

Provincial Clinical Knowledge Topic

Acute Kidney Injury, Adult – Inpatient

V 1.2

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Revision History

Version	Date of Revision	Description of Revision	Revised By
1.0	March 14, 2018	Topic Completion	Matthew James
1.2	January 25, 2019	Updates to topic	Matthew James

Important Information Before You Begin

The recommendations contained in this knowledge topic have been provincially adjudicated and are based on best practice and available evidence. Clinicians applying these recommendations should, in consultation with the patient, use independent medical judgment in the context of individual clinical circumstances to direct care. This knowledge topic will be reviewed periodically and updated as best practice evidence and practice change.

The information in this topic strives to adhere to Institute for Safe Medication Practices (ISMP) safety standards and align with Quality and Safety initiatives and accreditation requirements such as the Required Organizational Practices. Some examples of these initiatives or groups are: Health Quality Council Alberta (HQCA), Choosing Wisely campaign, Safer Healthcare Now campaign etc.

The scope of this topic is intended for patients receiving care on hospital/acute care wards. Considerations specific to management of acute kidney injury (AKI) in the setting of critical care (intensive care units) and management of AKI in outpatient (community) settings are not in the scope of this topic.

Guidelines

This topic is based on the following guidelines:

- [Kidney Disease Improving Global Outcomes \(KDIGO\) Clinical Practice Guideline for Acute Kidney Injury](#)
- National Institute for Health and Care Excellence (NICE) Guidance: [Acute Kidney Injury Prevention, Detection, and Management](#); and [Intravenous Fluid Therapy in Adults in Hospital](#)
- [Canadian Society of Nephrology Commentary on the 2012 KDIGO CPG for Acute Kidney Injury](#)

Keywords

- Acute Kidney Injury
- AKI
- Acute Renal Failure
- ARF
- Fluid balance
- Volume status
- Creatinine
- Proteinuria
- Hyperkalemia
- Kidney
- Renal
- Nephrology
- Dialysis

Rationale

AKI is a common, costly and an increasingly frequent complication of hospitalization in Canada. The incidence of AKI ranges from 10-30% of all medical and surgical hospital admissions and its risk rises substantially in association with patient age, pre-existing comorbidities, and exposure to major surgical and diagnostic imaging procedures. Standardized criteria, based on serum creatinine changes, are routinely measured to identify AKI. Several modifiable risk factors for progression of AKI have been identified in hospitalized patients, including intravascular volume depletion, low blood pressure, medication exposures, and infection. In most cases, if AKI is recognized early, it can be reversed by ensuring patients receive adequate fluids to correct volume depletion, and that medications that reduce kidney function or that are cleared by the kidneys, are modified or stopped. Unfortunately, AKI can go unrecognized in its initial stages and these relatively simple interventions can be neglected. When not recognized, AKI may progress to more advanced stages of kidney failure, requiring specialized care, dialysis treatment, a lengthy hospital stay, and high costs.

This knowledge topic has synthesized best-evidence from clinical practice guidelines and stakeholder input, developed guidance for decision support tools, and identified outcome measures specifically designed to improve and evaluate the quality of care provided for AKI in hospitalized patients in Alberta. The focus of this material is on early recognition and responses to AKI, informed by Kidney Disease Improving Global Outcomes (KDIGO) clinical practice guidelines for AKI National Institute for Health and Care Excellence (NICE) Guidance: Acute Kidney Injury Prevention, Detection, and Management, and the Canadian Society of Nephrology Commentary on the 2012 KDIGO CPG for AKI. This material includes guidance for appropriate clinical recognition and monitoring, fluid management and medication interventions to prevent worsening of AKI or adverse drug events, and standardized criteria about when to consider consultation with the nephrology team for patients with more complicated forms of AKI.

Goals of Management

Early Clinical Recognition

- Case identification and assessment of severity according to KDIGO guideline consensus definitions for AKI identification and staging

Standardized Clinical Assessment

- Initial assessment for reversible causes due to decreased kidney perfusion (“pre-renal”) or urinary tract obstruction (“post-renal”)
 - Medication review
 - Volume status assessment
 - Identification of whether the patient is hypovolemic / potentially volume responsive, euvolemic / volume replete, or volume overloaded
 - Assessment of safety of providing fluid (risk of pulmonary edema / fluid overload causing cardio-respiratory compromise)

- Assessment for risk of urinary tract obstruction
 - Selected use of kidney, ureter, and bladder (KUB) ultrasonography based on risk factors
- Evaluation for signs of sepsis
- Assessment for intrinsic kidney diseases (parenchymal diseases of the kidney) after pre- and post-renal causes have been identified and corrected
 - Urinalysis

Initial Clinical Response Focused on Reversible Causes

- Discontinue medications affecting kidney function
- Volume expansion (intravenous fluids)
 - Identification of need for fluid administration, selection of fluid type, and assessment of safety of providing fluid (risk of pulmonary edema / fluid overload causing cardio-respiratory compromise)
- Relief of obstruction
 - Bladder scan, urinary catheterization
 - Urology consultation (i.e. urinary stenting)
 - Interventional radiology consultation (i.e. nephrostomy tubes)
- Identification and treatment of sepsis when a contributor

Ensuring Patient Safety in Patients with Progressive or Persisting AKI

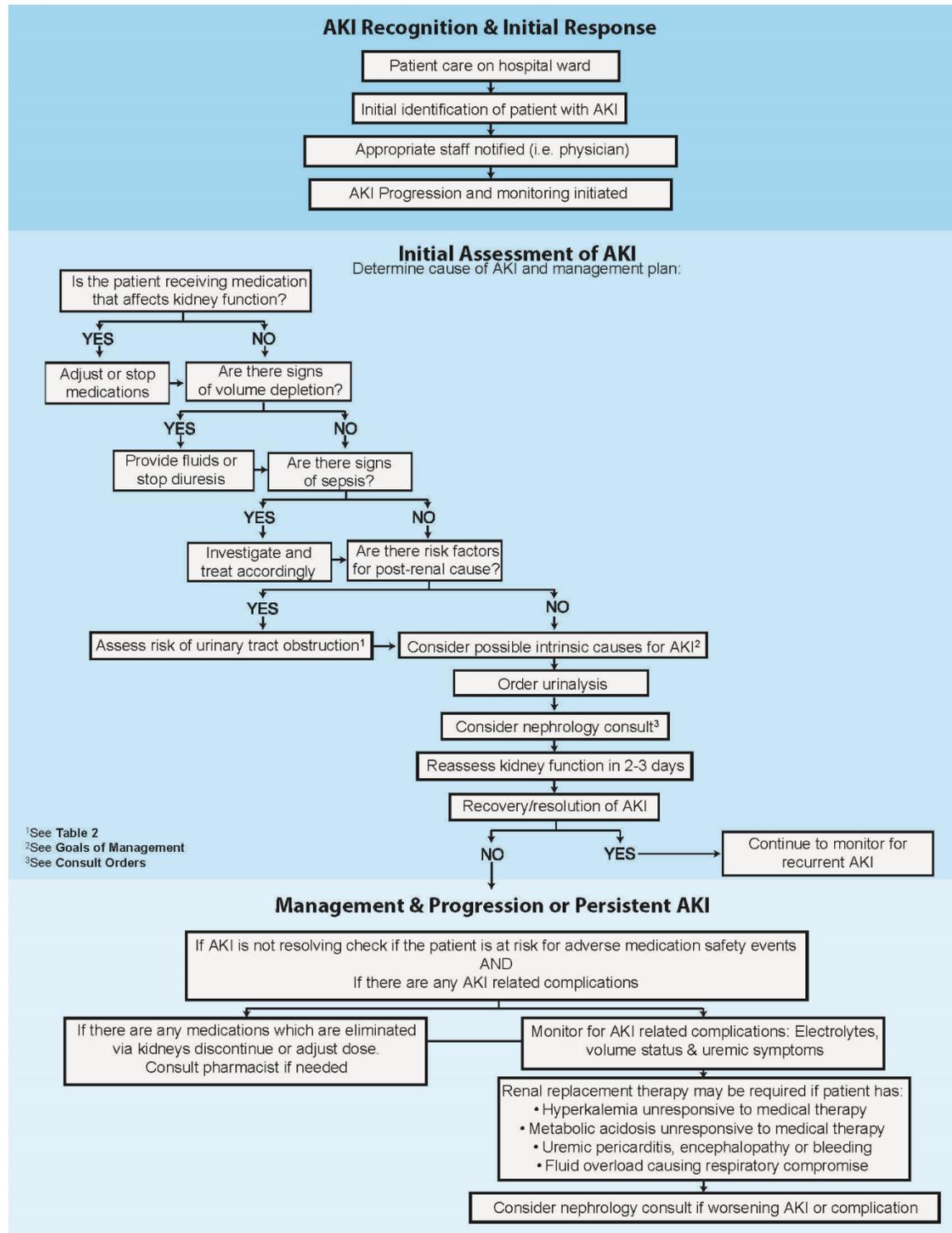
- Appropriate dose adjustment or discontinuing medications that are cleared by the kidney to avoid adverse medication safety events
- Monitoring for and managing complications of severe AKI
 - Assessment for volume overload and whether it is safe to continue fluid administration (signs of pulmonary edema / fluid overload causing cardio-respiratory compromise)
 - Metabolic/electrolyte disturbances
 - Kidney failure including identifying patients that may require dialysis
- Guidance for involvement/consultation with nephrology

Convalescence and Recovery

- Transition to community with follow-up of kidney function and need for chronic kidney disease care

Decision Making

Algorithm 1: Acute Kidney Injury Recognition and Initial Response



Risk Assessment for Fluid Resuscitation Safety

- Intravenous fluid administration to correct volume depletion in the setting of AKI should include an assessment of the patient's potential to respond to volume administration, assessment of risk of volume overload leading to pulmonary edema / cardiorespiratory compromise, and reassessment to determine whether fluid administration goals have been met and whether or not it is safe to continue providing more fluid.

Table 1 Risk of Fluid Overload Causing Cardio-Respiratory Compromise

Risk Level	Criteria
Low	No history of heart failure Left ventricular ejection fraction greater than 55% No history of chronic kidney disease No third spacing of fluids
Intermediate	Heart failure (mild systolic dysfunction) Left ventricular ejection fraction 45-55% History of chronic kidney disease Minor third spacing of fluids
High	History of heart failure (moderate or severe dysfunction) Left ventricular ejection fraction less than 45% History of advanced chronic kidney disease Significant third spacing of fluids

Risk Assessment for Urinary Tract Obstruction: To guide use of Kidney, Ureter, and Bladder (KUB) Ultrasonography

- Routine ultrasonography of the urinary tract is not required when a non-obstructive cause of the acute kidney injury has been identified. Initial investigation with ultrasonography is not required for patients without symptoms of obstruction, without risk factors, or at *low risk* of urinary tract obstruction based on the risk scoring system.
- Ultrasonography should be performed when there is no identified cause of acute kidney injury, when patients present with risk factors for or symptoms of urinary tract obstruction, when an infected and obstructed kidney is suspected, or when they are at *medium or high risk* of obstruction based on the risk scoring system.

	Points
Table 2 Risk Scoring System for Urinary Tract Obstruction¹	
History of hydronephrosis	Greater than 3 points and considered High Risk
Recurrent urinary tract infection	1 point
Diagnosis consistent with possible obstruction (e.g. Benign prostatic hyperplasia, Abdominal or pelvic cancer, neurogenic bladder, single functioning kidney, previous pelvic surgery)	1 point
Nonblack race	1 point
Absence of exposure to nephrotoxic medication	1 point
Absence of congestive heart failure	1 point
Absence of prerenal cause of AKI	1 point

Low Risk: Less than 2 points (3% have hydronephrosis, 0.4% have hydronephrosis requiring intervention)

Medium Risk: 3 points (11% have hydronephrosis)

High Risk: Greater than 3 points (16% have hydronephrosis, 4.7% have hydronephrosis requiring intervention)

Clinical Decision Support

Acute Kidney Injury Staging Alert

Table 3 is to be used for detecting Acute Kidney Injury (AKI), and the corresponding AKI stages 1, 2 and 3, based on serum creatinine changes captured over the specified time frames. The approach is outlined below, and is based on Kidney Disease Improving Global Outcomes (KDIGO) AKI guideline recommendations for AKI identification and staging. The table has been adapted from the algorithm for detecting AKI recommended by the National Health Service England Patient Safety Alert. Based on preliminary work identifying the frequency of silent AKI alerts, and recommended approaches to avoid false positive alerts, modifications to the KDIGO algorithm have been incorporated.

Acute Kidney Injury Staging Alert

This alert is to be generated based on the criteria in Table 3

Table 3 Staging System for AKI Staging Alert

Stage	Serum Creatinine Increase
AKI Stage 1	1.5 - 1.9 times baseline (50 to 99% increase) within 7 days if baseline serum creatinine greater than 53 µmol/L Greater than 26 µmol/L increase within 48 hours if baseline serum creatinine less than 100 µmol/L in women or 120 µmol/L in men
AKI Stage 2	2.0 - 2.9 times baseline (100 to 199% increase) within 7 days
AKI Stage 3	3.0 times baseline (200% increase) OR increase in serum creatinine to greater than 353 µmol/L OR initiation of renal replacement therapy

Exclusion Criteria/Restrictions for the AKI Staging Alert

1. All patients currently receiving dialysis should not generate the AKI Staging Alert.

Text to Display in AKI Staging Alert Messages:

AKI Stage 1 – Text to Display on Alert Message

This patient has met criteria for STAGE 1 Acute Kidney Injury (greater than 26 µmol/L increase in serum creatinine within 48 hours or 50% increase within 7 days) based upon the serum creatinine value drawn [Insert Date and Time Stamp of serum creatinine result].

This patient is currently receiving the following medications which may cause or are usually AVOIDED in Acute Kidney Injury:

[Insert Medication order Stamp (Display name of medication that triggered the alert) from “[Table 4.1 AHS Formulary Medications for AKI Alerts](#)” list here]

Current guidelines for management of Acute Kidney Injury suggest ensuring adequate volume status and blood pressure and avoiding nephrotoxic agents where possible. An Acute Kidney Injury order set to guide management can be accessed by typing 'aki' into the order entry field. For specific guideline recommendations see:

<http://insite.albertahealthservices.ca/assets/klink/et-klink-ckv-acute-kidney-injury-adult-inpatient.pdf>

AKI Stage 2 Alert – Text to Display on Alert Message

This patient has met criteria for STAGE 2 Acute Kidney Injury (a 2.0 to 2.9-fold increase in serum creatinine within 7 days) based upon the serum creatinine value drawn [Insert Date and Time Stamp of serum creatinine result].

This patient is current receiving the following medications which may cause or are usually AVOIDED in Acute Kidney injury:

[Insert Medication order Stamp (Display name of medication that triggered the alert) from “[Table 4.1 AHS Formulary Medications for AKI Alerts](#)” list here]

Current guidelines for management of Acute Kidney Injury suggest ensuring adequate volume status and blood pressure and avoiding nephrotoxic agents where possible. An Acute Kidney Injury order set to guide management can be accessed by typing 'aki' into the order entry field. For specific guideline recommendations see:

<http://insite.albertahealthservices.ca/assets/klink/et-klink-ckv-acute-kidney-injury-adult-inpatient.pdf>

AKI Stage 3 Alert – Text to Display on Alert Message

This patient has met criteria for STAGE 3 Acute Kidney Injury (a greater than 3-fold increase in serum creatinine or increase to greater than 353 µmol/L within 7 days) based upon the serum creatinine value drawn [Insert Date and Time Stamp of serum creatinine result].

This patient is current receiving the following medications which may cause or are usually AVOIDED in Acute Kidney injury:

[Insert Medication order Stamp (Display name of medication that triggered the alert) from “[Table 4.1 AHS Formulary Medications for AKI Alerts](#)” list here]

Current guidelines for management of Acute Kidney Injury suggest ensuring adequate volume status and blood pressure and avoiding nephrotoxic agents where possible. An Acute Kidney Injury order set to guide management can be accessed by typing 'aki' into the order entry field. For specific guideline recommendations see:

<http://insite.albertahealthservices.ca/assets/klink/et-klink-ckv-acute-kidney-injury-adult-inpatient.pdf>

Table of Medications

This list has been developing using the Alberta Health Services inpatient hospital medication formulary. Not all medications that reduce kidney function or are cleared by the kidneys are included on this list.

For guidance to medication dosing for renal impairment, refer to [Lexicomp Online](#) (Alberta Health Services)

1. Medications that affect kidney function or are nephrotoxic (consider discontinuing in all stages of AKI)

Table 4.1 AHS Formulary Medications for AKI Alerts
NSAIDS
celecoxib cap
diclofenac / misoprostol 50 tab
diclofenac / misoprostol 75 tab
diclofenac EC tab
diclofenac SR tab
diclofenac sup
ibuprofen tab
ibuprofen liquid
indomethacin cap
indomethacin inj
indomethacin liquid
indomethacin supp
ketorolac inj
naproxen tab
naproxen liquid
naproxen supp
DIURETICS
acetaZOLamide tab
acetaZOLamide inj
acetaZOLamide liquid
chlorthalidone tab
aMILoride tab
aMILoride liquid
hydrochlorothiazide tab
hydrochlorothiazide / aMILoride tab
hydrochlorothiazide / triamterene tab
hydrochlorothiazide liquid
ethacrynic acid inj
ethacrynic acid liquid
ethacrynic acid tab
furosemide tab

furosemide infusion
furosemide inj
furosemide liquid
indapamide tab
metoLAZONE liquid
metoLAZONE tab
spironolactone tab
spironolactone / hydrochlorothiazide liq
spironolactone / hydrochlorothiazide tab
spironolactone liquid
mannitol
mannitol inj
ACE INHIBITORS
capTOPRIL tab
capTOPRIL liquid
cilazapril tab
enalapril tab
enalapril liquid
enalaprilat inj
fosinopril tab
lisinopril tab
perindopril tab
ramipril cap
trandolapril cap
ANGIOTENSIN RECEPTOR BLOCKERS
candesartan tab
irbesartan tab
losartan tab
telmisartan tab
valsartan tab
CALCINEURIN INHIBITORS*
cycloSPORINE cap
cycloSPORINE for dose adjustment
cycloSPORINE infusion
cycloSPORINE inj
cycloSPORINE liquid
tacrolimus cap
tacrolimus ER cap
tacrolimus infusion
tacrolimus liquid
*Consider therapeutic drug monitoring and adjusting the dose in consultation with transplant service for patients receiving calcineurin inhibitors in the setting of solid organ transplantation.
ANTI-FUNGAL
amphotericin B inj

amphotericin B lipid complex

amphotericin B LIPOSOMAL inj

amphotericin B syringe

AMINOGLYCOSIDES

amikacin inj

amikacin syringe

gentamicin inj

gentamicin liquid

tobramycin inj

2. Medications requiring renal clearance that may require dose adjustment or discontinuation in greater than or equal to Stage 2 Acute Kidney Injury

**Table 4.2 Renally Eliminated
ANTIMICROBIALS**

acyclovir tab

acyclovir inj

acyclovir liquid

amantadine tab

amikacin inj

amikacin syringe

amoxicillin / clavulanate tab

amoxicillin / clavulanate liquid

amoxicillin cap

amoxicillin CHEW tab

amoxicillin liquid

ampicillin inj

ceFAZolin 1 g / metroNIDAZOLE 500 mg inj

ceFAZolin 2 g / metroNIDAZOLE 500 mg inj

ceFAZolin 500mg/metroNIDAZOLE 250mg inj

ceFAZolin inj

cefePIME inj

cefixime tab

cefixime liquid

cefotaxime inj

cefOXitin inj

cefTAZidime inj

cefTAZidime syringe

cefUROXime tab

cefUROXime inj

cefUROXime liquid
cephaLEXIN tab
cephaLEXIN liquid
ciprofloxacin tab
ciprofloxacin inj
ciprofloxacin liquid
clarithromycin ER tab
clarithromycin tab
clarithromycin liquid
colistin inj
DAPTOmycin inj
ethambutol tab
ertapenem inj
erythromycin EC cap
erythromycin estolate liquid
erythromycin inj
fluCONazole tab
fluCONazole inj
fluCONazole liquid
foscarnet inj
foscarnet syringe
ganciclovir inj
ganciclovir syringe
imipenem / cilastatin inj
levofloxacin tab
levofloxacin inj
levofloxacin liquid
meropenem inj
nitrofurantoin liquid
nitrofurantoin tab
oseltamivir tab
oseltamivir liquid
penicillin G benzathine inj
penicillin G sodium inj
penicillin V potassium tab
penicillin V potassium liquid
piperacillin / tazobactam inj
piperacillin inj
streptomycin inj

terbinafine tab
tetracycline cap
trimethoprim tab
sulfamethoxazole / trimethoprim tab
sulfamethoxazole / trimethoprim DS tab
sulfamethoxazole / trimethoprim PED tab
sulfamethoxazole / trimethoprim inj.
sulfamethoxazole / trimethoprim liquid
trimethoprim liquid
valACYclovir tab
valACYclovir liquid
valGANciclovir tab
valGANciclovir liquid
vancomycin infusion
vancomycin inj
vancomycin syringe
voriconazole inj
voriconazole syringe
ticarcillin / clavulanate inj
CARDIAC
digoxin tab
digoxin inj
digoxin liquid
nitroprusside infusion
quiNIDine bisulfate CR tab
ANTICOAGULANTS
apixaban tab
dabigatran cap
dalteparin inj
enoxaparin inj
eptifibatide infusion
eptifibatide inj
fondaparinux inj
rivaroxaban tab
tinzaparin inj
For patients receiving therapeutic LMWH who have a calculated creatinine clearance less than 30 mL/min), we suggest a reduction of the dose rather than using standard doses. See Additional Resources

HYPOGLYCEMICS

acarbose tab

glyBURIDE tab

GLICLAzide MR tab

GLICLAzide tab

metFORMIN tab

pioglitazone tab

SITagliptin tab

SAXagliptin tab

OTHER

allopurinol tab

allopurinol liquid

codeine tab

codeine CR tab

codeine inj

codeine liquid

colchicine tab

gabapentin tab

lithium carbonate cap

lithium citrate liquid

meperidine inj

meperidine PCA inj 10 mg/mL

methotrexate

metoclopramide

metoclopramide tab

metoclopramide infusion

metoclopramide inj

metoclopramide liquid

morphine tab

morphine ER cap

morphine infusion

morphine inj

morphine liquid

morphine PCA inj

morphine PCA inj 5 mg/mL

morphine supp

Order Set

Acute Kidney Injury, Adult – Inpatient Order Set

Order Set Keywords: Acute Kidney Injury, AKI, Acute Renal Failure, ARF, Fluid balance, Volume status, Creatinine, Proteinuria

Risk Assessment / Scoring Tools / Screening: [Table 1 Risk of Fluid Overload Causing Cardio-Respiratory Compromise](#) and [Table 2 Risk Scoring System for Urinary Tract Obstruction](#)

Diet

- Regular
- Renal – hemodialysis
- Renal – no dialysis

For patients with/at risk of hyperkalemia

- Low potassium – adult

For patients with volume overload

- Low sodium 2000 mg – adult

For hypovolemic / potentially volume responsive patients

- Clinical Communication - Encourage fluid intake

For volume overloaded patients

- Fluid Restriction - Restrict PO fluid intake _____mL/Day

Monitoring

Urinary catheter is not necessary unless obstruction is suspected (see [Table 2 Risk Scoring System for Urinary Tract Obstruction](#)) or there is difficulty voiding after recent catheter removal (consider bladder scan to identify urinary retention).

- Urine output every shift
- Intake and Output every shift
- Daily weight

Laboratory Investigations

Initial Investigations

- Complete Blood Count (CBC)
- Electrolytes (Na, K, Cl, CO₂)
- Creatinine

If no pre-renal or post-renal cause identified – consider an intrarenal cause

- Urinalysis Random

Day 2 and Day 3

To monitor for resolution versus progression of AKI

- Electrolytes (Na, K, Cl, CO₂)
- Creatinine

Diagnostic Imaging

Kidney, ureter, and bladder (KUB) US not routinely recommended when pre-renal cause identified or in absence of suspected urinary obstruction. See [Table 2 Risk Scoring System for Urinary Tract Obstruction](#) and guidance for ordering sonographic test.

- US KUB Male or Female with Prep
- Clinical Communication for DI Prep - Drink 500 to 1000 mL water as tolerated 1 hour prior to exam. DO NOT empty bladder.

Intravenous Therapies

This goal directed order set for fluid therapies incorporates both safety and efficacy considerations for individualizing intravenous fluid therapies.

Complete Risk Assessments for Fluid Resuscitation Safety, refer to [Table 1 Risk of Fluid Overload Causing Cardio-Respiratory Compromise](#).

Isotonic crystalloids are preferred for initial management for expansion of intravascular volume in patients with AKI. Crystalloids are preferred over colloid solutions in most scenarios – exceptions may include liver failure/suspected spontaneous bacterial peritonitis, and burns.

- Intravenous Cannula – Insert: Initiate IV
- IV Peripheral Saline Flush/Lock: Saline lock

For Hypovolemic / Potentially Volume Responsive Patient

Boluses of intravenous fluids are considered the most effective strategy for correcting hypovolemia. Diuretics are not recommended to treat AKI, except in the management of volume overload.

Boluses may need to be repeated until desired efficacy targets are reached. Bolus volumes can be varied based on need, degree of response, and patient risk of volume overload. An assessment of the safety of further volume administration should be made prior to each bolus.

Monitoring

Risk of cardio-respiratory deterioration increases with the number of abnormal vital signs

- Vital Signs every 1 hour starting prior to initiation of each bolus infusion
- Monitor Output - Urine 30 to 45 minutes after each bolus infusion
- Stop bolus infusion and notify Authorized Prescriber if either volume administration efficacy target(s) are met or if any safety parameter(s) are reached or exceeded as follows:
 - **Volume Administration Safety Concerns** are identified when any of the following safety parameters are reached or exceeded during bolus infusion administration:
 - Respiratory rate increase by 4 breaths/minute from baseline vital signs
 - Heart rate increase by 10 beats/minute from baseline vital signs
 - Oxygen requirement increase by 2 liters/minute from baseline vital signs
 - Maximum cumulative volume of _____ mL from all IV boluses
 - **Volume Administration Efficacy Targets** are met when one or more of the following is present (*specify below*):

- Urine output greater than _____ mL/hour
- Systolic blood pressure greater than _____ mmHg
- Heart rate less than _____ beats/minute

Use if low risk of volume overload:

Intravascular expansion without alkalinisation. Recommended bolus volume range is 250 to 1000 mL

- Initial IV Bolus: 0.9% NaCl infusion _____ mL over 15 to 30 minutes once
- Repeat IV Bolus NaCl infusion _____ mL over 15 to 30 minutes every 1 hour PRN if safety parameters have not been reached or exceeded and until efficacy targets reached

Intravascular volume expansion with alkalinization – lactate. Recommended bolus volume range is 250 to 1000 mL

- Initial IV Bolus: lactated ringers infusion _____ mL over 15 to 30 minutes once
- Repeat IV Bolus lactated ringers infusion _____ mL over 15 to 30 minutes every 1 hour PRN if safety parameters have not been reached or exceeded and until efficacy targets reached

Use if intermediate risk of volume overload

Intravascular expansion without alkalinization. Recommended bolus volume range is 100 to 500 mL

- Initial IV Bolus: 0.9% NaCl infusion _____ mL over 15 to 30 minutes once
- Repeat IV Bolus NaCl infusion _____ mL over 15 to 30 minutes every 1 hour PRN if safety parameters have not been reached or exceeded and until efficacy targets reached

Intravascular volume expansion with alkalinization - lactate. Recommended bolus volume range is 100 to 500 mL

- Initial IV Bolus: lactated ringers infusion _____ mL over 15 to 30 minutes once
- Repeat IV Bolus lactated ringers infusion _____ mL over 15 to 30 minutes every 1 hour PRN if safety parameters have not been reached or exceeded and until efficacy targets reached

Use if high risk of volume overload

Intravascular expansion without alkalinization. Recommended bolus volume range is 100 to 250 mL

- Initial IV Bolus: 0.9% NaCl infusion _____ mL over 15 to 30 minutes once
- Repeat IV Bolus NaCl infusion _____ mL over 15 to 30 minutes every 1 hour PRN if safety parameters have not been reached or exceeded and until efficacy targets reached

Intravascular volume expansion with alkalinization – lactate. Recommended bolus volume range is 100 to 250 mL

- Initial IV Bolus: lactated ringers infusion _____ mL over 15 to 30 minutes once
- Repeat IV Bolus lactated ringers infusion _____ mL over 15 to 30 minutes every 1 hour PRN if safety parameters have not been reached or exceeded and until efficacy targets reached

For Euvolemic / Volume Replete Patient

Consider one of the following for patients unable to meet their fluid and/or electrolyte needs orally or enterally – reassess need daily

- IV Maintenance: D5W - 0.9% NaCl infusion at _____ mL/hour
- IV Maintenance: 0.9% NaCl infusion at _____ mL/hour
- IV Maintenance: lactated ringers infusion at _____ mL/hour

Medications

- Clinical Communication: Minimize dilution volumes of intravenous medications for volume overloaded patients

Consider intravenous or oral diuretics for management of volume overload

- furosemide _____ mg IV every _____ hour(s)
- furosemide _____ mg PO every _____ hour(s)

Consider discontinuation of nephrotoxic drugs / medications that affect kidney function. Consider discontinuing or dose adjustment of renally cleared drugs for cases of persistent severe AKI (e.g. greater than or equal to Stage 2 AKI doubling score or sustained beyond 48 hours).

See [Table 2 Staging System for AKI Staging Alert](#) and [Tables of Medications](#) for relevant medications from AHS formulary.

For medication orders include: complete medication name, dose, route, frequency

- Discontinue nonsteroidal anti-inflammatory drugs (NSAIDs):

- Discontinue angiotensin converting enzyme inhibitors (ACEIs) or angiotensin II receptor blockers (ARBs):

- Discontinue diuretics:

- Discontinue aminoglycosides:

- Discontinue other:

- Adjust medication dose:

Consults

Consider discussing the management of acute kidney injury with a nephrologist when one or more of the following are present:

- A possible diagnosis that may need specialist treatment (e.g. presence of proteinuria or hematuria on urinalysis can suggest kidney vasculitis or glomerulonephritis; white blood cell casts can suggest tubulointerstitial nephritis; anemia, hypercalcemia, and fractures can suggest multiple myeloma)
- Acute kidney injury of unclear etiology (no pre-renal or post-renal cause identified)
- Progressive AKI despite correction of pre-renal/post-renal factors
- A kidney transplant
- Pre-existing advanced chronic kidney disease, eGFR less than 30mL/min/1.73m²
- Complications associated with AKI which may require renal replacement therapy (i.e. dialysis):
 - Hyperkalemia refractory to medical therapy
 - Metabolic acidosis refractory to medical therapy
 - Symptoms or complications of uremia (pericarditis, encephalopathy)
 - Fluid overload causing cardio-respiratory compromise (pulmonary edema)

In the setting of AKI in conjunction with liver failure (hepatorenal syndrome) or heart failure (cardiorenal syndrome), hepatology/nephrology or cardiology/nephrology consultations should be considered.

Consider consulting a transplant service when AKI occurs in conjunction with immunosuppression for solid organ transplant.

- Pharmacist Referral to review safety of discontinuing or adjusting dose of renally cleared medications
- Consult Nephrology
- Consult Hepatology
- Consult Cardiology
- Consult Transplant

Disposition Planning

Outpatient follow-up

1. Patients who have had an AKI event are at a higher risk of chronic kidney disease:
 - a. Blood pressure and volume status should be clinically assessed within three months of discharge of a patient with AKI.
 - b. The following laboratory investigations should be completed within three months of discharge:
 - i. Serum creatinine
 - ii. Serum electrolyte profile
 - iii. Urinalysis, Urine albumin-to-creatinine ratio
 - c. Further management of patients with chronic kidney disease should be decided based on the Alberta web-based CKD pathway (www.ckdpathway.ca)

Rural Considerations

For patients admitted to hospitals without acute dialysis facilities, or nephrology consultation services, consider consulting through Referral, Access, Advice, Placement, and Information & Destination ([RAAPID](#)) to discuss the management of acute kidney injury with a nephrologist from a referral centre when one or more of the following are present:

- A possible diagnosis that may need specialist treatment (eg., vasculitis, glomerulonephritis, tubulointerstitial nephritis or myeloma)
- Acute kidney injury of unclear aetiology (no pre-renal or post-renal cause identified)
- Inadequate response to treatment
- Complications associated with AKI which may require renal replacement therapy (i.e. dialysis) in a hemodynamically stable patient*:
 - Hyperkalaemia refractory to medical therapy
 - Metabolic acidosis refractory to medical therapy
 - Symptoms or complications of uraemia (pericarditis, encephalopathy)
 - Fluid overload causing respiratory compromise (Pulmonary edema)
 - Renal transplant
 - Pre-existing advanced chronic kidney disease, eGFR less than 30mL/min/1.73m²

*Patients requiring intensive care (e.g. hemodynamically unstable or intubated) may need to be discussed with a critical care physician.

Referral hospitals with acute dialysis facilities in Alberta:

- Southern Alberta:
 - Calgary - Foothills Medical Centre and Peter Lougheed Centre
 - Red Deer Hospital
 - Lethbridge Hospital
 - Medicine Hat Hospital
- Northern Alberta:
 - Edmonton - University of Alberta Hospital, Grey Nuns Hospital, Royal Alexandra Hospital

Analytics

Baseline Analytics – Measure 1

Name of Measure	Number of times order set Acute Kidney Injury, Inpatient is used
Definition	Number of times order set Acute Kidney Injury, Inpatient is used. Overall, by zone, by sites, by domain (ED, Inpatient, etc.), and by units. Will be required on an ongoing basis with the ability to filter by location, time period, domain, etc.
Rationale	Intended to measure how often the order set cited in the knowledge topic is being used, in what domain, and for different lengths of time. May indicate areas with adoption issues or gaps in topic.

Analytics – Measure 2

Name of Measure	Number of times Acute Kidney Injury Staging Alert was generated
Definition	Number (proportion) of AKI alerts generated and number of these acknowledged. Overall, by zone, by sites, by domain (ED, Inpatient, etc.), and by units. Will be required on an ongoing basis with the ability to filter by location, time period, domain, etc.
Rationale	Intended to measure how often the alert was generated within the order set. May indicate areas with adoption issues or gaps in topic.

Analytics – Measure 3

Name of Measure	Number of times url link to AKI Clinical Knowledge Topic was used
Definition	Number of times url link to AKI Clinical Knowledge Topic document is used.
Rationale	Overall, by zone, by sites, by domain (ED, Inpatient, etc.), and by units. Will be required on an ongoing basis with the ability to filter by location, time period, domain, etc.

Analytics – Measure 4

Name of Measure	Number of times Medication Alerts was generated
Definition	Number (proportion) of medication alerts generated and number of these acted upon. Overall, by zone, by sites, by domain (ED, Inpatient, etc.), and by units. Will be required on an ongoing basis with the ability to filter by location, time period, domain, etc.
Rationale	Intended to measure how often the alert was generated within the order set. May indicate areas with adoption issues or gaps in topic.

Analytics – Outcome Measure 1

Name of Measure	Post-AKI length of stay
Definition	In a patient who has developed AKI, how long are they hospitalized following AKI recognition.
Rationale	This measure reflects the burden of acute care required after a patient develops AKI, and is influenced by processes of care that impact the progression or resolution of AKI. This measure is intended to capture the impact of AKI on the resource intensity of hospital admission and how early recognition and responses might impact the amount of acute care subsequently required by a patient.
Notes for Interpretation	This measure is specific for patients admitted to a hospital ward only.
Cited References	KDIGO guideline, NICE guidance, Delphi process, Stakeholder input.

Analytics – Outcome Measure 2

Name of Measure	AKI progression (KDIGO stage)
Definition	Among patients who have developed AKI, what proportion experience progression of AKI over the next seven days after AKI onset, according to KDIGO serum creatinine staging criteria i.e. AKI Stage 1 to Stage 2/3/RRT AKI Stage 2 to Stage 3/RRT AKI Stage 3 to RRT
Rationale	This measure examines whether a patient who develops AKI has subsequently reversible AKI, and if not, the degree to which the AKI episode subsequently progresses to a more severe stage. This measure is relevant to determine how early recognition and response to AKI influences its progression.
Notes for Interpretation	This measure is specific for patients admitted to a hospital ward only.
Cited References	KDIGO guideline, NICE guidance, Delphi process, Stakeholder input.

Analytics – Outcome Measure 3

Name of Measure	AKI recovery
Definition	Among patients with AKI, what is the proportion of patients with AKI that recover (defined as reaching a serum creatinine level that is less than 50% of the baseline level <i>and</i> less than 26 µmol/L above the baseline level) and what is the time in days from AKI onset to recovery up to a maximum of 30 days following AKI onset
Rationale	Early recognition and management of AKI will be important for early recovery, whereas delayed management will prolong the duration of the condition and impede recovery. This measure will assess the proportion of patients who recover and the time to recovery up to a maximum of 30 days following AKI onset.
Notes for Interpretation	This measure is specific for patients admitted to a hospital ward only.
Cited References	KDIGO guideline, NICE guidance, Delphi process, Stakeholder input.

Analytics – Outcome Measure 4

Name of Measure	Change in estimated glomerular filtration rate (eGFR)
Definition	Among patients with AKI, what is the difference in eGFR from the time of measurement prior to AKI development to 3 months after the development of AKI.
Rationale	Patients who have not recovered kidney function or who have experienced progression of kidney disease after AKI may experience sustained loss of kidney function leading to chronic kidney disease. This measure will be a relevant assessment of the influence of early recognition and response on the degree of progression to chronic disease and permanent loss of kidney function.
Notes for Interpretation	This measure is specific for patients admitted to a hospital ward only.
Cited References	KDIGO guideline, NICE guidance, Delphi process, Stakeholder input.

Analytics – Process Measure 1

Name of Measure	Time to initial response to AKI onset
Definition	Time from AKI onset to a relevant clinical response (time from AKI onset to initiation of the AKI pathway or AKI order set or any element contained within the AKI pathway or order set)

Rationale	This measure captures the amount of time after AKI onset that it takes care providers to recognize and respond to the development of AKI. Recognizing AKI early in onset provides the greatest opportunity to avoid progression to more severe stages including kidney failure and provides an opportunity for more timely resolution of the condition. If AKI is recognized early, appropriate measures can be taken to avoid adverse complications of AKI (i.e. by suspending contributory medications, correcting volume depletion or states of low kidney perfusion, or, relieving urinary obstruction)
Notes for Interpretation	This measure is specific for patients admitted to a hospital ward only.
Cited References	KDIGO guideline, NICE guidance, Delphi process, Stakeholder input.

Analytics – Process Measure 2

Name of Measure	Volume intervention (change in fluid or diuretic order) within 48 hours of AKI onset.
Definition	A new or modified order for an intravenous fluid (any crystalloid solution) or diuretic (loop, thiazide or potassium sparing diuretic) including suspension of a diuretic within 48 hours of AKI onset. This measurement will be separated into orders for intravascular volume expansion (new or increase in IV fluid or suspension or discontinuation of a diuretic) versus orders for treatment of volume overload (reduction or discontinuation of IV fluid or increase or initiation of a diuretic).
Rationale	Volume assessment is a clinical assessment of fluid balance, which is an essential step in the assessment and management of AKI. In general, volume expansion with IV fluids or by stopping diuretics may be required in early stages of AKI in patients with volume depletion, whereas fluid restriction or diuretics may be appropriate when AKI progresses to later stages or is accompanied by volume overload.
Notes for Interpretation	This measure is specific for patients admitted to a hospital ward only.
Cited References	KDIGO guideline, NICE guidance, Delphi process, Stakeholder input.

Analytics – Process Measure 3

Name of Measure	Response to an adverse AKI medication exposure within 48 hours of AKI onset.
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Definition	Among patients with AKI and an active adverse AKI medication exposure, the proportion of patients who receive dose modification or suspension of the targeted medication is achieved with 48 hours of AKI onset. (Specific medication components of this measurement include – Suspend/Discontinue NSAID, ACE/ARB, diuretic, aminoglycoside/amphotericin, or other at any stage of AKI. Dose adjustment or suspension of medications that are cleared by the kidneys will be measured only in patients with stage 2 or greater AKI (≥ 2 -fold increase in serum creatinine). Among exposed patients, time of relevant order change will also be measured.
Rationale	Identified medications, including ACEI/ARBs, NSAIDs, diuretics, and nephrotoxic antibiotics can contribute to or worsen AKI. In the majority of cases these medications should be stopped or modified upon recognition of AKI. Certain other medications depend on clearance via the kidney and can therefore accumulate, leading to unwanted or adverse effects when AKI is persistent and leads to significant reductions in kidney function. Early recognition and suspension of medications that influence kidney function can halt progression or lead to reversal of AKI, while avoiding medications that are renally cleared can avoid adverse safety drug events due to drug or metabolite accumulation.
Notes for Interpretation	This measure is specific for patients admitted to a hospital ward only.
Cited References	KDIGO guideline, NICE guidance, Delphi process, Stakeholder input.

Analytics – Process Measure 4

Name of Measure	Consultation with nephrology or general internal medicine (GIM) for AKI during the index hospital admission
Definition	Among all patients with AKI, the frequency of consultation with nephrology or GIM for AKI patients.
Rationale	Change in frequency of consultations with nephrology and GIM specialists for AKI patients reflect changes in resource use and may be an unintended consequence of changes in care. Clinical decision support tools may decrease the need for consultations for AKI if they help providers manage AKI with more confidence. Increase in consultations may also be an unintended consequence of increased AKI recognition if it contributes directly to increased resource use without improvement in patient outcomes or experience.
Notes for Interpretation	This measure is specific for patients admitted to a hospital ward only.

Cited References	KDIGO guideline, NICE guidance, Delphi process, Stakeholder input.
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References

1. Licurse A, Kim M, Dziura J et al. Renal Ultrasonography in the Evaluation of Acute Kidney Injury. *Arch Intern Med.* 2010;170(21). doi:10.1001/archinternmed.2010.419.

Additional Resources

Therapeutic Dosing of Low Molecular Weight Heparins in Patients with Chronic Kidney Disease
https://share.ahsnet.ca/teams/PSPP/drugstewardship/DSInitiatives/UFHSpring/AHSDocs/UFH_Spring_CKD_Treatment_Formatted%20Jan_2016_Final.pdf

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