GENERAL

# anaesthesia for chronic renal disease and renal

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## Introduction

When a patient with chronic renal disease (CRD) is scheduled for surgery, the anaesthetic plan becomes a critical component of the overall peri operative strategy. The kidneys play a pivotal role in drug elimination, fluid balance, and electrolyte regulation, all of which are altered in chronic kidney disease (CKD). These changes can affect the choice of anaesthetic agents, the monitoring strategy, and the postoperative care required to prevent complications such as acute kidney injury (AKI) or electrolyte disturbances. This guide provides an in depth, evidence based overview of anaesthesia for patients with chronic renal disease, covering pre operative assessment, intra operative management, and post operative considerations. Whether you are a clinician preparing for an upcoming procedure, a patient seeking to understand what to expect, or a trainee looking to deepen your knowledge, this comprehensive resource will help you navigate the complexities of anaesthesia in the renal context.

## Understanding Chronic Renal Disease

### What Is CKD?

Chronic kidney disease is defined as abnormalities of kidney structure or function that persist for more than three months, with implications for health. It is usually staged based on the estimated glomerular filtration rate (eGFR) and the presence of albuminuria. CKD is a progressive condition that can culminate in end stage renal disease (ESRD), requiring dialysis or transplantation.

### Stages of CKD

- Stage 1: eGFR /"e /90 /mL/min/1.73 /m² with kidney damage
- Stage 2: eGFR /60 89 /mL/min/1.73 /m²
- Stage 3: eGFR /30 59 /mL/min/1.73 /m² (divided into 3a and 3b)
- Stage 4: eGFR /15 29 /mL/min/1.73 /m²
- Stage 5: eGFR

### Common Symptoms

Early stages of CKD are often asymptomatic, but as kidney function declines patients may experience fatigue, edema, hypertension, anemia, bone disease, and electrolyte imbalances. These manifestations can influence anaesthetic risk and choice of peri operative management.

## Why Anaesthesia Care Is Critical for Renal Patients

### Impact of Renal Dysfunction on Drug Metabolism

Many anaesthetic drugs and adjuncts are metabolized or excreted by the kidneys. Reduced renal clearance can lead to drug accumulation, prolonged action, and increased toxicity. For example, the opioid fentanyl is metabolized by the liver but its metabolites are renally excreted; in CKD, even small amounts of metabolites can accumulate and cause respiratory depression.

### Fluid Balance Concerns

Patients with CKD have a limited ability to excrete excess fluid. Intra operative fluid overload can precipitate

pulmonary edema and worsen kidney function, whereas hypovolemia can reduce renal perfusion and trigger AKI. Precise fluid management is therefore essential.

### Cardiovascular Implications

CKD is closely linked to cardiovascular disease, including hypertension, left ventricular hypertrophy, and coronary artery disease. Anaesthesia can cause significant hemodynamic swings, which may be poorly tolerated by these patients. Maintaining stable blood pressure and avoiding abrupt drops in perfusion pressure is a top priority.

## Types of Anaesthesia Relevant to Renal Patients

### General Anaesthesia

General anaesthesia provides unconsciousness, immobility, and analgesia. It is often required for major abdominal or thoracic procedures. In CKD patients, careful selection of induction agents (e.g., propofol, etomidate) and maintenance agents (e.g., sevoflurane, desflurane) is necessary to avoid nephrotoxic metabolites and to preserve renal perfusion.

### Regional Anaesthesia

Spinal, epidural, or combined spinal epidural techniques can offer excellent analgesia while limiting systemic drug exposure. They are especially useful for lower limb, pelvic, or abdominal surgeries. However, they may affect blood pressure and require close monitoring.

### Local Anaesthesia

Local infiltration or nerve blocks can provide targeted analgesia with minimal systemic effects. For CKD patients undergoing minor procedures, local anaesthesia can reduce the need for systemic analgesics that may harm the kidneys.

### Sedation

Conscious sedation is often used for endoscopic or minor surgical procedures. Agents such as dexmedetomidine or propofol can be titrated to avoid excessive respiratory depression and maintain hemodynamic stability.

## Preoperative Assessment and Planning

### Medical History Review

Obtain a detailed history of renal disease progression, dialysis schedules, transplant status, and comorbidities such as diabetes or cardiovascular disease. Document any previous anaesthetic complications, drug allergies, and current medications.

### Laboratory Investigations

- Serum creatinine, eGFR, electrolytes (Na z, K z, $Ca^{2}$ z, $Mg^{2}$ z)
- Serum albumin, total protein
- Coagulation profile (PT/INR, aPTT)
- Hemoglobin, hematocrit
- Urinalysis for proteinuria or hematuria

### Medication Review

Identify nephrotoxic drugs (e.g., NSAIDs, aminoglycosides) and consider dose adjustments or discontinuation. Review antihypertensives, antidiabetic agents, and anticoagulants. Adjust dosing of renally excreted drugs according to eGFR.

### Risk Stratification

Use tools such as the Revised Cardiac Risk Index (RCRI) or the American Society of Anaesthesiologists (ASA) Physical Status Classification to estimate peri operative risk. CKD itself is a significant risk factor for postoperative complications.

## Drug Considerations in Renal Dysfunction

### Analgesics

Acetaminophen is generally safe at therapeutic doses. NSAIDs should be avoided due to their nephrotoxic potential. For opioid analgesia, morphine and codeine are contraindicated because of active metabolites that accumulate in CKD. Alternatives include fentanyl, sufentanil, or hydromorphone, which have minimal renal clearance.

### Anticholinergics

Agents such as atropine or glycopyrrolate are used to reduce secretions. Glycopyrrolate has limited renal excretion and is preferred in CKD patients. Atropine may accumulate and cause prolonged anticholinergic effects.

### Muscle Relaxants

Succinylcholine is short acting but may cause hyperkalemia in CKD; use with caution. Non depolarizing relaxants such as atracurium or cisatracurium undergo Hofmann elimination and are preferred because they are not renally cleared.

### Induction Agents

Propofol is commonly used for induction. It has a short half life and is metabolized hepatically, making it suitable for CKD patients. Etomidate is another option but may cause adrenal suppression in prolonged use.

### Maintenance Agents

Volatile agents like sevoflurane and desflurane are primarily metabolized by the liver and have minimal renal excretion. They provide reliable anaesthesia with predictable recovery profiles. Total intravenous anaesthesia (TIVA) with propofol and remifentanil can also be employed, ensuring careful dosing to avoid accumulation.

### Adjuncts

Ketamine is avoided in CKD due to its active metabolite, norketamine, which may accumulate. Dexmedetomidine is an attractive sedative with minimal renal clearance and can reduce opioid requirements post operatively.

## Fluid Management Strategies

### Crystalloids vs Colloids

Balanced crystalloid solutions (e.g., Ringer''s lactate, Plasma Lyte) are preferred over normal saline to minimize hyperchloremic metabolic acidosis. Colloids such as albumin can be used judiciously for volume expansion, especially in patients with hypoalbuminemia, but caution is warranted due to potential renal side effects.

### Avoiding Fluid Overload

Use goal directed fluid therapy guided by dynamic indices (e.g., stroke volume variation, pulse pressure variation) or non invasive cardiac output monitoring. Maintain a neutral fluid balance and avoid aggressive liberal fluid replacement that could precipitate pulmonary edema.

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