A 49-year-old woman presented to the emergency department with one-day history of worsening left lower abdominal pain, two days of intermittent fever with chills and frequency of micturition. She had a past history of poorly controlled type 2 diabetes mellitus of ten years’ duration. On clinical examination, the patient was febrile (38.6°C). She appeared tired and was mildly dehydrated but not toxic. Tenderness was present in the left iliac fossa and left renal angle. No guarding was elicited. Laboratory tests revealed normal total leucocyte count (10.3 × 10⁹/L) with a mild neutrophilia (7.8 × 10⁹/L). Random blood glucose level was very high (23.4 mmol/L; normal range 3–6 mmol/L). Renal function tests were normal. Glycated haemoglobin was 12% (reference range 4.5%–6.4%). Blood culture revealed growth of *Escherichia* (*E.*) *coli*. Urine examination showed the presence of glucose (3+), numerous leucocytes (3+) and ketone bodies. Abdominal radiograph was normal, with no calculi seen.

What do the ultrasonography (US) of the abdomen (Fig. 1) and computed tomography (CT) image of the abdomen and pelvis (Fig. 2) show? What is the diagnosis?
IMAGE INTERPRETATION
US of the left kidney (Fig. 1) shows mild dilatation of the left pelvicalyceal system, with no dilatation of the ureter. No calculus is seen. Subtle posterior acoustic shadowing is seen. CT of the upper abdomen (Fig. 2) shows an enlarged left kidney with gas and dense fluid (35–40 HU) within the dilated pelvicalyceal system.

DIAGNOSIS
Emphysematous pyelitis.

CLINICAL COURSE
An emergency percutaneous nephrostomy with an 8-French (F) Navarre pigtail catheter (CR Bard) (Fig. 3) was performed under US- and fluoroscopic-guidance. On aspiration of the left renal collecting system, thick pus and gas was obtained. Microscopy showed Gram-negative rods and neutrophils. Culture grew E. coli. The patient’s condition improved after the nephrostomy and parenteral antibiotics. A few days later, a 7-F, 24-cm double ‘J’ ureteric stent (Inlay Optima®) was inserted and the nephrostomy tube removed (Fig. 4). The patient was well when discharged home after two weeks, and continued on a course of oral antibiotics.

DISCUSSION
Gas-forming infections in the kidney can be classified into two main groups.11 One involves only the pelvicalyceal system and is known as emphysematous pyelitis, and the other involves the renal parenchyma with or without involvement of the collecting system, known as emphysematous pyelonephritis.

Emphysematous pyelonephritis has been subdivided into two types by Wan et al:20 Type I has a very high mortality rate, and is the more severe form of infection, where there is parenchymal destruction with mottled air in the parenchyma and little or no collection.21 Type II is characterised by loculated gas within the
parenchyma or collecting system, with associated renal or perirenal fluid collection, and is likely due to a favourable immune response. Type II carries a lower mortality rate.

Early diagnosis of these conditions is very important due to their high mortality rates (1) (emphysematous pyelitis 20% and emphysematous pyelonephritis 50%). Differentiation of emphysematous pyelitis (air only in the collecting system) from intraparenchymal gas is important, as the former has a better prognosis and may resolve with medical therapy while the latter usually requires intervention. Approximately 90% of patients are known to have diabetes mellitus. (1) Emphysematous pyelonephritis or pyelitis may be associated with an obstructive calculus in the collecting system or ureter.

Diagnosis of emphysematous pyelonephritis or pyelitis on radiography is difficult, (5) as locules of gas may be seen in the region of the kidneys or renal pelvis (Fig. 5). Sometimes, infection may be confined to the urinary bladder with the presence of intramural or intraluminal air (Fig. 6), which is known as emphysematous cystitis.

Fig. 6 Emphysematous cystitis. (a) Plain radiograph shows air outlining the urinary bladder (arrows). Dilated bowel loops consistent with paralytic ileus are also seen. (b) Coronal and (c) axial CT images show intramural air in the urinary bladder wall (arrows). (d) Sagittal and (e) axial CT images of another patient with emphysematous cystitis show air inside the lumen and the wall of the urinary bladder (arrows).
cystitis. US may be misleading and may give an appearance of calculus due to the presence of gas in the dilated collecting system. Infection of the urinary bladder by gas-forming organisms is very rare, and the gas may be present in the wall of the urinary bladder either by transmural dissection or true infection of the bladder wall. However, on careful examination, the posterior acoustic shadowing caused by gas is ‘dirty’ compared to a calculus, which produces sharp, ‘clean’ shadowing. In some cases, both gas and calculus may be present, causing confusion.

CT is the modality of choice to diagnose gas-forming renal infections. Apart from gas-forming infections, gas may rarely be seen in the kidney/collecting system due to a fistula with gastrointestinal tract, iatrogenic (after procedures) or reflux from the urinary bladder. Common organisms causing gas-forming upper urinary tract infections include *E. coli*, *Klebsiella pneumoniae* and *Aerobacter*. Differentiation between emphysematous pyelonephritis and pyelitis is important, as management is more aggressive in the former case. Drainage or nephrectomy is usually required for emphysematous pyelonephritis, whereas only antibiotic therapy with or without drainage is required for emphysematous pyelitis.

In conclusion, we stress the importance of emergent imaging with CT for poorly-controlled diabetic patients with clinical features that suggest urinary tract infection or obstructive uropathy. CT can accurately diagnose emphysematous pyelonephritis or pyelitis and can detect any associated calculous disease. This allows prompt management with parenteral antibiotics and drainage of the infected collecting system, which improves the prognosis in this serious condition.

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Question 1. The following organisms can cause emphysematous pyelonephritis:
(a) *Escherichia (E.) coli*.
(b) *Streptococcus*.
(c) *Aerobacter*.
(d) *Staphylococcus aureus*.

Question 2. Gas can be seen in the collecting system in the following cases:
(a) Diabetics with *E. coli* infection.
(b) After percutaneous nephrostomy.
(c) Reflux from urinary bladder.
(d) Xanthogranulomatous pyelonephritis.

Question 3. The following imaging modalities are often useful in diagnosing emphysematous pyelonephritis or cystitis:
(a) Plain radiography.
(b) Computed tomography.
(c) Ultrasonography.
(d) Magnetic resonance imaging.

Question 4. The following are statements regarding emphysematous pyelonephritis:
(a) Gas-forming infections of the kidneys are usually managed conservatively.
(b) Mortality is around 5%.
(c) Interventional radiology has a role in management.
(d) Patients may need nephrectomy.

Question 5. Regarding emphysematous pyelitis:
(a) It is synonymous with emphysematous pyelonephritis.
(b) It has a mortality rate of 50%.
(c) It requires nephrectomy.
(d) Drainage and antibiotic therapy are usually the treatments of choice.

Doctor’s particulars:
Name in full : ____________________________________________________________
MCR number :__________________________________________________________ Specialty:__________________________________________________________
Email address : __________________________________________________________

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