approved	AMHP* 2 doctors (usually psychiatrists), 1 doctor must be Section 12 approved
Duration?	Up to 72 hrs	Up to 28 days	For 6 months
Discharge?	If not converted to Section 2 or 3, automatic discharge occurs after 72 hrs	By the RC** (responsible clinician) Nearest Relative The Tribunal Mental Health Act Managers	By the RC** (responsible clinician) Nearest Relative The Tribunal Mental Health Act Managers

AMHP** (Approved Mental Health Professional)* *****RC (Responsible Clinician)

The Clinical Case

What is psychosis / schizophrenia?
Psychosis – perceptual disturbances and delusional thinking, i.e. seeing or hearing things that are not there and having paranoid beliefs that are fixed and unshakeable. Individuals' functioning is impaired as a result of these symptoms. Schizophrenia is chronic psychosis that can be relapsing and remitting.

1. Should we be assessing capacity? Yes, she has a known mental illness and is currently being treated for an acute exacerbation of the illness
2. Under what legal framework would you be managing this individual? Common law, this is an emergency situation. There is no time to carry out a MCA. She is presenting as a risk to herself and others.
3. What do we think about her capacity? Psychotic thinking significantly impairs her ability to understand and weigh up the information. She believes the treatment is trying to harm her and is part of her delusional thought process. She lacks capacity.

What are the risks?

Self

- Deterioration in physical health secondary to blood loss
- Deterioration in mental health due to low levels of antipsychotic medication
- Injury to self with sharp objects

Others

- Injury to staff from needles / sharp objects; known Hepatitis C positive so risk of infecting others
- Aggression and possible injury towards staff due to psychotic state

Management

- Ensure personal safety with gloves, apron and eye protection
- Call for help from colleagues on ward
- Call for medical assistance – peri-arrest call
- Call security for further assistance
- Give space, position yourself near the door
- Use a calm authoritative tone
- Restraint may be required for further medical intervention
- Rapid sedation PO / IM, 1-2mg Lorazepam, 2.5-5mg Haloperidol, 50mg Promethazine

Further action / considerations

- Good communication needed amongst the staff managing haemodialysis and with the psychiatric team
- Senior clinicians should be involved from both teams to make a clear care plan which should be written and verbally handed over
- Communication should be ongoing between professionals
- Consider 1:1 RMN nurse
- Consider bringing PRN medication as required from psychiatric ward, so it can be given as early as possible if needed

Part 2. CASES ADAPTED FOR NURSE-LED SATELLITE UNITS

In situ simulation team training was also taken out to the satellite haemodialysis units. These units are nurse led with no on-site doctors. The scenarios therefore needed to be adapted to make them relevant to the team caring for patients in the satellite units. Changes to the scenarios included tailoring the emergencies to the local resources; this may involve a different lay out and content of the simulated crash trolley, a different defibrillator (manual or AED), and changing the scenario according to whether the unit has access to a "crash team" or whether an ambulance needs to be called.

As well as in situ simulation team training, a skills workshop session (see Part 3) was run which took place prior to the simulation scenario. The simulation scenario was then run to contextualise the learning and focus on human factor training.

When running the simulation training, questions were raised about which emergency medications nurses were permitted to administer from the crash trolley without verbal or written authorisation by a doctor. In the absence of a specific patient group direction (PGD), guidance can be taken from the Statutory instrument (SI) 1997 from the Prescription Only Medicines Order 1830 article 7 (http://www.legislation.gov.uk/uksi/1997/1830/made) and the resuscitation council UK. This gives a list of drugs that can be administered parenterally without prescription or verbal authorisation by a licenced prescriber in the context of a life threatening emergency. The table below illustrates the more commonly used medications which can be administered without a licenced prescriber's authorisation.

Commonly used medications that can be administered in a life threatening emergency without authorisation by a licenced prescriber

Drug	Usual Dose	Route	Main emergency indication	Who can administer
Adrenaline	0.5mg-1mg 1:1000*	IM	Anaphylaxis	Any individual
Adrenaline	1mg 1:10000	IV	Cardiac arrest	ALS trained healthcare member (as per ALS cardiac arrest protocol)
Amiodarone	300mg	IV	Cardiac arrest	ALS trained healthcare member (as per ALS cardiac arrest protocol)
Atropine sulphate	0.5mg- 3mg	IV	Bradycardia	Any individual
Chlorphenamine	10mg	IM/IV	Anaphylaxis	Any individual
Glucagon	1mg	IM	Hypoglycaemia	Any individual
Hydrocortisone	200mg	IM/IV	Anaphylaxis	Any individual

**Statutory instrument does not specify doses of drugs except adrenaline, where a non licenced prescriber can give up to 1mg of 1:1000 adrenaline IM in the context of a life threatening emergency*

Example timetable in satellite unit

Morning session

4x 30min: workshop sessions

Afternoon: scenario

15mins: Introduction, orientation to simulation set up & manikin

15 mins: Scenario

45 mins: Debrief of scenario

15 mins: Small group handover exercise

Scenario: Carla Williams; Anaphylaxis

Scenario Quick Notes

Patient name:
Carla Williams

Age: 28 years

Clinical Headline:
Anaphylactic reaction secondary to dialysis membrane

Background:
HD since 2015 via AVF x3/week, TW 60kg

PMH: ESRF secondary to anti GBM disease 2015, asthma, active on transplant waiting list

DH: ramipril, calcium acetate, IV iron, salbutamol inhalers prn, NKDA

SH: Hairdresser, lives with fiancée, recent ex- smoker

Clinical learning objectives:

Recognition of acutely unwell patient
Recognition of anaphylaxis
Recognition of cause of anaphylaxis likely to be the dialysis membrane; relevance of cause
Treatment of anaphylaxis
Management of respiratory/cardiac peri-arrest
Timely call for urgent medical help- ambulance or cardiac arrest team

Anticipated human factor objectives:

Communicates clearly in a variety of settings
Works effectively as a team
Demonstrates leadership skills
Forward planning and escalation

Expected scenario progression:
Carla, a 28- year-old woman, is well on arrival to her routine dialysis session. She is 2kg above her target weight and a 2L UF is planned. She has been attached to a new dialysis machine. 5 minutes into dialysis she feels flushed, breathless, and rapidly progresses to stridor, has difficulty breathing and desaturates with cardiovascular collapse. The nurses should identify that the patient is in extremis, call for help and instruct a colleague to put out a 2222 cardiac arrest call or call for a blue light ambulance. An A to E assessment should be performed, high flow oxygen administered and haemodialysis stopped. If the team suspect anaphylaxis, 500mcg 1:1000 intramuscular adrenaline should be given at the earliest opportunity and without delay, and the patient disconnected from the machine. Parenteral hydrocortisone 200mg and chlorphenamine 10mg should be given. If adrenaline is not administered the patient will have a PEA cardiac arrest. If a fluid bolus is administered through

the dialysis machine, or the venous needles are used at any point during the scenario, she will deteriorate further. The scenario ends with arrival of the cardiac arrest team/ambulance.

Faculty and participants

Faculty: minimum of three	*Participants:*
Sim technician and patient voice, control room lead, embedded practitioner	2 dialysis nurses
Member of faculty trained for structured debrief plus a senior member of renal team	Joined by 2 further nurses

Sim Set Up

Extra Props and Settings

ECG: Sinus tachycardia
Drug chart
Clinic Letter
Training AED/manual defib
Emergency drugs/O2/kit for intubation and airway adjuncts

Manikin Settings

Chest: initially wheeze bilaterally

Initial Observations:

Sats	98% OA
RR	20
HR	90
BP	125/75
Temp	36.5

Non Manikin Observations:
Cap Refill: <2s
GCS: E4V5M6
BM 6.0

HD settings:

Dry weight 60kg planned 2L UF over 4hours
FX80 A7
Blood flow rate 300ml/min
UF 500ml/hr
Enoxaparin 20mg
Observations on arrival at HD: BP 130/80, HR 60, 62kg

Participant Briefing: to Dialysis Nurse

Carla is well on attending her routine dialysis. She is using a new dialysis machine. A few minutes into her session she complains of feeling dizzy and breathless. You are called by the junior dialysis nurse to help.

Control Room Lead Briefing: Up to 10 minute scenario.

1-2mins:
Initial observations normal (see above).

2-5mins:
A – Worsening stridor
B - RR increases to 26, bilateral wheeze, SaO2 92%
C – HR increases to 130, BP initially maintained
D – GCS 15/15
E – Nil

5-7mins: ***If IM 500mcg of 1:1000 adrenaline, high flow oxygen, hydrocortisone and chlorphenamine administered and the patient taken off dialysis***
A – Improving stridor
B – Improving wheeze. RR 20-25. SaO2 98% if on O2 via non rebreathe mask (NRBM)
C – HR 140, No change in BP.
D – GCS 15/15
E – Nil

5-7mins: ***If adrenaline not administered or fluid bolus given from dialysis machine:***
A – Apnoea
B – Apnoea, SaO2 reduces to 30% despite O2, (if the patient is manually ventilated, SaO2 can increase to 85% but chest compliance is poor).Chest compliance improves and SaO2 increases to 95% only if anaphylaxis protocol drugs given delivered
C – HR140, BP 60/20
D – GCS E1V1m1, Pupils 3+/3+
E – Nil

7-10mins: ***If medications for anaphylaxis given correctly, and venous dialysis needles not used:***
A – Stridor resolves
B – Breathing improves, RR 20, SaO2 99% on O2,
C – HR 100, BP 130/70, Normal cap refill
D – GCS 15/15, calm
E – Nil

7-10mins: ***If adrenaline not given or fluid bolus given via dialysis machine:***
A – Apnoea
B – Apnoea, No SaO2 monitor pick up
C – Bradycardia leading to PEA cardiac arrest
D – GCS 3/15, pupils 3+/3+
E – Nil

8-10mins: ***If cardiac arrest appropriately managed with CPR and IV 1mg 1:10000 adrenaline administered by ALS trained staff or arrival of crash team/paramedics***
A – Apnoea
B – Apnoea, SaO2 92% if bag valve mask (BVM) ventilation with O2
C – ROSC, HR 120 ST, NIBP 110/70
D – GCS 3/15 Pupils 4+/4+
E – Nil

Patient Voice Briefing
Initially:
A – Itchy throat, able to speak in full sentences
B – No difficulty in breathing
C – N/A
D – GCS 15/15, but frightened- is this her asthma? She had all her normal medications. She didn't have IV iron today. The participants are able to take a brief history from her.

2-3 mins
A – Stridor
B – Difficulty in breathing and speaking
C – N/A
D – GCS 15/15, increasingly agitated
E – Nil

3-5mins
A – Increasing stridor, unable to verbalise
B – N/A
C – N/A
D – E4V2M6, agitated, only able to make sounds
E – Nil

5-7mins: ***If adrenaline, high flow oxygen, hydrocortisone and chlorphenamine administered :***
A – Improving stridor
B – Able to speak single words
C – N/A
D – E4V5M6, able to speak single words only
E – Nil

5-10mins: ***If adrenaline not administered:***
A – Apnoea
B – Apnoea
C – N/A
D – GCS E1V1M1
E – Nil

Embedded Practitioner Briefing
You are a junior nurse and you called your nursing colleagues for help. Carla was well before commencing HD, but a few minutes into the session she started to complain of feeling breathless and dizzy. It is a new dialysis machine.
If asked, there have been no recent changes to her medications. She has no known allergies.
You are helpful and competent in following instructions e.g. to stop dialysis, provide oxygen (they should specify the delivery device), retrieve drugs and deliver chest compressions.

Further Reading
Ebo D G, et al "Haemodialysis-associated anaphylactic and anaphylactoid reactions." *Allergy* 61.2 (2006): 211-220.
https://www.resus.org.uk/EasySiteWeb/GatewayLink.aspx?alId=824

Clinic Letter

Carla Williams

28-year-old lady

Problem list

HD since 2015 on main unit M/W/F, via AVF, TW 60 kg

ESRF secondary to anti GBM disease

Asthma

Active on transplant waiting list

DH

Ramipril 2.5mg od

Calcium acetate Ŧ tds

Alfacalcidol 0.25mcg

IV iron

Salbutamol inhaler

NKDA

Carla is continuing to have dialysis on our satellite dialysis unit through her fistula. She is doing well. Her blood pressure is well controlled, and she has minimal interdialytic weight gain. Her haemoglobin and phosphate / PTH are all within target range and potassium well controlled.

She is working as a hairdresser and is active on the transplant waiting list.

We will review her in 2 months' time.

Yours sincerely

Dr Scott

Learning Points

Anaphylaxis on haemodialysis is a rare but life-threatening event, quoted as occurring in around 1 in 12000 dialysis sessions (Ebo D G et al, 2006). Recognised culprits include chemicals used to sterilise the dialysis membranes (particularly ethylene oxide), the dialysis membrane itself (particularly the high flux polyacylnitrile membrane), or reaction to heparin or iron if given on dialysis.

If suspecting anaphylaxis, stop dialysis and do not give fluid back from the dialysis machine. Treatment initiated early with adrenaline is imperative (IM 1:1000 0.5mg), and high flow oxygen, intravenous fluid, hydrocortisone and chlorphenamine should be given.

The learning points were:

- Consider the time frame: in this scenario the patient was entirely well on starting her routine HD using a new dialysis machine and became symptomatic soon after starting dialysis with breathless and wheeze- this acute nature with classical symptoms suggests an anaphylactic reaction.

- Anaphylaxis can present in many ways, a rash, wheeze and lip swelling is not always present. Initial presentation can be with cardiovascular collapse.

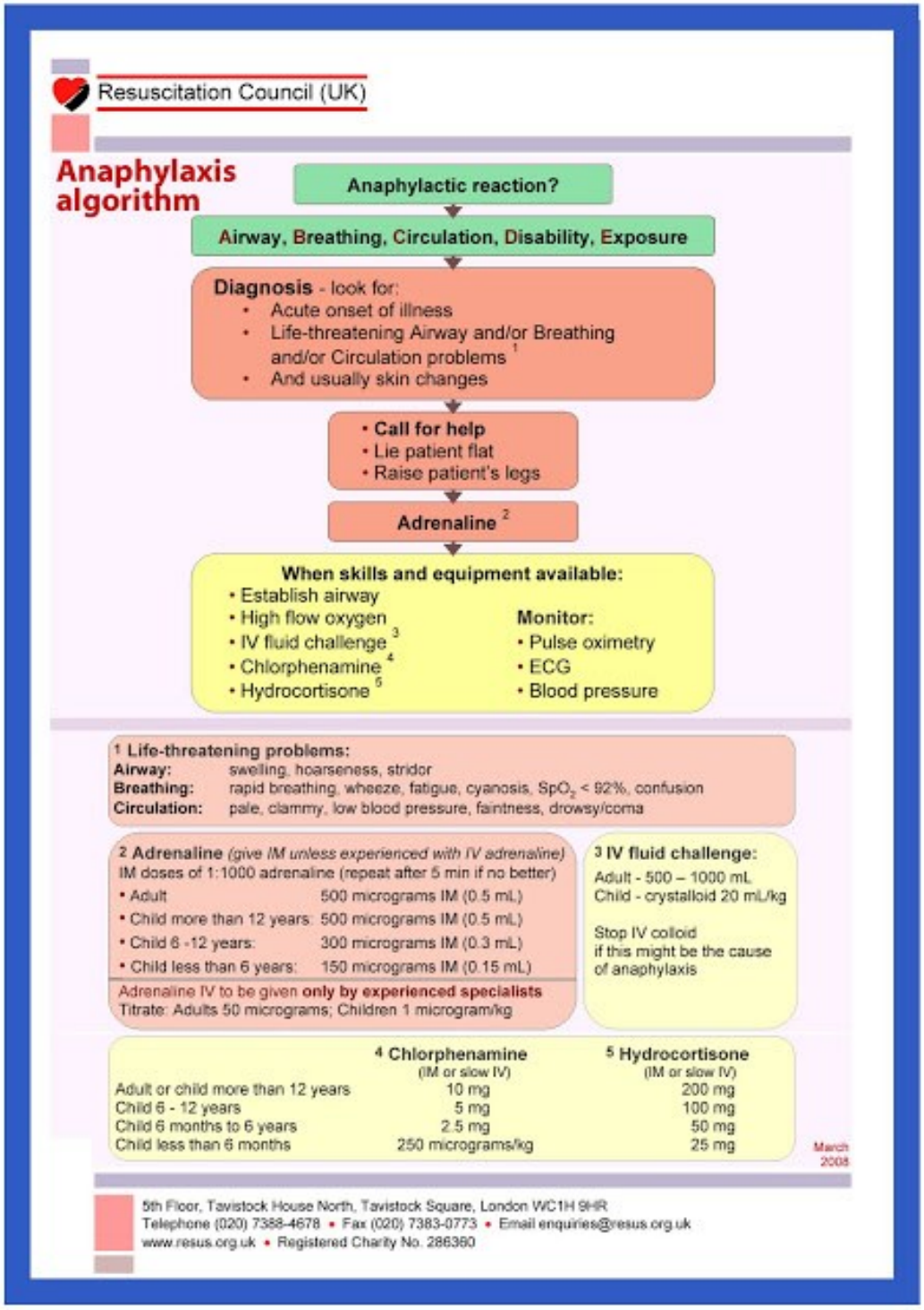
- If suspecting anaphylaxis, adrenaline should be given immediately, then proceed with treatment according to an A to E approach. Any individual can give IM adrenaline 1:1000 for suspected anaphylaxis.

- Consider the source of the anaphylaxis and remove this immediately- in this case the dialysis membrane. Disconnect the patient from dialysis, remove the venous needle and only use the arterial needle for access.

- The importance of using the systematic A to E approach was discussed to ensure most time critical interventions are performed first.

- Escalating the patient's care urgently, and using the SBAR framework to communicate clearly.

- Leadership and supporting the leader was discussed. This may be through empowering them to lead; this was seen during our scenario with "let me perform chest compressions so you can stand at the end of the bed", and members of the team volunteering "I am bringing the crash trolley", "I will call for the ambulance".



Resuscitation Council (UK) 2008
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King's Clinical Training

In Situ Dialysis Simulation Scenario for satellite units

Scenario: Evelyn Reid; Cardiogenic Shock

Scenario Quick Notes

Patient name:
Evelyn Reid

Age: 67 years

Clinical Headline:
Ventricular tachycardia on haemodialysis
Cardiogenic shock
Cardiac arrest- shockable rhythm

Background:
HD since 2005 via AVF x3 week, TW 45 kg

PMH: ESRF secondary to HTN,
IHD, Previous myocardial infarction
Poor LV function & diastolic dysfunction, EF 30%

DH: aspirin, bisoprolol ,ramipril, calcium acetate, alfacalcidol, neorecormon

SH: Lives in a warden controlled retirement home with husband, husband main carer, only leaves her flat for dialysis.

Clinical learning objectives:

Recognition of the acutely unwell patient
Early call for cardiac arrest team/ ambulance
Systematic A to E assessment and treatment
Early connection of patient to monitor/ defibrillator on crash trolley
Recognition of cardiac arrest and treat according to shockable rhythm
Administration of adrenaline IV and amiodarone IV as per cardiac arrest algorithm (ALS trained staff only)

Anticipated human factor objectives:

Communication
Teamwork
Leadership
Escalation
SBAR handover
Knowledge of location of emergency resources

Expected scenario progression:
Evelyn has attended for her regular haemodialysis; she arrives 3kg above her TW and is breathless.

The junior dialysis nurse plans to remove 3L UF over the 4 hour session. Evelyn's blood pressure is 95/50 on arrival, within her normal range.
The scenario starts ½ hr into the session, with Evelyn complaining of feeling dizzy and tired and the machine alarming due to low blood flows.

Nursing team participants arrive: Evelyn expresses feeling very dizzy, tired and breathless. The team should make an A to E assessment and record her observations. She is maintaining her airway, saturations 92% on air. Her RR is high, and she has bilateral crackles on auscultation. High flow oxygen should be administered. She is tachycardia 180, and hypotensive 80/50. She is confused GCS 14 with a normal blood sugar and is afebrile. Dialysis should be stopped and a fluid bolus administered. She should be tilted head down/ legs raised and response to fluid bolus assessed. The emergency buzzer/call for more help should be made, and instructions given to call for an ambulance/ cardiac arrest team and to bring the crash trolley. The patient should be attached to the defibrillator. A broad complex tachycardia will be present on the defibrillator monitor. Evelyn will then arrest pre-arrival of the cardiac arrest team/ambulance. Expect team to confirm cardiac arrest, give an early shock, followed by good quality CPR, and appropriately manage the patient's airway using adjuncts as well as ventilate her using a bag valve mask (BVM). *If members of the team have been ALS trained then 1mg Adrenaline 1:10000 IV should be given each 3-5 mins and amiodarone 300mg IV after the third shock as per the cardiac arrest algorithm*. CPR should continue until the ambulance/cardiac arrest team arrives. If well managed the patient will have signs of return of spontaneous circulation (ROSC). On arrival of the ambulance /crash team a SBAR handover should take place and the scenario ends.

Faculty and participants

Faculty: minimum of three	*Participants:*
Sim technician and patient voice, control room lead, embedded practitioner Member of faculty trained to give a structured debrief plus a senior member of renal team	Minimum of 3 nurses

Sim Set Up

Extra Props and Settings:

Clinic letter
Drug chart

Training AED/manual defib
Emergency drugs/O2/ airway adjuncts

Manikin Settings:

Chest: bilateral crackles
Initial Observations
½ hour into dialysis:

Sats	92% OA
RR	26
HR	180-200
BP	80/50
Temp	37.0

Non Manikin Observations:
Cap Refill: 3s
GCS: 13 (E3, V4, M6)
BM 6

HD Settings:

Dry weight 45kg, planned UF 3L over 4 hours
FX80 A7
Blood flow rate 300ml/min
UF 750ml/hr
Enoxaparin 20mg
Observations on arrival at HD: BP 95/50, HR 90, weight 48kg

Initial observations ½ hour into dialysis

Sats	90% (On air)
RR	26
HR	180-200
BP	80/50
Temp	37.0
GCS	14
BM	6

Observations post 250 ml fluid

Sats	98% (15 L)
RR	28
HR	180
BP	85/50
Temp	37
GCS	12
BM	6

Peri-arrest Observations

Sats	98% (15L)
RR	40
HR	200
BP	65/40
Temp	37
GCS	9
BM	6

Participant Briefing: to Dialysis Nurses

You are called by the junior dialysis nurse to see Evelyn. She is 67-year-old lady with ischaemic heart disease and has been on dialysis for 12 years. She struggles with fluid restriction, and she often drops her blood pressure on HD. She came today 3 kg above her target weight. The dialysis machine is set to remove 3L of fluid over 4 hours. Evelyn is 1/2 hour into the session and you are asked to help as Evelyn is feeling dizzy.

Control Room Lead Briefing

This scenario is designed to show management of ventricular tachycardia and cardiogenic shock which progresses to cardiac arrest-shockable rhythm on the satellite dialysis unit. The scenario starts with Evelyn in extremis with ventricular tachycardia, she is hypotensive and confused. The team should recognise that she is in extremis and make an early call for the ambulance/cardiac arrest team. The team should assess and treat the patient using an A to E approach. Evelyn will arrest and should be resuscitated according to the cardiac arrest algorithm – shockable pathway. If well managed return on spontaneous circulation will be achieved. The scenario ends with the arrival of the ambulance/cardiac arrest team.

Patient Voice Briefing
You are confused and feel dizzy, tired and breathless. You speak only on direct questioning, managing a few words at a time. Later in the scenario you become unresponsive.

Embedded Practitioner Briefing
You are the junior dialysis nurse. You are helpful but not experienced. Evelyn came to dialysis with a blood pressure of 95/50, this is around her normal blood pressure. She was a bit dizzy and breathless on arrival. She was 3kg above her target weight and you planned to remove 3L over her 4 hour session. The scenario starts ½ hour into Evelyn's HD session with the machine alarming and the patient reporting dizziness.

Blood Results (from last session pre-dialysis)

Hb 100, Plt 180, WCC 8.3, INR 1.2, K 6.4, Na 130, Bil 2, ALT 5, CRP 3

Technical points for discussion:
- Safe fluid removal on haemodialysis
- Risk factors for arrhythmias on haemodialysis
- CPR algorithm, situational planning and early call for cardiac arrest team/ambulance
- Handover to ambulance/ cardiac arrest team
- Suitability for long-term HD at satellite unit

Clinic Letter

Evelyn Reid

67-year-old lady

Problem list

HD since 2005 on main unit M/W/F via AVF, TW 45 kg

ESRF secondary to HTN

IHD, previous MI

Poor LV function EF 30%, diastolic dysfunction

Lives in warden controlled flat

DH

Aspirin 75mg

Bisoprolol 1.25mg

Ramipril 2.5mg

Calcium acetate † tds

Alfacalcidol 0.25mcg

Neorecormon 2000 IU three times week

NKDA

Evelyn is continuing to have dialysis on our satellite haemodialysis unit via her fistula. Her interdialytic weight gain is around 2-3 kg. Her blood pressures are always low around 100-90/50-40, with syncopal episodes reported around once a month on haemodialysis. Her pre- dialysis potassium levels have been running high at 6.
She lives with her husband, can walk around her flat with an exercise tolerance of around 10-20m. She doesn't leave her home other than to attend haemodialysis.
We talked today about the importance of reducing her weight gain in between dialysis sessions, tightly restricting her fluid intake, and complying to a low potassium diet.
Her recent echo showed a functional MR, with dilated LV and EF 30%, and diastolic dysfunction.
We are unable to increase her cardiac medications further given her low blood pressures.
We will review her in 2 months' time.

Yours sincerely

Dr Sharma

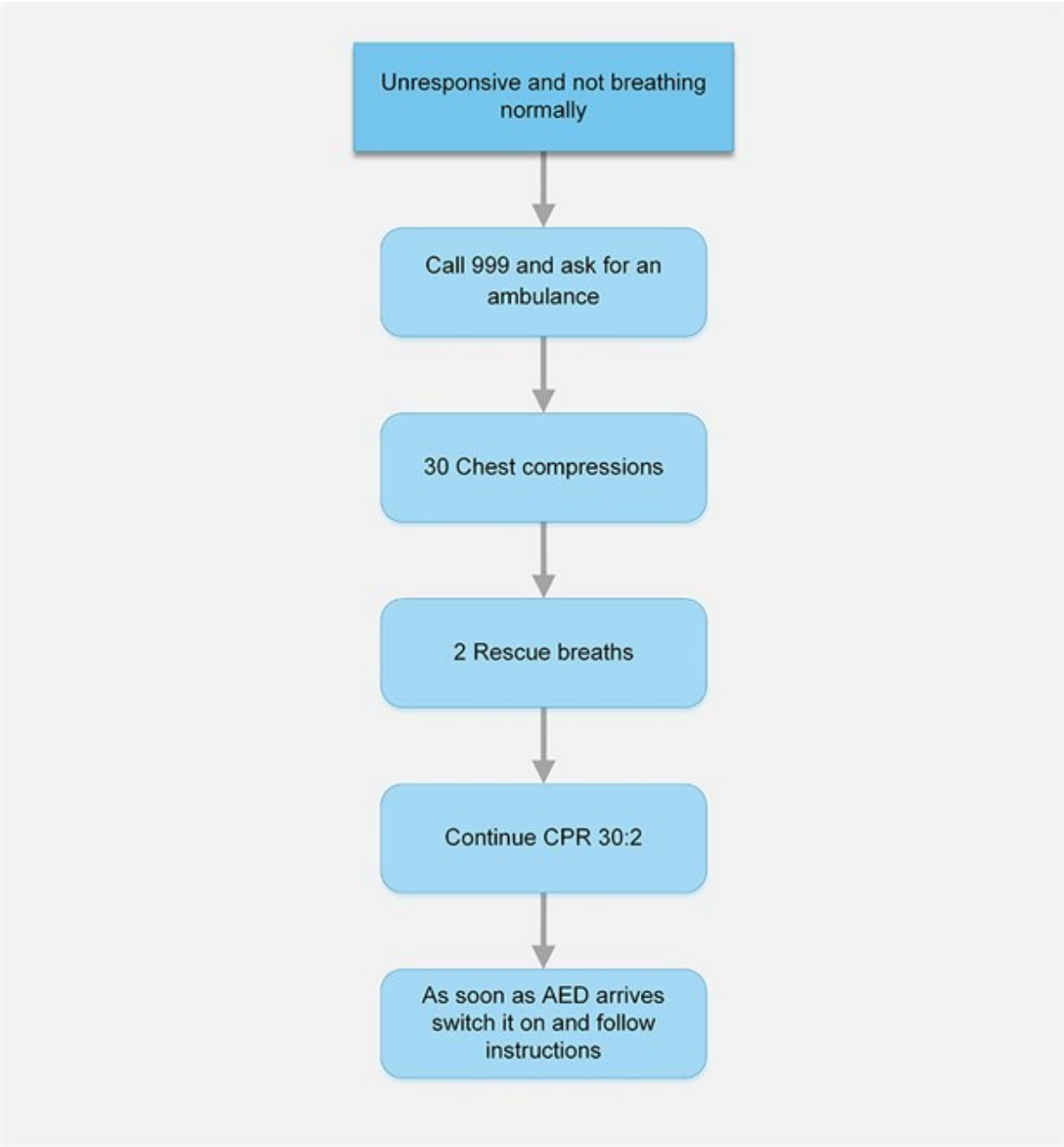
Learning Points

This scenario demonstrates management of cardiogenic shock and cardiac arrest in a 67- year- old lady receiving haemodialysis in a satellite unit.

The technical learning points were:
Prevention of the scenario occurring in first instance:
- Consider the appropriateness of large UF volumes in a hypotensive patient with a cardiac background; consider whether additional HD sessions for isolated UF should be scheduled. The importance of fluid restriction should be discussed with the patient to reduce the need for large volume UF. This unstable patient with frequent syncopal episodes on haemodialysis should ideally be dialysed in the main hospital unit where medical support is on site.

Management of this scenario:
- Use a systematic A to E approach, give high flow oxygen, stop dialysis, and give a cautious fluid bolus for hypotension. Get the crash trolley and attach the patient to defibrillator.
- Send-off bloods and a spot K, if this resource is available.
- Call the crash team/ambulance early.
- Continue to re-assess using and A to E approach. This will ensure that cardiac arrest is detected early. Once cardiac arrest is confirmed, defibrillate immediately and start CPR, proceeding according to the shockable side of the cardiac arrest algorithm. ALS trained staff are authorised to give IV adrenaline 1:10000 and IV amiodarone once in cardiac arrest and administer the drugs in accordance with the algorithm.

Human Factors:
This scenario highlighted the importance of clear communication, and how this can be achieved by using the “closed loop communication” model. This is where clear instructions are given to a named individual; the individual then accepts the task and feeds back when the task has been performed or if they are unable to perform it. SBAR was discussed as a model to give a succinct handover, with the importance of stating the most important information first.



BLS algorithm Resuscitation Council UK 2015

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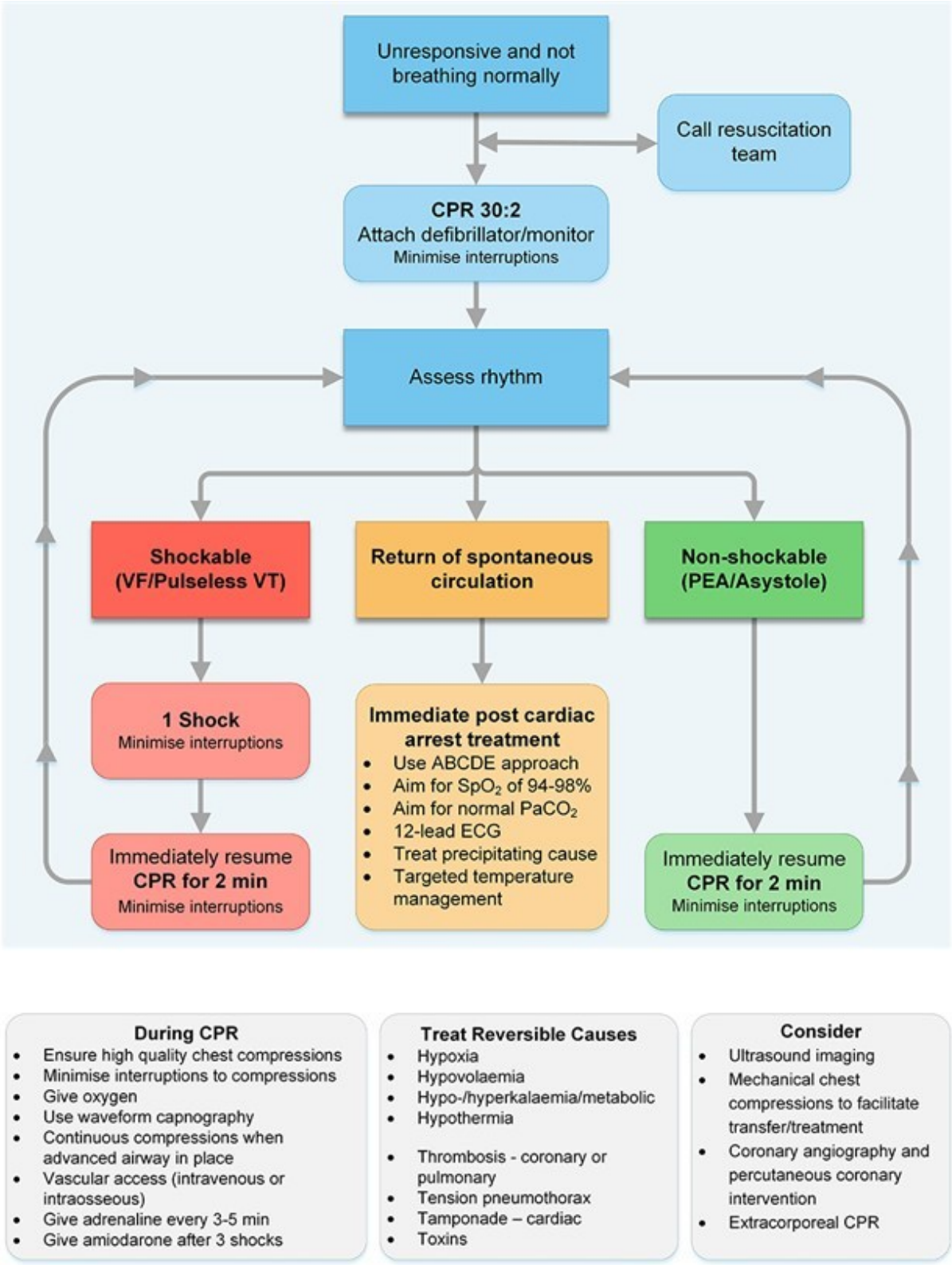

ALS Cardiac Arrest Algorithm Resuscitation Guidelines 2015
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In Situ Dialysis Scenario for satellite units

King's Clinical Training

Scenario: Ivy Shivers; Seizures

Scenario Quick Notes

Patient name:
Ivy Shivers

Age: 65 years

Clinical Headline:
Seizures on HD

HD since 2016 via AV graft x3 week, TW 75kg

PMH: ESRF secondary to diabetic nephropathy, hypertension, diverticulitis

DH: aspirin, ramipril, calcium acetate, alfacalcidol, neorecormon, levemir 6 units od, novorapid 2-4units tds

SH: Lives with husband- independent.

Clinical learning objectives:
Recognition of the acutely unwell patient
Management of seizures; mantaining a safe airway
Detection and appropriate treatment of hypoglycaemia (note nurses can administer IM glucagon without doctor authorisation)
Stabilisation pre- ambulance/crash team arrival with effective handover

Anticipated human factor objectives:
Communication
Team work
Leadership skills
Situational awareness, forward planning and escalation

Expected scenario progression:
Ivy attends her routine HD session. She has been diagnosed with a urinary infection and has been prescribed oral antibiotics. She reports being a little more muddled and forgetful over the last week. She comes to dialysis 1kg above her target weight, BP 120/80.
The scenario starts 1 hour into Ivy's dialysis session, the nurse participants are asked to see Ivy who is complaining of feeling dizzy and tremulous. The nursing team should perform an A to E assessment and take a focused history; shortly after obtaining the observations/ a few minutes into the scenario, Ivy starts to have a seizure. It may need to be pointed out by the embedded practitioner that she is having a seizure if it is not easily seen.
Expect nurses to call for more help (press the emergency buzzer) and instruct one of the team to call for the cardiac arrest team /ambulance, and bring the crash trolley. The nurses should assess and treat using a systematic A to E approach. High flow oxygen should be given, the patient put in the recovery position, and airway manoevres performed/airway adjuncts used to maintain the airway- an oropharyngeal airway will not be tolerated due to trismus but a nasopharyngeal airway will be tolerated. The seizure should be timed. Haemodialysis should be stopped and dialysis tubing secured. Ivy's conscious level should assessed using the

glasgow coma score (GCS) or "AVPU" score. Her blood sugar should be checked. This will be 1.7mmol/L. The team should identify this as hypoglyceamia, and a likely cause for the seizure. The hypoglycaemia should be corrected with 1mg glucagon IM (as this can be administered by nurses without authorisation by a doctor), unless a PGD is in place allowing the hypoglycaemia to be treated with IV dextrose. The patient stops having seizures once her blood sugar has been appropriately corrected. The scenario ends with arrival and handover to the cardiac arrest team / paramedics.

Faculty and Participants

Faculty: minimum of three

Sim technician and patient voice, control room lead, embedded practitioner

Member of faculty trained to give a structured debrief plus a senior member of renal team

Participants:

Initially 2 nurses, joined by further 2 or more nurses

Sim Set Up

Extra Props and Settings:

ECG None: unable to get trace
Clinic letter
Drug chart

Training AED/manual defib emergency drugs/O2/kit for intubation and airway adjuncts

Manikin Settings:

Chest: clear
Observations at 1 hour into HD

Sats	96% OA
RR	18
HR	120
BP	120/80
Temp	37.0

Non Manikin Observations:

Cap Refill: <2sec
GCS: E4, V4, M6
BM 1.7 mmol/L

HD Settings:

Dry weight 75kg, planned 1 L UF over 4 hours
FX80 A7
Blood flow rate 300ml/min
UF 250ml/hr
Enoxaparin 20mg
Observations on arrival at HD: BP 120/80, HR 90, weight 76kg

Few minutes into scenario patient starts to have seizures

Sats	Poor trace due to seizure
RR	18
HR	Poor trace due to seizure manual 120
BP	Unrecordable due to seizure
Temp	37.5
GCS	E1, V1, M2 , all limbs seizing
BM	**1.7**

Post ictal observations-following correction of BM

Sats	96% 15L
RR	12
HR	110
BP	150/80
Temp	37.5
GCS	E2, V3, M6
BM	**3.2**

Participant Briefing:
Ivy is at her regular haemodialysis session. She is being treated for a urinary infection and has been rather muddled. She attends feeling a little dizzy. Her blood pressure at the start of dialysis is 120/80; she is planned for 1L UF to bring her to her target weight of 75kg. You are called to see her as she is feeling dizzy…
(Do not mention diabetes in this briefing, the patient notes will be available)

Control Room Lead Briefing
The aim of this scenario is to safely manage seizures in a patient on haemodialysis by using an A to E approach, with a focus on securing a safe airway. The team needs to consider the differential diagnosis of seizures in a patient receiving haemodialysis. Blood sugars should be measured and hypoglycaemia identified and treated according local guidelines (where a PGD is in place treatment should be in accordance with this, alternatively 1mg glucagon IM, should be administered). The team should recheck and continue to monitor the blood sugars post treatment. The scenario ends post handover to the crash team / or ambulance.

Patient Voice Briefing
At the start of the scenario you say a few words such as " I am feeling strange"; you then start to have a seizure and you snore/grunt. Once your BM is corrected you stop fitting and you are drowsy-post ictal.

Embedded Practitioner Briefing:
You call the nurse for help as Ivy is feeling dizzy and tremulous. You mention she has been a little muddled since starting dialysis, that she is being treated for a urinary infection, and that her observations were all fine when she started dialysis. If ask about her sugars, say you haven't measured them, and direct them to the glucometer.
A few minutes into the scenario Ivy starts to have a seizure, please point this out to them if they don't recognise it.
Once her blood sugars have been appropriately corrected she will stop fitting. If they try and put in an oral airway explain her teeth are clamped down, and her neck is rigid, so it is hard to do a head tilt/chin lift. Assist the team in putting her in a recovery position.

Further Points to discuss in debrief
- Differential diagnosis of seizures in a patient on haemodialysis
- Emergency management of a seizure prior to arrival of medical support
- Maintaining a safe airway
- Safe, appropriate treatment of hypoglycaemia in the satellite haemodialysis unit
- Consideration of whether a patient is safe to self-administering insulin during inter-current illness.

Suggested exercise: Following the debrief, ask participants to handover the patient to the renal registrar using the SBAR format to inform them they are being transferred to their emergency department.

Clinic Letter

Ivy Shivers

65-year-old lady

Problem list

HD since 2016 on main unit M/W/F via AV graft, TW 75 kg

ESRF secondary to diabetic nephropathy

Hypertension

Diverticulitis

Active on transplant waiting list

DH

Ramipril 2.5mg od

Calcium acetate † tds

Alfacalcidol 0.25mcg

Neorecormon 2000 IU a week

Aspirin 75mg od

Levemir 6 units ON

Novorapid 2-4 units with meals

NKDA

Ivy continues to receive haemodialysis on the satellite unit through her AV graft. She is doing very well. Her blood pressure is well controlled, and she has minimal interdialytic weight gain. Her biochemical parameters are all within target range. She has a residual urine output of 1 litre. Her blood sugars are well controlled between 6-10mmol/L.

In clinic she had symptoms of dysuria. A urine sample sent from clinic has cultured a heavy growth of Ecoli sensitive to ciprofloxacin. She has been informed, and will commence a five-day course of ciprofloxacin.

We will review her in 2 months' time.

Yours sincerely

Dr Scott

Learning Points

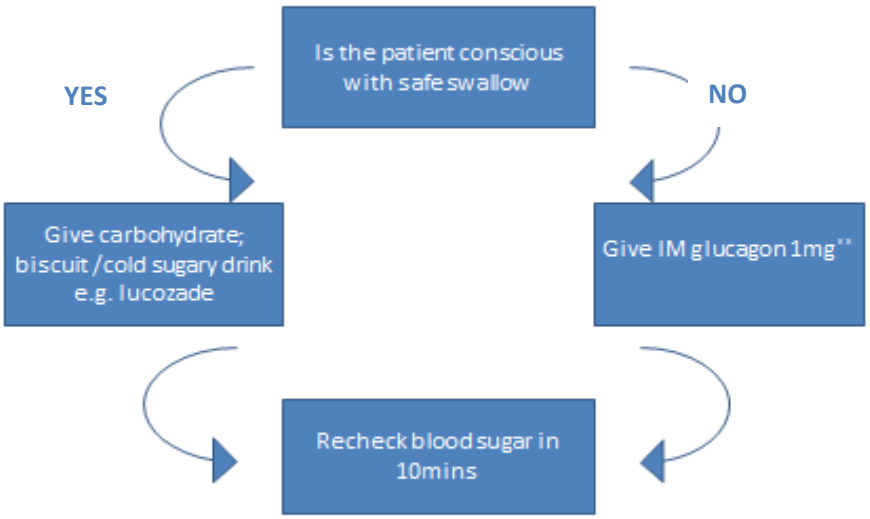
This scenario demonstrates seizures in a patient on haemodialysis secondary to hypoglycaemia.

The technical learning points are:
- Management of seizures: Consider airway patency, position patient in the recovery position, stop dialysis, and use of airway manoeuvres and airway adjuncts. Oral airway adjuncts can be difficult with jaw clenching and a nasopharyngeal airway is often required. Administer high flow oxygen. Time the seizure and call the crash team/ ambulance early.
- During seizure activity the Dynamap®, electronic blood pressure, heart rate and saturation monitor will often not work, in this case go back to clinical examination findings / perform manual observations.
- If the seizures last over 5 minutes then the diagnosis is status epilepticus.
- Identify and treat factors that may reduce seizure threshold such as hypoglycaemia. Glucose level should be checked as part of the A to E assessment.
-Consider differential diagnosis of seizures on a patient receiving haemodialysis: Intracranial pathology e.g. stroke, bleed, meningitis; alcohol withdrawal; epilepsy; severe hypertension and dialysis disequilibrium syndrome.

The Human Factors we discussed when running this scenario:
- "Freezing" during times of stress; coping strategies included using a systematic A to E approach, to ensure the most urgent issues are dealt with first in a structured manner.
- Ways to improve communication/teamwork were discussed with the leader delegating specific tasks to members of the team, and that member reporting back when the task had been carried out. The nursing team on the satellite unit knew each other by name and were familiar with each other's skill set, this facilitated good communication and appropriate delegation of the task.

Feedback from the group was that everyone found it very helpful. They reported increased confidence managing seizures on dialysis and using the A to E assessment to manage the acutely unwell patient.

Management of Hypoglycaemia on the Satellite Unit



* IV dextrose ≥10% is choice agent. This should be given if a PGD authorising its use is in place; treat as per trust guidelines.

**IM glucagon 1mg should only be given once and may take 15mins to work

PART 3. Workshops for Satellite Units

A skills workshop focuses the learner on how to perform a specific clinical task. It enables a skill to be broken down into a series of steps which can be observed and then practised by the learner until the individual is confident performing the task. Skills workshops for the satellite HD units were designed to run prior to the team simulation scenario, enabling the skill to be learnt and later applied in the context of a full clinical simulation scenario.

Skills workshops each lasted 30 minutes, with a maximum of 3 nurses participating per workshop. The workshops were rerun until all nurses/HCAs had the opportunity to take part.

1. Confirmation of Cardiac Arrest and Intermediate Life Support

2. A to E Systematic Assessment of the Unwell Patient

WORKSHOP 1: Confirmation of Cardiac Arrest and Intermediate Life Support

Each 30 mins duration, requires ideally x2 faculty and minimum x2 participants; a plastic manikin is also needed (can be the same manikin as used for scenario simulation).

Objectives

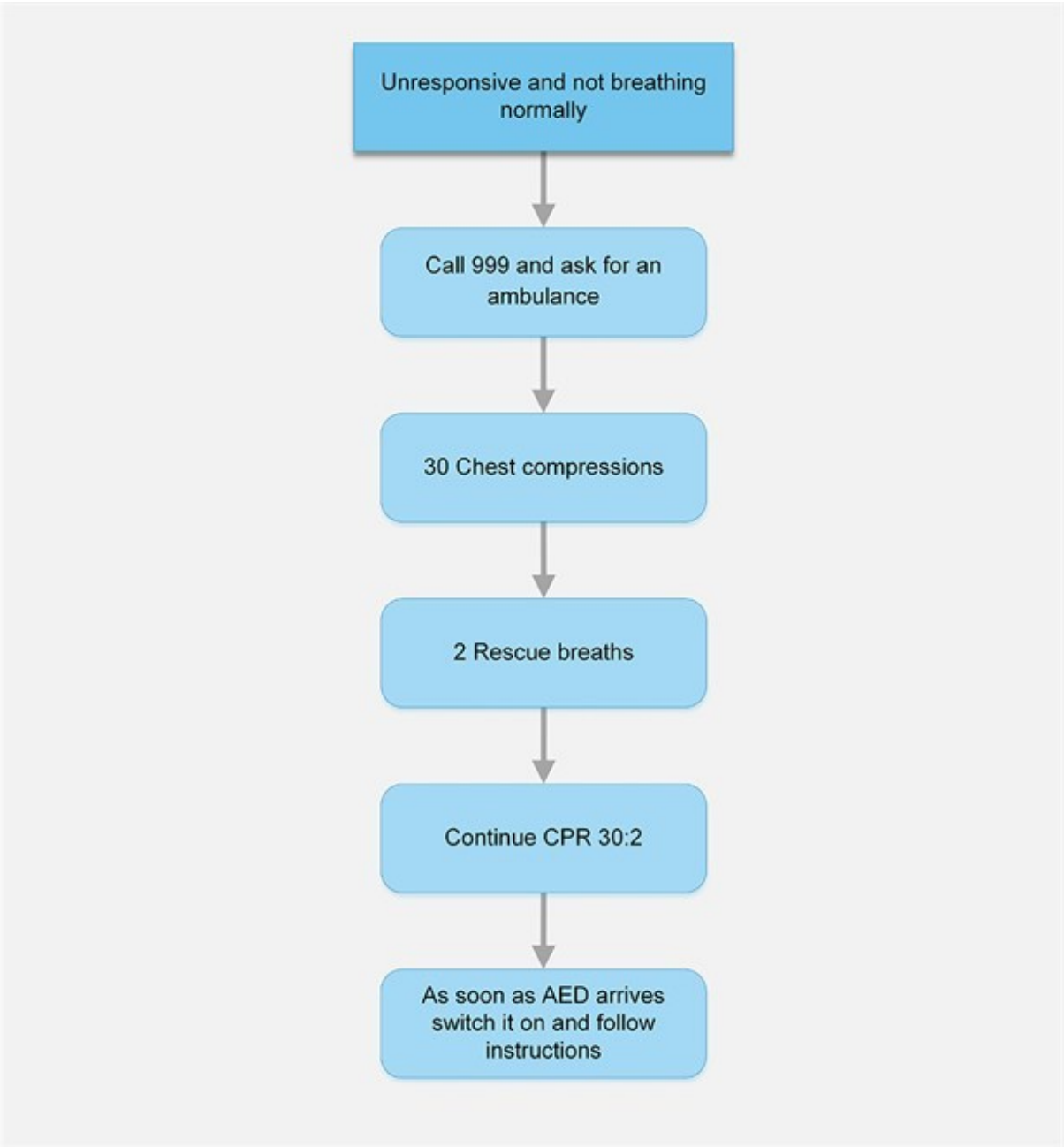
1) Assessment of the unwell patient, how to look for signs of life/ confirm cardiac arrest
2) Airway manoeuvres and adjuncts
3) Delivery of effective CPR
4) Use of cardiac defibrillator, including attaching chest pads, and indication for/how to deliver a shock.
5) Familiarisation with the unit's crash trolley

First, faculty demonstrate, then participants perform the clinical skill:

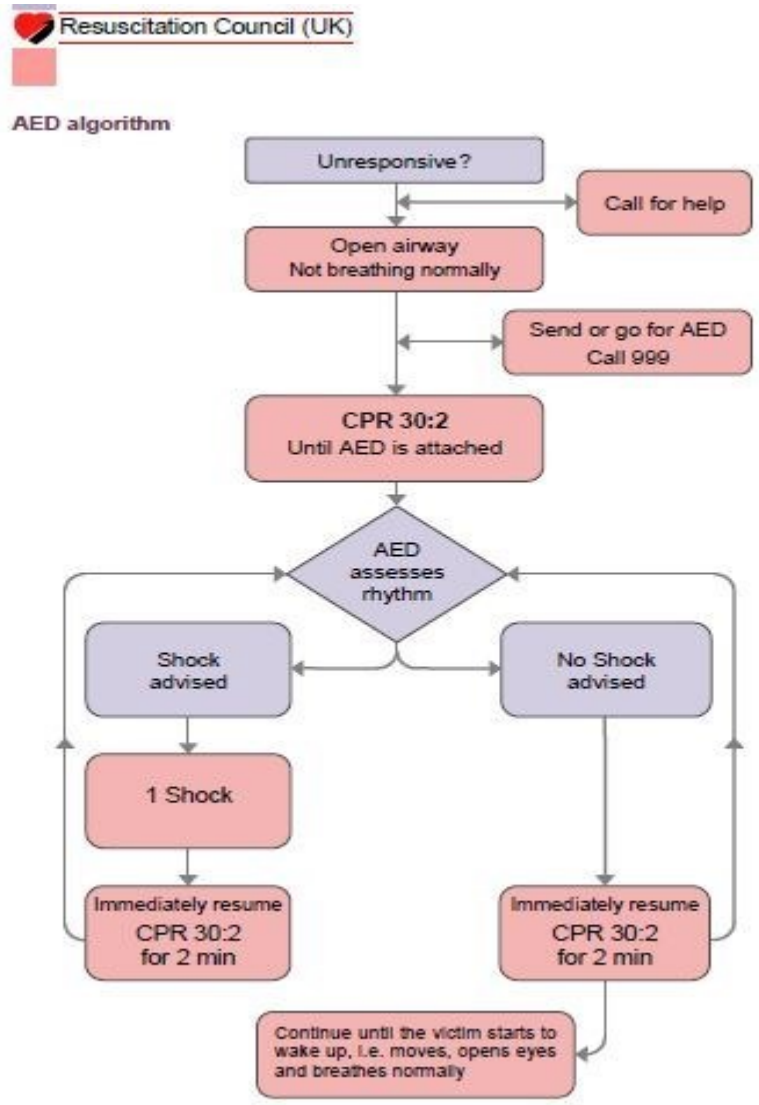
- How to approach an unresponsive patient, how to confirm cardiac arrest and perform effective CPR (see algorithms below). The demonstration should include how to attach the defibrillator pads to the patient, and indications for/ how to deliver a shock.

- Explore participants' knowledge of oxygen delivery systems such as nasal cannulae, Venturi systems and non rebreathe mask. Ensure they can apply the treatment and know the indications for use. Demonstrate and then ensure participants perform airway manoeuvres, insert airway adjuncts including nasopharyngeal, oropharyngeal, laryngeal masks and can manually ventilate the manikin using a bag valve mask.

- Review the unit's crash trolley with participants. Focus on the location of the airways adjuncts and adrenaline. Clarify anaphylaxis v cardiac arrest dose of adrenaline and route of administration; show protocols. Discuss that only ALS trained nurses can give IV adrenaline 1mg 1:10 000 in the case of a cardiac arrest, but all staff can give IM 0.5mg (up to 1mg) 1:1000 adrenaline for anaphylaxis.



BLS algorithm Resuscitation Council UK 2015 *Reproduced with kind permission of the Resuscitation Council UK, for review 2020*



Resuscitation Council UK Algorithm 2010
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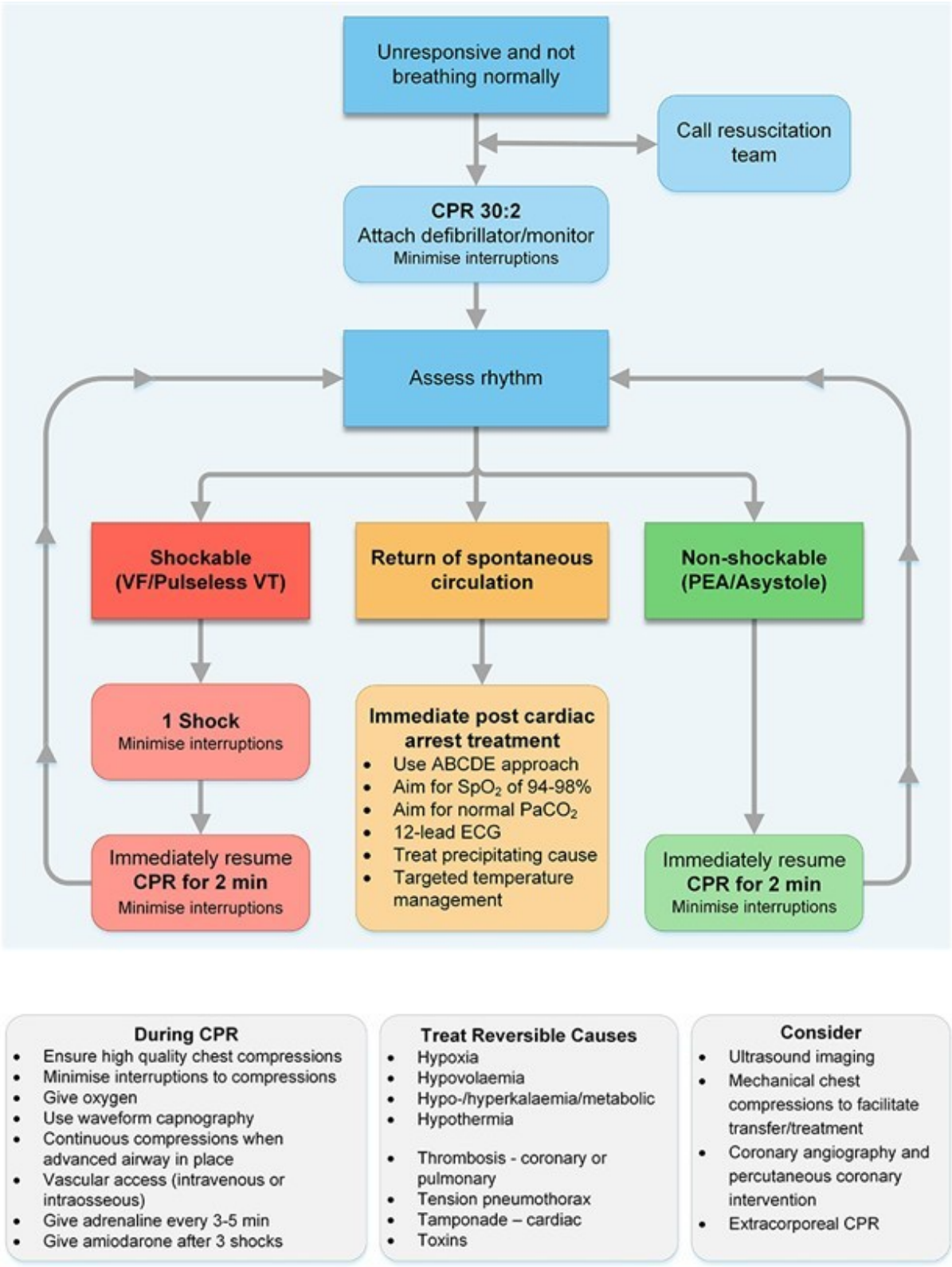

Cardiac Arrest Algorithm, Resuscitation Council UK 2015

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WORKSHOP 2: A to E Systematic Assessment of the Unwell Patient

30 mins duration, requires ideally x2 faculty and minimum x2 participants; a plastic manikin also needed (can be same manikin as used for scenario simulation).

Objectives

1) How to assess the unwell patient using an A to E approach, application of monitoring and initiation of treatment.

2) Knowledge of the different oxygen delivery systems and indications for their use.

3) How to perform airway manoeuvres, use airway adjuncts and manual ventilation using a bag valve mask

Faculty demonstrate how to use an A to E approach to manage an unwell patient, then participants practise the clinical assessment (***manikin settings shown in bold italics below***)

Case brief: Margaret is a 75-year-old lady who has been dialysis dependent for 3 years, dialysing via her AV fistula. She has a background of ischaemic heart disease and hypertension.

Margaret (Patient voice): *"I am feeling funny, it feels like my chest is in a vice. I feel dizzy and can't breathe; it started this morning, but it is really bad now".*

Nurse (played by faculty 1) "Ok Margaret, we will take this seriously, I'm going to call for HELP (call for nursing staff/ press patient alarm). To nurse colleague (faculty 2) "Please bring the dyna-map". Nurse (faculty 1) then demonstrates how to perform an A to E assessment.

-A, Airway; Margaret is talking so I am happy she is maintaining her airway.

"Margaret we are going to apply some monitoring"

Margaret (patient voice) "*this is the worse pain ever, I feel really hot and clammy. I'm scared"*

-B, Breathing; Nurse (faculty member 1) demonstrates using pulse oximeter, (***sats 88%)*** and gives high flow oxygen to keep saturations above 94%. Looks for cyanosis, measures the respiratory rate (***RR 30***) and auscultates the chest, listens for air entry and crackles (***chest clear***).

-C, Circulation; Nurse (faculty member 1) measures the pulse rate (***HR 90***), blood pressure (***BP 95/60***) using the Dynamap®, and measures capillary refill (***4s)***. Nurse (faculty member 1) asks a second nurse / HCA (faculty member 2) to bring the ECG machine and the cardiac arrest trolley. Dialysis is stopped and 250ml of fluid is given back on dialysis.

-D, Disability; Nurse (faculty member 1) assesses and score consciousness level according to the AVPU scale or Glasgow coma score (GCS); ***patient is now drowsy and only responding to voice on the AVPU scale. Blood sugar 7mmol/L***.

-E, Exposure; ***Cool peripheries***, nothing seen on exposure.

The A to E assessment should be repeated, to assess response to the fluid challenge. Now the patient is ***snoring***, her saturations have dropped to ***92% on 15L*** and her blood pressure has dropped further to ***BP 85/60***. She is only responding to pain.

Nurse (faculty member 1) informs colleague (faculty member 2) to put out an adult cardiac arrest call or call a blue light ambulance.

Then faculty repeat assessment again using the A to E approach as below.

-A, Airway; Her airway is compromised and an airway manoeuvre is needed with an airway adjunct. Faculty demonstrate airway manoeuvres (head tilt chin lift and jaw thrust) and then ask the participants to perform it. Faculty show the airway adjuncts found on the crash trolley, nasopharyngeal, oropharyngeal and the laryngeal mask, Igel®, demonstrate how to use them, and there indications for use. Faculty clarify when the patient requires manual ventilation, i.e. when the patient has no or poor respiratory effort and demonstrate the two handed technique of ventilating using the bag valve mask; the learners can then practise this skill.
In this case Margaret tolerates a nasopharyngeal airway but gags on an oropharyngeal airway.

-B, Breathing; With high flow oxygen and nasopharyngeal airway, ***saturations 98%, RR 14, chest clear***

-C, Circulation; Her blood pressure is ***BP 90/60***, ***HR 100***. Nurse (faculty member 1) gives a further fluid bolus back from the machine (250ml) in response to the hypotension. The patient should be attached to the defibrillator if not already. Bloods should be taken including a spot K or VBG if resources allow. A 12 lead ECG should be performed.

-D, Disability; Consciousness level according to the AVPU scale or Glasgow coma score (GCS); ***patient is only responding to pain on the AVPU scale. Blood sugar 7mmol/L***.

-E, Exposure; ***Cool peripheries***, nothing seen on exposure.

Crash team arrives. Nurse (faculty member 1) demonstrates handover using the SBAR format.
The importance of assisting the crash team should be highlighted, given the dialysis nurses will know more about the patient, the current situation and the whereabouts of local resources.

Part 4. Supplementary Material

1) Email template; invitation to participate in simulation

2) Patient awareness poster

Email template; invitation to participate in simulation

Dear All

We are running the renal simulation session next ……. You are next to have a go!

It is meant to be fun, and it is all about learning in a safe environment. We just ask you to act in your normal work roles. This is not an assessment, and anything taking place or discussed during the session will remain confidential.

Venue: Please attend the ……..

Please arrive at ……; we will be finished by …... You will be given a good orientation and told what you need to do on the day, but below is a link about simulation training to give you more of an idea if this is unfamiliar to you.

https://vimeo.com/191126882

We hope that you will find this training session useful. You will be asked to complete an evaluation form both pre and post session which will help us to develop and improve the training.

Please encourage your colleagues to come along, watch and participate in the debrief discussion which is where most of the learning occurs. Certificates will be provided to all those attending the session.

Patient Awareness Poster

SIMULATION TRAINING IS TAKING PLACE FOR RENAL HEALTH-CARE STAFF TODAY

BE AWARE THERE MAY BE MORE ACTIVITY AND YOU MAY SEE A MANIKIN PASSING THROUGH THE DIALYSIS UNIT

Part 5. Evaluation

1) Example pre-course questionnaire, for main haemodialysis unit
2) Example post-course questionnaire, for main haemodialysis unit
3) Example pre- course questionnaire, for satellite haemodialysis unit
4) Example post- course questionnaire, for satellite haemodialysis unit

We used anonymous questionnaires with unique identifiers to look for any change in an individual's pre and post training confidence. Our questionnaire allowed for both quantitative and qualitative data collection.

Example pre-course questionnaire, for main haemodialysis unit

Location of work (e.g. main dialysis unit, ward, satellite unit)

Job role (e.g. Consultant nephrologist, SpR, SHO, Renal matron, senior nurse, junior dialysis nurse, HCA)

Please score your answers to the following questions from 1 - 5 where 1 is unconfident and 5 is very confident, by circling the number:

How confident you are managing the following emergencies on a patient who is receiving haemodialysis?

Confidence managing acute chest pain? 1 2 3 4 5

Confidence managing seizures? 1 2 3 4 5

Confidence managing anaphylaxis? 1 2 3 4 5

Confidence managing septic shock? 1 2 3 4 5

Confidence managing cardiac arrest? 1 2 3 4 5

Confidence managing acute stroke? 1 2 3 4 5

Confidence managing acute GI bleed? 1 2 3 4 5

Confidence managing pulmonary oedema? 1 2 3 4 5

Confidence managing air embolus? 1 2 3 4 5

Confidence managing acute psychosis? 1 2 3 4 5

Knowledge of the inter-professional team: How well do you understand the skill set of your colleagues working on the haemodialysis unit, e.g. if you are a doctor how well do you understand what the dialysis nurses can do and vice versa? (please circle)
1 2 3 4 5

Knowledge of your surroundings: In an emergency how confident are you in locating emergency resources on the dialysis unit? (please circle) 1 2 3 4 5

Example post-course questionnaire, for main haemodialysis unit

Location of work (e.g. main dialysis unit, ward, satellite unit)

Job role (e.g. Consultant nephrologist, SpR, SHO, Renal matron, senior nurse, junior dialysis nurse, HCA)

What was your simulation emergency?

Did you find this simulation training helpful? Yes or No (please circle)

What did you like about the simulation training? (free text box)

What didn't you like about the simulation training? (free text box)

Please score your answers to the following questions from 1 - 5 where 1 is unconfident and 5 is very confident, by circling the number:

How confident are you managing this emergency on a patient who is receiving haemodialysis following this training? 1 2 3 4 5

Knowledge of the inter-professional team: How well do you understand the skill set of your colleagues working on the dialysis unit e.g. if you are a doctor how well do you understand what the dialysis nurses can do and vice versa? 1 2 3 4 5

Knowledge of your surroundings: In an emergency how confident are you in locating emergency resources on the dialysis unit? 1 2 3 4 5

Has this training session highlighted any latent errors such as faculty equipment, lack of awareness of how to use or locate equipment etc. which could potentially lead to future patient harm? (please circle) Yes/ No

Please give details (free text box)

What other scenarios would you find useful to simulate? (free text box)

Example pre-course questionnaire, for satellite haemodialysis unit

Location of work (which satellite unit)

Job role (e.g. renal matron, senior nurse, junior dialysis nurse, HCA)

Please score your answers to the following questions from 1 - 5 where 1 is unconfident and 5 is very confident, by circling the number:

How confident are you managing the following emergencies on a patient who is receiving haemodialysis at this satellite unit?

Confidence managing acute chest pain? 1 2 3 4 5

Confidence managing seizures? 1 2 3 4 5

Confidence managing anaphylaxis? 1 2 3 4 5

Confidence managing septic shock? 1 2 3 4 5

Confidence managing cardiac arrest? 1 2 3 4 5

Confidence managing acute stroke? 1 2 3 4 5

Confidence managing acute GI bleed? 1 2 3 4 5

Confidence managing pulmonary oedema? 1 2 3 4 5

Confidence managing air embolus? 1 2 3 4 5

Confidence managing acute psychosis? 1 2 3 4 5

Team working: How confident are you in effectively communicating with other nursing staff during an emergency on an HD patient in this satellite unit? (please circle)
1 2 3 4 5

How confident are you in effectively communicating with the renal doctors about an acutely unwell patient on dialysis in this satellite unit? (please circle)
1 2 3 4 5

How confident are you in leading the team during an emergency situation in this satellite dialysis unit? (please circle) 1 2 3 4 5

Knowledge of your surroundings: In an emergency how confident are you in locating emergency resources on this satellite dialysis unit? (please circle) 1 2 3 4 5

Example post-course questionnaire, for satellite haemodialysis unit

Location of work (which satellite unit)

Job role (e.g. renal matron, senior nurse, junior dialysis nurse, HCA)

What was your simulation emergency?

Did you find this simulation training helpful? Yes or No (please circle)

What did you like about the simulation training? (free text box)

What didn't you like about the simulation training? (free text box)

Please score your answers to the following questions from 1 - 5 where 1 is unconfident and 5 is very confident, by circling the number:

How confident are you managing this emergency on a patient who is receiving haemodialysis at this satellite unit following this training? 1 2 3 4 5

Team working: How confident are you in effectively communicating with other nursing staff during an emergency on a patient on dialysis in this satellite unit? 1 2 3 4 5

How confident are you in effectively communicating with the renal doctors about an acutely unwell patient on dialysis in this satellite unit? 1 2 3 4 5

How confident are you in leading the team during an emergency situation in this satellite dialysis unit? 1 2 3 4 5

Knowledge of your surroundings: In an emergency how confident are you in locating emergency resources on this satellite dialysis unit? 1 2 3 4 5

Has this training session highlighted any latent errors such as faculty equipment, lack of awareness of how to use or locate equipment etc. which could potentially lead to future patient harm? (please circle) Yes/ No

Please give details (free text box)

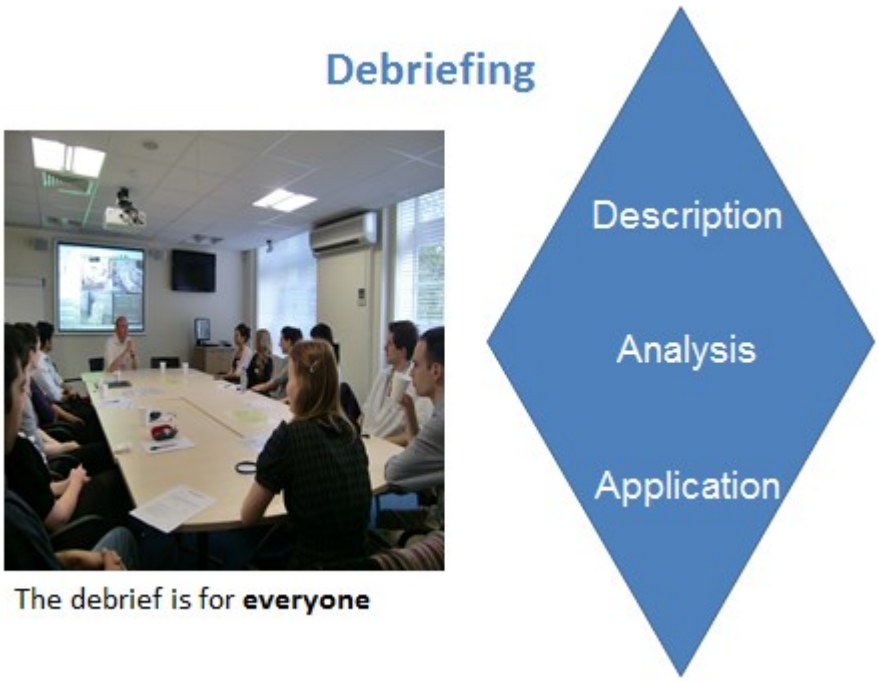
What other scenarios would you find useful to simulate? (free text box)

Part 6. Additional Resources

1. DAA debrief model
2. Modified plus/delta model

Below is an outline of simple models that can be used to run a simulation debrief. We recommend attending a simulation debrief training course to gain skills in simulation debriefing.

DAA debrief model



The DAA model: Description, Analysis and Application, is a simple format for structuring the debrief session.
Description: In this phase, individuals who watched the scenario but did not directly participate in it, give an objective time line of events that occurred. This both engages those who didn't directly participate in the scenario and ensures all learners and faculty members are aware of all notable events that occurred.
Analysis: Following the description phase, the faculty member facilitating the debrief will encourage the participants individually to reflect on their feelings of how the scenario ran. The faculty member will encourage the participant to analyse their behaviour by getting them to consider any difficulties they faced and the specifics that made the situation challenging, or reflecting on how something was achieved by the team. In this way, the debrief can focus on human factors such as leadership, teamwork, communication, stress and situational awareness. Participants will often share their own personal clinical experiences which can further enrich the learning. Then the team, guided by the facilitator, can consider strategies to overcome the difficulties they may have faced in the training scenario which they can apply in their future clinical practice.
Application: The debrief ends with the team considering what they have learnt from the simulation session and how they will apply this learning to their clinical practice.

The Diamond model: is an extended version of the DAA structure. This "Diamond model" incorporates transition steps to lead the debrief through the phases of Description, Analysis and Application. It suggests teaching the clinical management of the scenario after the description phase. Handouts to refresh the learning group on the clinical management and signpost the learner to guidelines/references for further reading are recommended. The diamond shape reflects the length of time that should be assigned to each part of the debrief, with the majority of the time for the analysis phase, to encourage reflective practice and human factor training.

Modified Plus/Delta debrief model (Miller)

Adjectives How would you describe your experience?	**+** What went well? What would you do again?	**Δ** What would you do differently?	**Take Aways** How would you summarise your experience? What did you learn?
Examples: • Scary • Fun • Challenging • Frustrating	Examples: • Rapport with the patient • Knew more than I thought	Examples: • Take longer to get a history from patient • Review patient information more carefully before going into the room	Examples: • Review my course content • Think differently about what "leadership" means

Modified Plus/Delta (Miller)

This simple model can lead to good discussions around clinical error and human factor training. It is easy to use, and helpful at focusing on specific behaviours relevant to the learning group.

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We hope you found this resource helpful.
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