Kidney disease in the elderly

William White

Andrea Cove-Smith

Abstract

Chronic kidney disease (CKD) and acute kidney injury (AKI) are more common in the elderly due to ageing-related changes in the kidney. Renal pathology in the elderly will in future form an increasing proportion of the workload of nephrologists, specialists in internal medicine and general practitioners due to ageing of the general population. AKI in the elderly can often be anticipated and prevented. Published guidelines concerning the management of CKD in younger adults may not be universally implementable in the elderly, and may ignore complications and challenges specific to this age group. There is a growing demand for renal services to provide renal replacement therapy (RRT) to elderly patients. The decision to start an elderly person on a particular form of RRT should follow careful assessment of their biological age, function and lifestyle, and their health priorities and quality of life must be kept at the centre of decision-making at all times. Patients who are unsuited to or do not wish to commence RRT may do very well with maximal conservative management (MCM). End-of-life and palliative care remains somewhat underused in nephrology, and is an area that needs to be developed further.

Keywords Acute kidney injury; aged; chronic kidney disease; palliative care; renal replacement therapy

Introduction

Glomerular filtration rate (GFR) declines with age, and the prevalence of chronic kidney disease (CKD) rises with increasing age in populations studied: among females in the Chinese general population the prevalence of CKD rises from 7.4% in 18–39 year olds to 24.2% in those aged 70 years or over.[1] The ageing of the general population (primarily consequent to socioeconomic development and greater life expectancy) means that elderly people form an increasing proportion of patients with kidney disease and end-stage renal failure (ESRF).

The ageing kidney

GFR declines by about 8 ml/min/1.73 m^2 per decade after the fourth decade, though this varies between individuals.[2] Loss of function may result from a combination of cumulative exposure to extrinsic risk factors (e.g. hypertension and vascular disease), disease acquisition (often occult) and intrinsic ageing.[3] A history of one or more episodes of acute kidney injury (AKI) has been implicated in the development of CKD.[2]

Kidney mass increases from birth to the fourth decade but is subsequently lost at a rate of 10% per decade, the reduction being greater in the renal cortex than medulla.[3] The number of functioning glomeruli falls with age (approximately 50% fewer are present at 70 years than at 30) with the proportion of sclerotic glomeruli increasing.[3]

Renal blood flow exhibits a steady decline with ageing, more so in the cortex than medulla, with an increase in post-glomerular renovascular resistance helping to preserve GFR. However, the renovascular response to vasodilatory agents and the sensitivity of renal arterioles to endogenous and exogenous vasoactive substances is also altered, predisposing to a decline in GFR as a result of haemodynamic changes.[4]

Renal tubule number also declines, with a decrease in tubular length and volume, and an increase in tubular atrophy, diverticula (giving rise to cysts) and scarring.[4] Ageing-related changes in tubular anatomy result in altered function. Maintenance of sodium balance in the elderly depends upon increased proximal sodium reabsorption coupled to reduced distal fractional reabsorption: this limits the kidney's ability to conserve sodium in response to low salt intake, and predisposes the individual to volume depletion. Reduced activation of the renin-angiotensin-aldosterone system, decreased responsiveness to vasopressin, and loss of thirst sensation also contribute to this. Elderly people also have a relative inability to excrete sodium excess in response to salt loading, predisposing them to salt and water retention.[4]

Tubular atrophy and scarring lead to reduced Na^+—K^+ ATPase activity. This contributes to an increased risk of hyperkalaemia, alongside declining GFR and reduced activation of the renin-angiotensin-aldosterone system. Elderly people are more likely to develop hyperkalaemia when taking drugs such as NSAIDs, spironolactone and ACE inhibitors.[4] Conversely, poor intake and diuretic use may cause hypokalaemia.[3]

The kidneys' ability to dilute and concentrate urine decreases with age: in elderly rats this has been attributed to reduced expression of urea transporters in the inner medullary collecting ducts, down-regulation of vasopressin-2 receptors in the collecting duct and a reduced expression of the water channels aquaporin 2 and 3.[5] Reduced concentrating ability commonly gives rise to nocturia, and predisposes to hyponatraemia after a water load. Elderly people are prone to develop acidosis due to an inability to increase ammonia and H^+ synthesis.[4]

Renal 1-hydroxylase activity declines with age, reducing the kidney's capacity to convert 25-hydroxyvitamin-D to 1,25-dihydroxyvitamin-D, and increasing the likelihood of vitamin D deficiency (Table 1).[4]

Estimating glomerular filtration rate in the elderly

Age-related loss of GFR is accompanied by a reduction in creatinine excretion due to reduced muscle mass, so the relationship between serum creatinine (SCr) and GFR changes; substantial reductions in GFR may occur with only slight rises in SCr.[6] A formula that takes age and weight into account, such as the Cockcroft-Gault or Modification of Diet in Renal Disease (MDRD) formulae, should be used when estimating an elderly patient's renal function.

Acute kidney injury (AKI)

The overwhelming majority of cases of AKI in the elderly result from decreased renal perfusion and acute tubular necrosis (ATN).[3]

William White *MBBS BSc MRCP is a Specialty Trainee in Nephrology and General Internal Medicine at the Royal London Hospital, Barts Health NHS Trust, UK. Competing interests: none declared.*

Andrea Cove-Smith *BA BM BCh MRCP PhD is a Consultant Nephrologist at Barts Health NHS Trust, UK. Competing interests: none declared.*

Ageing-related changes in kidney function and fluid and electrolyte homeostasis[4]

Structural	Functional	Complications of functional change
↓ Renal mass	↓ GFR	↓ Renal reserve
↓ Blood flow	↓ Response to sodium loading/depletion	Hyper-/hyponatraemia
↓ Functioning glomeruli	↓ Urine concentrating/diluting ability	Nocturia, hyper-/hyponatraemia
↓ Functioning tubules	↓ Renin + aldosterone levels	Volume depletion, hyperkalaemia
	↓ Response to vasopressin	Volume depletion, dehydration
	↓ Na^+—K^+ ATPase activity	Hyperkalaemia
	↓ Ammonia + H^+ synthesis	Metabolic acidosis
	↓ 1-Hydroxylase activity	Vitamin D deficiency

Table 1

Impaired ability to maintain circulating volume in the face of stress increases susceptibility to acute renal hypoperfusion. Older people are more likely to have co-morbid conditions compromising renal perfusion, such as cardiac failure and renovascular disease, and to be taking medications such as diuretics, which reduce circulating volume, and ACE inhibitors/angiotensin-receptor blockers and NSAIDs, which modulate renal haemodynamic autoregulation. They are also more likely to become dehydrated due to decreased sensitivity to thirst and impaired mobility.[3]

ATN most frequently results from ischaemic damage occurring when reduced renal perfusion is not corrected quickly. Elderly people are also more likely to suffer kidney injury as a result of obstruction of the renal tract (Table 2).[3]

The increased vulnerability of the elderly to AKI should be recognized and measures taken to prevent it. Volume assessment represents a particular challenge in the elderly. Thirst is often absent despite dehydration. Tachycardia and hypotension may occur due to cardiac failure, and postural hypotension because of medication or autonomic dysfunction. Jugular venous pressure (JVP) may be elevated in cardiac failure and tricuspid regurgitation. Peripheral oedema may occur as a result of hypoalbuminaemia, and will collect in the sacrum in bedbound patients.[3]

Regular measurement of kidney function is essential in all elderly in patients, especially those who are acutely unwell or being given nephrotoxic medications or contrast agents, with attention to appropriately calculated eGFR rather than serum creatinine or urea.

Patients with blood and protein on urine dipstick, or otherwise suspected to have an intrinsic renal disease such as an acute glomerulonephritis, should be referred to a renal physician. The management of complications of AKI and the indications for RRT are the same in the elderly as for the general population (Table 3).

Common causes of AKI in the elderly

↓ Renal perfusion
Sepsis
Volume loss (e.g. gastrointestinal haemorrhage, diarrhoea + vomiting)
↓ Cardiac output (e.g. myocardial infarction, arrhythmias)
Acute tubular necrosis
Uncorrected renal hypoperfusion
Aminoglycoside antibiotics
Iodinated contrast agents
Myoglobin (rhabdomyolysis)
Parenchymal kidney disease
Glomerulonephritis
Interstitial nephritis (especially drug-induced)
Obstruction
Prostatic enlargement
Renal calculi
Pelvic tumours

Table 2

Chronic kidney disease

Controversy exists as to what distinguishes pathological CKD from age-related loss of GFR. Current guidelines advise that CKD be diagnosed at an eGFR of less than 60 ml/min/1.73 m^2, in the presence or absence of proteinuria;[1] up to 50% of over-75 year olds in the general population meet these criteria.[7] Most CKD diagnoses in the elderly are based on moderate and

Prevention and basic investigation of AKI in the elderly

Prevention
Maintain hydration
Monitor vital signs
Withdraw/minimize exposure to nephrotoxic drugs/agents
Monitor eGFR rather than creatinine or urea
Prevent/address sepsis promptly and appropriately
Investigation
Careful fluid balance assessment and judicious fluid challenge with monitoring
Septic screen
Ultrasound of the urinary tract
Medication review
Urine dipstick and protein:creatinine ratio
Creatine kinase

Table 3