Acute Kidney Injury in Pregnancy and the Puerperium

Catherine Brumby[1], Graeme Duke[1], Elizabeth Low[1], Lawrence McMahon[1]

[1]Eastern Health Clinical School, Monash University, Melbourne, Victoria

MONASH University
Medicine, Nursing and Health Sciences

easternhealth

Background

- Acute kidney injury (AKI) during pregnancy or postpartum is associated with significant maternal and neonatal morbidity, and remains poorly studied

- AKI is linked to CKD later in life in the general population[1]

- Two population-based studies exist examining obstetric-related AKI (US and Canada). Both observed the incidence may be increasing, with possible contributing factors being rising rates of severe pre-eclampsia and CKD

  ❖ **United States (Mehrabadi et al.)**
  1999-2011 → 10,000,000 hospital deliveries. Hospital admission coding database

  ❖ **Canada (Mehrabadi et al.)**
  2002-2006 → 2,000,000 hospital deliveries. Hospital admission coding database

- Pregnancy-related AKI is yet to be evaluated in the recent era, or within a local population

[1]Coca S et al. *Kidney International*. 2012
[2]Mehrabadi A et al. *Obstet Gynaecol.* 2016
[3]Mehrabadi A et al. *BMJ.* 2014

Aims

- Determine rates of AKI coding in pregnancy-related hospital admissions which include delivery

- Examine factors associated with AKI coding, including potential risk factors and maternal/fetal outcomes

Methods

Database

- Victorian Admitted Episode Dataset (VAED) --> validated administrative database for all hospital admissions in Victoria, Australia
- All public hospital admissions related to pregnancy (June 2006 – July 2016)
- ICD-10-AM/ACHI diagnostic and procedural codes

Admission Type	Number of Admissions
Antenatal	309,714
Antenatal with delivery > 20 weeks (confinement)*	**533,876**
Postpartum (42 days)	107,159

Analysis

- Restricted to 'Antenatal with delivery > 20 weeks' admission (chronic dialysis excluded)
  - Associations with birth outcomes, and AKI rate per delivery
- Trends over time in AKI coding and associated risk factors examined
- Comparison to other published cohorts
- Multivariate logistic regression to determine association between risk factors/outcomes and AKI coding

Definition of Acute Kidney Injury by ICD-10-AM code

Admission coded for AKI with any of the following codes:

Acute renal failure – N17

Post-partum renal failure – O90.4

Post-procedural renal injury – N99.0

Unspecified renal failure – N19*

Drug-induced renal failure- N14

*N19 sampled as >80% specific for acute rather than chronic renal failure

No biochemical data available (creatinine, eGFR)

Associations

Potential Risk Factors

Year of admission
Maternal age
Chronic kidney disease (CKD)
Chronic HT
Pre-existing diabetes
Multiple gestation

Pregnancy Outcomes

Maternal
GH/Pre-eclampsia
Sepsis (admission/discharge dx)
Postpartum haemorrhage (PPH)
Caesarean delivery
Cardiac failure
Renal replacement therapy
Critical care admission
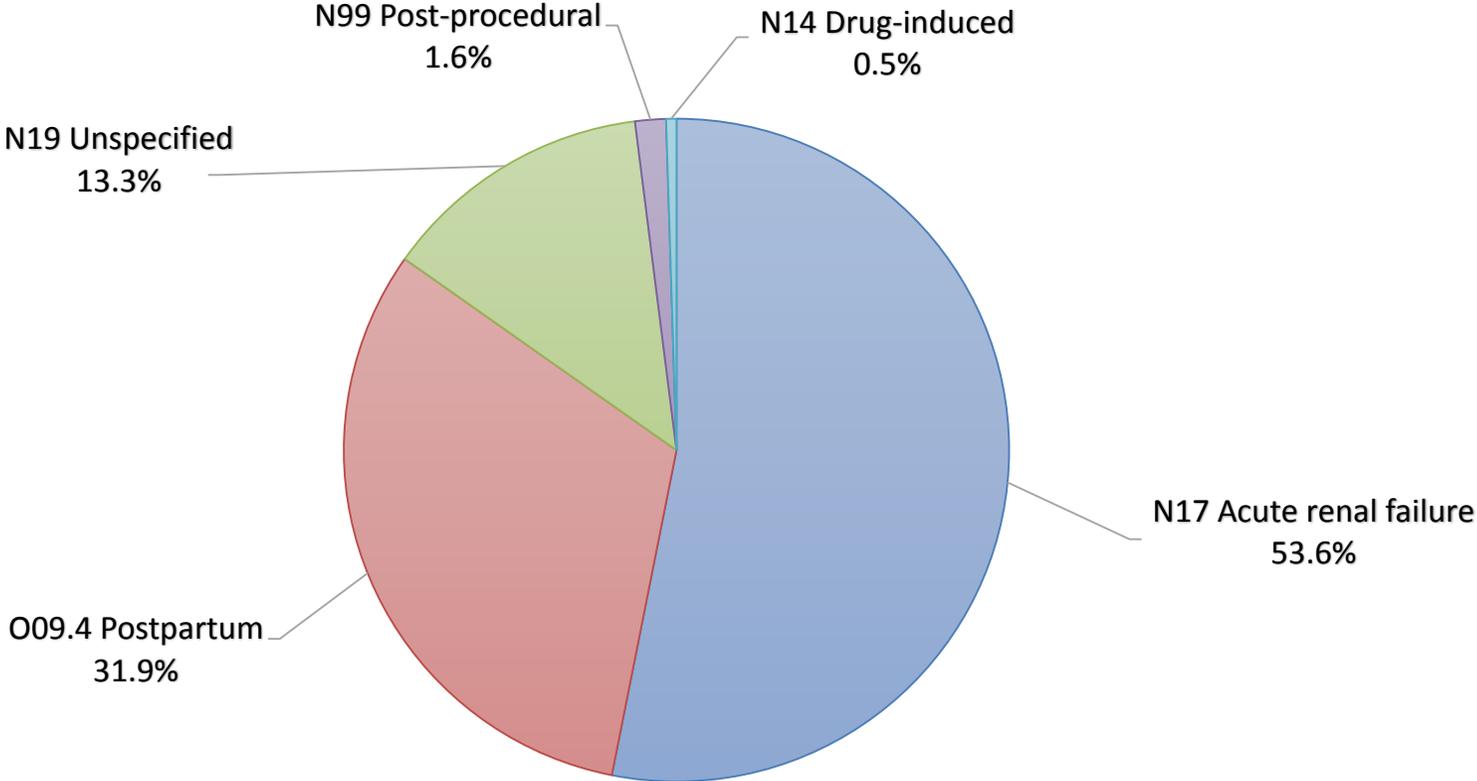Length of Stay
Maternal mortality

Perinatal
Premature delivery ≤ 33 weeks
Perinatal mortality

Results

Prevalence of AKI codes by Admission Type:

	Total	AKI coding	AKI rate per 10,000 admissions
Antenatal	309,714	136	4.39
Antenatal with delivery (confinement)	533,876	499*	9.34
Postpartum	107,159	323	30.14

Acute Kidney Injury by ICD-10-AM codes for admissions with delivery

N99 Post-procedural
1.6%

N14 Drug-induced
0.5%

N19 Unspecified
13.3%

N17 Acute renal failure
53.6%

O09.4 Postpartum
31.9%

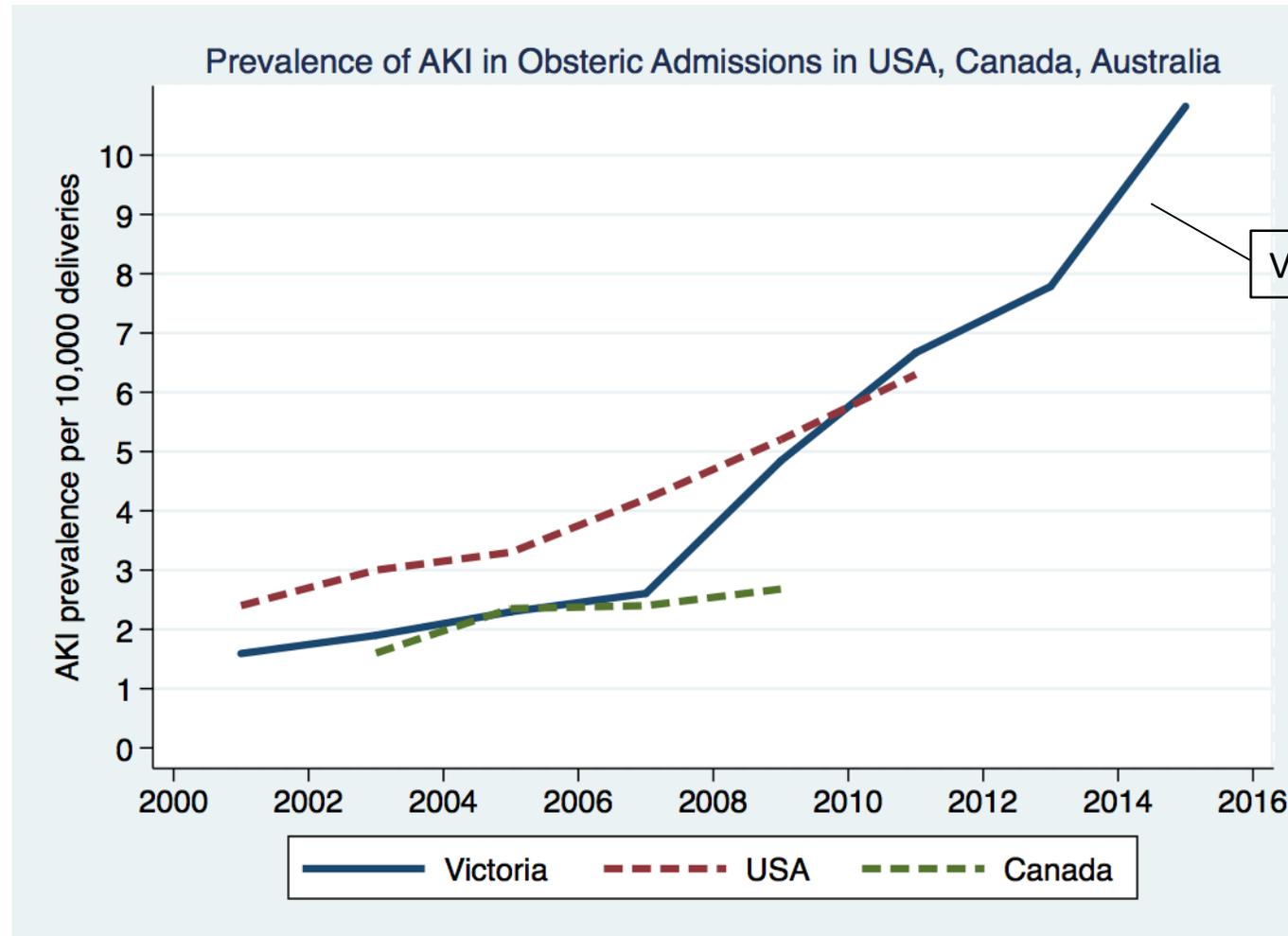n = 499

Reporting of AKI codes in pregnancy has increased over the past decade

Year	AKI rate per 10,000 deliveries
2007	2.37
2008	4.65
2009	5.03
2010	7.19
2011	6.15
2012	7.54
2013	8.02
2014	9.66
2015	11.97
2016	11.59
p-trend	<0.001

Rise in AKI prevalence per delivery in Victoria is comparable to other cohorts

Prevalence of AKI in Obsteric Admissions in USA, Canada, Australia

Victorian cohort

*p-trend Victoria <0.001

Mehrabadi A et al. *Obstet Gynaecol.* 2016
Mehrabadi A et al. *BMJ*. 2014

Possible risk factors associated with AKI codes

	Frequency	AKI rate per 10,000 deliveries	Unadjusted OR	Adjusted OR	p
Year	533,876	-	1.15 (1.10-1.21)	1.14 (1.09-1.19)	<0.001
Maternal age	533,876	-	1.19 (1.05-1.35)	1.12 (1.00-1.25)	<0.001
CKD	228	1,842.1	268.8 (182.0-397.1)	37.83 (25.95-55.16)	<0.001
Chronic HT	3,023	124.9	49.8 (29.17- 88.03)	1.71 (0.96-1.56)	ns
Pre-existing DM	1,245	174.4	21.71 (15.92-29.60)	2.06 (1.42-2.98)	<0.001
Multiple gestation	7,713	23.2	6.47 (4.70-8.89)	2.26 (1.91-2.67)	<0.001

Adjusted for all above covariates including: site, GH/pre-eclampsia, sepsis, PPH, LUSCS, cardiac failure

Association between AKI codes and pregnancy outcomes

Outcome	n	Adjusted OR (95% CI)	p
Maternal outcomes			
GH/Pre-eclampsia	35,897	19.74 (15.58-25.01)	<0.001
Sepsis	7,518	6.96 (5.58-10.08)	<0.001
PPH	72,363	2.22 (1.92-2.58)	<0.001
Blood transfusion	11,490	6.69 (4.65-9.64)	<0.001
Cardiac failure	4,428	5.91 (3.81-9.17)	<0.001
Caesarean section	155,753	3.44 (2.9-4.07)	<0.001
ICU admission	1,136	17.34 (10.75-27.97)	<0.001
Renal replacement therapy	33	2,823.74 (1,012.7-7,783.3)	<0.001
Maternal hospital mortality	28	118.94 (26.6-530.8)	<0.001
Length of stay (with AKI), median [IQR]	6 [4,9]	1.69 (1.48-1.93)	<0.001
Length of stay (without AKI), median [IQR]	3 [2,4]	-	-
Fetal outcomes			
Premature delivery ≤33weeks	13,261	3.15 (2.04-4.87)	<0.001
Perinatal hospital mortality	4,424	6.66 (3.63-12.24)	<0.001

Adjusted for all above variables including: year, site, maternal age, CKD, pre-existing DM, chronic HT, multiple gestation.
*Length of Stay reported as incident rate ratio, not odds ratio.

Limitations

- Demonstrates associations with AKI coding, not causal links

- Difficulties with diagnosis and recognition of AKI in pregnancy:
  - Poor reliability of eGFR in pregnancy
  - Lack of pregnancy-specific biochemical reference ranges
  - Unknown baseline renal function

- Relies on accuracy of coding

- Data anonymity
  - Multiple admission episodes for same pregnancy not linked (eg. transfers or readmission) → under-reporting of AKI rate per delivery
  - Neonates within dataset not linked to mother → limited perinatal outcome data
    Data linkage underway
    - link antenatal and postnatal admissions to birth admission
    - link with Victorian Perinatal Data Collection
      → will add perinatal outcomes: birthweight, gestation, neonatal morbidity, and additional demographic and birth outcome details (eg. parity, BMI, smoking, socioeconomic status, severity of PPH, emergency LUSCS etc.)

- Current dataset does not include private hospital data
 - 24% of all births in Victoria → requested from VAED

Conclusions

- Coding for obstetric-related AKI in birth admissions has risen over the past decade and is associated with adverse pregnancy outcomes

- Factors with strongest association: CKD, GH/pre-eclampsia and sepsis

- Temporal trend persists after adjustment for factors such as maternal age, CKD, diabetes and GH/pre-eclampsia
  - Unmeasured or unidentified factors may be implicated, such as increasing complexity of maternal comorbidities or increased awareness and reporting of AKI

- Improved techniques for measuring, defining and identifying AKI in pregnancy need further development

- Long term risks of obstetric-related AKI remain to be determined

Future direction

Data linkage

- More comprehensive evaluation of factors associated with AKI coding in pregnancy
- Evaluate 10-fold rise in rates of AKI coding in postpartum admissions (need linkage for details of delivery)
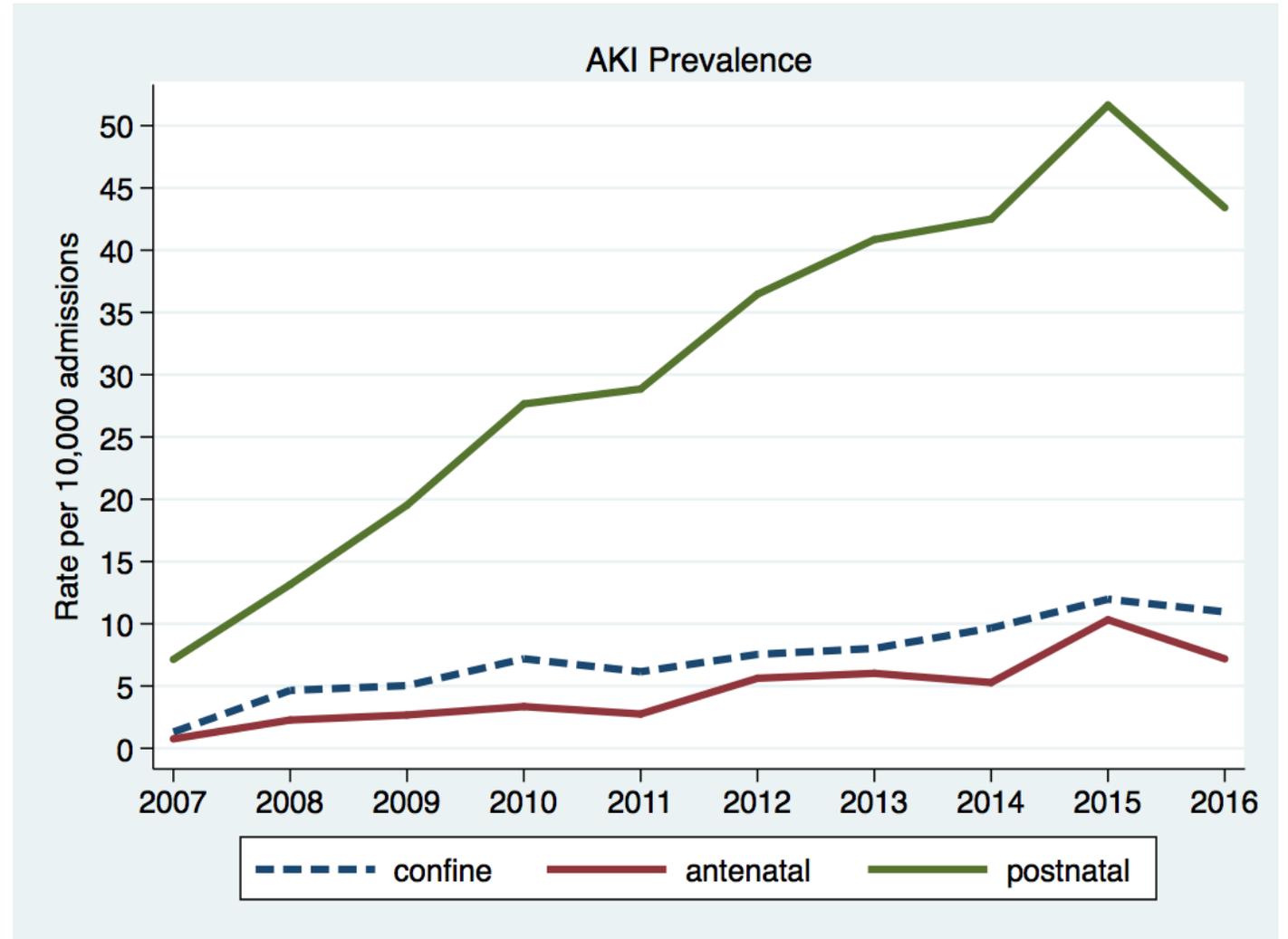
*P<0.001 for trend in all categories

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