

Nephroquiz

(Section Editor: M. G. Zeier)

Supported by an educational grant from **AMGEN**

Dialysis-resistant pulmonary oedema

Case

A 61-year-old woman with hypertension and kidney failure due to type 2 diabetes mellitus presented with fatigue, stinging pain in her legs, and nausea and vomiting. A radial-cephalic arteriovenous fistula had been created 6 weeks earlier, but she was unwilling to initiate haemodialysis therapy. One week later, she was admitted because of shortness of breath. She had fever and symptoms of upper respiratory infection, but denied having chest pain and use of alcohol. The patient had a poor dietary intake, but had gained 3 kg of body weight in the preceding month. She was taking valsartan, labetalol, simvastatin and furosemide.

On physical examination, her blood pressure was 208/96 mmHg, temperature 38.7°C, pulse 120/min and

irregular, and respirations 19/min. She had distended neck veins, a loud first heart sound, gallop rhythm, and grade 2 systolic ejection murmurs best heard over the aortic area. Carotid and femoral pulses were strong, but extremities were cold. Rales were present in the right lung field. She had 2+ pitting oedema on her legs. There was a thrill over the arteriovenous fistula on her left wrist. Her pulse rate remained rapid during fistula occlusion by finger pressure (a negative Branham's sign).

A chest radiograph revealed an increase in heart size when compared with a film taken 2 months earlier. There were increased infiltrates over the right lung, suggesting an inflammatory process or localized oedema (Figure 1). ECG showed atrial fibrillation at 120/min with non-specific ST and T wave changes. Her white blood cell count was 9100/mm³ and haemoglobin was 7.5 g/dl. Her blood urea nitrogen was 77 mg/dl, creatinine 6.6 mg/dl, albumin 2.2 g/dl and plasma



Fig. 1. A chest radiograph shows cardiac enlargement and alveolar infiltrates located predominantly in the right perihilar region.

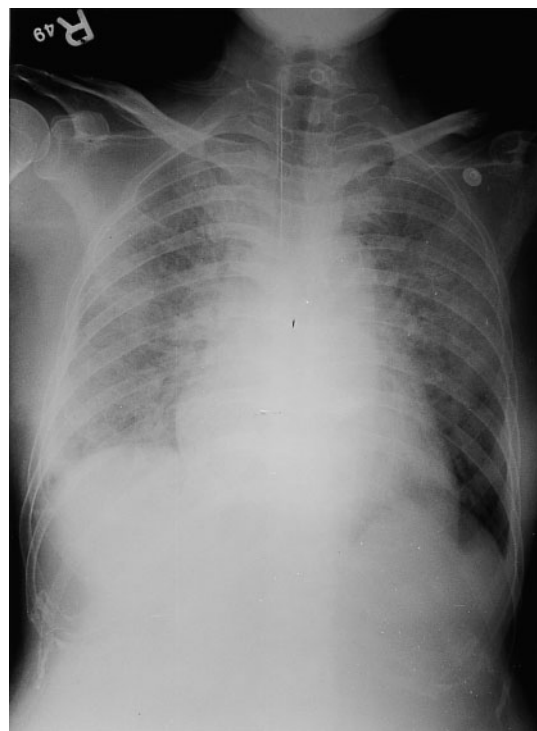


Fig. 2. Persisted pulmonary oedema resistant to haemodialysis.

glucose 154 mg/dl. Her thyroid function test was normal. She was treated with empirical antibiotics, diuretics, vasodilator, digitalis, diltiazem and packed RBC transfusions. Her rapid heart rate was controlled and her anaemia was corrected, but repeated chest radiograph revealed progressive haziness of bilateral lungs. Microbiology studies were negative. Arterial blood gas analysis showed pH 7.27, PaO₂ 67 mmHg, PaCO₂ 31.5 mmHg and bicarbonate 14.6 mmol/l. Haemodialysis was started.

She lost 7 kg by aggressive ultrafiltration in 10 days. Her skin turgor became poor, but dyspnea remained. Pulmonary oedema persisted shown by a follow-up chest radiograph (Figure 2). An echocardiogram revealed concentric left ventricular hypertrophy, mild-to-moderate mitral and tricuspid regurgitation,

moderate biatrial enlargement, mild pericardial effusion, and a hyperdynamic left ventricle. The estimated pulmonary-artery systolic pressure was 65 mmHg. There were no segmental wall-motion abnormalities. Doppler sonography of the patient's left wrist showed a patent arteriovenous fistula with a flow of 600 ml/min. She was placed on a bi-PAP ventilator because her dyspnea became exacerbated.

Questions

- What is your diagnosis?
- What consequences of therapy should be expected and treated?

Answers to the quiz on the preceding page

Congestive heart failure should be suspected in this patient with 'unusual' pulmonary oedema refractory to aggressive ultrafiltration. Many potential causes lead to the development of congestive heart failure in haemodialysis patients, and each cause is often multifactorial. Echocardiogram rules out left ventricular systolic dysfunction due to valvular heart disease, pericardial disease, ischaemic heart disease and cardiomyopathy. Furthermore, her biventricular congestive heart failure, an enlarged heart size, and worsening symptoms with a reduction in her heart rate make diastolic dysfunction seem unlikely. The patient has a long history of hypertension, diabetes mellitus, dyslipidaemia and kidney failure. Intermittent ischaemia associated with extensive coronary disease stays a possibility, but should be carefully ruled out by thallium stress test or cardiac catheterization if her symptom persists in despite of appropriate therapy. However, her characteristic physical findings of a hyperdynamic circulation imply the cause of her congestive heart failure is primarily high-output heart failure [1].

The differential diagnosis of high-output heart failure is shown in Table 1. Hyperthyroidism and overflow of arteriovenous fistula are excluded by laboratory and sonographic examinations. The failure of her symptoms to be improved after correction of anaemia suggests anaemia itself is a minor contributor rather than the sole cause of her congestive heart failure. Although the patient is not an alcoholic, she is at risk of chronic thiamine deficiency due to restricted diet and use of diuretics [2]. Her vomiting and fever at presentation is likely to precipitate acute thiamine depletion, which is further aggravated owing to removal during aggressive dialysis. The presence of peripheral neuritis (dry beriberi), as evidenced by her stinging leg pain, also raised the possibility of wet beriberi. The diagnosis of thiamine deficiency was confirmed on the basis of a low serum thiamine level at 25 nmol/l (normal 50–125 nmol/l).

Clinical manifestations of thiamine deficiency include congestive heart failure, peripheral neuropathy and encephalopathy, which may mimic many uraemic complications and make the diagnosis easily missed in patients with end-stage kidney failure. Thiamine is a small molecular water-soluble vitamin with a low affinity to plasma proteins and can be lost into the

dialysate. Routine thiamine supplementation is therefore recommended in malnourished dialysis patients [3]. High-output heart failure associated with thiamine deficiency results from a decrease in systemic vascular resistance and a compensatory increase of cardiac output. The response to thiamine is often dramatic, with an increase in systemic vascular resistance, decrease in cardiac output, diuresis, and clearing of pulmonary congestion in 48 h [4]. Nevertheless, in this diabetic patient with a high probability of cardiovascular comorbidity due to her multiple risk factors, the sudden return of vascular tone after thiamine supplementation will pose a haemodynamic load to her already diseased myocardium. Moreover, diuresis may be only marginal because of her advanced kidney failure. Thus, both increased afterload and preload may unmask her coexistent cardiovascular diseases, paradoxically leading to a low-output heart failure [5]. Accordingly, treatment with thiamine alone may actually worsen her pulmonary oedema. Medical therapy for congestive heart failure and further ultrafiltration should be continued in addition to intravenous thiamine 100 mg daily. Her dyspnea gradually improved in 2 weeks. A follow-up chest radiograph showed a complete resolution of pulmonary oedema and return of heart size to normal (Figure 3).

Conflict of interest statement. None declared.



Fig. 3. Clearing of pulmonary oedema and return of heart size to normal after thiamine administration.

Table 1. Differential diagnosis of high-output heart failure

1. Hyperthyroidism
2. Severe anaemia
3. Pregnancy
4. Arteriovenous fistulas
5. Thiamine deficiency (wet beriberi)
6. Paget's disease

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