Improving recognition and management of acute kidney injury

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Abstract

Acute kidney injury (AKI) is currently suboptimally recognised and managed in the UK, despite its association with significant patient morbidity, mortality and consequent implications for healthcare economics. Our prospective study, performed in a large urban London hospital, demonstrated that the introduction of a specially designed care bundle can significantly improve documentation of baseline creatinine, assessment and optimisation of fluid status, performance of urine dip, withholding of nephrotoxic drugs, appropriate monitoring of urine output, prescription of renal drug doses, and appropriate consideration of a renal ultrasound and urinary protein-creatinine ratio. Improved compliance of appropriate investigations and initial treatments translated to decreased requirement for intensive care admission and a trend towards shorter length of stays.

Keywords

Acute Kidney Injury, Care Bundles, Acute Medicine

Key points

- Acute kidney injury (AKI) is currently under-recognised in the acute medical setting, delaying prompt initiation of investigations and acute treatments
- An AKI bundle is an effective method to improve compliance in including appropriate investigations and management among junior doctors
- Improved recognition and initial management of AKI translates to improved patient outcomes

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Introduction

Acute kidney injury (AKI) is a spectrum of pathology ranging from mild reversible loss of renal function to advanced injury requiring renal replacement therapy. Clinically, the patient is unable to maintain fluid, acid-base and electrolyte homeostasis, in addition to inability to excrete toxic and waste substances.

The prevalence of AKI has been ascertained mainly from U.S. data. It has been reported between 1%[1] and 7.1%[2] of all patients acutely admitted to hospitals present with some degree of AKI. Between 5% and 20% of patients requiring intensive care treatment suffered from AKI at some point during their hospital admission.[3] The risk of mortality associated with AKI positively correlates with the number of organ systems involved: patients presenting with uncomplicated AKI have a 10% risk of mortality during their admission,[4] increasing to 50% with multi-organ failure, rising further to 85% if renal replacement therapy is required.[5] A recent UK national enquiry into patient outcome and death (NCEPOD) reported inpatient AKI mortality at up to 25-30%.[6] From a health economics perspective, the UK National Institute for Clinical Excellence (NICE) estimated the financial burden of AKI at £434 to £620 million per year.[7]

Despite the importance of detection and appropriately managing AKI, NCEPOD reported that only half of patients admitted to a UK hospital with AKI received "good care".[6] It is recognised that patients with AKI are often admitted under the care of a senior doctor practicing in a specialty other than renal medicine, and are initially managed by a junior doctor who may be unfamiliar in the appropriate investigations and actions that should be undertaken. In an effort to improve standards, the first NICE guideline on the detection and management of AKI was published in August 2013.[7]

A number of expert groups, including the acute dialysis quality initiative (ADQI)[8] and the acute kidney injury network (AKIN),[9] had previously described different definitions and staging systems. This had made comparison of epidemiological data difficult. Recently, an international network of kidney injury experts, "Kidney Disease: Improving Global Outcomes" (KDIGO), has harmonized previous criteria to produce the most universal accepted definition of AKI:[10] first, creatinine increases of greater than 26 micromol/l in 48 hours; second, creatinine rises greater than 1.5 times a value from within the last 7 days; and third, urine output of less than 0.5mls/kg/hr for more than 6 consecutive hours. The KDIGO criteria recognises that even small changes in serum creatinine can signal poor outcomes and has been recommended by the UK renal association in its latest AKI guidelines.

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Aims of Audit

This study documented the ability of junior doctors at a large London hospital to detect AKI in the acute medical setting, initiating appropriate treatment for reversible causes of AKI, preventing deterioration by withholding nephrotoxic medications and appropriate prescribing of renal dosing of applicable drugs. We also tested the hypothesis that an AKI care bundle can improve the detection and management of AKI, associated with an improvement in patient outcomes.

Audit Standards

The gold standard used by this audit is the UK renal association AKI guideline published in 2011,[10] outlining that every patient presenting with AKI should receive:

1. Documentation of baseline creatinine
2. Assessment of fluid status
3. Urine dip
4. Stopping of any nephrotoxic drugs
5. Prescription of any appropriate new medications at renal dosing
6. Appropriate urinary biochemistry, such as urinary protein creatinine ratio (PCR)
7. Investigation with ultrasound of the renal tract if AKI has not improved within 24 hours of admission with fluid status optimisation, an obstructive cause is suspected or an unusual cause of AKI is suspected that will required renal biopsy.

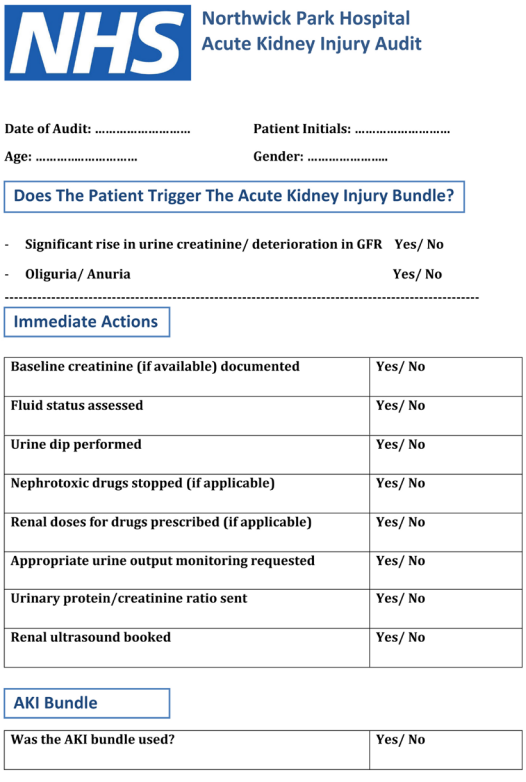
Methods

In the first study phase, suitable patients were prospectively identified via the "acute medical take" list on Northwick Park hospital's intranet, applying the KDIGO AKI definition as the inclusion criteria. The creatinine of all admitted patients was checked on the hospital intranet and any meeting the KDIGO AKI criteria were also included. All patients referred by accident and emergency or their general practitioner with oliguria or anuria for longer than 6 consecutive hours were also included. Staging of the patient's AKI was defined as per KDIGO, in which stage 1, 2 and 3 were defined as per creatinine increases between 1 to 1.9 times, 2 to 2.9 times, and greater than 3 times respectively. In recognition of the junior acute medical rota consisting of two sets of doctors working alternate days on the same week, data collection was performed every Monday and Tuesday to reduce duplicate inclusion of the same junior doctors. The first phase of the study continued every Monday and Tuesday until fifty patients had been recruited.

A proforma was specially designed prior to patient recruitment (figure 1). The authors examined the medical notes of each included patient and completed the proforma.

Junior doctors were presented with an educational package after the first phase of the audit: firstly, at the medical directorate clinical governance meeting attended by all junior doctors, a presentation was given to highlight the importance of appropriately managing AKI, the results of the study's first phase. Junior doctors were taught the appropriate investigations and management actions when encountering an acute patient with AKI. Next, a new care bundle to aid AKI management was designed and advertised daily for two weeks amongst clerking junior doctors (figure 2). Thirdly, the new AKI bundle was then advertised using posters amongst junior doctors for 2 weeks in acute medical areas. Junior doctors using the AKI bundle were instructed to stick the bundle into the patient's medical notes to demonstrate use and to aid the authors' data collection.

The second phase of the study was performed every Monday and Tuesday again until 50 patients had been recruited: blood results for every patient admitted under the medical team were checked on consecutive days and medical notes examined for oliguria or anuria. Any patients with AKI as defined by the KDIGO criteria were included in the second study phase. Medical notes for included patients were examined for whether an AKI bundle had been used and whether the appropriate management actions had been performed.



NHS Northwick Park Hospital
Acute Kidney Injury Audit

Date of Audit: ..... Patient Initials: .....

Age: ..... Gender: .....

Does The Patient Trigger The Acute Kidney Injury Bundle?

- Significant rise in urine creatinine/ deterioration in GFR Yes/ No
- Oliguria/ Anuria Yes/ No

Immediate Actions

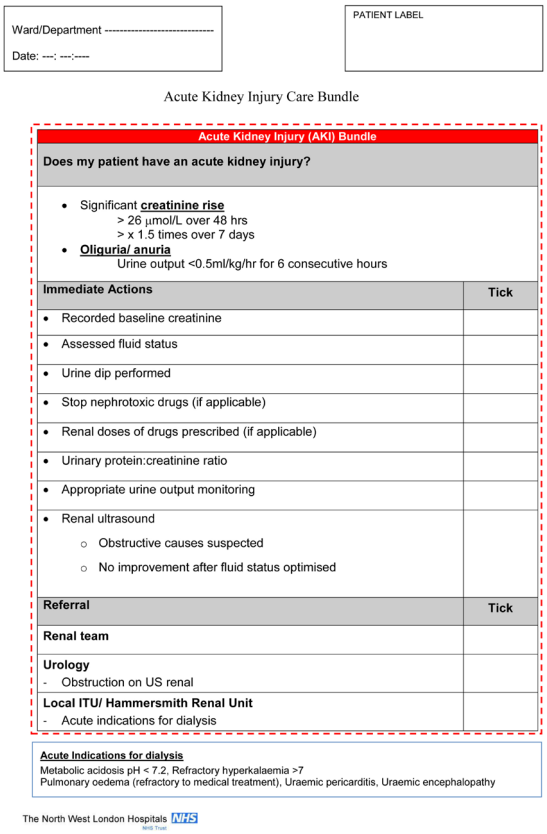
Baseline creatinine (if available) documented	Yes/ No
Fluid status assessed	Yes/ No
Urine dip performed	Yes/ No
Nephrotoxic drugs stopped (if applicable)	Yes/ No
Renal doses for drugs prescribed (if applicable)	Yes/ No
Appropriate urine output monitoring requested	Yes/ No
Urinary protein/creatinine ratio sent	Yes/ No
Renal ultrasound booked	Yes/ No

AKI Bundle

Was the AKI bundle used?	Yes/ No

Figure 1. Audit data collection proforma

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Ward/Department ----------

Date: ---: ---:----

PATIENT LABEL

Acute Kidney Injury Care Bundle

Acute Kidney Injury (AKI) Bundle

Does my patient have an acute kidney injury?

- Significant **creatinine rise**
  > 26 µmol/L over 48 hrs
  > x 1.5 times over 7 days
- **Oliguria/ anuria**
  Urine output <0.5ml/kg/hr for 6 consecutive hours

Immediate Actions	**Tick**
• Recorded baseline creatinine	
• Assessed fluid status	
• Urine dip performed	
• Stop nephrotoxic drugs (if applicable)	
• Renal doses of drugs prescribed (if applicable)	
• Urinary protein:creatinine ratio	
• Appropriate urine output monitoring	
• Renal ultrasound o Obstructive causes suspected o No improvement after fluid status optimised	
Referral	**Tick**
Renal team	
Urology - Obstruction on US renal	
Local ITU/ Hammersmith Renal Unit - Acute indications for dialysis	

Acute Indications for dialysis
Metabolic acidosis pH < 7.2, Refractory hyperkalaemia >7
Pulmonary oedema (refractory to medical treatment), Uraemic pericarditis, Uraemic encephalopathy

The North West London Hospitals NHS

Figure 2. AKI Care Bundle

One month after the conclusion of the re-audit, patient outcomes data were retrospectively collected for patients included in the first and second study phases, including length of stay, requirement for escalation of care to high dependency unit, requirement for haemodialysis in the intensive care unit and mortality.

The compliance of junior doctors in performing the appropriate action points before and after the introduction of the acute kidney injury bundle were collated in a data spreadsheet (Windows Excel 2007). Statistical significance in actions performance as a result of the AKI bundle was calculated using a chi-square test (SPSS version 17), assuming non-parametric distribution and one degree of freedom. The statistical significance of care bundles on patient outcomes was calculated using Mann-Whitney U test, assuming non-matched, non-parametric data (SPSS version 17).

Results

The first phase of the study, prior to the introduction of an AKI bundle, recruited 55 patients admitted to the acute medical take over a six-week period. 28 male and 27 female patients were included, with an average age of 76.5 years. The second phase of the study, repeated after the AKI bundle was implemented, recruited 53 patients over a four-week period. 33 male and 20 female patients were included, with an average age of 77.45 years. The first cohort consisted of forty-six patients with stage 1 AKI, three stage 2, six stage 3. The second cohort consisted of forty-three patients in stage 1 AKI and ten patients in stage 2, zero stage 3. The patient demographics and AKI staging were statistically non-significant and sufficiently similar to allow comparison.

The performance of appropriate investigations and management when treating patients presenting with AKI before and after the introduction of the AKI bundle, during the first and second phases of the study respectively, is tabulated below (table 1). The gold standard of 100% compliance as defined by the UK renal association's management of AKI guideline was not achieved in the first phase of our study. However, following the introduction of our AKI bundle, significant improvement was demonstrated in documentation of baseline creatinine (52.7% to 83%, $p<0.001$), assessment of fluid status (58.2% to 81%, $p<0.001$), performance of urine dips (41.8% to 92%, $p< 0.001$), stopping of nephrotoxic drugs (18.5% to 85.7%, $p <0.001$), prescription of renal doses of new medications (18.5% to 83.3%, $p<0.001$), appropriate fluid balance monitoring (10.9% to 67.9%, $p <0.001$), urinary protein: creatinine ratio monitoring (0% to 62%, $p<0.001$), and appropriate consideration of renal ultrasound (7.27% to 75% $p<0.001$)

In addition, compliance was even more successful in patients managed using an AKI bundle (figure 3), achieving the 100% standard in compliance for five of eight specified appropriate investigations and initial management actions.

Improved performance of appropriate investigations and treatments following the introduction of the AKI bundle was associated with improved patient outcomes (table 2). The requirement for escalated care to the high-dependency unit (HDU) decreased significantly from 7.3% to 0% ($p <0.001$), while requirement for emergency inpatient haemodialysis in intensive care unit (ITU) also significantly decreased from 1.8% to 0%. The mean and median length of stay trended towards a decrease after the bundle introduction (mean 12.31 days to 10.66 days, median 9 to 7 days) but was not statistically significant ($p = 0.18$).

Discussion

This study demonstrated that AKI had not been sufficiently recognised in acute medical admissions at Northwick Park Hospital, a large urban London hospital. Appropriate investigations and management had not been initiated to the standard recommended by the UK renal association and NICE.

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Table 1. Acute medical clerking compliance on AKI management points

	Pre-AKI Bundle	Post-AKI Bundle	AKI Bundle Used
Number of patients	55	53	34
Average age	76.5	77.5	79.3
Average AKI stage	1.27	1.19	1.17
Baseline creatinine documented	52.7%	83%	100%
Fluid status assessed	58.2%	81%	97%
Urine dip performed	41.8%	92%	100%
Nephrotoxic drugs stopped	18.5% (5 of 27 applicable patients)	85.7% (30 of 35 applicable patients)	100%
Renal doses of drugs prescribed	18.5% (5 of 27 applicable patients)	83.3% (30 of 36 applicable patients)	100%
Appropriate urinary monitoring requested	10.9%	67.9%	91%
Urinary PCR requested	0%	62%	90%
Renal ultrasound requested or considered on admission	7.27%	75%	100%

Finlay and colleagues demonstrated similar deficiencies in patient care in a recently published multi-centre retrospective study:[11] intravenous fluids were not prescribed when appropriate in 16.7% of patients, fluid balance were not chart in 35.4% of patients, while nephrotoxic drugs were not stopped appropriately in 19.7% of patients. The authors acknowledged the small number of medical admissions in some centres, impacting the experience of medical trainees in appropriately managing AKI on a regular basis.[11] However, results from our study demonstrate deficiencies in AKI management generalisable to a large and busy hospital such as Northwick Park and St. Mark's hospitals, when the medical take regularly range between 60 and 80 patients within a 24-hour period. Despite regular experience amongst junior doctors in managing AKI, deficiencies remain in appropriate recognition and initial management.

It has previously been suggested that medical trainees do not receive sufficient training in the management of AKI[12] and our results may reflect a consequent lack of knowledge. One recent study reported that 30% of trainees failed to name two or more risk factors for AKI, 37% failed to name one indication for specialist renal referral while half of surveyed trainees failed to define AKI.[13]

Finlay and colleagues suggested a simple recognition tool or bundle can improve the recognition and management of AKI, as has been demonstrated in our results. Care bundles have previously been demonstrated to improve patient outcomes. Implementation of care bundles in 13 medical diagnoses in the same urban London hospital resulted in significant reductions in standardized hospital mortality over two consecutive years.[14] Our bundle provides a simple checklist to prompt junior doctors in within a busy acute medical environment and resulted in improved outcomes in our patient cohort, reducing the length of stay and required admission to escalated care services. Our bundle prompts junior doctors to correct immediate easily

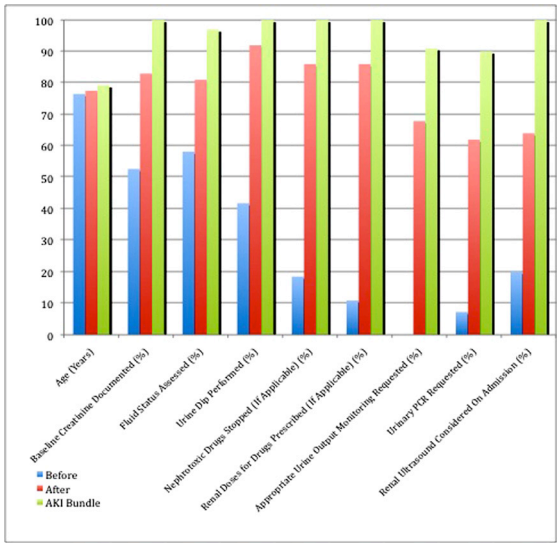


Figure 3. Compliance rates before and after introduction of AKI care bundle

Table 2. Outcomes after introduction of AKI bundle

	Before AKI Bundle	After AKI Bundle
Mean length of stay (days)	12.31	10.66
Median length of stay (days)	9	7
Admission to high dependency unit (HDU)	7.3	0
Admission to intensive care unit (ITU)	1.8	0
Mortality (%)	1.8	5.7

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reversible causes of AKI such as hypovolaemia, demonstrated to increase the risk of AKI 6.2-fold,[11] while removing exacerbating factors such as nephrotoxic drugs.

Early recognition and appropriate management also reduced the requirement of escalated care. It is likely that early optimization of fluid status and removal of exacerbating factors prevented the need of centrally monitored fluid replacement in a high-dependency setting or emergency renal replacement therapies in an intensive care setting. In addition, early recognition of AKI that had not been reversed with fluid status optimization results in earlier renal specialist review, performance of screening investigations, diagnosis of underlying AKI cause and definitive treatment. For example, in the case of systemic vasculitis presenting as AKI, early immunosuppressive therapy is proven to result in better patient outcomes.[15]

However, there was no trend towards improvement in mortality, which unexpectedly increased from 1.8 to 5.7%. This unexpected rise is likely an insignificant statistical anomaly, as both figures remain significantly lower than the 25-30% figure reported as the national average mortality for inpatient admissions with AKI.[7]

However, the authors recognise a number of limitations within our study. In the first phase of our study, there remains the possibility of a misrepresented sample, as only junior doctors working in the acute medical areas at Northwick Park hospital were included. Secondly, we recognise that junior doctors clerk multiple patients during their "on-call" days. Therefore, each trainee's performance or failure to demonstrate optimal AKI management points would be amplified in our study results. Thirdly, our study may have revealed problems regarding medical documentation rather than inability to appropriately manage AKI: for example, it is unknown if appropriate urinary monitoring and requests for urine dips were verbally made to nursing staff without formal documentation in the acute medical clerking. Lastly, patients admitted under other specialties, as well as AKI presenting on the wards after admission, were not studied. Recognition and management is poorer in patients who developed AKI after admission than patients who presented to acute medical units with AKI.[6]

The study was performed in a large London center serving a large catchment area with a population in which vascular diseases are prevalent. As a result, medical trainees at Northwick Park hospital are relatively experienced in recognizing and managing AKI. Although our study demonstrates deficiencies in management of patients admitted in the acute medical take, it is likely that the issues highlighted extend into patients cared already admitted under medical and surgical specialties. AKI is an important medical issue and its appropriate recognition and management directly translates to better patient outcomes. It is hoped that our AKI care bundle can be a simple adjunct in medical and surgical areas to improve AKI management in primary and secondary care.

Competing Interests

The authors declare no competing interests.

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