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Review Article

Emphysematous Pyelonephritis: Nephrectomy is not necessary, a narrative review

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Abstract

Emphysematous pyelonephritis (EPN) is a severe, life-endangering, necrotising, gas-producing infection affecting the kidney and perinephric tissue. It is associated with renal loss, high morbidity, and mortality. Diabetes, obstructive uropathy, female gender and hypertension are the most common risk factors. *Escherichia coli, Klebsiella pneumoniae* and *Proteus mirabilis* are the most common pathogens causing Emphysematous pyelonephritis. EPN presents as a clinical triad of fever, flank pain, and nausea. Non-contrast CT scan is the mainstay of early diagnosis of EPN. It is diagnosed by demonstrating gas in renal parenchyma and perinephric tissue. Huang and Sang's classification is used for the classification and management of EPN. Treatment of EPN progressed from early nephrectomy to minimally invasive treatments including newer and advanced antibiotics and percutaneous drainage along with Percutaneous nephrostomy and DJ stenting. Early nephrectomy was the treatment of choice in the last century however newer studies suggest conservative treatment is associated with renal preservation, decreased morbidity and mortality. The initial use of broad-spectrum antibiotics such as Third-or fourth generation cephalosporins and carbapenems is recommended. Emergency drainage is indicated with a larger-sized pigtail catheter as pus is thick and frequent blockage of tubes is common. Nephrectomy should be done for those patients who fail to respond to conservative therapy i.e., antibiotics and percutaneous drainage. This review aims to provide comprehensive, evidence-based recommendations for the diagnosis and management of this life-threatening urological infection Emphysematous pyelonephritis.

Keywords: Emphysematous pyelonephritis, Diabetes, Antibiotics, Conservative, Percutaneous drainage, Nephrectomy

Abbreviations

Emphysematous pyelonephritis	EPN
Computed tomography	CT
White Blood Counts	
Percutaneous Nephrostomy	PCN
Diabetes Mellitus	DM
Non-Contrast CT scan	NCCT

Introduction

Emphysematous pyelonephritis (EPN) is a life-threatening gas-producing necrotizing infection of kidney parenchyma and perinephric tissue.

EPN was first described by Kelly and Maccallum and named by Schultz and Klorfein. EPN is commonly associated with diabetes mellitus and female gender. Bacterial infection with Escherichia coli along with diabetes mellitus is the commonest cause of Emphysematous pyelonephritis. It presents with flank pain, fever, vomiting and on examination tenderness can be present. The symptoms are like pyelonephritis although with a fulminating course with high morbidity and mortality. Blood investigations show elevated WBC counts, increased blood glucose levels, and deranged creatinine[1,2,3].

Complications are frequent in EPN with high mortality, if not recognized and treated aggressively[4].

Treatment of patients with EPN comprises resuscitation, correction of any electrolyte and glucose problems, administration of antibiotics targeting Gram-negative bacteria, drainage of obstructed kidneys with DJ stenting or PCN, and percutaneous drainage of collection. Previously EPN was associated with high mortality but with the advent of antibiotics, early diagnosis with imaging (CT scan), advances in diabetes management, and minimally invasive treatments significant improvement in morbidity and mortality is seen. Open surgical drainage and nephrectomy were previously advocated before the advent of percutaneous drainage. Percutaneous catheter drainage is the current standard of treatment although few patients may require nephrectomy[5,6].

Risk factors and aetiology

Risk factors for EPN are DM, urinary tract infection, and female gender[2,3]. Diabetes mellitus is a known predisposing factor for the development of EPN in 95 % of patients[7]. Elevated glucose levels and impaired vascular perfusion are fertile grounds for gas-producing bacteria. Gas is formed because of the fermentation of elevated glucose levels in tissues in DM. Gas in EPN is comprised of Nitrogen (60%), hydrogen (15%), Carbon dioxide (5%) and oxygen (8%). Huang et al proposed the fermentation of mixed acid as a cause of gas formation in tissues in EPN[7,8]. The most common organisms causing EPN are E coli (66%), Klebsiella (26%), Proteus, Pseudomonas, streptococcus etc.

Severe EPN patients have higher glycosylated haemoglobin[2]. High glucose levels and urinary tract obstructions decrease renal blood flow and tissue perfusion, which can worsen the infection. Immunocompromising diseases, such as alcohol abuse, acquired immunodeficiency syndrome, or tuberculosis, are often diagnosed among nondiabetic EPN patients. [9,10,11,12,13,14].

Table 1: Risk factors and organisms causing Emphysematous pyelonephritis

Risk factors	***Infective organisms***
DM	*E coli (47-67%)*
Urinary tract infection	*Klebsiella Pneumoniae (20-24%)*
Females	*Proteus (5-18%)*
Immunocompromised state	*Enterococcus (14%)*
Hypertension	*Pseudomonas (5%)*
Obstructed Uropathy	*Clostridia*
Urolithiasis	*Candida*
Urinary Catheters	
Urinary tract malignancies	

Epidemiology

Emphysematous pyelonephritis (EPN) is an uncommon condition encountered. However, it is not infrequent in India as the prevalence of uncontrolled diabetes is Increasing. Females are affected six times more than males. The mean age of presentation is 55 years (19-81 years). Diabetes is found in ninety-five of patients presenting with EPN.

Prognosis

Huang and Tseng described successful outcomes with percutaneous drainage and antibiotics (66%) with a mortality rate of 19%[2].

EPN carries a poor prognosis in patients having risk factors leukocytosis, uncontrolled DM (increased glucose levels), impaired level of consciousness, and multiple organ failure[15].

Koratala et al described the presence of thrombocytopenia, acute renal impairment, hypoalbuminemia, and septic shock at presentation also confers a poor prognosis[16].

Comorbid diabetic ketoacidosis, although rare, is associated with high mortality[17].

The risk of mortality is higher in patients treated with antibiotics alone than in those who receive additional interventions such as percutaneous drainage of the abscess[18].

EPN patients who receive medical treatment only may progress to uncontrollable sepsis that requires surgical intervention. Perinephric abscess and renal failure are other possible complications.

Table 2: Poor Prognostic factors

Poor Prognostic Markers
Thrombocytopenia
Renal Failure (need for dialysis)
Shock
Altered mental status
Advanced age
Proteinuria
Class III and IV EPN (Huang and song)
Hyponatremia

Clinical features

Patients typically present with fever (79%), abdominal or flank pain (71%), nausea and vomiting (17%), dyspnoea (13%), acute renal impairment (35%), altered sensorium (19%), shock (29%), and thrombocytopenia (46%).

Subcutaneous emphysema, skin induration, crepitus over the flank area may occur in advanced cases of EPN. Uncommon presentation includes pneumaturia, ARDS, skin and subcutaneous involvement. Prevalent conditions in these patients are Diabetic ketoacidosis, renal calculi, malnutrition and alcoholism[1,2,3,19].

Table 3: Clinical features, examination, investigations, and imaging

Clinical Features	Examination	Investigations	Imaging
Fever	Tenderness	Elevated WBC count	X ray Abdomen
Chills	Subcutaneous crepitus	Thrombocytopenia	Ultrasound Abdomen
Flank Pain	Abdominal Lump	Deranged creatinine	NCCT KUB
Nausea/ Vomiting		High blood sugars	CECT Abdomen
Hematuria		Decreased Albumin	
Altered sensorium		Increased Glycosylated Haemoglobin	
Shock		Increased CRP	
Dyspnoea		Pyuria	

Investigations and imaging

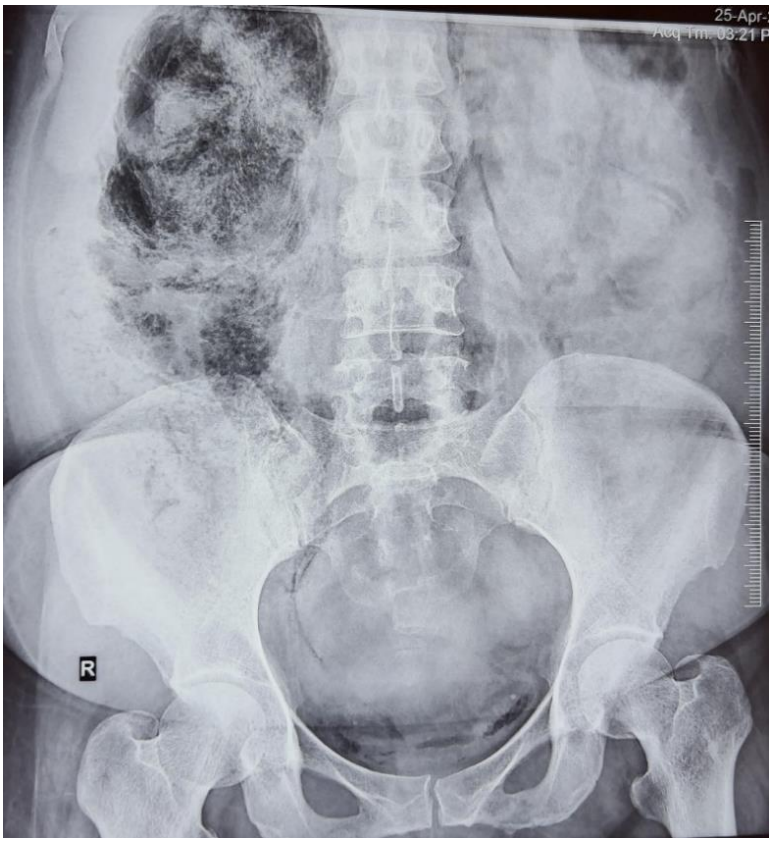

Figure 1: X ray KUB shows Gas in right renal fossa

An X-ray can show gas in the renal fossa, with a radiopaque shadow suggesting EPN. A patient presented with typical features of EPN showing gas in the right renal fossa. (Figure 1)

Ultrasound of these patients shows echogenic areas with dirty shadowing, associated features of hydronephrosis and perinephric collection can be seen.

Computed tomography usually shows features according to the staging of EPN. On a CT scan abdomen can show gas which may be streaky, mottled, rim-like, or crescent-shaped in the kidney, perinephric region. (Figure 2)

In 2000, Huang and Tseng modified the staging proposed by Michaeli et al, as follows:

· Class 1 - Gas confined to the collecting system

· Class 2 - Gas confined to the renal parenchyma alone

· Class 3A - Perinephric extension of gas or abscess

· Class 3B - Extension of gas beyond the Gerota fascia

· Class 4 - Bilateral EPN or EPN in a solitary kidney

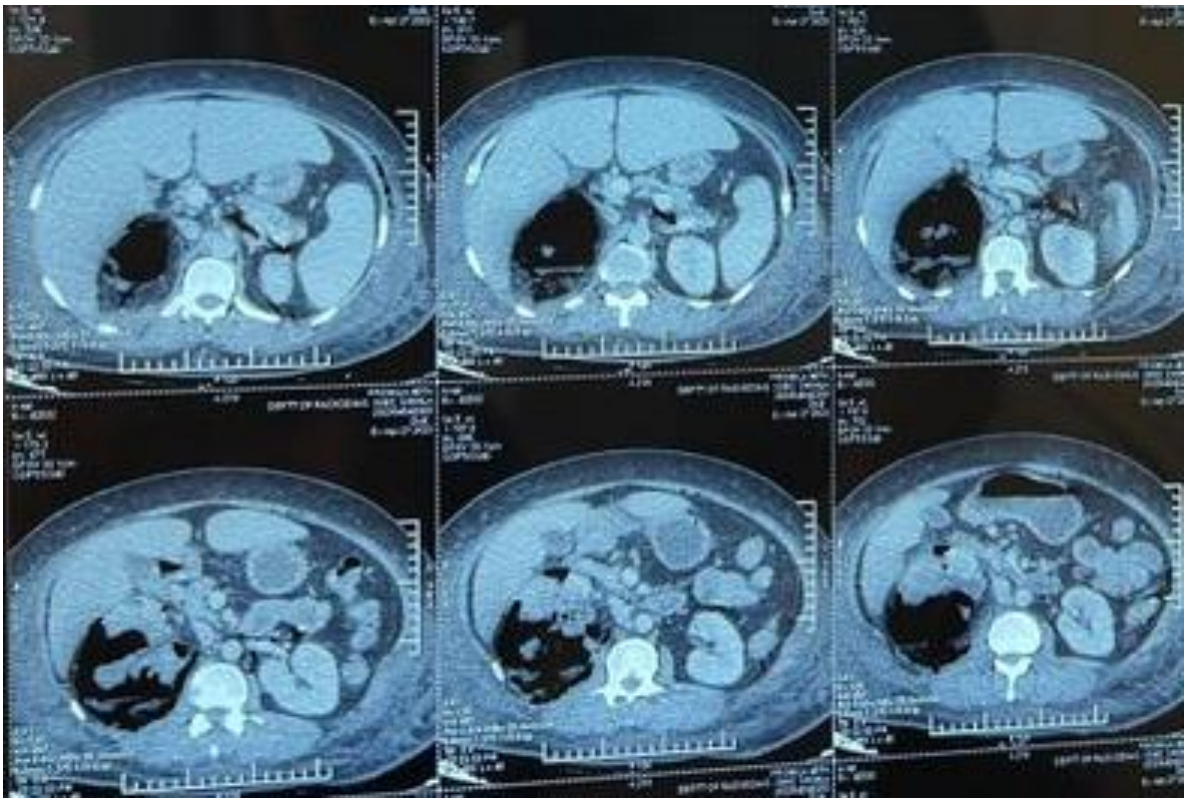

Figure 2: Axial sections of CT scan show gas in Right renal fossa, renal parenchyma is destroyed and pushed medially

Management

Patients diagnosed with emphysematous pyelonephritis (EPN) are critically ill and need a multidisciplinary approach of physician, radiologist, endocrinologist, dietitian, and ICU. These patients are evaluated first regarding the need for intensity of treatment. A critically ill patient will require oxygen, intravenous fluids, inotropic support if required, correction of acid-base balance, control of diabetes, antibiotics, and percutaneous drainage[5].

Prompt initiation of empiric IV antibiotic therapy is critical. The regimen chosen should be broad spectrum, primarily target gram-negative bacteria, and consider individual patient characteristics and local patterns of antibiotic resistance[4].

Ubee et al suggest aminoglycosides, β-lactamase inhibitors, cephalosporins, and fluoroquinolones, with the selection guided by local hospital policy.

Huang and Tseng concluded (case series 48 patients) that class 1 and class 2 EPN could be managed with antibiotics and percutaneous drainage. Class 3 or 4 EPN patients, who have fewer than two risk factors (e.g., thrombocytopenia, elevated serum creatinine levels, altered sensorium, shock) can also be managed conservatively although in the presence of two or more risk factors, nephrectomy is better[20].

Although emergency nephrectomy has historically been the preferred treatment for EPN, a conservative nephron-sparing approach is increasingly favoured[21,25].

Percutaneous drainage is to be done in all classes of Huang classification. Larger bore pigtail especially more than 14 Fr should be inserted as fluid is thick and blockage of catheters is frequent. Commonly collections are multiloculated and multiple drains need to be placed. Patients whose collection is not drainable, and patients whose condition not improving despite percutaneous drainage need to be considered for early nephrectomy.

Aswathaman reported a success rate of 80 % while Huang and Tseng reported a 66% success rate with percutaneous drainage and antibiotics. Huang and Tseng described a success rate of more than 90% who underwent nephrectomy.

Table 4: Medical and surgical treatment of Emphysematous pyelonephritis

Medical	**Surgical**
Oxygen Inhalation	Percutaneous Drainage
Intravenous fluids	Percutaneous Nephrostomy
Inotropic support (if required)	DJ stenting
Antibiotics	Open Drainage
Diabetes control	Early Nephrectomy
Correction of acid base balance	Delayed Nephrectomy

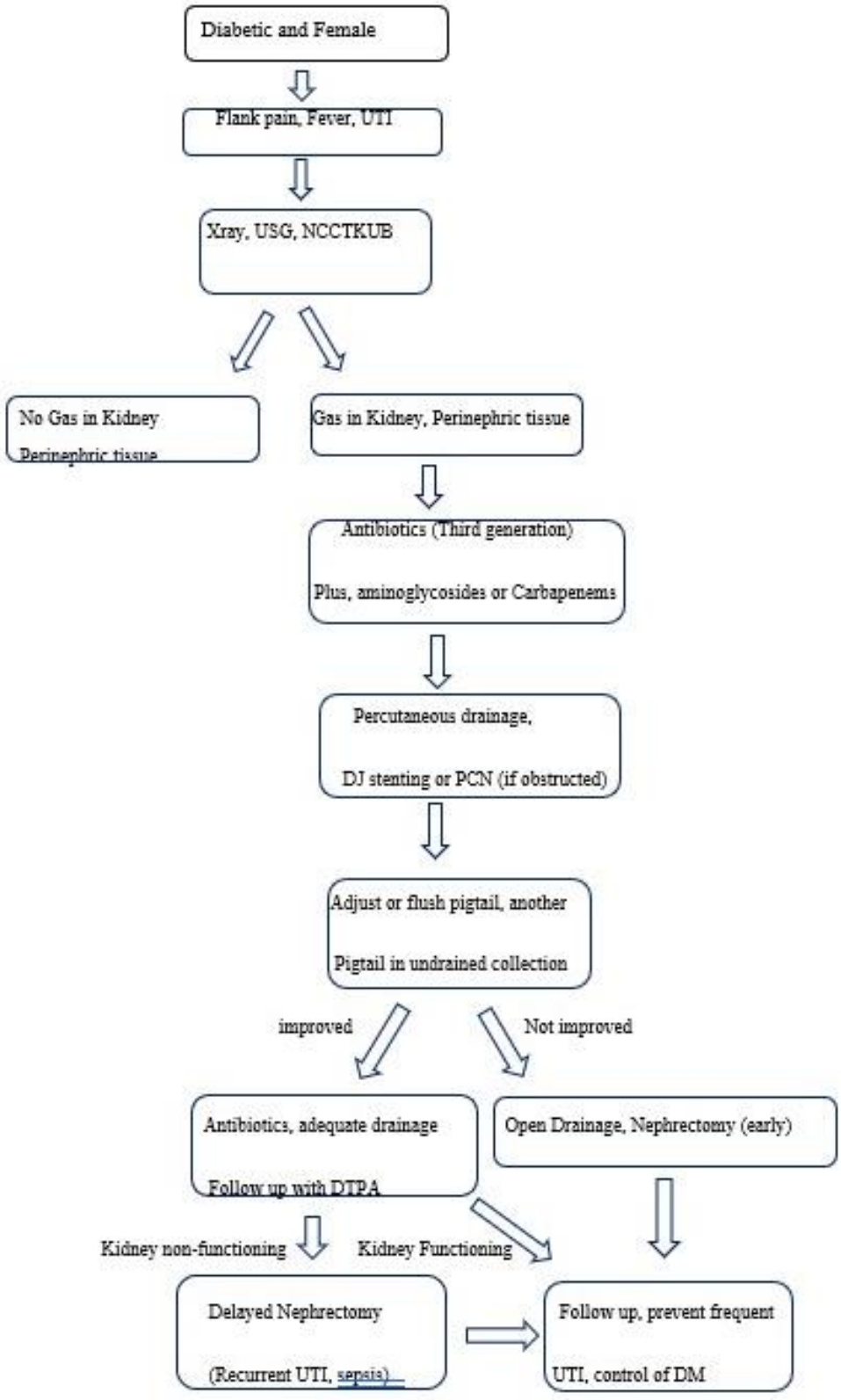

Figure 3. Management algorithm for management of Emphysematous pyelonephritis

EPN has been traditionally treated with nephrectomy or open drainage along with systemic antibiotics. More recently, it has been shown that treatment with percutaneous nephrostomy is a viable option, eliminating the need for surgical intervention. A systematic review of 10 retrospective studies including 210 patients showed that the mortality rate in patients treated with percutaneous drain placement (13.5%) was lower than that seen in patients treated with nephrectomy (25%)[3] or medical management alone (50%). All patients were treated with systemic antibiotics regardless of other interventions[26]. We suggest the management of EPN as shown in algorithm figure 3

Although there is still a role for nephrectomies in more severe cases of EPN, percutaneous drainage combined with medical management is a viable initial management strategy and may serve as an effective bridge to nephrectomy. The severity of the disease course of EPN is determined by an interplay of many clinical findings including the extent of renal and perirenal involvement, presence of renal necrosis, thrombocytopenia, and hemodynamic instability. Elawday et al recently published a case series of 34 patients concluding that most patients responded to medical treatment and only 2 patients required nephrectomy. Carbapenems and ureidopenicillin were the most common antibiotics used and only eight patients required CN/ DJ stenting. There was no mortality in this study[27,28].

A forty-year-old diabetic female presented with typical features of EPN in respiratory distress (Figures 1 and 2), managed with antibiotics, diabetes control, and percutaneous drainage. We could salvage her kidney after 3 weeks of frequent changes of PCN, and antibiotics according to pus culture. Her differential function (DTPA scan) after 3 months was 20%.

Factors that confer a worse prognosis and mortality increase among patients with EPN include bilateral disease, presence of renal parenchymal necrosis on imaging, thrombocytopenia, and treatment conservatively without percutaneous drainage. Hyponatremia has also been shown to predict mortality.

Conclusions

EPN is a life-threatening gas-producing necrotizing infection which requires a collaborative multidisciplinary approach. Early diagnosis with a CT scan is key for salvaging kidneys and improving outcomes. Conservative treatment comprising antibiotics, oxygen therapy, intravenous fluids, and percutaneous drainage yield excellent outcomes. Early diagnosis of Diabetic patients with urinary tract infections is key for preventing the development of EPN. Early nephrectomy has a limited role although should be done if not responding to conservative treatment.

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Human and animal rights: This article does not contain any studies with animals performed by any of the authors.

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