Acute Kidney Injury (AKI) Fact Sheet

"AKI is potentially preventable and treatable with timely intervention…delayed recognition of the condition is associated with high morbidity, mortality and costs."[1]

What is AKI?

Acute kidney injury (AKI) is a condition characterized by a rapid reduction in the ability of the kidneys to filter waste from the blood, resulting in a failure to maintain fluid, electrolyte and acid-base (pH) homoeostasis. Previously called acute renal failure (ARF), AKI is now recognized as a spectrum of kidney injury. AKI develops rapidly over a few hours or days. It's most common in those who are critically ill and already hospitalized.[2]

Who is at risk for hospital-acquired AKI?

Acute Kidney Injury almost always occurs in connection with another medical condition or event. There are many AKI risks and exposure factors, including:

- Sepsis (potentially life-threatening complication of an infection)
- Critical care illness
- Cardiovascular surgery (especially with cardiopulmonary bypass)
- Other complex surgery (major trauma, abdominal surgery)
- Shock
- Major burns
- Chronic heart, lung, GI, liver, or kidney disease
- Diabetes
- Hypovolemia (a decreased volume of circulating blood in the body, usually due to dehydration or bleeding)
- Oliguria (urine output less than 0.5 ml/kg/hour)
- Hematological (blood) cancer, such as leukemia, lymphoma, and multiple myeloma
- Symptoms or history of urological obstruction, or a risk factor for it
- Use of iodinated radio-contrast agents within the previous week
- Current or recent medication with kidney-damaging (nephrotoxic) potential - for example, NSAIDs, ACE inhibitors, AIIRAs, certain antibiotics (aminoglycosides), and diuretics
- Deteriorating early warning scores
- Additionally in children or young adults: severe diarrhea, symptoms or signs of nephritis (such as edema or hematuria), and hypotension[3]

What are the symptoms and signs of AKI?

Sometimes symptoms may be subtle or may not appear at all. Signs and symptoms of AKI may include:

- Decreased urine output, although occasionally urine output remains normal
- Fluid retention, causing swelling in your legs, ankles or feet
- Drowsiness
- Shortness of breath
- Fatigue

- Confusion
- Nausea
- Seizures or coma in severe cases
- Chest pain or pressure[4]

What is the incidence of hospital-acquired AKI in the U.S.?

It is estimated that 7-18% of hospitalized patients acquire AKI,[5] and up to 50% of those patients admitted to critical care units develop AKI.[6] In numbers, 3-6 million Americans experience hospital-acquired AKI each year.

What is the human and financial cost of AKI?

Delayed recognition of AKI can result in permanent kidney damage, causing patients to require dialysis for the rest of their lives. Among critical care patients, AKI is often associated with sepsis and non-renal organ system failure, resulting in a 40-80% mortality rate.[7] AKI has been documented to more than double the length of stay and increase the cost of care, resulting in annual U.S. healthcare expenditures estimated at over $10 Billion.[8,9]

How is AKI diagnosed?

The International Kidney Disease: Improving Global Outcomes (KDIGO)[10] uses the following criteria to diagnose AKI:

Blood test of serum creatinine (SCr) levels

- Increase in SCr by ≥0.3 mg/dl (≥26.5 lmol/l) within 48 hours; **or**
- Increase in SCr to ≥1.5 times baseline, which is known or presumed to have occurred within the prior 7 days; **or**

Functional measurement

- Urine volume <0.5 ml/kg/h for 6 hour

Other commonly used classification systems have similar criteria, specifically the RIFLE (Risk, Injury, Failure, Loss of kidney function, and End stage) and AKIN (Acute Kidney Injury Network) systems.[11]

What complications are associated with AKI?

- **Fluid buildup** in lungs, causing shortness of breath.
- **Chest pain** due to inflammation of the lining that covers the heart (pericardium).
- **Muscle weakness** due to imbalance in the body's fluids and electrolytes (blood chemistry); especially dangerous is elevated levels of potassium in the blood.
- **Permanent kidney damage** causing permanent loss of kidney function, or end-stage renal disease. This requires either ongoing, maintenance dialysis — a mechanical filtration process used to remove toxins and wastes from the body — or a kidney transplant to survive.

- **Death.** Loss of kidney function can ultimately cause death.[12]

What is the prognosis of AKI?

Timely identification of patients who are at increased risk of developing AKI is pivotal for preventative strategies. A prompt diagnosis and early intervention can minimize further renal injury. As AKI is a dynamic, degenerative process, delays in diagnosing the condition are associated with poorer outcomes, lifelong disability, and loss of life. [13]

Why can there be a delayed recognition of AKI by hospital-based clinicians?

There are several compounding factors that can delay the prompt diagnosis of AKI:

- Patients at risk for AKI usually are seen first by general practitioners, ER physicians, and/or allied practitioners who may not be trained to screen for the condition. [14]
- The complexity of treating critically ill patients with co-morbid medical disorders or patients recovering from cardiac or other major surgery, can confound the early detection of AKI.
- AKI is not associated with any specific symptoms and must be diagnosed through close observation of UO or laboratory tests.
- A major barrier to the application of UO criterion for diagnosing AKI is that accurate hour urine output measurements are difficult to obtain, and there is no standardized UO recording method.[15,16,17]

What is the Hospital Readmissions Reduction Program (HRRP)?

In 2012, as part of the Accountable Care Act, the Centers for Medicare & Medicaid Services (CMS) established the HRRP, which decreases payments to acute care hospitals for excessive readmissions for the applicable conditions of acute myocardial infarction (AMI), heart failure (HF), and pneumonia (PN).[18] These are all co-morbid risk factors for developing AKI.

As a result, health care organizations across the U.S. have a heightened awareness of the number of patients who are readmitted for these targeted conditions.

Note: In 2007, the Medicare Payment Advisory Commission (MedPAC)[19] provided a "Report to the Congress: Promoting Greater Efficiency in Medicare," which highlighted a finding that almost 20% of Medicare beneficiaries who had been discharged from a hospital were readmitted within 30 days, accounting for an estimated $15 Billion annual cost. Reducing hospital readmissions was identified as a key opportunity for decreasing Medicare spending.

What is the hospital readmission rates for patients discharged with a diagnosis of AKI?

In a 2013 study of 2,209 patients undergoing coronary artery bypass or valve surgery, patients with AKI showed a higher readmissions rate as compared to patients without AKI, and more than twice the readmissions rate with moderate and severe AKI. Readmission rates: no AKI:9.3% ; Stage 1 (mild) AKI: 16.1%; Stage 2 (moderate) AKI: 21.8%; Stage 3 (severe) AKI: 28.6%. [20]

A 2015 cohort study matching 3,345 (of 22,001) patients with hospital-acquired AKI to similar patients without AKI, showed that survivors of even mild AKI (stage 1 of 3) had greater odds of hospital readmission within 30-days of discharge. The AKI group was also more likely to be readmitted to the hospital within 30 days for cardiovascular-related conditions, and there was an increased risk of readmission at 60 and 90 days for patients with these conditions.[21]

What is the importance of urine output (UO) in detecting AKI?

Urine output has been termed the sixth vital sign since it often mirrors the patient's hemodynamic and physiologic condition. Low urine output (oliguria) and elevated serum creatinine (SCr) are the key biomarkers in commonly used classifications systems for AKI. In patients with indwelling urinary catheters, UO is a non-invasive diagnostic indicator, where obtaining SCr values requires a blood chemistry analysis.

In a prospective study of 317 critically ill patients, Macedo et al.[22] showed that UO alone was a sensitive and specific criterion for AKI, and that the diagnosis of AKI occurred earlier in oliguric than in non-oliguric patients.

In a retrospective cohort study of 14,524 patients, it was found that in patients who developed AKI, UO alone was a better mortality predictor than creatinine alone or the combination of both.[23] And in a study of 21,207 unselected ICU patients, it was found that UO obtained within the first 24 hours of critical care admittance was an independent predictor of mortality irrespective of diuretic use.[24]

Why isn't UO used more frequently as a criteria for diagnosing AKI?

Current methods of measuring urine output are manual, time-consuming, and error-prone. In patients with an indwelling urinary catheter, urine drains through a tube into a collection bag which is hung below the bed's mattress on a bed rail. To measure the urine, the nurse must bend down and "eye ball" the measurement.

A secondary method is to drain the bag into a graduated beaker for more accurate measurement. These measurements are either mentally remembered or manually written down before being recorded into the hospital's electronic medical record (EMR) system.

In critical care units, UO is to be recorded with the same frequency as other vital signs by busy, highly-skilled critical care nursing staff. In practice, UO data is not measured at a consistent time and often not recorded into the hospital's EMR system until the end of a 12-hour shift. Sometimes an aggregate number for the shift is divided by 12 to get an hourly value.

Due to the inconsistencies in measuring and recording UO data, this information is often inadequate or insufficient for physicians to use for diagnostic purposes.

What is an e-ICU and how important is UO data for patient management?

An Electronic Intensive Care Unit (eICU) is a form of telemedicine that uses state of the art technology to provide an additional layer of critical care service, often 24/7 coverage. The eICU incorporates a two-way, audio-video technology that links remote practitioners to monitoring centers staffed by highly-trained critical care physicians (Intensivists) and critical care nurses. Studies over the past twelve years have demonstrated positive patient outcomes in hospital systems with eICU programs.[25]

In 2000, Sentara Hospital in Virginia was the first hospital to implement an eICU program. As of 2011, over 40 eICUs were being used throughout 249 hospitals, covering 5,789 ICU beds. Barriers to adoption include the start-up costs, unproven ROI, and technical difficulties.[26]

The ability of the eICU to provide up-to-the-minute, state-of-the-art care is dependent on timely and accurate data in the EMR. A commonly used system used by eICU staff to trigger a medical alert at covered hospitals is MEWS (Modified Early Warning Score).[27] One of the factored observations in MEWS is hourly urine output, which is often not available to critical care specialists in the eICU.

How does a "kidney attack" (AKI) compare to a "heart attack?"

In comparison to a myocardial infarction (heart attack), AKI has a similar level of incidence (2.1 vs. 2.4/1000). Both have a high rate of morbidity and mortality. However, most people understand the concept of a heart attack, whereas acute injury to the kidneys is less well understood by clinicians and researchers and is barely known by the public. In addition, unlike myocardial infarction, AKI usually is co-morbid with other conditions such as sepsis, which are associated with a significant mortality risk. *"In these cases, AKI appears to amplify the risk of death associated with the underlying disease."*[28]

Who treats AKI?

The most common physician groups treating AKI today are hospitalists, Intensivists, and nephrologists in the critical care setting. There is no "rapid-response" team for AKI, and often intervention is initiated in the later stages of AKI. With broader awareness and training, a wider range of physician generalists and specialists would be able to identify patients at risk for AKI and detect early signs of AKI, reversing the downward spiral into disability or death.

What are the treatments for AKI?

Treatments for AKI must be managed in consideration of other treatments for co-morbid conditions. Certain medications that can cause injury to the kidneys (nephrotoxins) should be discontinued. Key goals are ensuring adequate hydration and maintaining hemodynamic (blood chemistry) stability and oxygenation. Common interventions include:

- **Treatments to balance the amount of fluids in the blood.** Dehydration can lead to a decrease in blood volume circulating in the body (hypovolemia), and may require intravenous (IV) fluids. In other cases, AKI can cause too much fluid in the blood (hypervolemia), leading to swelling in arms and legs. In these cases diuretic medication may be used to expel extra fluids, although there is some controversy regarding the risk/benefit of using diuretics in patients with AKI.
- **Medications to control blood potassium.** If the kidneys aren't properly filtering potassium from the blood, intravenous calcium gluconate or other medications may be used to prevent the accumulation of high levels of potassium. Too much potassium in the blood can cause dangerous irregular heartbeats (arrhythmias) and muscle weakness.
- **Medications to restore blood calcium levels.** If the levels of calcium in the blood drop too low, an infusion of calcium may be prescribed.
- **Renal Replacement Therapy (RRT - dialysis) to remove toxins from the blood.** During RRT therapy or dialysis, a machine pumps blood out of the body through an artificial kidney (dialyzer) that filters out waste. The blood is then returned to the body. Temporary RRT as a treatment for AKI is indicated when life-threatening changes occur in the patient's fluid status, serum electrolyte, and acid-base (pH) balance. Some clinicians and researchers support earlier use of RRT to halt the progression of AKI, for instance, in cases of fluid overload. [29,30]

What is the International Society of Nephrology "0by25" initiative?

The International Society of Nephrology is a global not-for-profit society dedicated to improving kidney care and reducing the incidence and impact of kidney disease worldwide. Through its global network and programs, ISN brings together the developing and developed world in a collaborative effort in fighting and treating kidney disease on a global scale.

The 0by25 (Zero by 2025) Initiative aims to eliminate preventable deaths from AKI by 2025. A global human rights initiative, 0by25 places a strong emphasis on low and middle-income countries in Africa, Asia, and Latin America with disadvantaged populations and poor access to care.

0by25 is endorsed by many regional and national nephrology societies worldwide and welcomes support from partners across the global healthcare community. [31]

Why hasn't more been done to address the issue of AKI before now?

According to the International Society of Nephrology, *"Few systematic efforts to manage (prevent, diagnose, and treat) AKI have been put in place and few resources have been allocated to inform health-care professionals and the public of the importance of AKI as a preventable and treatable disease."*[32]

AKI is a complex condition usually associated with other modifiable factors (such as dehydration) and non-modifiable, co-morbid medical disorders (such as chronic heart disease) or post-operative recovery from major surgery. Medications and certain diagnostic tests which may be indicated for the treatment of co-morbid disorders, may induce or exacerbate kidney injury.

AKI is a relatively new area of medicine for most non-kidney specialists. Recognition of kidney injury as a dynamic process has occurred only in the past 10 years, resulting in "acute renal failure" being renamed "acute kidney injury." It has taken a number of years to get agreement on the definition and progression of the condition, with national guidelines first issued in 2008.

As a dynamic process, when untreated, AKI continues to cause further injury and progression of the disease. Therefore, early recognition of risk factors and early intervention is necessary to avoid permanent kidney damage leading to disability or death. This requires a broad awareness and knowledge among medical professionals, and a consistent approach to care using available guidelines developed by experts in the field.

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