Author/s:
Bendall, AC;Tan, SJ;See, EJ;Toussaint, ND

Title:
Electronic alerts for early detection of acute kidney injury: considering their implementation in Australian hospitals

Date:
2021-05-01

Citation:
Bendall, A. C., Tan, S. J., See, E. J. & Toussaint, N. D. (2021). Electronic alerts for early detection of acute kidney injury: considering their implementation in Australian hospitals. Medical Journal of Australia, 214 (8), pp.347-349.e1. https://doi.org/10.5694/mja2.51024.

Persistent Link:
https://hdl.handle.net/11343/298446

Article begins on page three of this document.

Title	Electronic alerts for early detection of acute kidney injury: considering their implementation in Australian hospitals

Authors:

	Title	First name	**Mid inits**	Last name	Postnom (eg, PhD) [3 only for publication]	Position1	Address1	Position2	Address2	Tel	Email
1	Dr.	Anna	C	Bendall	MBBS	Nephrology Advanced Trainee	1				annabendall@gmail.com
2	Dr.	Sven-Jean		Tan	MBBS, B Med Sci, Grad Cert Clin Res Methods, PhD, FRACP	Nephrologist	1	Honorary Senior Fellow	2		Jean.Tan@mh.org.au
3	Dr.	Emily	J	See	MBBS, BMedSci, MSc(Oxon), FRACP	Nephrologist	1	Intensive Care Fellow	3		emilyjsee@gmail.com
4	Assoc. Prof.	Nigel	D	Toussaint	MBBS, PhD, FRACP,	Interim Director of Nephrology	1	Clinical Associate Professor	2		nigel.toussaint@mh.org.au
5											

Number of corresponding author:	1
Number of alternative corresponding author:	

Addresses:

	Institution		City	State	Post Code	
1	Royal Melbourne Hospital		Melbourne	VIC	3050	
2	University of Melbourne		Melbourne	VIC	3010	
3	Austin Health		Melbourne	VIC	3084	
4						
5						

Postal address of first corresponding author (if different from the institutional address given above)	

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1002/MJA2.51024

Primary Keywords [Office use only]	Health services administration; Urologic diseases; Information science; General medicine
Secondary keywords [Office use only]	Quality assurance, health care; Economics, medical; Kidney diseases; Information management; Clinical decision-making
Notes:	

Article details (press ctrl – 9 to enter details):

Article type	Perspective
Blurb	To better appreciate the role for e-alerts and care bundles within Australian hospitals, further studies are required to understand the current landscape and impact of acute kidney injury.

Office use

Ms. Number	mja20.01359.R3
Medical editor	Tania (Tatiana) Janusic
Medical editor email	tjanusic@mja.com.au
Structural editor	Laura Teruel
Structural editor email	lteruel@mja.com.au
Section/Category	Perspective
Strapheading	Perspective
Substrap	

Wiley – file data:

Filename for copyediting	ben_mja20.01359_ms.docx
Accompanying graphics	None
Stock images	ben_mja20.01359_im.tif, ben_mja20.01359_im.jpg
Appendices	None

Office use – history:

Event	Date
Original submission received	29/07/2020

Event	Date
Accept	12/11/2020

Proof sent to author	
Proof returned by author	
Published (date format xx/xx/xx)	03/05/21
Issue	8
Vol	214
DOI	10.5694/mja20.01359
Journal	The Medical Journal of Australia
Original article DOI (for response)	

Electronic alerts for early detection of acute kidney injury: considering their implementation in Australian hospitals

International use of acute kidney injury care bundles, including e-alerts, represents a potential pathway for significant improvement in acute kidney injury management in Australia

The incidence of acute kidney injury in Australia is increasing, and its impact on morbidity, mortality, and health care costs is universally acknowledged.[1,2] In a national snapshot, acute kidney injury was the principal or additional diagnosis in 1.6% of Australian hospital admissions between 2012 and 2013.[2] However, its true incidence is likely greater, with international data estimating one in five adults worldwide experience acute kidney injury during a hospital admission.[3,4] In the short term, acute kidney injury increases length of stay, intensive care and rehabilitation admissions, early readmission to hospital, and death.[2,5] In Australia, hospital-acquired acute kidney injury incurs additional costs of about $55 000 per patient admission.[1] In the long term, it is an important risk factor for chronic kidney disease and long term morbidity.[6]

With no targeted therapies for established acute kidney injury, early recognition and best supportive care remain fundamental to mitigating progression and need for kidney replacement therapy.[4] Nevertheless, delayed diagnosis is common and basic supportive measures are often overlooked.[7,8] Key international bodies have recognised that acute kidney injury electronic alerts (e-alerts) may increase detection, enhance the quality of acute kidney injury care, and improve patient and health care outcomes.[9] This article explores the utility and role for such systems in early detection and management of acute kidney injury in the Australian hospital setting.

Electronic alerts

E-alerts are part of clinical decision support systems (CDSS), defined as tools that provide clinicians with targeted information for a specific situation. CDSS are designed

to improve the quality and efficiency of care, aiming to avoid adverse events.[10] Common examples include electronic reminders and condition-specific medication order sets. With the rise of integrated electronic health records and prescribing, there is exponential potential for CDSS.[10]

Automated e-alerts were first reported to improve early detection and management of acute kidney injury in 1994.[11] However, it was not until the landmark National Confidential Enquiry into Patient Outcome and Death (NCEPOD) from acute kidney injury in the United Kingdom in 2009 that e-alerts gained momentum. NCEPOD highlighted significant deficiencies in management, including that 30% of hospital-acquired acute kidney injuries were avoidable and that 40% of patients who died with acute kidney injury as a primary diagnosis had suboptimal management.[8] Consequently, the National Health Service mandated that automated acute kidney injury e-alerts be established across all UK laboratories in 2015. That year, the International Society of Nephrology released the "0 by 25" project, which targeted zero preventable deaths of acute kidney injury worldwide by 2025, and outlined e-alerts as an area of focus.[12] Despite intensification in the volume of e-alert research worldwide, there remains no published experience from Australian centres.

Efficacy of electronic alerts

The impact of e-alerts alone on meaningful clinical end points such as reduced acute kidney injury progression, need for kidney replacement therapy, mortality, or reduced hospital length of stay has not been proven. Two systematic reviews appraised e-alerts for acute kidney injury in the hospital setting. A 2017 review identified 16 primary publications, including two randomised controlled trials (RCTs), and concluded there was significant heterogeneity in study designs (including e-alert design), which yielded inconsistent results.[13] An earlier review included six studies that published outcome data in response to instigating e-alerts, including only one RCT, and similarly discussed study heterogeneity and that introduction of acute kidney injury e-alerts gave no additional benefits to patient outcomes or resource utilisation.[14]

The only two published RCTs explored the stand-alone intervention of automated acute kidney injury e-alerts, but both failed to achieve significant results. A single-centre RCT in the United States involved patients with at least stage 1 acute kidney injury, as determined by the 2012 Kidney Disease: Improving Global Outcomes (KDIGO) definition.[15] Computer-generated randomisation assigned patients to an intervention arm, in which treating clinicians and pharmacists received a text-based e-alert notification (n = 1201), or a control arm of standard care (n = 1192).[15] The e-alert also contained a website hyperlink to the KDIGO guidelines. There was no difference in the composite end point of maximum change in serum creatinine, need for kidney replacement therapy, and mortality at 7 days and no difference in treatment provided.

A single-centre RCT in China randomly allocated patients to an automated pop-up e-alert on the treating team's computer dashboard (n = 467) or control arm of standard care

(n = 408).[16] Detection rates were higher in the intervention arm and more patients were referred for nephrology consultation. Again, there was no significant difference in the incidence of kidney replacement therapy, kidney recovery, or death.

Pitfalls of acute kidney injury e-alerts

It is unsurprising that evidence supporting acute kidney injury e-alerts has been inconsistent. This may reflect technological or human factors. Early e-alerts were automated, untargeted, and stand-alone interventions. These basic alerts ignored crucial factors such as patient population (whole hospital or intensive care unit), target recipient (treating team, outreach team or allied health staff), mode of transmission (pop-up box, email or SMS), hierarchy of disruption ("hard-stop" that must be actioned or a pop-up box), timing (real-time or in-hours only), and content (diagnostic notification alone or combined recommendations for further management and follow-up).[17,18]

Alert fatigue and clinician desensitisation are additional barriers to e-alert effectiveness.[17] Alert fatigue is frequently discussed in literature exploring medication alerts systems, but is likely to be relevant to all automated e-alerts. Desensitisation may occur when e-alerts lack sensitivity and specificity, resulting in high override rates and poor clinician acceptability.

Acute kidney injury care bundles

Incorporation of e-alerts into acute kidney injury care bundles has shown more compelling results. Defined as sets of evidence-based practices, treatments or interventions that collectively improve outcomes, care bundles have been effectively used to reduce central line-associated bloodstream infections in the intensive care unit[18,19] and to improve the management of patients with sepsis in the emergency department.[20]

In the UK, numerous publications have reported research combining e-alerts with additional hospital-wide strategies.[21-24] Central design elements include hospital-wide education and awareness campaigns on acute kidney injury incidence and impact, e-alerts for early detection, and a care bundle or checklist for interventions that are priorities in acute kidney injury management. A trial in a UK hospital employed two renal nurse specialists to ensure consistency in implementing recommendations and a dedicated pharmacist for medication review, in addition to e-alerts and an education program.[21] This multifaceted approach increased acute kidney injury early detection (< 24 hours) from 53% to 100%, reduced incidence from 9% to 6.5%, and reduced the time to recovery by 36% and the length of stay for patients with acute kidney injury by 23%.

An acute kidney injury quality improvement project at a large UK hospital combined e-alerts, an education program, a management priority checklist, and an outreach support team including a critical care nurse who screened at-risk patients using a live database that flagged abnormal pathology.[22] The outreach support team facilitated early review, initiated management, prompted treating teams to use the acute kidney injury care bundle,

and referred patients to nephrology and intensive care unit teams as required. Results showed a 14% reduction in length of stay of patients with acute kidney injury (2.6 days) and a 23% reduction of in-hospital mortality.

A quality project was undertaken at a large UK hospital where interventions included e-alerts, an educational program, an acute kidney injury smartphone application, and a pharmacy team for medication reconciliation for patients flagged with acute kidney injury.[23] Patients flagged were also discussed at the changeover of nursing shifts during "safety huddles". This project did not include additional staff or a dedicated outreach support team, possibly reducing overall cost, but reported a 22% reduction in acute kidney injury and a 48.5% reduction in acute kidney injury progression.

Another UK multicentre study, employing a stepped wedge cluster RCT design, investigated grouped interventions including e-alerts, a health care worker educational program, and a management care bundle.[24] Interventions were stepped out sequentially to the five participating hospitals. During the study, 24 059 acute kidney injury episodes occurred, approximating an incidence of 7.6% of all admissions, and although interventions did not alter the 30-day mortality, there were statistically significant differences in important secondary end points, including improved acute kidney injury detection, shorter duration, and median reduction in hospital length of stay (0.7 days).

Next steps

The American Society of Nephrology released its AKI!Now initiative in 2020. Similar to strategies in the UK, it promotes acute kidney injury e-alerts and highlights increased awareness and education as essential in reducing acute kidney injury-related morbidity and mortality.[25] Moreover, they recognise an acute kidney injury toolkit or care bundle is beneficial for clinicians as a simple and rapid measure to provide consistent care.

Significant international experience demonstrates e-alerts alone do not improve outcomes. However, as part of a multifaceted approach, there may be benefits for both hospitals and patients. Although the efficacy of acute kidney injury care bundles including e-alerts is likely to relate to the e-alert design, multidisciplinary collaborative processes supporting clinicians to provide best practice management and a robust institution-wide acute kidney injury education campaign also appear paramount. Despite a lack of evidence supporting improved patient survival with a care bundle approach, reductions in hospital-acquired acute kidney injury incidence and length of stay are likely to translate into significant economic benefit for countries, including Australia.

To better appreciate the role for e-alerts and care bundles within Australian hospitals, further studies are required to understand the current landscape and impact of acute kidney injury. Firstly, the true incidence of acute kidney injury in Australian hospitals must be quantified to establish the breadth of the problem faced. Secondly, current management must be assessed, focusing on alignment of care provided with best practice recommendations. Finally, areas for improved efficiency require investigation to enhance patient outcomes and minimise costs to the community. Such studies would likely confirm the high acute kidney injury incidence, identify its delayed diagnosis,

demonstrate inconsistent implementation of recommendations, and outline important opportunities for Australian hospitals to improve health care provision and patient outcomes in acute kidney injury.

Competing interests: No relevant disclosures.
Provenance: Not commissioned; externally peer reviewed.

Author details

Anna C Bendall[1]
Sven-Jean Tan[1,2]
Emily J See[1,3]
Nigel D Toussaint[1,2]
1 Royal Melbourne Hospital, Melbourne, VIC.
2 University of Melbourne, Melbourne, VIC.
3 Austin Health, Melbourne, VIC.

annabendall@gmail.com

doi: 10.5694/mja20.01359

References

1 Australian Commission on Safety and Quality in Health Care. Hospital-acquired complication: renal failure. Sydney: ACSQHC, 2018. https://www.safetyandquality.gov.au/sites/default/files/migrated/Renal-failure-detailed-fact-sheet.pdf (viewed Mar 2020).

2 Australian Institute of Health and Welfare. Acute kidney injury in Australia: a first national snapshot [Cat. No. PHE 190]. Canberra: AIHW, 2015. https://www.aihw.gov.au/reports/chronic-kidney-disease/acute-kidney-injury-in-australia/contents/table-of-contents (viewed Mar 2020).

3 Susantitaphong P, Cruz DN, Cera J, et al. World incidence of AKI: a meta-analysis. *Clin J Am Soc Nephrol* 2013; 8: 1482-1493.

4 Kidney Disease: Improving Global Outcomes (KDIGO) Acute Kidney Injury Work Group. KDIGO clinical practice guideline for acute kidney injury. *Kidney Inter* 2012; 2 (Suppl): 1-138.

5 Koulouridis I, Price LL, Madias NE, Jaber BL. Hospital-acquired acute kidney injury and hospital readmission: a cohort study. *Am J Kidney Dis* 2015; 65: 275-285.

6 See EJ, Jayasinghe K, Glassford N, et al. Long-term risk of adverse outcomes after acute kidney injury: a systematic review and meta-analysis of cohort studies using consensus definitions of exposure. *Kidney Int* 2019; 95: 160-172.

7 Aitken E, Carruthers C, Gall L, et al. Acute kidney injury: outcomes and quality of care. *QJM* 2013; 104: 323-332.

8 Steward L, Findlay G, Smith N, et al. Adding insult to injury: a review of the care of patients who died in hospital with a primary diagnosis of acute kidney injury (acute renal failure). London: National Confidential Enquiry into Patient Outcome and Death (NCEPOD), 2009. https://www.ncepod.org.uk/2009report1/Downloads/AKI_report.pdf (viewed Apr 2020).

9 James MT, Hobson CE, Darmon M, et al. Applications for detection of acute kidney injury using electronic medical records and clinical information systems: workgroup statements from the 15th ADQI Consensus Conference. *Can J Kidney Health Dis* 2016; 3: 9.

10 Wasylewicz AT, Scheepers-Hoeks AM. Clinical decision support systems. In: Kubben P, Dumontier M, Dekker A; editors. Fundamentals of clinical data science. Springer, Cham, 2019; pp 153-169.

11 Rind DM, Safran C, Phillips RS, et al. Effect of computer-based alerts on the treatment and outcomes of hospitalized patients. *Arch Intern Med* 1994; 154: 1511-1517.

12 Mehta RL, Cerdá J, Burdmann EA, et al. International Society of Nephrology's 0by25 initiative for acute kidney injury (zero preventable deaths by 2025): a human rights case for nephrology. *Lancet* 2015; 385: 2616-2643.

13 Haase M, Kribben A, Zidek W, et al. Electronic alerts for acute kidney injury. *Dtsch Arztebl Int* 2017; 114: 1-8.
14 Lachance P, Villeneuve PM, Rewa OG, et al. Association between e-alert implementation for detection of acute kidney injury and outcomes: a systematic review. *Nephrol Dial Transplant* 2017; 32: 265-272.
15 Wilson FP, Shashaty M, Testani J, et al. Automated, electronic alerts for acute kidney injury: a single-blind, parallel-group, randomised controlled trial. *Lancet* 2015; 385: 1966-1974.
16 Wu Y, Chen Y, Li S, et al. Value of electronic alerts for acute kidney injury in high-risk wards: a pilot randomized controlled trial. *Int Urol Nephrol* 2018; 50: 1483-1488.
17 Ancker JS, Edwards A, Nosal S, et al. Effects of workload, work complexity, and repeated alerts on alert fatigue in a clinical decision support system. *BMC Med Inform Decis Mak* 2017; 17: 36.
18 Institute for Healthcare Improvement. What is a bundle? [Website]. http://www.ihi.org/resources/Pages/ImprovementStories/WhatIsaBundle.aspx (viewed May 2020).
19 Entesari-Tatafi D, Orford N, Bailey MJ, et al. Effectiveness of a care bundle to reduce central line-associated bloodstream infections. *Med J Aust* 2015; 202: 247-249. https://www.mja.com.au/journal/2015/202/5/effectiveness-care-bundle-reduce-central-line-associated-bloodstream-infections
20 Rhodes A, Evans LE, Alhazzani W, et al. Surviving sepsis campaign: international guidelines for management of sepsis and septic shock: 2016. *Crit Care Med* 2017; 45: 486-552.
21 Ebah L, Hanumapura P, Waring D, et al. A multifaceted quality improvement programme to improve acute kidney injury care and outcomes in a large teaching hospital. *BMJ Qual Improv Rep* 2017; 6: u219176.
22 Chandrasekar T, Sharma A, Tennent L, et al. A whole system approach to improving mortality associated with acute kidney injury. *QJM* 2017; 110: 657-666.
23 Sykes L, Sinha S, Hegarty J, et al. Reducing acute kidney injury incidence and progression in a large teaching hospital. *BMJ Open Qual* 2018; 7: e000308.
24 Selby NM, Casula A, Lamming L, et al. An organizational-level program of intervention for AKI: A pragmatic stepped wedge cluster randomized trial. *J Am Soc Nephrol* 2019; 30: 505-515.
25 Lui K, Goldstein S, Vijayan A, et al. AKI!Now initiative: recommendations for awareness, recognition, and management of AKI. *Clin J Am Soc Nephrol* 2020; 15: 1838-1847.