The unwell patient on haemodialysis: what you need to know on an acute medical take

Introduction

In the UK, approximately 300 people per million population require maintenance haemodialysis for end-stage renal failure. Although haemodialysis prevents death from overt renal failure, 4-year survival remains poor at only 48%, falling to 24% in those aged ≥65 years (Levy et al, 2004).

Cardiac deaths contribute around 50% of the total mortality (Levy et al, 2004) and are around 20 times more likely than in the general population (Steddon et al, 2006). Traditional risk factors (e.g. diabetes, hypertension) are compounded by those resulting from end-stage renal failure itself (through hyperparathyroidism, oxidant stress and inflammation).

Deaths from infection contribute a further 20% of total mortality (Levy et al, 2004), the propensity arising from factors such as a high prevalence of diabetes, the use of venous catheters and immunosuppression as a result of uraemia or drugs.

Unsurprisingly, both cardiac disease and infection are frequent acute presentations in these patients. Other common presentations include vascular access complications, and fluid and electrolyte imbalances as a result of acute illness, under-dialysis or non-compliance.

Haemodialysis patients can deteriorate rapidly. Their treatment is complicated both by management issues unique to this group and because presentation is often to non-renal, emergency services rather than their own base unit because of geographical proximity. This article highlights the salient features of initial management but frontline doctors should also be keenly aware that specialist renal advice must be sought at an early stage.

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Emergency resuscitation

Haemodialysis patients are at risk of circulatory collapse as a result of cardiac disease, volume depletion, sepsis, cardiac tamponade as a result of pericardial effusions or arrhythmias secondary to electrolyte imbalances. Resuscitation should follow established guidelines (Resuscitation Council UK, 2005), but the following are important considerations:

- Peripheral vascular access and venepuncture must avoid arteriovenous fistulae. Venous dialysis catheters should only be used in extreme circumstances. Do not take blood pressure from the same arm as an arteriovenous fistula, as this risks rupture. Loss of haemodialysis access – the patient's 'lifeline' – contributes to morbidity and mortality.
- Even if urine is still passed, the haemodialysis patient should be seen as a 'closed tank' – once full, further fluid administration risks pulmonary oedema. Careful assessment and reassessment of fluid status is vital with particular attention to the jugular venous pressure, the presence of a third heart sound or basal inspiratory chest crackles. Knowledge of an individual patient's usual blood pressure can be useful in guiding resuscitation. In such circumstances, therefore, it is prudent to call the patient's dialysis unit to enquire about the patient's typical blood pressure readings (which will be documented in the patient's dialysis folder).

  A postural fall in blood pressure >20/10 mmHg suggests significant volume depletion in the correct context (consider other causes such as autonomic neuropathy); sitting-lying readings can provide useful information even if the patient cannot stand. Urine output is not an adequate indicator of fluid resuscitation.
- If haemorrhage underlies circulatory collapse, intravenous desmopressin can ameliorate uraemic platelet dysfunction. Discuss its use with a nephrologist first, because of the risk of vascular occlusion.

Fluid and electrolyte imbalances

A number of questions should be asked:

Does the patient require urgent renal replacement therapy?

Remember the mnemonic 'A HOPE':

- Acidaemia (pH <7.2) (there is no need to routinely check arterial pH; be guided by the venous bicarbonate level with significant depression regarded as <16 mmol/litre)
- Hyperkalaemia (≥6.5 mmol/litre, with or without electrocardiogram changes) (*Figure 1*)
- Oedema (pulmonary)
- Pericarditis, demonstrated by a pericardial rub (caused by uraemia)
- Encephalopathy (caused by uraemia).

Does the patient require critical care involvement?

Seekinput from the critical care team if the patient is haemodynamically unstable or has other organ failure or a high Modified Early Warning Score or equivalent (exclude urine output in the calculation). If the patient is unstable or urgent haemodialysis is required but unavailable, initial stabilization on the critical care unit may be necessary.

If the patient presented with a biochemical derangement, why is this?

Consider non-attendance for previous dialysis or non-compliance with dietary restriction (patients requiring haemodialysis are usually encouraged to follow a low potassium diet). Also:

1. Could acidaemia reflect lactic acidosis, diabetic ketoacidosis, poisoning or other acute pathology?
2. Could hyperkalaemia be caused by drugs or rhabdomyolysis?

Are non-dialysis interventions needed to stabilize the patient?

Definitive treatment of fluid and/or biochemical disturbances associated with end-stage renal failure requires haemodialysis or another form of renal replacement therapy (Murray et al, 2009). Medical interventions are only holding measures until renal replacement therapy is available and should not delay such definitive therapy.

Pulmonary oedema

Reasons for the propensity to develop pulmonary oedema (*Figure 2*) include an increased likelihood of volume overload (see 'closed tank' analogy above) and diastolic cardiac dysfunction (as a result of hypertensive, left ventricular hypertrophy). Volume overload is often associated with hypertension but, regardless of blood pressure, an acute coronary event should be excluded, especially if the pulmonary oedema has a swift onset.

Loop diuretics are of limited use, even if the patient is not anuric. If blood pressure allows, intravenous nitrates can be used. Continuous positive airways pressure can 'blow back' alveolar fluid into the pulmonary capillary bed.

Hyperkalaemia

If routine haemodialysis is due, values <6.0 mmol/litre are of little concern. If the next session is >24 hours away, however, levels should be watched closely. A K+ ≥6.5 mmol/litre may be tolerated but cardiac monitoring is vital while temporizing therapy and renal replacement therapy are being arranged. Consider sub-optimal dialysis, dietary non-compliance, drugs (e.g. angiotensin-converting enzyme inhibitors, angiotensin II receptor blockers, beta blockers, non-steroidal anti-inflammatory drugs) and metabolic acidosis as causes. Temporizing therapy (*Table 1*) aims to stabilize the myocardium or transfer potassium into cells. Total body potassium depletion is through renal replacement therapy, as other methods are unlikely to be successful (diuretics require reasonable renal function, calcium resonium works too slowly).

Uraemic pericarditis and encephalopathy

The accumulation of uraemic toxins can initially cause anorexia, nausea, vomiting and malaise. More advanced manifestations include pericarditis and encephalopathy but are unusual unless the patient is poorly dialysed.

In uraemic pericarditis, a pericardial rub is often present but may disappear if complicated by an effusion. Clinical features of the latter include elevated jugular venous pressure, Kussmaul's sign, muffled heart sounds and a pulsus paradoxus. The electrocardiogram in a patient with uraemic pericarditis can show saddle-shaped ST elevation but if an effusion is present, low amplitude complexes and electrical alternans (beat-to-beat alterations in the QRS axis) may be evident. Anticoagulation increases the risk of pericardial bleeding and is contraindicated until the uraemic pericarditis resolves.

The differential diagnosis of an acute disturbance of mental function in the haemodialysis patient includes not just uraemic encephalopathy but also hypoglycaemia, an intracranial event, sepsis and intoxication.

Figure 1. Electrocardiogram changes of hyperkalaemia showing tented T waves, QRS widening and small P waves. The PR interval will prolong. Eventually, P waves will disappear. The S wave will deepen and will merge with the T wave to produce a sine wave pattern. This precedes the development of ventricular fibrillation and asystolic cardiac arrest.

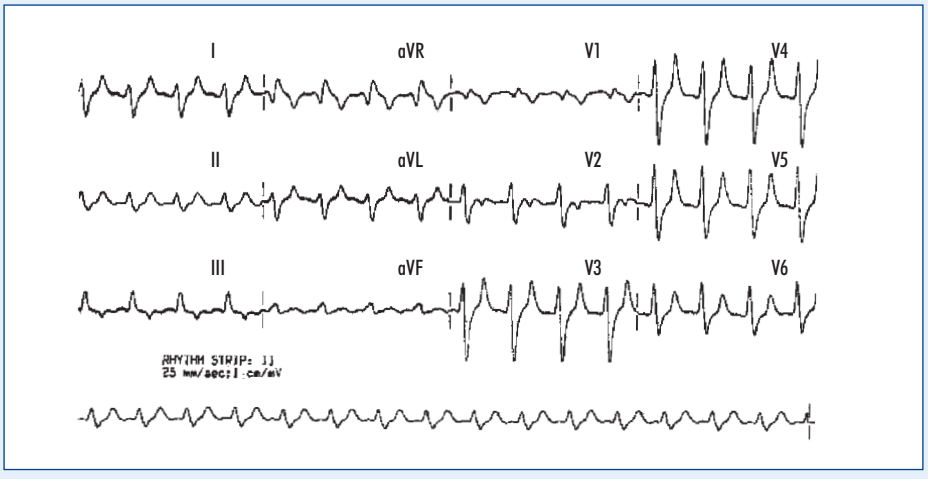
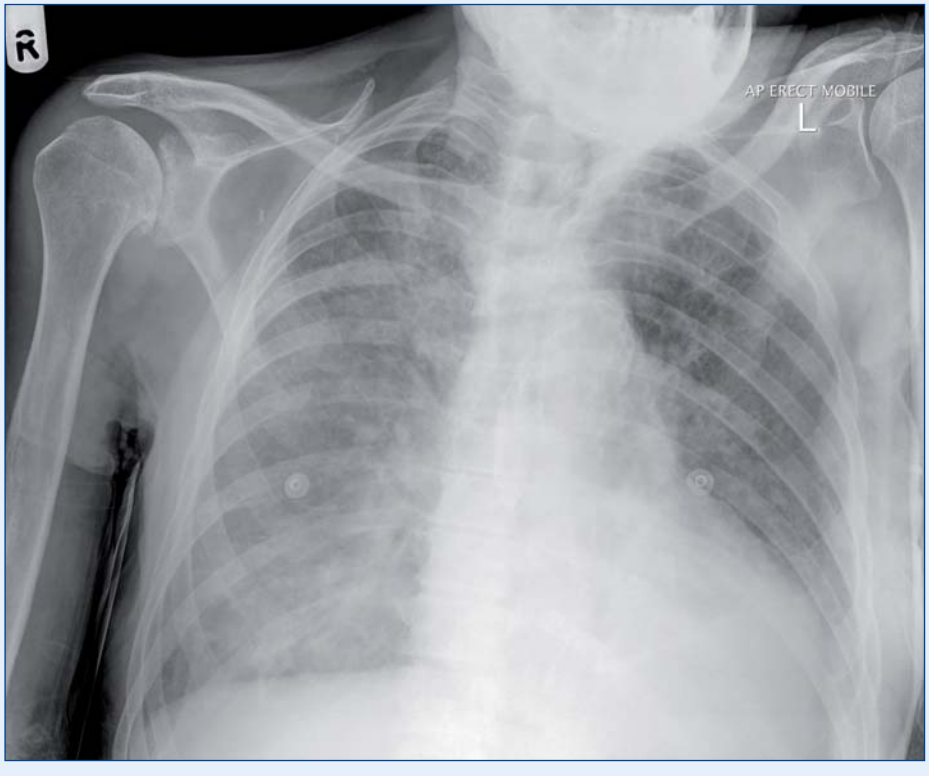


Figure 2. Bilateral pulmonary oedema in a patient receiving long-term haemodialysis.



Problems with vascular access

Vascular access is vital for haemodialysis and any problems should be addressed promptly. More information can be found in Murray et al (2009).

Problems with an arteriovenous fistula or graft

A thrombosed or thrombosing arteriovenous fistula or graft may present as the loss of a palpable thrill or audible bruit. Urgent specialist assessment is needed with a view to surgical or radiological intervention. Although most patients will present to their local renal unit, if they do not, prompt contact is needed.

The most catastrophic complication, however, is bleeding from an aneurysmal or infected fistula; as flows through an arteriovenous fistula or graft are usually at least several hundred ml/min, swift exsanguination can occur. Urgent vascular surgical input should be sought while bleeding is controlled with firm localized pressure over the bleeding site.

Problems with a tunnelled dialysis catheter

Infection is the commonest complication of tunnelled lines. It should be considered in any patient with a dialysis line and a fever. Most renal units have an antibiotic protocol for empirical treatment of line sepsis and should be consulted early. Take blood cultures peripherally and, where experience allows, from each catheter lumen before starting empirical antibiotics.

Management of acute coronary syndrome

Compared to those without chronic kidney disease, end-stage renal failure patients have a worse outcome after acute coronary syndrome. Electrocardiograms can be difficult to interpret as a result of co-existing left ventricular hypertrophy, bundle–branch block and hyperkalaemic changes. Troponins tend to be chronically elevated in end-stage renal failure but troponin I, if available, is more sensitive, with trends in results being more helpful than isolated readings.

Treatment modalities are generally the same as for the non-end-stage renal failure patient although a clear evidence base is lacking.

Aspirin and clopidogrel loading can be administered in standard doses. Low molecular weight heparins pose specific difficulties for the chronic haemodialysis patient (see below). With the exception of abciximab, platelet glycoprotein IIb/IIIa inhibitors need dose adjustment. Thrombolysis may be used with the usual cautions but with pertinent contraindications including recent renal biopsy, dialysis catheter insertion (peritoneal or venous) within the last 14 days, uraemic pericarditis and uncontrolled hypertension. Primary percutaneous intervention, where available, may be appropriate. Coronary bypass surgery should be offered when indicated.

Table 1. Medical treatments used in the treatment of hyperkalaemia of 6.5 mmol/litre or more or if electrocardiogram changes are seen

Treatment	Dose	Onset (minutes)	Duration (hours)	Mechanism
Calcium gluconate	10 ml 10% solution, intravenously, over 2–5 minutes; repeat after 5 minutes if electrocardiogram changes persist up to maximum dose of 40 ml	1	1	Cardioprotective
Calcium chloride	5 ml 10% solution, intravenously, over 2–5 minutes	1–5	1	Cardioprotective
Insulin or dextrose*	15 iu actrapid in 50 ml 50% dextrose, intravenously, over 10 minutes; can be repeated after 4 hours	15–30	2–4	Promotes intracellular K+ transfer by increased Na+K+ATPase activity
Sodium bicarbonate†	200–500 ml of 1.26% or 1.4% solutions, intravenously over 15–60 minutes‡	30–60	1–2	Promotes intracellular K+ transfer by increased K+cell uptake

* Use a large bore cannula – highly irritant; regular blood glucose monitoring for 6 hours after administration – treat hypoglycaemia with intravenous 10% dextrose. N.B. Salbutamol works via a similar mechanism to insulin so has no additional benefit. The high doses needed (e.g. 20 mg) can be unpleasant and precipitate arrhythmias. † Use only if venous bicarbonate <16 mol/litre and no volume overload. Risks fluid overload. Rapid correction of acidaemia can quickly drop ionized calcium, leading to tetany, seizures and cardiac instability. Incompatible with intravenous calcium – use separate route. ‡ In cardiac arrest, use 50 ml 8.4% solution or 50–100 ml 4.2% solution of sodium bicarbonate, intravenously, as onset of action is quicker than with 1.26% or 1.4% solutions of sodium bicarbonate

Infection

A high index of suspicion is needed for this population who are both susceptible to infection and more likely to become unwell when it has developed. Close and early liaison with microbiology is essential.

Most infections are caused by the pathogens that usually affect non-end-stage renal failure patients. Consider atypical or opportunistic organisms or a complication of a common agent if resolution is slow. Tunnelled dialysis catheter infection can, for instance, result in major sequelae such as osteomyelitis, endocarditis and septic arthritis.

Specific diagnostic difficulties include distinguishing pneumonia from interstitial oedema on chest X-ray and diagnosing urosepsis in the oliguric patient (a quick 'in-out' urethral catheter may yield a sample where there is a high index of suspicion but risks actually introducing infection).

Although the diagnosis and treatment of infection is potentially complicated, its prevention is far more straightforward – from adherence to local infection control policies to provision of a vascular access service that will keep the number of temporary and tunnelled dialysis catheters at a minimum.

Drug prescribing

Drug handling is complicated by both altered pharmacokinetics in end-stage renal failure and the potential for clearance by haemodialysis itself. The British National Formulary can give information on the former but the extent of extracorporeal clearance is specifically addressed within the *Renal Drug Handbook* (Ashley and Currie, 2008), which may be available locally via the hospital pharmacy. The importance of contact with the nearest renal unit, where experience and access to specialist pharmacy advice will be available, is emphasized to avoid the risks of under- as well as over-treatment.

Low molecular weight heparins pose specific problems because of their crucial therapeutic window and their renal elimi-

nation. Weight-adjusted dosing, without monitoring, has unpredictable anticoagulant effects in patients with renal impairment. It has been recommended that doses are reduced by 33–50% and that anti-Xa activity is regularly monitored but this is confounded by the fact that the drug is actually cleared on haemodialysis. The authors, therefore, encourage the use of infusions of unfractionated heparin, which is not cleared by dialysis and is easily monitored by the activated partial thromboplastin time, in the acute or emergency setting.

KEY POINTS

- Chronic haemodialysis patients have a high morbidity and mortality, with cardiovascular disease and infection being particularly common.
- Haemodialysis patients can deteriorate rapidly.
- Biochemical and fluid disturbances usually need definitive treatment with dialysis although medical interventions can tide patients over until this becomes available.
- Vascular access is the patient's lifeline – it should be preserved and any problems addressed urgently.
- Careful assessment of fluid status is a vital part of the initial assessment.
- Drug prescribing is complicated by both poor renal function and the potential for drug clearance on dialysis – seek advice.
- Non-renal teams should make early contact with the renal unit for specific advice and potential transfer.

Conclusions

End-stage renal failure patients on maintenance haemodialysis are a complex population with a high mortality and morbidity. Given the frequency of presentation to non-renal emergency services, it is important that the frontline clinician understands the basics of initial management but it is vital that the base renal unit is consulted promptly for specific advice and potential transfer. **BJHM**

Figure 1 *is reproduced courtesy of www.ecglibrary.com. Conflict of interest: none.*

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