

# NEPHwork National AKI Audit

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An audit of care quality  
in the identification and  
management of AKI stages 2  
and 3 in acute NHS trusts in  
England and Wales in 2019



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## Suggested citation

NEPHwork National AKI Audit (2021) – an audit of care quality in the identification and management of AKI stages 2 and 3 in acute NHS trusts in England and Wales in 2019.

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*The data reported here have been supplied by the NEPHwork Consortium, funded by the UK Kidney Association (UKKA) and Kidney Research UK and supported by the UKKA UK Renal Registry and UKKA Renal SpR club. The interpretation and reporting of these data are the responsibility of the authors and in no way should be seen as an official policy or interpretation of the UKKA or Kidney Research UK.*

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# FOREWORD

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**Dr Graham Lipkin**  
UKKA Past-President  
GIRFT Joint Clinical Lead for Renal Medicine



I strongly commend this important national acute kidney injury (AKI) audit. The NEPHwork structure crucially explored care processes and outcomes of almost 1,000 adult patients with the most severe stages of AKI (AKI stage 2 and 3) admitted across a sample of hospital trusts in England and Wales in 2019. Disturbingly, the audit demonstrates little improvement in the care and outcomes of patients with AKI over the past decade.

Acute kidney injury is a sudden, potentially reversible, loss of kidney function. Affecting up to one in five emergency hospital admissions, and 7.6% of admissions overall, it is associated with a marked increase in short term morbidity, a mortality of 18-33% by 30 days, substantial healthcare utilisation and costs (estimated between £400-600m/annum) and an increased subsequent risk of chronic kidney disease<sup>ii</sup>. For patients admitted in England in 2017, 32% of AKI developed in hospital, while 68% arose in the community or soon after admission<sup>iii</sup>.

In 2009, the National Confidential Enquiry into Patient Outcome and Death (NCEPOD) report Acute Kidney Injury: Adding Insult to Injury, raised the profile of AKI and provided the impetus for national efforts to improve care<sup>iv</sup>. Clinical experts reviewing cases of AKI in hospital where the patient died concluded that AKI could have been prevented in 15% of cases and that only 50% of patients received a standard of care that was considered 'good'.

I congratulate the NEPHwork initiative, a ground-breaking audit process, engaging renal trainees in national kidney data collection. It is enabled by the UK Kidney Association (UKKA), UK Renal Registry (UKRR) and Kidney Research UK (KRUK). The audit judged the care of patients against robust nationally accepted UK Kidney Association AKI Clinical Practice Guidelines 2019<sup>v</sup>, identifying patients using the UKRR AKI master patient index with data coming directly from all English laboratories.

Ten years since the last National enquiry into care quality and outcomes of patients admitted to hospital with AKI, significant variation remains between trusts in the achievement of AKI care-quality measures with significant variations in assessment of AKI between different specialties. In-hospital mortality was 31% for all AKI episodes included. 30-40% of those discharged with AKI were readmitted within 90 days. The UKRR AKI dashboard describes case-mix adjusted benchmarking of patient mortality. It is almost certainly a measurable and reliable discriminator of the quality of acute care quality across all trusts and between medical and surgical specialities.

This report should act as a clarion call to healthcare commissioners and clinicians to focus attention on improving care quality and patient outcomes. Recent high-quality evidence indicates that the introduction of a combination of AKI e-alerts, care bundles and education can lead to improved detection, reduced length of stay and enhanced quality of care, albeit without delivering any reductions to mortality<sup>vi</sup>. The recommendations of NICE and UKKA AKI national guidelines together with the recent National Renal Getting it Right First Time (GIRFT) national report provide an important road map to deliver the care to which we all aspire<sup>vii</sup>.

<sup>i</sup> Lameire, N.H., Bagga, A., Cruz, D. et al. (2013) Acute kidney injury: an increasing global concern. *Lancet*, 382(9887): 170–179. <https://pubmed.ncbi.nlm.nih.gov/23727171/>

<sup>ii</sup> Selby, N.M., Fluck, R.J., Kolhe, N.V. et al. (2016) International Criteria for Acute Kidney Injury: Advantages and Remaining Challenges. *PLoS Med.*, 13(9): 1002122. <https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1002122>

<sup>iii</sup> <https://www.ncepod.org.uk/2009akitoolkit.html>

<sup>iv</sup> <https://www.ncepod.org.uk/2009akitoolkit.html>

<sup>v</sup> <https://ukkidney.org/sites/renal.org/files/FINAL-AKI-Guideline.pdf>

<sup>vi</sup> Selby, N.M., Casula, A., Lamming, L. et al. (2019) An Organizational-Level Program of Intervention for AKI: A Pragmatic Stepped Wedge Cluster Randomized Trial. *J.Am.Soc.Nephrol.*, 30(3): 505–515 <https://jasn.asnjournals.org/content/30/3/505>

<sup>vii</sup> <https://ukkidney.org/sites/renal.org/files/Renal%20Medicine%20Sept21k.pdf>

## FOREWORD

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**Dr Hannah Beckwith**  
UKKA Renal SpR Club Committee Chair



This audit represents Nephrology's first trainee-led national multicentre collaborative project. It is the culmination of outstanding commitment, enthusiasm and teamwork from registrars across England and Wales, and is particularly impressive given the challenges and competing priorities over the last 18 months.

This outstanding piece of work is no doubt the first of many high quality academic outputs to come from the NEPHwork community- huge congratulations and thank you to all who have been involved.

# CONTENTS

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<b>Executive Summary</b>	<b>6</b>
<b>Introduction</b>	<b>8</b>
Acute Kidney Injury: definition and burden	8
AKI algorithm and UK Renal Registry Master Patient Index	8
NEPHwork National AKI Audit	9
Objectives of the report	9
<b>Methods</b>	<b>10</b>
NEPhwork workforce	10
Audit process and identification of hospitalised AKI episodes	10
Organizational survey	11
Statistical methods	11
<b>Data return and clinicodemographic features of AKI episodes</b>	<b>12</b>
<b>Attainment of care quality indicators</b>	<b>15</b>
<b>Outcomes of AKI episodes</b>	<b>20</b>
<b>Principal Conclusions</b>	<b>22</b>
<b>References</b>	<b>23</b>
<b>Acknowledgements</b>	<b>23</b>
<b>Appendices</b>	<b>26</b>



# EXECUTIVE SUMMARY

## INTRODUCTION

Acute kidney injury (AKI) is a sudden deterioration of kidney function that is accompanied by high morbidity and mortality.

From the 2009 National Confidential Enquiry into Patients Outcomes and Deaths (NCEPOD) report (Acute Kidney Injury: Adding Insult to Injury) approximately 1,000 episodes of AKI care in people who died in England with an ICD-10 code for AKI (N17) contained in Hospital Episode Statistics (HES) were reviewed. Of these episodes, in only 50% of cases was AKI care considered good by consultants. The audit found poor assessment of risk factors for AKI and an unacceptable delay in recognition of AKI post-admission, which corresponded to 43% of cases reviewed. In one-fifth of AKI episodes reviewed, AKI was considered predictable and therefore avoidable, and complications of AKI were missed in 13%, avoidable in 17%, and poorly managed in 22% of cases.

Since 2014, NHS England mandated all testing laboratories in England to incorporate AKI alert test scores (AKI alerts) into their laboratory testing systems with the aim to improve both early detection and outcomes of AKI. In addition, with the aim of facilitating nationwide related analyses of AKI care, these AKI alerts have since been regularly sent to the UK Renal Registry (UKRR) along with demographic data. This allowed the publication in 2019 of the first UKRR AKI report which was based on the analysis of the alerts sent to the UKRR in 2018.

The establishment of the NEPHwork consortium, with support from the UK Kidney Association (UKKA), UKRR and Kidney Research UK, has allowed trainees in nephrology to be brought together to conduct audit and/or research projects on a national scale. The first project chosen was the NEPHwork AKI National Audit which, 10 years after the publication of the NCEPOD report, has aimed to describe the hospital standard of care for AKI in its most severe stages, AKI stage 2 and 3, and to explore the achievement of current guidelines in the recognition and management of AKI.

A workforce of 57 SpRs from the UKKA SpR club reviewed almost 1,000 care episodes across 24 NHS acute trusts in England and Wales. Between 1<sup>st</sup> December 2020 and 28<sup>th</sup> February 2021, electronic and paper care-records for patients with AKI episodes admitted to hospital between December 2018 and February 2019, were reviewed by renal SpRs within each hospital trust against an agreed proforma based on the UKKA AKI guidelines published in 2019.

## KEY FINDINGS

- 989 AKI care episodes were included in the analyses, of these 50.3% were AKI stage 2 and 49.7% AKI stage 3.
- Approximately 73% of all AKI episodes included occurred in patients aged  $\geq 65$  years, 54% in males, 90% in people of White ethnicity.
- For both stage 2 and stage 3 AKI, there were no differences between groups of different socioeconomic deprivation status.
- Ten years since the last National enquiry into care quality and outcomes of patients admitted to hospital with AKI, significant variation remains between organizations in the achievement of care-quality measures, in particular for those related to clinical assessment of AKI.
- Variations in clinical assessment of AKI were also found between different specialties.
- In almost 20% of cases the discharge summary did not mention AKI.
- 24 (2.4%) AKI episodes required long-term dialysis.
- 90-day re-admission rate amongst AKI survivors was high and between 30-40%.
- In-hospital mortality was high and about 31 % for all AKI episodes included.
- 30-day mortality was also high at 33%, reaching 35.4% in AKI stage 3.

## CONCLUSIONS

This is the first audit report that, using AKI alerts collected by the UKRR directly from laboratories, describes the attainment of guidelines in the identification and management of hospitalised AKI episodes. This audit report is therefore the first one to explore how in-hospital standards of care of AKI have improved 10 years after the NCEPOD report and 5 years after the introduction of the AKI alerts in the NHS, providing essential data for both service planning and QI projects development in this area.

# INTRODUCTION

## ACUTE KIDNEY INJURY – DEFINITION AND BURDEN

Acute kidney injury (AKI) is a sudden decline in kidney function that lasts from a few hours to a few days. Recognised examples of risk factors include advanced age and pre-existing conditions, such as chronic kidney disease (CKD)<sup>1</sup>.

AKI is a significant cause of mortality and morbidity and carries significant healthcare costs<sup>2</sup>.

From the 2009 National Confidential Enquiry into Patients Outcomes and Deaths (NCEPOD) report (Acute Kidney Injury: Adding Insult to Injury), in which approximately 1,000 AKI care episodes were reviewed in people who had died in England with an ICD-10 code for AKI (N17) held in Hospital Episode Statistics (HES)<sup>3</sup>, only 50% of AKI care was considered good by the advisors. There was poor assessment of risk factors for AKI and an unacceptable delay in recognising post-admission AKI in 43% of patients. A fifth of post-admission AKI was both predictable and avoidable, and complications of AKI were missed in 13%, avoidable in 17% and managed badly in 22% of cases.

Following the publication of the NCEPOD report, the need therefore arose to improve the ability to detect and manage AKI in the health service. This was the spark that led to the development of quality improvement projects, first and foremost, the “Think Kidneys” programme that was instrumental in the development of the NHS England funded AKI warning test score or alert system and enabled the introduction of the AKI alert system into the NHS laboratories.

## AKI ALGORITHM AND UK RENAL REGISTRY MASTER PATIENT INDEX

As of March 2015, NHS England has implemented a standardised biochemical classification of AKI by installing an algorithm in their laboratory information management system<sup>4</sup>.

The algorithm compares a person’s serum creatinine with their historical blood tests (if any) to determine if the person may have AKI.

The AKI algorithm has five possible outcomes, three of which are AKI warning test scores or alerts (from the least severe AKI stage 1 to the most severe AKI stage 3). These results are in agreement with the Kidney Disease: Improving Global Outcomes (KDIGO) AKI staging system<sup>5</sup>:



1. Null (no evidence of AKI).
2. Stage 1 AKI.
3. Stage 2 AKI.
4. Stage 3 AKI.
5. Not applicable (insufficient creatinine values but marked as abnormal if outside the reference range).

Laboratories are required to send such alerts to the UKRR along with basic demographic information on all persons detected by the algorithm. The UKRR collates these AKI alerts (stages 1, 2 and 3) into a single Master Patient Index (MPI), which each adult or child in England who has had an AKI alert.

### **NEPHWORK NATIONAL AKI AUDIT**

The aim of the renal specialty (SpR) trainee driven NEPHwork was to develop, coordinate and deliver audit and research projects that answer specific and simple questions on a large scale by coordinating the audit and research activity of a large number of renal trainees nationally. The NEPHwork is supported by a collaboration between the UKKA and Kidney Research UK. The first NEPHwork project was an audit of the care provided to people with an acute kidney injury (AKI): the NEPHwork National AKI Audit.

10 years after the results of the NCEPOD audit and following the improvement projects introduced, NEPHwork therefore set out to audit whether and how identification and management of AKI had improved.

### **OBJECTIVES OF THE REPORT**

The NEPHwork National AKI Audit aims are to explore care process and outcomes of adult patients with the most severe stages of AKI (AKI stage 2 and 3) admitted across a sample of hospital trusts in England and Wales in 2019. The audit pro-forma (Appendix) was developed by the NEPHwork steering committee against [the UKKA's AKI clinical practice guideline 2019](#). The audit explored the attainment of prompt recognition of AKI as outlined in the guidelines and its subsequent clinical management in accordance with the guidelines.

# METHODS

## NEPHWORK WORKFORCE

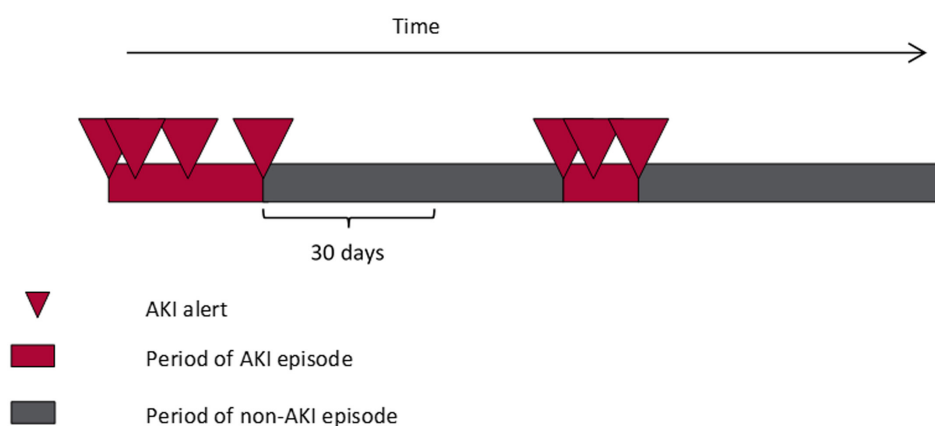
Twenty-four NHS acute trusts took part in the NEPHwork National AKI Audit with a target of 1,000 care episodes reviewed by a workforce of 57 SpRs from the UKKA SpR club. Between 1st December 2020 and 28th February 2021, electronic and paper care-records for patients with AKI episodes admitted to hospital between December 2018 and February 2019, were reviewed by renal SpRs within each hospital trust against the agreed proforma. The full list of the NEPHwork workforce is available at the end of this report.

## AUDIT PROCESS AND IDENTIFICATION OF HOSPITALISED AKI EPISODES

AKI care episodes in England were identified using the linkage between the UKRR AKI-MPI of AKI warning test scores and Hospital Episodes Statistics (HES). A pre-populated pro-forma for each patient identifier and AKI date was made available electronically by the UKRR through a specially designed, secure, electronic portal that was accessible to SpRs completing the audit locally. SpRs reviewed patient notes and records for the selected episodes and then returned the data using the electronic pro-forma through the secure UKRR data portal.

An AKI episode was defined by one or more e-alerts separated by no more than 30 days (figure 1), i.e. if more than one alert was present, all alerts following the first were considered part of the episode unless a 30-day alert-free period had passed. AKI episodes identified from the UKRR-MPI were linked to HES data to identify hospitalised patients with AKI.

Figure 1 AKI episode definition



For this audit, adult patients that had an AKI-episode which started any time between one week before and two weeks after hospital admission were included, resulting in both community-acquired hospitalised (CAH) AKI subsequently hospitalised and hospital-acquired (AH) AKI cases being selected. A further inclusion-criterion was the presence of an AKI-alert at stage 2 or 3 at any point during the first 2 weeks in hospital. Day-cases and maternity admissions were excluded.

A point-by-point guide was produced and sent to the Wales representative of the NEPHwork Steering Committee for the AKI audit so that the same selection criteria for identifying AKI episodes could be applied. In Wales the episodes were selected from the hospital data on hospital AKI alerts available in Wales for the same period. The analyses of this audit were carried out for the whole cohort and at centre level. Centre-level analyses were sent at the end of August 2021 to each centre participating in the audit so that each centre could compare its performance in meeting the AKI standards of care against the average of all participating centres in the NEPHwork audit.

## **DATA SOURCES**

Data available for this audit came from various sources. The AKI-MPI provided demographic information on age and gender. Patients' residence postcodes were available via the AKI-MPI dataset for English patients, while for Welsh patients they were obtained through tracing from the NHS Batch Demographics Service. Postcodes were then used to assign patients the Index of Multiple Deprivation (IMD)<sup>7</sup>, a measure of relative deprivation for small areas, categorised into quintiles for analysis (from 1=least deprived to 5=most deprived group).

Ethnicity was obtained using the HES linkage for English patients, while it was asked as an extra variable during the audit for Welsh patients. Hospital admissions were classed as elective or emergency admissions based on the admission-method available from HES-linkage, and divided into admission with hospital-acquired AKI (HA-admissions) or community-acquired AKI (CA-admissions) based on time between first AKI-alert and hospital admission (HA- if AKI commencing from day 3 of a hospital admission, CA- if AKI beginning outside of hospital, or within the first 2 days of an admission). The NHS Batch Demographics Service was used to trace dates of death for all patients. The pro-forma is shown in its entirety in the appendix.

## **ORGANIZATIONAL SURVEY**

Registrars were asked to complete a 13-question survey about the organisation of their renal service. Data about the survey was sent by email and collected through a spreadsheet which was returned by the end of the audit period.

## STATISTICAL METHODS

Demographic characteristics and audit metrics are presented as percentages for categorical variables and as median and interquartile range (IQR) for continuous variables, for the full cohort and separately by peak AKI-stage, with no test for differences between groups performed.

Variation between hospitals in the attainment of quality indicators is shown with funnel plots, with hospital level of attainment adjusted for age and sex using logistic analysis.

Outcomes such as in-hospital or 30day mortality, re-admission or recovery of renal function are summarised for the full cohort and by peak AKI-stage. Variation in in-hospital mortality rate between hospital, adjusted by age and sex using logistic analysis, is presented as a funnel plot.

All analyses were performed using SAS version 9.4.

## DATA RETURN AND CLINICODEMOGRAPHIC FEATURES OF AKI EPISODES

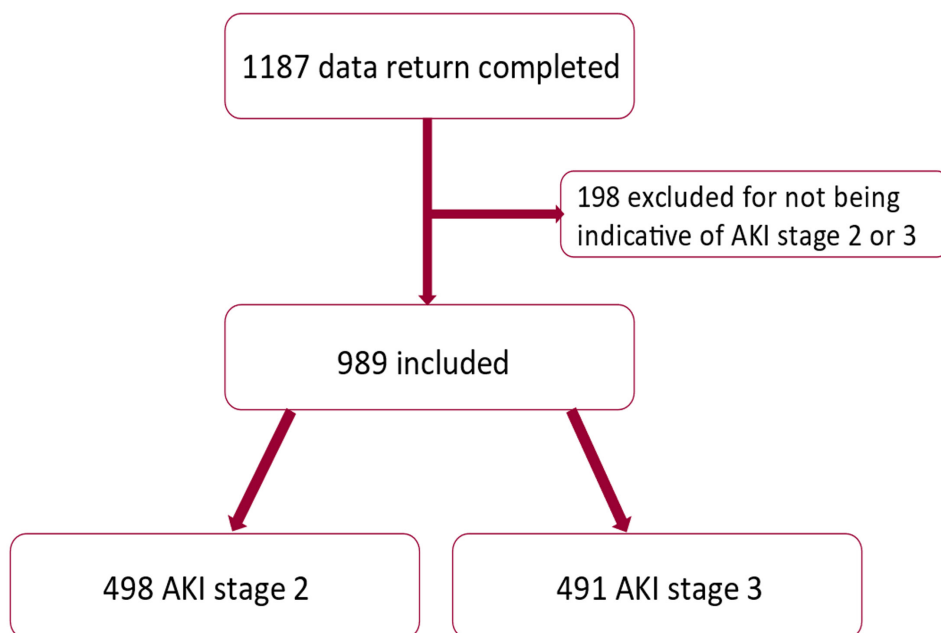
The NEPHwork AKI national audit was attended by 57 registrars from 24 NHS acute Trusts of which 22 were in England and 2 in Wales. The audit covered 8 of the 9 English regions with the exception of the Northwest where, unfortunately, the concomitant COVID-19 pandemic made it impossible for centres in this area to participate.

Figure 1.1 map of NEPHwork AKI national audit participants in England and Wales



Against the target of 1000 records 1187 records were returned as complete and of these 989 were included in the study cohort.

**Figure 1.2 Flowchart of data return and of study cohort**



Approximately 73% of all AKI episodes occurred in patients aged  $\geq 65$  years, 54% in males, 90% in people of White ethnicity. For both stage 2 and stage 3 AKI, there were no differences between groups of different socioeconomic deprivation status. All sociodemographic and clinical features of AKI episodes are summarised in table 1.1.

**Table 1.1 Sociodemographic and clinical features of AKI episodes overall and by peak stage AKI**

Variables	Peak-2 AKI		Peak-3 AKI		ALL AKI	
Total N (%)	498	50.3	491	49.6	989	
Age group N (%)						
18- 29	10	2	7	1.4	17	1.7
30- 49	31	6.2	46	9.4	77	7.8
50- 64	72	14.5	96	19.6	168	16.9
65 - 74	109	21.9	99	20.2	208	21
75 - 84	157	31.5	141	28.7	298	30.1
$\geq 85$	119	23.9	102	20.8	221	22.3
Sex N (%)						
Female	245	49.2	209	42.6	454	45.9
Male	253	50.8	282	57.4	535	54.1

<b>IMD quintile N (%) - missing N=2</b>						
deprivation score-1 (least-deprived)	101	20.3	85	17.3	186	18.8
deprivation score-2	115	23.1	102	20.8	217	22
deprivation score-3	98	19.7	104	21.2	202	20.5
deprivation score-4	99	19.9	89	18.2	188	19.1
deprivation score-5 (most deprived)	84	16.9	110	22.4	194	19.7
<b>Ethnicity N (%) - missing N= 72 (33 Eng + all Wales)</b>						
Asian	18	3.8	14	3.1	32	3.5
Black	16	3.4	20	4.5	36	3.9
Other/Mixed	11	2.4	11	2.4	22	2.4
White	423	90.4	404	90	827	90.2
<b>Cause of AKI N (%)</b>						
Hypovolemia	151	30.3	115	23.4	266	26.9
Circulatory failure	51	10.2	59	12	110	11.1
Sepsis	166	33.3	149	30.3	315	31.8
Rhabdomyolysis	3	0.6	2	0.4	5	0.5
Nephrotoxicity	16	3.2	24	4.9	40	4
Obstruction	32	6.4	68	13.8	100	10.1
Multifactorial	17	3.4	34	6.9	51	5.1
No specific cause	56	11.2	36	7.3	92	9.3
Not completed	6	1.2	4	0.8	10	1
<b>Type-AKI N (%) - from AKI-MPI+HES England only (n=950)</b>						
CAH	334	69.2	351	75.2	685	72.1
HA	149	30.8	116	24.8	265	27.9
<b>Type-admission N (%) - from HES England-only (n=950)</b>						
Elective	40	8.3	28	6	68	7.2
Emergency	443	91.7	439	94	882	92.8
<b>Admission specialty N (%)</b>						
Medicine	350	70.3	364	74.1	714	72.1
Surgery	109	21.9	86	17.5	195	19.7
ITU	24	4.8	30	6.1	54	5.4
Discharged from ED	3	0.6	1	0.2	4	0.4
Other	11	2.2	10	2	21	2.1
Not completed	1	0.2	0	0	1	0.1
Creatinine re-checked within 30 days N (%), if alive 30days after discharge, N=628 (330 AKI stage 2 - 298 AKI stage 3)	221	67	224	75.2	445	70.9
<b>Life-threatening complications N (%) missing N = 17</b>						
Hyperkalaemia	59	11.9	130	26.5	189	19.2
Uraemia	61	12.2	114	23.3	175	17.7
Pulmonary oedema	51	10.3	52	10.6	103	10.5
Acidosis	134	27.2	204	41.8	338	34.5
<b>Median Length of Stay (IQR)</b>	10	(5-19)	11	(5-20)	10	(5-20)

All participating centres completed the organizational survey conducted in parallel with the collection of audit data, results are shown in table 1.2.



**Table 1.2 Results of organizational survey.**

<b>QUESTIONS</b>		
How many days per week you have a consultant nephrologist on site?	<b>N</b>	<b>%</b>
2 days	1	4
5 days	2	8
7 days	21	88
	<b>N-Yes</b>	<b>% Yes</b>
Is emergency RRT service available 24 hours a day 7 days a week?	24	100
Are there locally derived guidelines (for example, via abnormality flags on pathology results) to encourage timely referral into the in-hospital renal service?	23	96
Is there a communication guidance to local hospitals to ensure prompt access to renal specialists to discuss cases; this will include written criteria to ensure safe transfer?	15	62
Is there a communication guidance with local primary care to ensure prompt access to renal specialists to discuss cases?	21	88
Are available trained nurses able to deliver intermittent haemodialysis 24 hours a day 7 days a week, separate from the delivery of treatment to patients with established renal failure?	20	83
Is Renal unit staffed so that there is access to trained nurses to deliver plasma exchange seven days a week within 24 hours of a patient being identified as requiring plasma exchange treatment.?	20	83
Is a dialysis access available in appropriate settings 24 hours a day? Appropriate settings include operating theatres, radiology departments and clean areas on renal wards	20	83
Is access to the following medical specialties available 24 hours a day: urology, critical care, general and vascular surgery, cardiology, haematology and obstetrics?	24	100
Is access to renal ultrasound available within 24 hours of presentation?	21	88
Is access to process specialised tests, such as immunology and specialty biochemistry, available 5 days a week?	22	92
Is access to routine biochemistry, haematology and blood transfusion services available 24 hours a day?	24	100
Is access to interventional radiology and clinical microbiology available 7 days a week?	19	79

## **ATTAINMENT OF CARE QUALITY INDICATORS**

Timely clinical assessments after admission varied by type of assessment, ranging from 37% of episodes for the request of an ultrasound scan within 24 hours of admission (6 hours if pyelonephritis was suspected) to 87% for fluid balance assessment. Overall, the standard AKI interventions were completed in more than 80% of all episodes. Attainment of quality indicators for both assessment and clinical management of AKI and its follow-up are shown in table 2.1.

**Table 2.1 Attainment of quality indicators overall and by peak stage AKI**

Variables	Peak-2 AKI		Peak-3 AKI		ALL AKI	
Total N (%)	498	50.3	491	49.6	989	
Clinical Assessment: timely review N (%)						
Consultant review within 6 hours	283	58	288	59.8	571	58.9
Medication review (dose adjustments and discontinuation within 6 hours)	392	79.5	400	82.1	792	80.8
Fluid balance assessment (Fluid balance assessment within 6 hours)	425	86.2	425	87.5	850	86.8
Urinalysis test recorded	173	35.5	233	48.3	406	41.9
USS renal tract [within 24hrs (<6hrs if pyelo) or any other imaging to exclude obstruction]	139	27.9	228	46.5	367	37.2
Blood/gas acid-base recorded	328	66.3	372	76.2	700	71.2
Clinical management: timely Interventions - treatment completed when indicated N (%)						
Antibiotics (Within 1 hour) (indicated, with data, N=612, 302 AKI stage 2 - 310 AKI stage 3)	274	90.7	271	87.4	545	89.1
IV fluids (indicated, with data, N=798, 400 AKI stage 2 - 398 AKI stage 3)	384	96	391	98.2	775	97.1
Diuretics (indicated, with data, N=93, 47 AKI stage 2, 46 AKI stage 3)	47	100	45	97.8	92	98.9
Bladder catheterization (indicated, with data, N=525, 226 AKI stage 2 - 299 AKI stage 3)	210	92.9	281	94	491	93.5
Nephrostomy/stent (indicated, with data, N=52, 14 AKI stage 2 - 38 AKI stage 3)	13	92.9	33	86.8	46	88.5
Follow-up: Discharge letter including AKI diagnosis - N (%)						
AKI mentioned on discharge letter (alive at discharge, N= 682, 357 AKI stage 2 - 325 AKI stage 3)	250	71.7	285	87.7	541	79.3
GP Instructions re medicine and blood tests on discharge letter when applicable (with data N = 553, 274 AKI stage 2 - 279 AKI stage 3)	177	64.6	187	67	364	65.8
Follow-up of unresolved renal function mentioned on discharge letter (applicable, with data, N= 370, 169 AKI stage 2 - 201 AKI stage 3)	98	58	131	65.2	229	61.9
Nephrology Involvement N (%)						
One off advice when applicable (with data N=531, 225 AKI stage 2 - 306 AKI stage 3)	50	22.2	110	35.9	160	30.1
Ongoing review when applicable (with data N = 488, 194 AKI stage 2 - 294 AKI stage 3)	34	17.5	141	48.0	175	35.9
Take-over including RRT when applicable (with data N = 458, 187 AKI stage 2 - 271 AKI stage 3)	4	2.1	54	19.9	58	12.7
Transferred to secondary care when applicable (with data = 457, 203 AKI stage 2 - 254 AKI stage 3)	6	3.0	46	18.1	52	11.4
ICU involvement N (%)						

Take over from Nephrology when applicable (with data N= 457, 203 AKI stage 2 - 254 AKI stage 3)	13	6.4	29	10.8	42	8.9
Advice from Intensivist when applicable	97	19.5	133	27.1	230	23.3
Take-over supportive management when applicable	65	13.1	83	16.9	148	15.0
Take-over RRT when applicable	21	4.2	59	12.0	80	8.1
ICU involvement NOT applicable	212	43.3	211	43.2	423	43.2

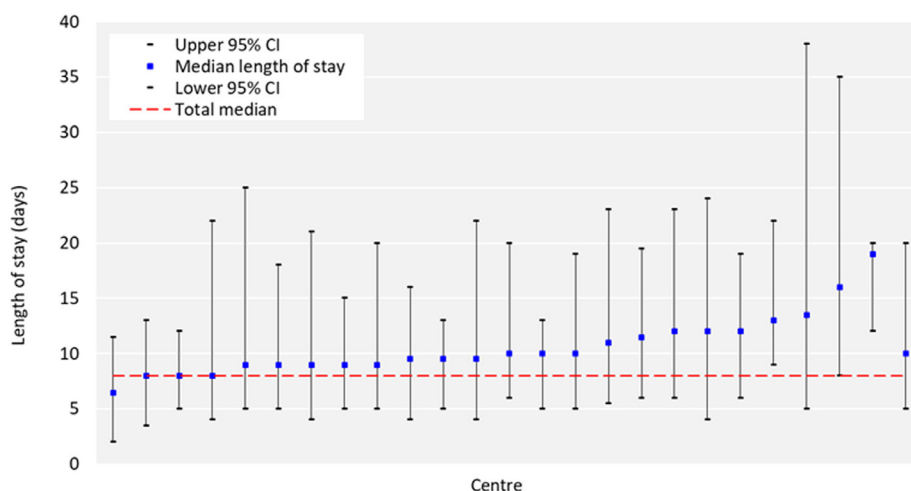
A stratified analysis shows that completion of assessments varied based on the admitting specialty. While overall compliance with requesting diagnostic imaging was low, it improved if the admitting specialty was Surgery compared to Medicine (48% vs 35% of all episodes). In contrast, compliance with medication review was slightly better when the admitting specialty was Medicine compared to Surgery (82% vs 71% of all episodes) (table 2.2).

**Table 2.2 Attainment of quality indicators by speciality**

Variables	Medicine		Surgery		ITU/ED/ Others	
Total N (%)	714		195		79	
Clinical Assessment: timely review N (%)						
Consultant review within 6 hours	419	59.7	88	46.1	63	82.9
Medication review (dose adjustments and discontinuation within 6 hours)	585	82.7	137	71.0	69	87.3
Fluid balance assessment (Fluid balance assessment within 6 hours)	621	87.8	155	80.3	73	93.6
Urinalysis test recorded	315	44.9	61	32.1	30	39.0
USS renal tract [within 24hrs (<6hrs if pyelo) or any other imaging to exclude obstruction]	251	35.2	95	48.7	21	26.6
Blood/gas acid-base recorded	511	72.1	121	62.4	67	84.8
Clinical management: timely Interventions - treatment completed when indicated N (%)						
Antibiotics (Within 1 hour) (indicated, with data, med=448, surg=115, other=48)	403	90.0	96	83.5	45	93.8
IV fluids (indicated, with data, med=572, surg=165, other=60)	557	97.4	158	95.8	59	98.3
Diuretics (indicated, with data, med=81, surg=6, other=6)	80	98.8	6	100	6	100
Bladder catheterization (indicated, with data, med=345, surg=123, other=100)	318	92.2	116	94.3	56	100
Nephrostomy/stent (indicated, with data, med=28, surg=24, other=none)	24	85.7	22	91.7	na	na

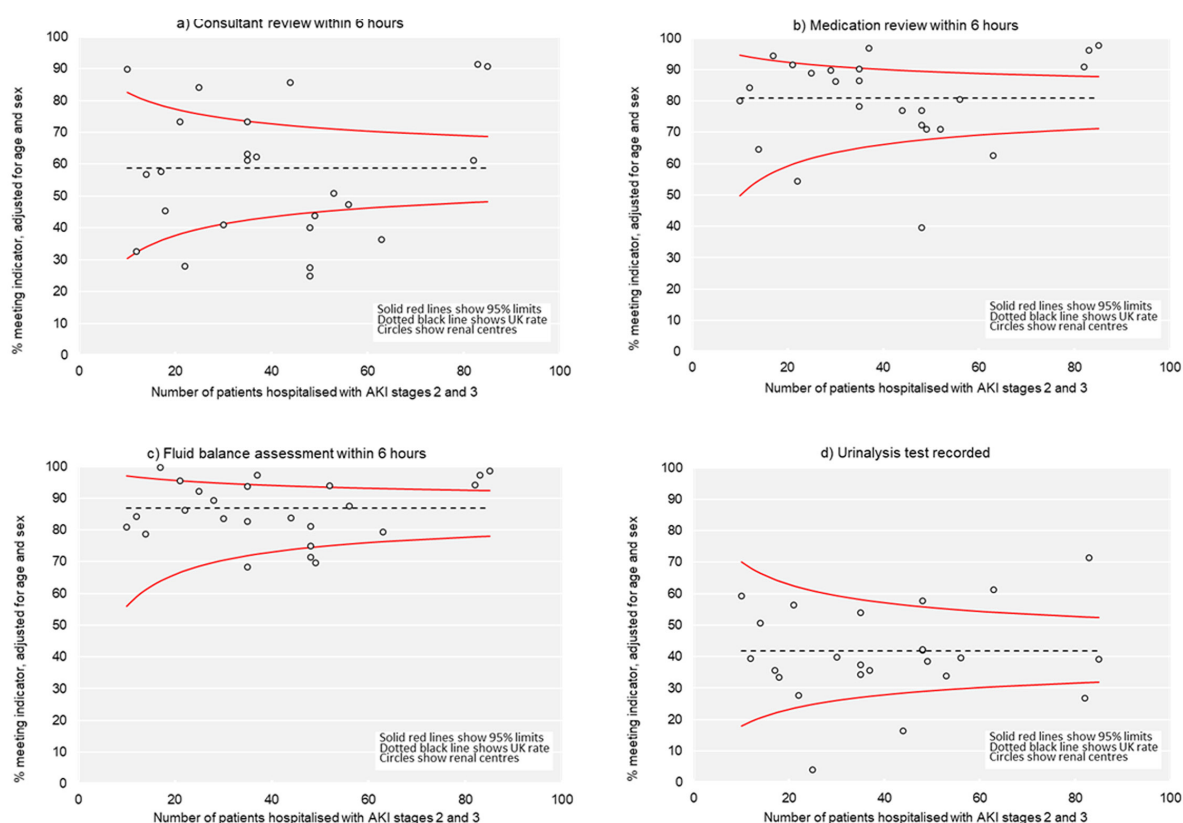
Median length of stay in hospital for all AKI episodes included in the audit was highly variable across hospitals participating in the project.

Figure 2.1 Caterpillar plot of hospital length of stay in all stages of AKI (includes patients that died in hospital)



The inter-hospital variation in the attainment of the quality indicators for both timely AKI assessment and clinical management depended on the type of quality indicator considered and is shown adjusted by sex and age.

Figure 2.2 Funnel plots showing inter-hospital variations in attainment of quality indicators for AKI assessment, adjusted for age and sex: a) consultant review within 6 hours, b) medication review (dose adjustments and discontinuation) within 6 hours, c) fluid balance assessment within 6 hours, d) urinalysis test recorded, e) blood/gas acid-base recorded, f) timely review of USS renal tract/other imaging to exclude obstruction



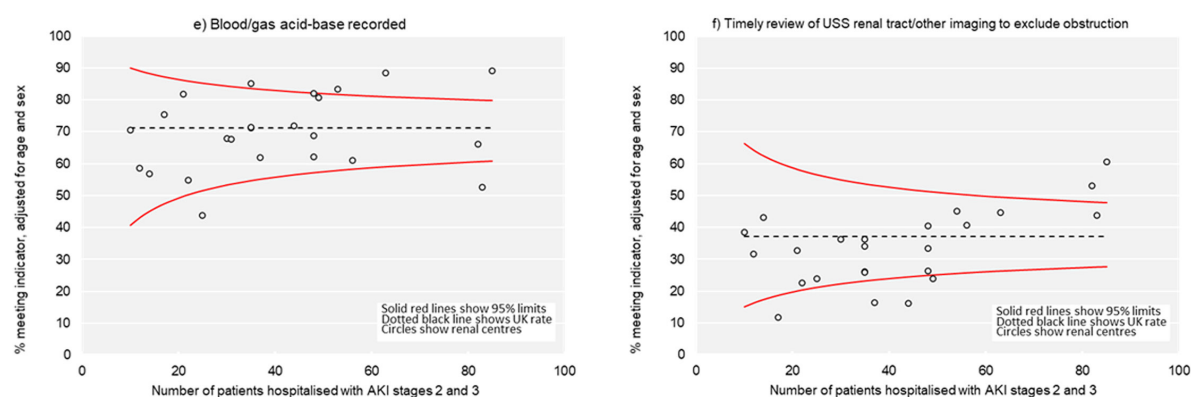
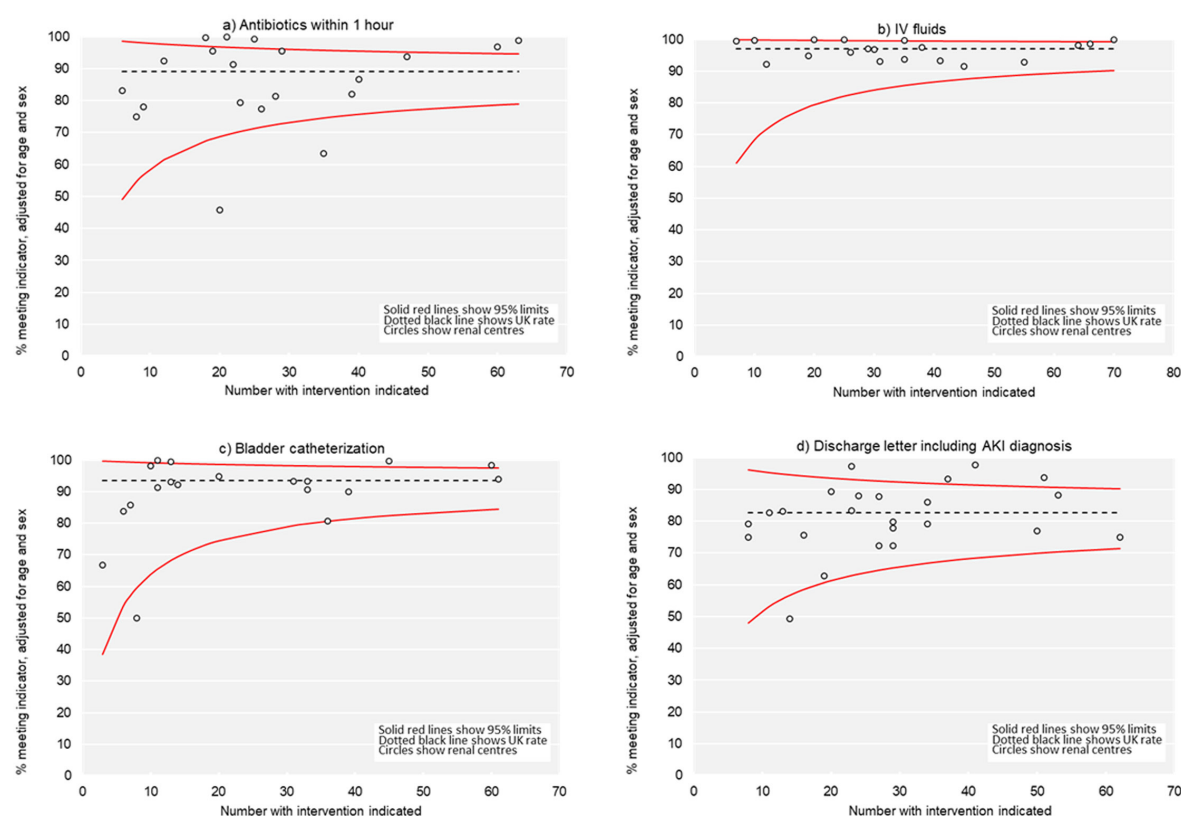


Figure 2.3 Funnel plots showing inter-hospital variations in attainment of quality indicators for AKI interventions when clinically indicated, adjusted for age and sex: a) antibiotics within 1 hour, b) IV fluids, c) bladder catheterization, d) discharge letter including AKI diagnosis



# OUTCOMES OF AKI EPISODES

Outcomes of AKI episodes included in the study are summarised in Table 3.1 overall and by peak stage AKI.

**Table 3.1 Outcomes of AKI episodes overall and by AKI peak stage**

Variables	Peak-2 AKI		Peak-3 AKI		ALL AKI	
Total N (%)	498	50.3	491	49.6	989	
Re-admission within 90- days N (%), if alive after 90days after discharge, N=587 (304 AKI stage 2 - 283 AKI stage 3)	99	32.6	115	40.6	214	36.5
Renal function back to baseline N (%)	286	57.4	209	42.6	495	50.1
Entered maintenance dialysis N (%)	4	0.8	20	4.1	24	2.4
In-hospital mortality N (%)	141	28.3	166	33.8	307	31
30-day mortality N (%)	153	30.7	174	35.4	327	33.1

Inter-hospital variations related to in-hospital mortality, 30-day mortality and re-admission within 90 days from discharge are shown as sex-age adjusted.

**Figure 3.1 Funnel plot showing inter-hospital variations in in-hospital mortality, adjusted for sex and age, for all AKI episodes**

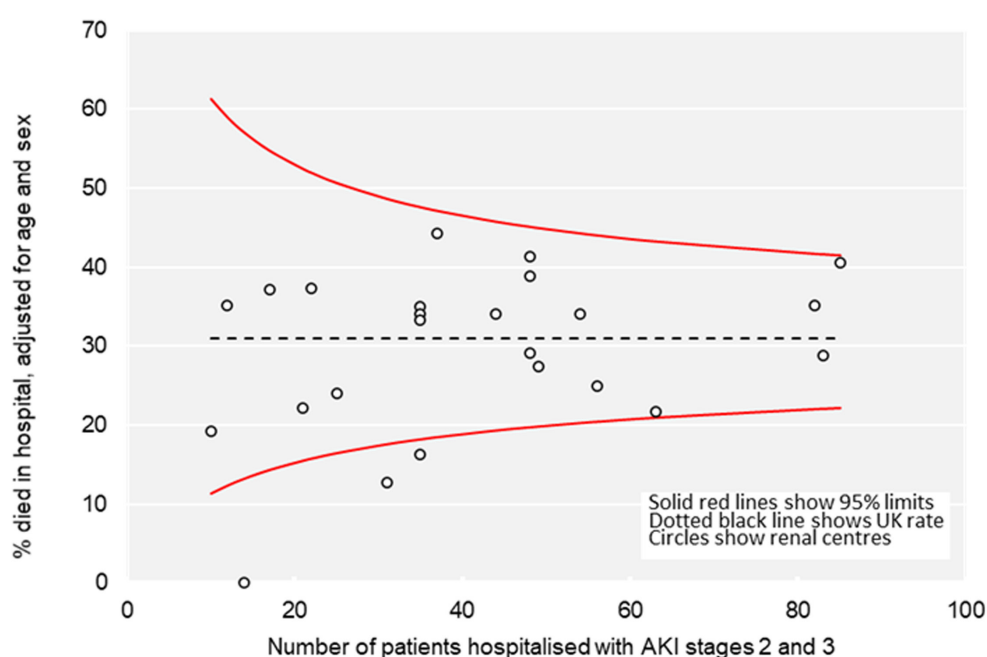




Figure 3.2 Funnel plot showing inter-hospital variations in 30-day mortality, adjusted for sex and age, for all AKI episodes

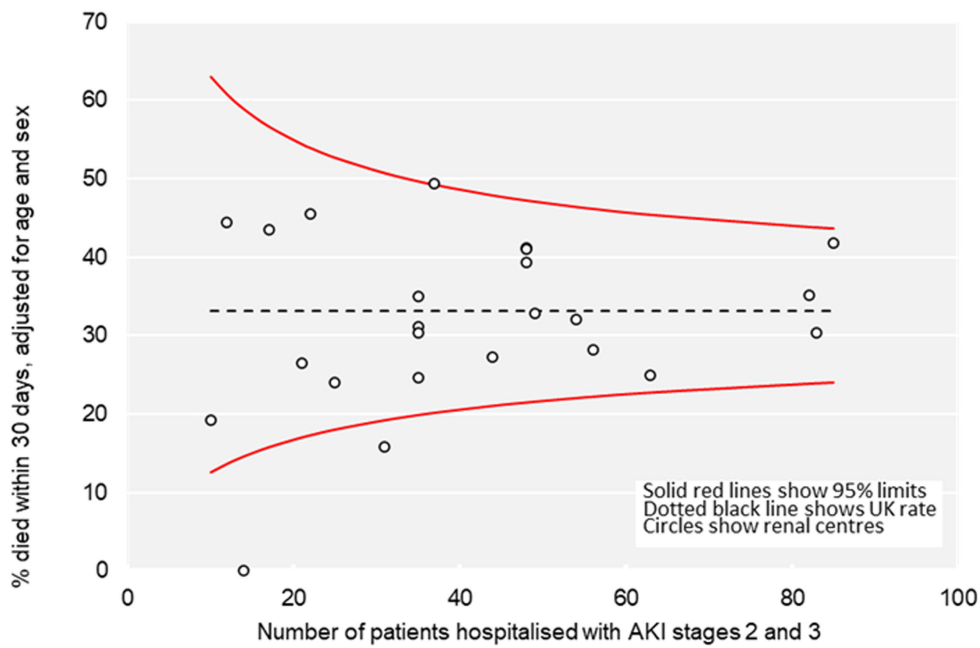
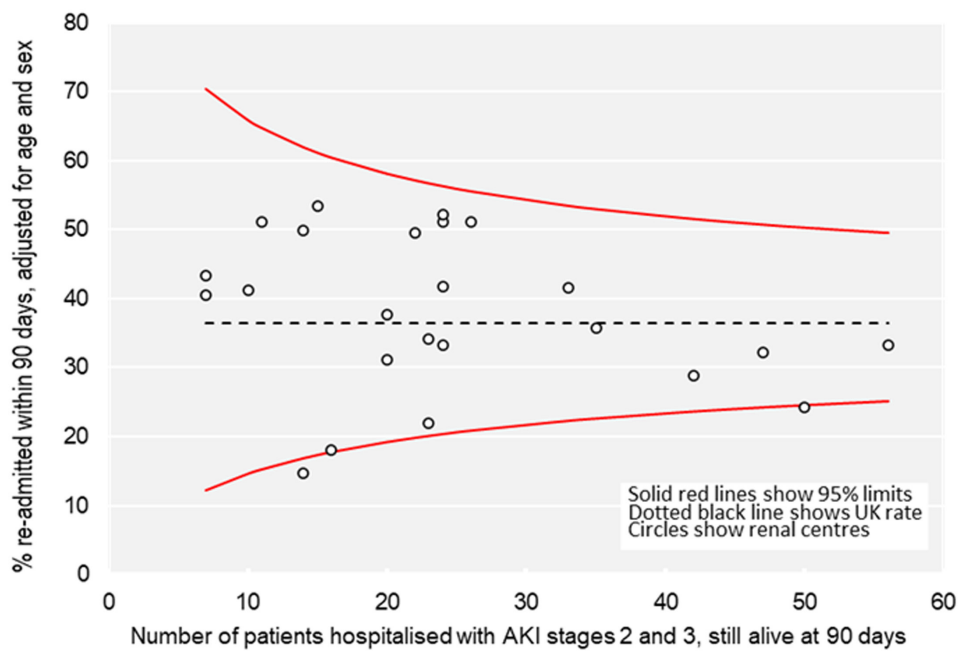


Figure 3.3 Funnel plot showing inter-hospital variations in re-admission within 90 days of discharge, adjusted for sex and age, for all AKI episodes



## PRINCIPAL CONCLUSIONS

- Cases identified in the NEPHwork AKI audit using the Nationally mandated AKI warning test score were significantly more likely to have clinical AKI (989 out of 1187 episodes) than those identified through clinical coding in the previous NCEPOD audit supporting the research findings that the warning algorithm is specific<sup>6</sup>. The case selection method means that no comment is possible on any cases of clinical AKI not detected.
- Consistent with other analysis of patient with AKI stages 2 and 3<sup>8</sup> in-hospital mortality is high (approximately 30%), with most but not all deaths occurring in hospital and very similar outcomes between the two AKI.
- Ten years since the last National enquiry<sup>3</sup> into care quality and outcomes of patients admitted to hospital with AKI there remains significant variation between organisations in the achievement of care-quality measures. Many of these are well established NICE recommendations [NICE QS174 2018]. For a condition associated with a 30% mortality it is disappointing that only 60% achieved the QS174 standard of a consultant review in 6 hours.
- The NEPHwork AKI audit differed from the NCEPOD audit because it included survivors of hospital admissions including an episode of AKI whilst the NCEPOD audit only reviewed the care of those who had died. The proportion of people who achieved each care standard cannot therefore be directly compared.
- Discharge from hospital is a key transition of care, and given a 90 day re-admission rate amongst AKI survivors of between 30-40% it is disappointing that the discharge summary did not mention AKI in 20% of cases.
- Although only 24 (2.4%) people required long-term dialysis this represents a significant health burden for these people, and a significant increase in cost to long-term care.

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## ACKNOWLEDGEMENTS

We thank the UKKA and KRUK for their support of the NEPHwork National AKI audit. We also thank the UKKA Renal SpR Club members who helped to recruit members of the NEPHwork Consortium National AKI Audit.

We acknowledge and thank all members of the NEPHwork Consortium National AKI Audit for their hard work in collecting data especially during the difficult time due to the COVID-19 pandemic.

We acknowledge the NEPHwork National AKI Audit Steering Committee who coordinated the project and made its realisation possible: Matthew Graham-Brown, Manuela Savino, Toby Humphrey, Rhodri Pyart, James Medcalf, Adnan Sharif, Mark Andrews, Suren Kanagasundaram and Elizabeth Wallin.

We thank the UKRR staff who facilitated the realisation of the National AKI audit project and the production of this report.

We acknowledge Jennifer Williams and Kirsty Crowe new NEPHwork Steering Committee members for their contribution to the dissemination of the results of the National AKI audit developed by the NEPHwork Consortium.

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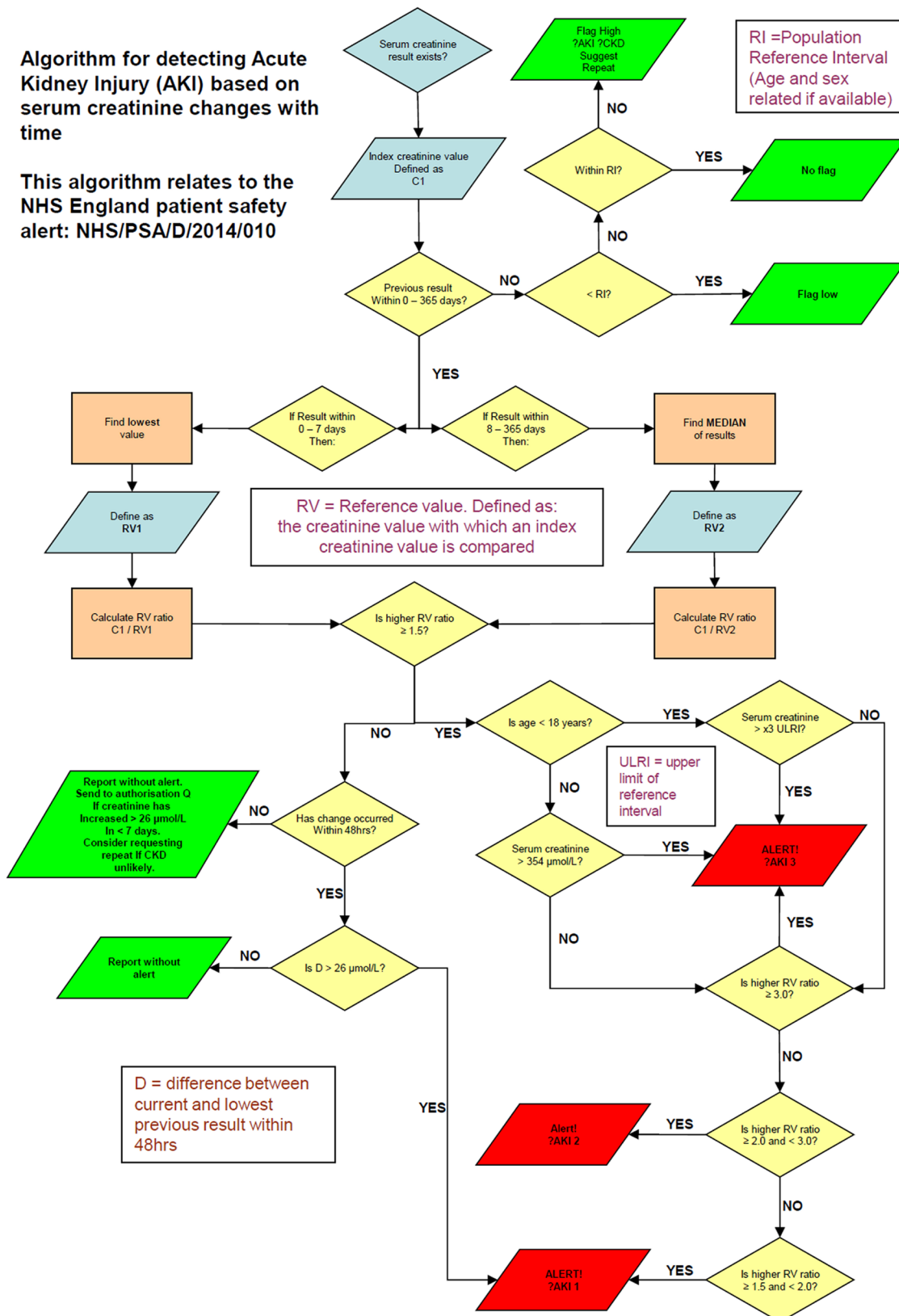
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# APPENDICES

**Algorithm for detecting Acute Kidney Injury (AKI) based on serum creatinine changes with time**

**This algorithm relates to the NHS England patient safety alert: NHS/PSA/D/2014/010**



Conceptual design: Members of the consensus group whose names and meeting report can be accessed on: [http://www.acb.org.uk/docs/E-Alerts\\_for\\_AKI\\_meeting\\_statement](http://www.acb.org.uk/docs/E-Alerts_for_AKI_meeting_statement)

Graphic design: Robert Desborough, Mike Bosomworth, Robert Hill



# NEPHWORK DATA-ENTRY FORM

Nephwork

Home

AKI Audit

Username

Options

## Update Record

HES Extracted Identifiers

Discharge

Development of AKI

Timely Completion of AKI Review

Timely Completion of AKI Interventions

Life threatening complications

Nephrology Involvement

ITU Involvement

TTO

NHS number\*

Supplied NHS number

First name\*

Supplied first name

Last name\*

Supplied last name

Date of birth\*

Supplied date of birth

Hospital\*

HES supplied hospital

Identity confirmed\*

Not Completed

Confirm patient record matches details in patient file

Reviewer

-----

Name of who reviewed this patient

Admission date\*

Admission date for patient should be within two weeks of audit

Admission type\*

Not Completed

First destination post ED

Admission speciality\*

Not Completed

Save progress

Next »

Nephwork

Home

AKI Audit

Username

Options

## Update Record

HES Extracted Identifiers

Discharge

Development of AKI

Timely Completion of AKI Review

Timely Completion of AKI Interventions

Life threatening complications

Nephrology Involvement

ITU Involvement

TTO

Discharge date from the hospital

Renal function back to baseline\*

Not Completed

Entered maintenance dialysis\*

Not Completed

Did the patient die?\*

Not Completed

In-hospital death

Re-admitted within 90 days\*

Not Completed

Length of stay

0

Autofilled from admission date and discharged date or death date

Save progress

« Previous

Next »

Nephwork

Home

AKI Audit

Username

Options

## Update Record

HES Extracted Identifiers

Discharge

Development of AKI

Timely Completion of AKI Review

Timely Completion of AKI Interventions

Life threatening complications

Nephrology Involvement

ITU Involvement

TTO

Date of clinical development of AKI

This date should be less than 7 days before admission and discharge date

Location\*

Not Completed

Date of AKI 1st warning test result

This date should be less than 7 days before admission and discharge date

Creatinine peak (umol/L)

Expected range is 30 to 2000

Date

Date of measurement

Baseline creatinine

Lowest in last 7 days. If no bloods in last 7 days use average for last 12 months. Expected range is 30 to 2000

Date

Ideally, this would be in the last 7 days

Was the renal function re-checked within 30 days?\*

Not Completed

Creatinine within day 30 after discharge. Date required if answer is Yes, leave blank otherwise

AKI cause

Not Completed

Acute Kidney Injury due to hypovolaemia

Acute Kidney Injury due to circulatory failure

Acute Kidney Injury due to sepsis

EDTA code for the cause

Consultant review in 6 hours\*

Not Completed

Did the patient get senior medical review post development of AKI within 6 Hours? (review - recognition, fluid assessment and documented plan)

Save progress

« Previous

Next »

# Update Record

HES Extracted Identifiers Discharge Development of AKI Timely Completion of AKI Review Timely Completion of AKI Interventions Life threatening complications Nephrology Involvement ITU Involvement

TTO

Antibiotics indicated*	Requested*	Completed*
<div>Not Completed</div>	<div>Not Completed</div>	<div>Not Completed</div>
Within 1 hour	Within 1 hour	Within 1 hour
IV fluids indicated*	Requested*	Completed*
<div>Not Completed</div>	<div>Not Completed</div>	<div>Not Completed</div>
Diuretics indicated*	Requested*	Completed*
<div>Not Completed</div>	<div>Not Completed</div>	<div>Not Completed</div>
Bladder catheterization indicated*	Requested*	Completed*
<div>Not Completed</div>	<div>Not Completed</div>	<div>Not Completed</div>
Nephrostomy/stent indicated*	Requested*	Completed*
<div>Not Completed</div>	<div>Not Completed</div>	<div>Not Completed</div>

Save progress « Previous Next »

# Update Record

HES Extracted Identifiers Discharge Development of AKI Timely Completion of AKI Review Timely Completion of AKI Interventions Life threatening complications Nephrology Involvement ITU Involvement

TTO

Antibiotics indicated*	Requested*	Completed*
<div>Not Completed</div>	<div>Not Completed</div>	<div>Not Completed</div>
Within 1 hour	Within 1 hour	Within 1 hour
IV fluids indicated*	Requested*	Completed*
<div>Not Completed</div>	<div>Not Completed</div>	<div>Not Completed</div>
Diuretics indicated*	Requested*	Completed*
<div>Not Completed</div>	<div>Not Completed</div>	<div>Not Completed</div>
Bladder catheterization indicated*	Requested*	Completed*
<div>Not Completed</div>	<div>Not Completed</div>	<div>Not Completed</div>
Nephrostomy/stent indicated*	Requested*	Completed*
<div>Not Completed</div>	<div>Not Completed</div>	<div>Not Completed</div>

Save progress « Previous Next »

# Update Record

HES Extracted Identifiers Discharge Development of AKI Timely Completion of AKI Review Timely Completion of AKI Interventions Life threatening complications Nephrology Involvement ITU Involvement

TTO

Hyperkalaemia*
<div>Not Completed</div>
Pulmonaryodema*
<div>Not Completed</div>
Acidosis*
<div>Not Completed</div>
Uraemia*
<div>Not Completed</div>
Was nephrology referral indicated?*
<div>Not Completed</div>
Did the referral happen?*
<div>Not Completed</div>

Save progress « Previous Next »

# Update Record

[HES Extracted Identifiers](#)
[Discharge](#)
[Development of AKI](#)
[Timely Completion of AKI Review](#)
[Timely Completion of AKI Interventions](#)
[Life threatening complications](#)

Nephrology Involvement

ITU Involvement

TTO

One off advice\*

Not Completed

Ongoing review\*

Not Completed

Take-over including RRT\*

Not Completed

ITU took over from nephrology\*

Not Completed

Transferred to secondary renal care\*

Not Completed

Save progress

« Previous

Next »

# Update Record

[HES Extracted Identifiers](#)
[Discharge](#)
[Development of AKI](#)
[Timely Completion of AKI Review](#)
[Timely Completion of AKI Interventions](#)
[Life threatening complications](#)

Nephrology Involvement

ITU Involvement

TTO

Advice from intensivist\*

Not Completed

Take-over supportive management\*

Not Completed

Take-over RRT\*

Not Completed

Not a candidate for ITU\*

Not Completed

Please respond yes if the patient was not a candidate

Was there a delay if deemed for RRT?\*

Not Completed

>24hrs from decision

Save progress

« Previous

Next »

# Update Record

[HES Extracted Identifiers](#)
[Discharge](#)
[Development of AKI](#)
[Timely Completion of AKI Review](#)
[Timely Completion of AKI Interventions](#)
[Life threatening complications](#)
[Nephrology Involvement](#)
[ITU Involvement](#)

TTO

AKI mentioned on TTO\*

Not Completed

Followup of unresolved renal function documented on TTO\*

Not Completed

GP instructions re medicine and bloods on TTO\*

Not Completed

90 day renal followup if CKD4\*

Not Completed

30 day renal followup if CKD5 or Dialysis\*

Not Completed

« Previous

Save record