Acute Kidney Injury
An overview

22 April 2022

EMS ECHO

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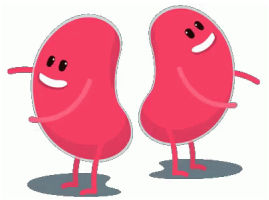
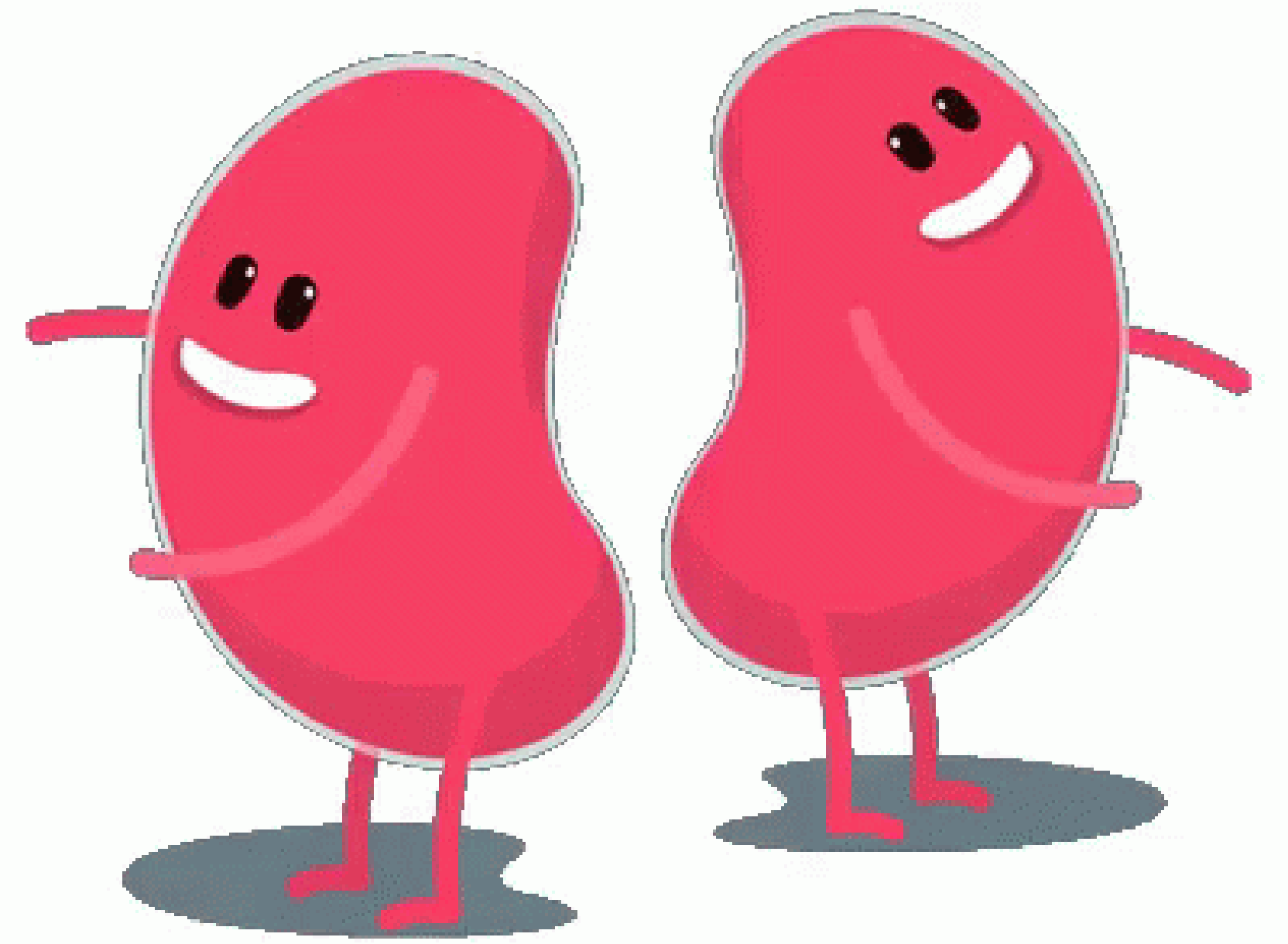


Presented at the 11th EMS ECHO Session

Goal of Presentation

- Appreciate the gravity of Acute Kidney Injury (AKI)
- Be able to identify those at risk
- Get acquainted with ongoing assessment for AKI and its risks
- Recap the basic interventions in AKI



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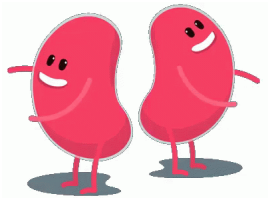
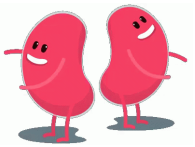
The key questions

- Is my patient at risk of AKI?
- Does my patient have AKI?
- What am I going to do differently for this patient?



Introduction

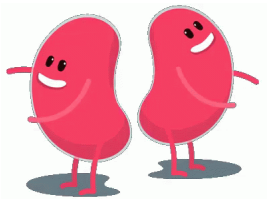
- Acute kidney Injury (AKI) is serious
  - Annually affects >10 million people worldwide
  - 1.7- to 6.9-fold increased risk of hospital mortality
  - Incidence of AKI is now greater than that for myocardial infarction!
- Etiologies vary by country, urbanicity, age, hospital department, economic status
- Several preventable causes by interventions at
  - Individual
  - Community
  - Regional
  - In-hospital levels



Kellum JA, Lameire N: Diagnosis, evaluation, and management of acute kidney injury: a KDIGO summary (part 1). Crit Care 2013;17:204

Where along the continuum of care does AKI develop!

- 1/3 AKI events already present at admission
  - Or develop 24 h after hospital admission
  - Therefore, early recognition is mandatory
    - Sawhney S, et al: KDIGO-based acute kidney injury criteria operate differently in hospitals and the community-findings from a large population cohort. Nephrol Dial Transplant 2016;31:922-929
- Geographical settings
  - Developing countries
    - Hypovolemia due to diarrhea
    - Trauma patients
    - Sepsis
  - Procedures common cause in advanced care environments
    - Open heart surgery
    - Angiographies
    - Contrasted imaging

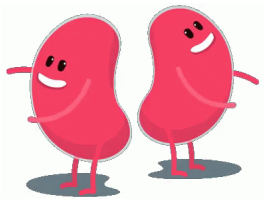


Is AKI common!

- 35.1% among children >6 YOA with malaria complicated by anemia and cerebral malaria, Hickson et al, 2019. Mulago

- Among children with malaria, 45.3%. Conry, Namazzi, Batte et al, 2021
  - Jinja (57.5%)
  - Kampala (35.5%)

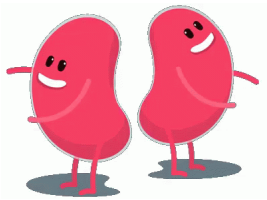
- 16.3% among adults with sepsis. Bagasha et al, 2015



AKI Definition

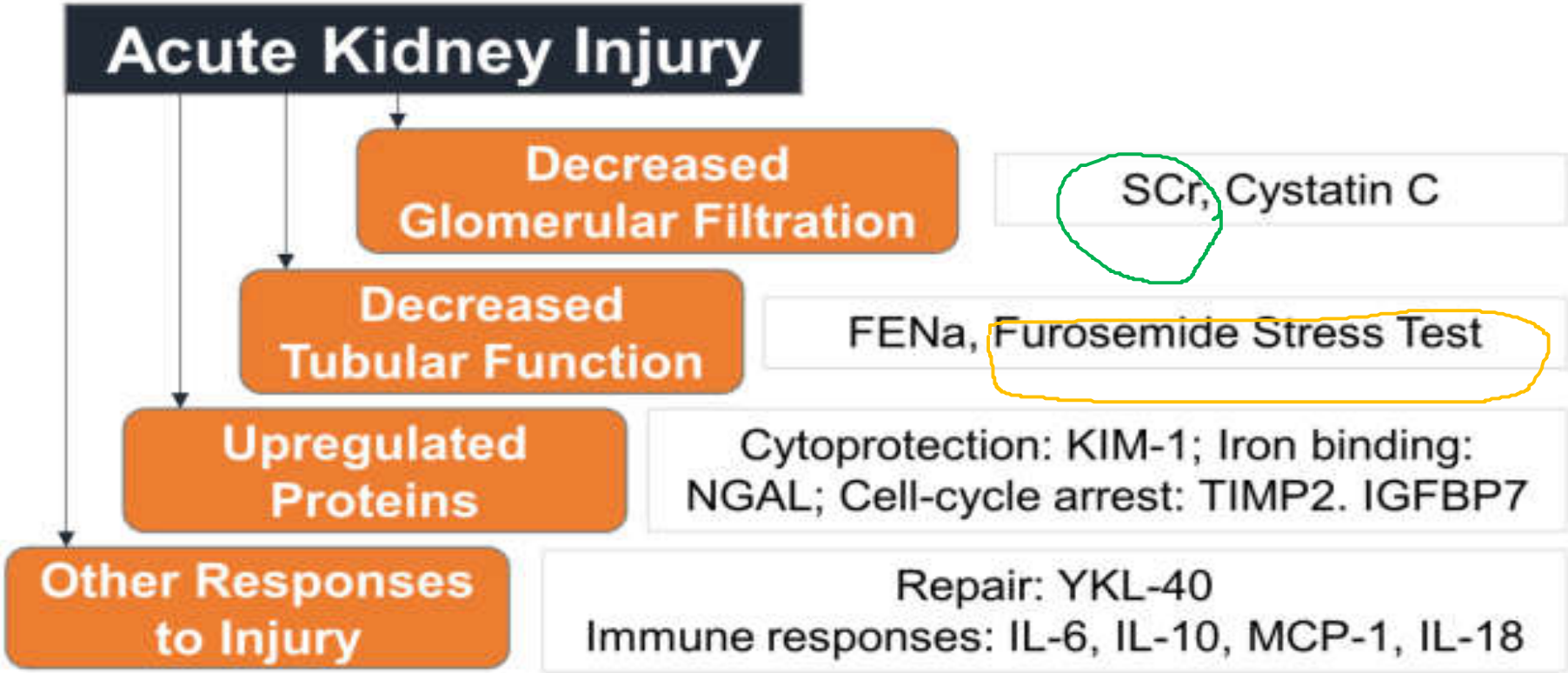
- An abrupt decrease in kidney function that includes, but is not limited to, acute renal failure

- AKI is a broad clinical syndrome encompassing various etiologies, with multiple conditions coexisting in the same patient
  - Ronco C: Acute kidney injury: from clinical to molecular diagnosis. Crit Care 2016;20:201
- Clinical identification
  - History
  - Physical/Bedside assessment
  - Biomarkers



Ideal vs available biomarkers of AKI

Figure 2. Classification of biomarkers of AKI.



SCr, serum creatinine; FENa, fractional excretion of sodium; KIM-1, kidney injury molecule-1; NGAL, neutrophil gelatinase-associated lipocalin; TIMP2, tissue inhibitor of metalloproteinases-2; IGFBP-7, insulin like growth factor binding protein-7; IL, interleukin; MCP-1, monocyte chemotactic protein 1

Moledina, Dennis & Parikh, Chirag. (2018). Phenotyping of Acute Kidney Injury: Beyond Serum Creatinine. Seminars in Nephrology. 38. 3-11. 10.1016/j.semnephrol.2017.09.002.

In our setting

- Point-of-care tests in LMIC settings in situations where advanced biochemistry testing is unavailable
  - Creatinine
- Blood urea nitrogen (BUN) or saliva urea nitrogen (SUN)
- Urine neutrophil-gelatinase associated lipocalin-1 (NGAL)
- Albuminuria or proteinuria (urine dipsticks)
- Estimate urine output
- Urine microscopy and urine biochemistry to elucidate etiology and assess severity
- Renal imaging or biopsy as indicated (and available)

Batte A, Berrens Z, Murphy K, Mufumba I, Sarangam ML, Hawkes MT, Conroy AL. Malaria-Associated Acute Kidney Injury in African Children: Prevalence, Pathophysiology, Impact, and Management Challenges. *Int J Nephrol Renovasc Dis*. 2021;14:235-253 https://doi.org/10.2147/IJNRD.S239157

Definitions of AKI

RIFLE, 2004		Pediatric RIFLE, 2007		AKIN, 2007		KDIGO, 2012		Urine Output
Criteria	**Creatinine Definition**	**Criteria**	**Creatinine Definition**	**Criteria**	**Creatinine Definition**	**Criteria**	**Creatinine Definition**	
Risk	≥1.5x increase in SCr from baseline or decrease in GFR ≥25%	Risk	Decrease in GFR ≥25%	Stage 1	≥0.3 mg/dL increase in SCr within 48hrs or ≥1.5x increase in SCr from baseline	Stage 1	≥0.3 mg/dL increase in SCr within 48 hrs or ≥1.5x increase in SCr from baseline	<0.5 mL/kg/h for >6hrs
Injury	≥2x increase in SCr from baseline or decrease in GFR ≥50%	Injury	Decrease in GFR ≥50%	Stage 2	≥2x increase in SCr from baseline	Stage 2	≥2x increase in SCr from baseline within 7 days	<0.5 mL/kg/h for ≥12 hrs
Failure	≥3x increase in SCr from baseline or decrease in GFR ≥75%, SCr ≥4.0 mg/dL with an acute increase of >0.5 mg/dL	Failure	Decrease in GFR ≥75% or an eGFR<35 mL/min per 1.73m^2	Stage 3	≥3x increase in SCr from baseline, SCr ≥4.0 mg/dL with an acute increase of >0.5mg/dL or initiation of KRT	Stage 3	≥3x increase in SCr from baseline within 7 days, SCr ≥4.0 mg/dL with an acute increase of >0.5 mg/dL or initiation of KRT	<0.3 mL/kg/h for ≥24hrs or anuria for ≥12hrs
Loss	Failure for >4 weeks	Loss	Failure for >4 weeks					
ESRD	Failure for >3 months	ESRD	Failure for >3 months					

Abbreviations: RIFLE, risk, injury, failure, loss, end-stage renal disease; AKIN, acute kidney injury network; KDIGO, kidney disease: improving global outcomes; SCr, serum creatinine; GFR, glomerular filtration rate; KRT, kidney replacement therapy.

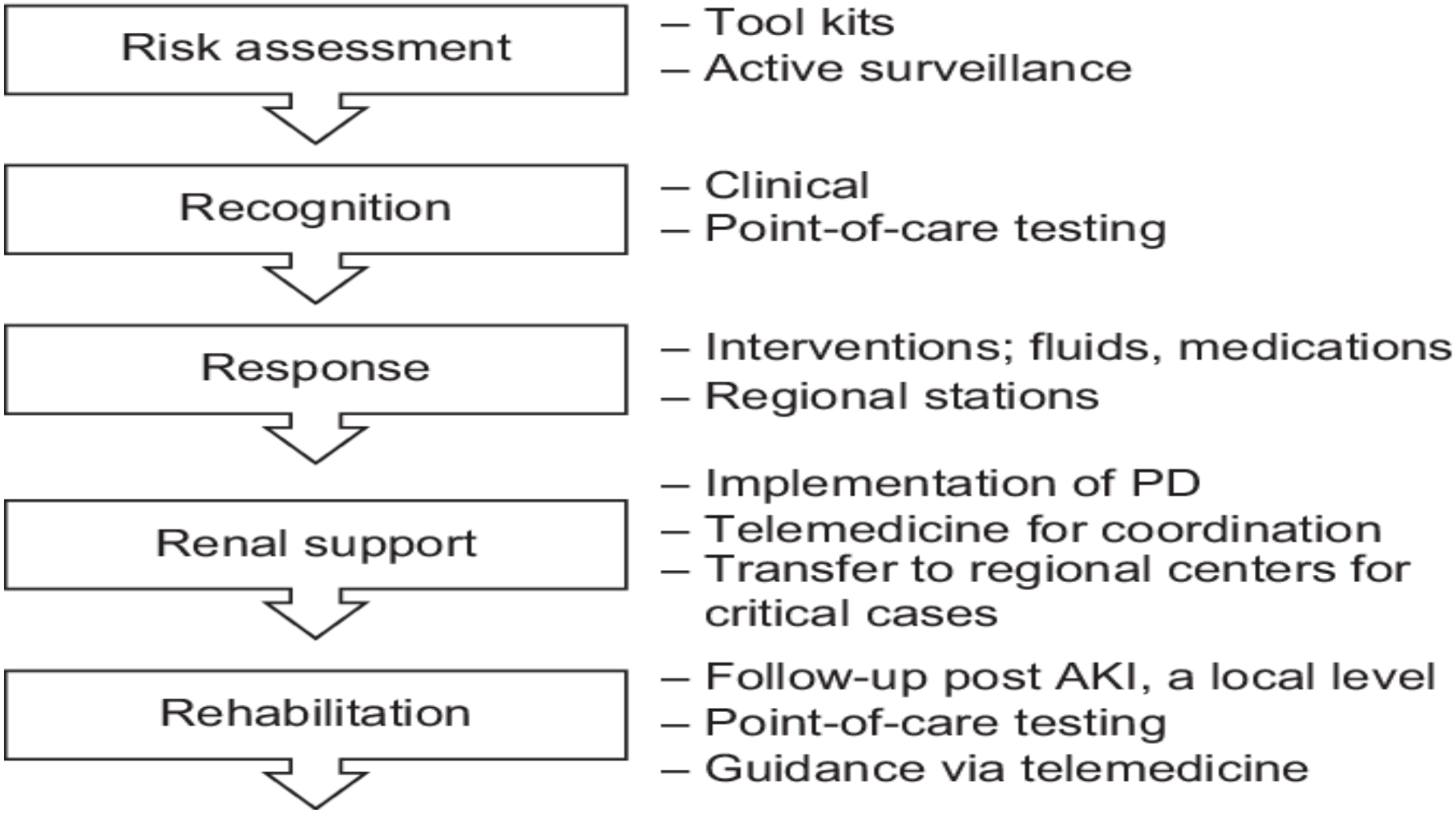
What does an episode of AKI mean to the body!

- Epidemiological evidence supports the notion that even mild, reversible AKI has important clinical consequences
  - Kellum JA, Lameire N: Diagnosis, evaluation, and management of acute kidney injury: a KDIGO summary (part 1). Crit Care 2013;17:204

- The damage induced by subclinical or manifest episodes of AKI may, in fact, produce an irreversible loss of a variable amount of renal mass with deleterious effects on the overall renal function

- This may be the case even though baseline glomerular filtration rate (GFR) appears to return to normal
  - When measured in these patients, renal reserve is impaired
    - Ronco C, Rosner MH: Acute kidney injury and residual renal function. Crit Care 2012;16:144

Eliminating Preventable Deaths from AKI worldwide by 2025
5R 0 by 25 ISN Initiative - 2013

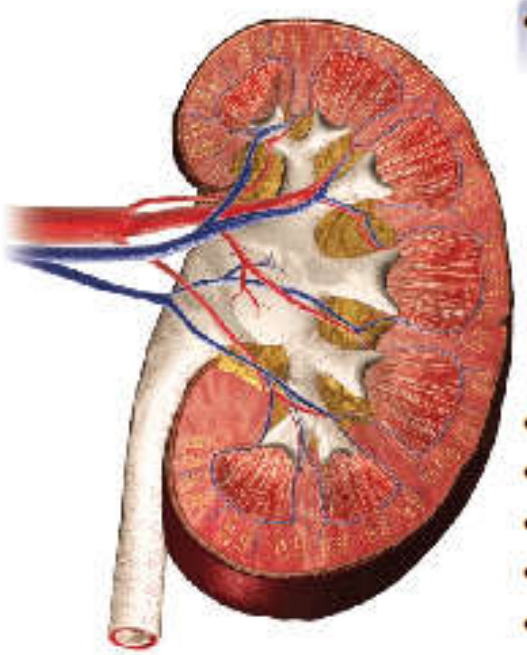


Ponce, Daniela & Balbi, Andre. (2016). Acute kidney injury: Risk factors and management challenges in developing countries. International journal of nephrology and renovascular disease. 9. 193-200. 10.2147/IJNRD.S104209.

The vast causes of AKI

Pre-renal AKI

- Sepsis
- Toxins – IV contrast
- Hypotension
  - Vomiting
  - Diarrhoea
  - Diuretics
  - Haemorrhage
  - Burns
  - Medication
    - ACEi
  - Cardiac Failure
- Hepatorenal Syndrome
- Renal Artery Stenosis



Intrinsic AKI

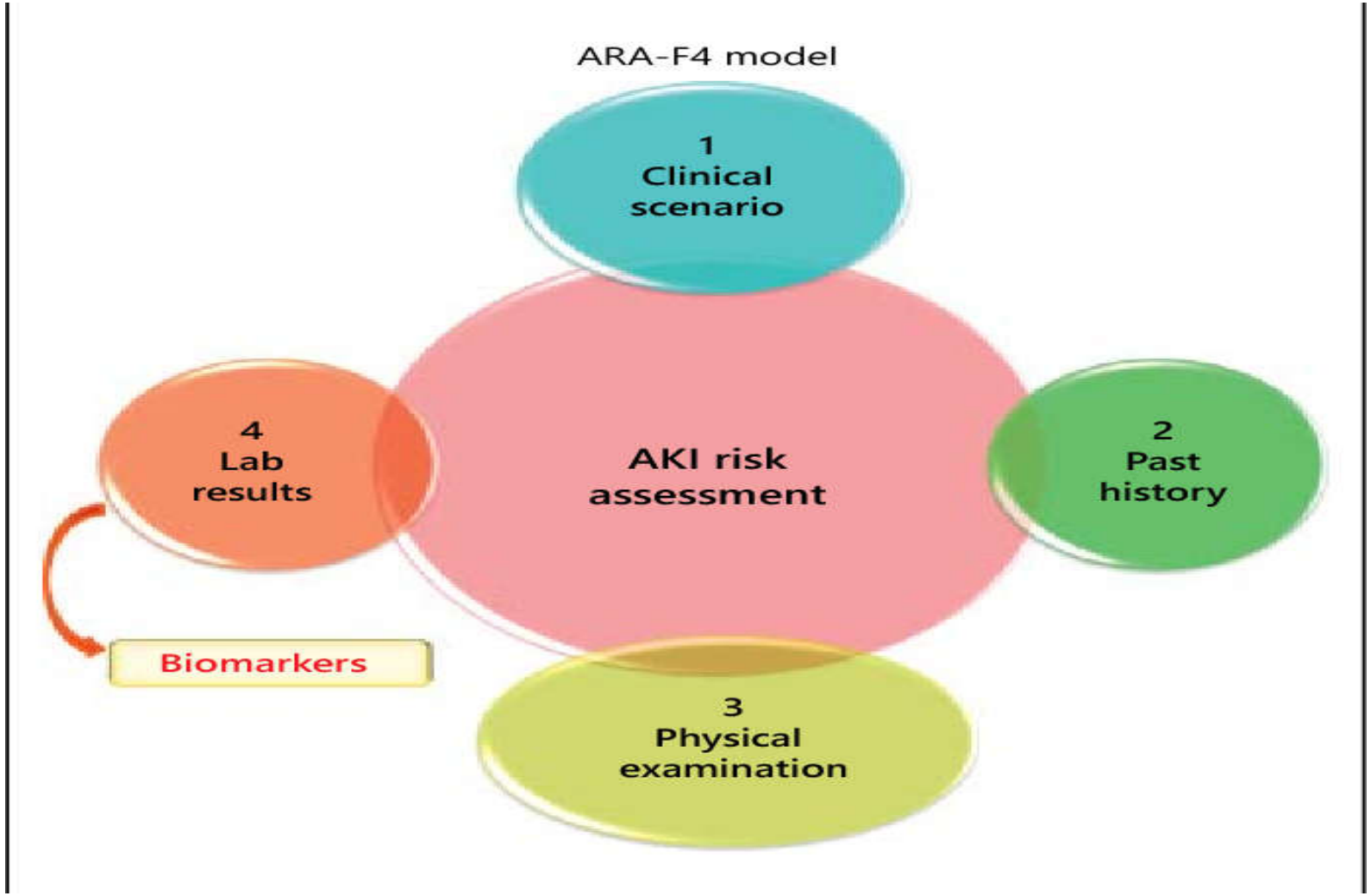
- Acute tubular injury
  - Prolonged pre-renal
  - Nephrotoxins
    - Gentamicin
    - IV contrast
    - NSAIDs
    - Rhabdomyolysis
    - Haemoglobinuria
- Tubulointerstitial injury
- Glomerulonephritis
- Myeloma
- Lupus Nephritis
- Vasculitis
  - ANCA
- Haemolytic Uraemic Syndrome (HUS)
- Thrombotic Thrombocytopenic Purpura (TTP)

Post-renal AKI

- Kidney stones
- Prostatic hypertrophy
- Tumours
- Retroperitoneal fibrosis

Acute Kidney Injury in Adults Guideline (Secondary Care). Trust Clinical Guidelines Group. Copyright© Leeds Teaching Hospitals NHS Trust 2020

‘Fantastic 4’ Systematic Approach



Rizo-Topete, L.M., Rosner, M.H., & Ronco, C. (2016). Acute Kidney Injury Risk Assessment and the Nephrology Rapid Response Team. *Blood Purification, 43*, 82 - 88.

‘Fantastic 4’ Systematic Approach Cont

- F1: ‘Clinical scenario’
  - Patient's signs and symptoms and the surrounding circumstances and risks
- F2: Interview the patient or his/her relatives and review the ‘past history’
  - Identify the level of susceptibility and intensity of exposures
- F3: ‘Physical examination’
  - Characterize hemodynamic instability, volume depletion or fluid overload and signs/source of infection
- F4: Analyze ‘laboratory results' including possible AKI biomarkers to complete the patient risk stratification

- The AKI F4 should trigger activation of the nephrology rapid response team (NRRT).

Features in the 'Fantastic 4'

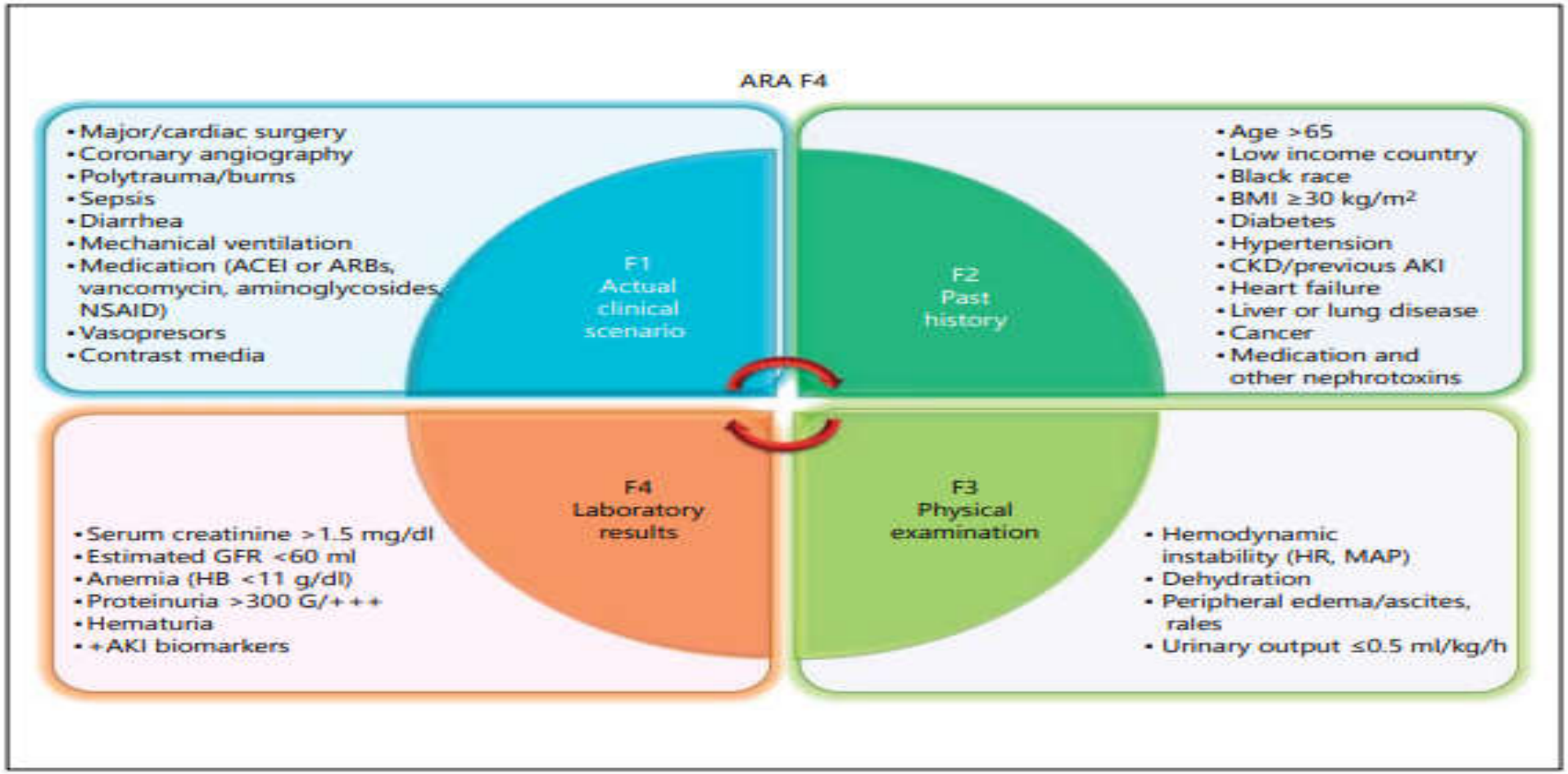
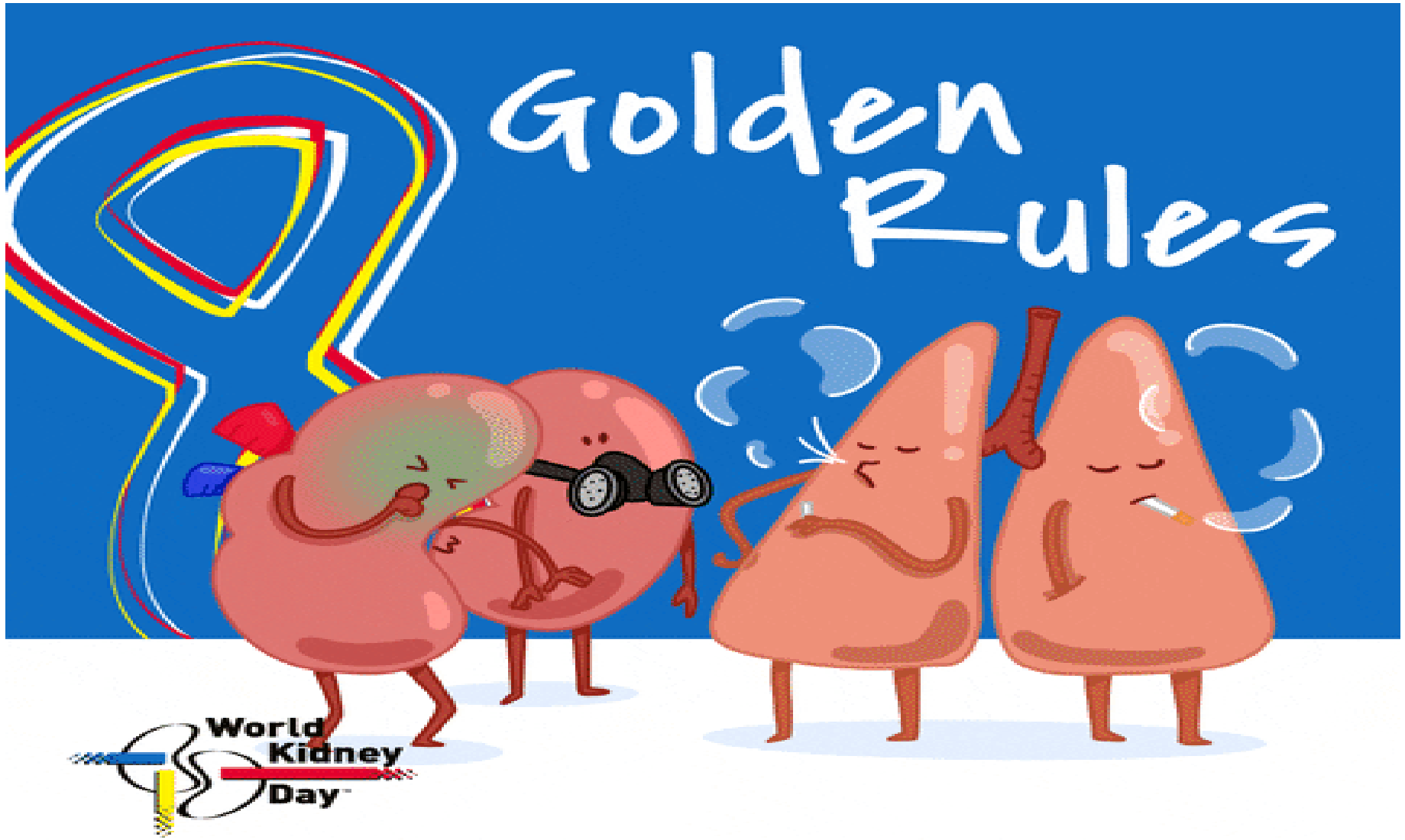


Fig. 2. The algorithm is based on 4 simple steps that systematically evaluates if patients have AKI risk. Patient with a positive item is at moderate risk, 2 or more items is at high risk.

Rizo-Topete, L.M., Rosner, M.H., & Ronco, C. (2016). Acute Kidney Injury Risk Assessment and the Nephrology Rapid Response Team. *Blood Purification, 43*, 82 - 88.

Troubleshooting AKI and the risks!



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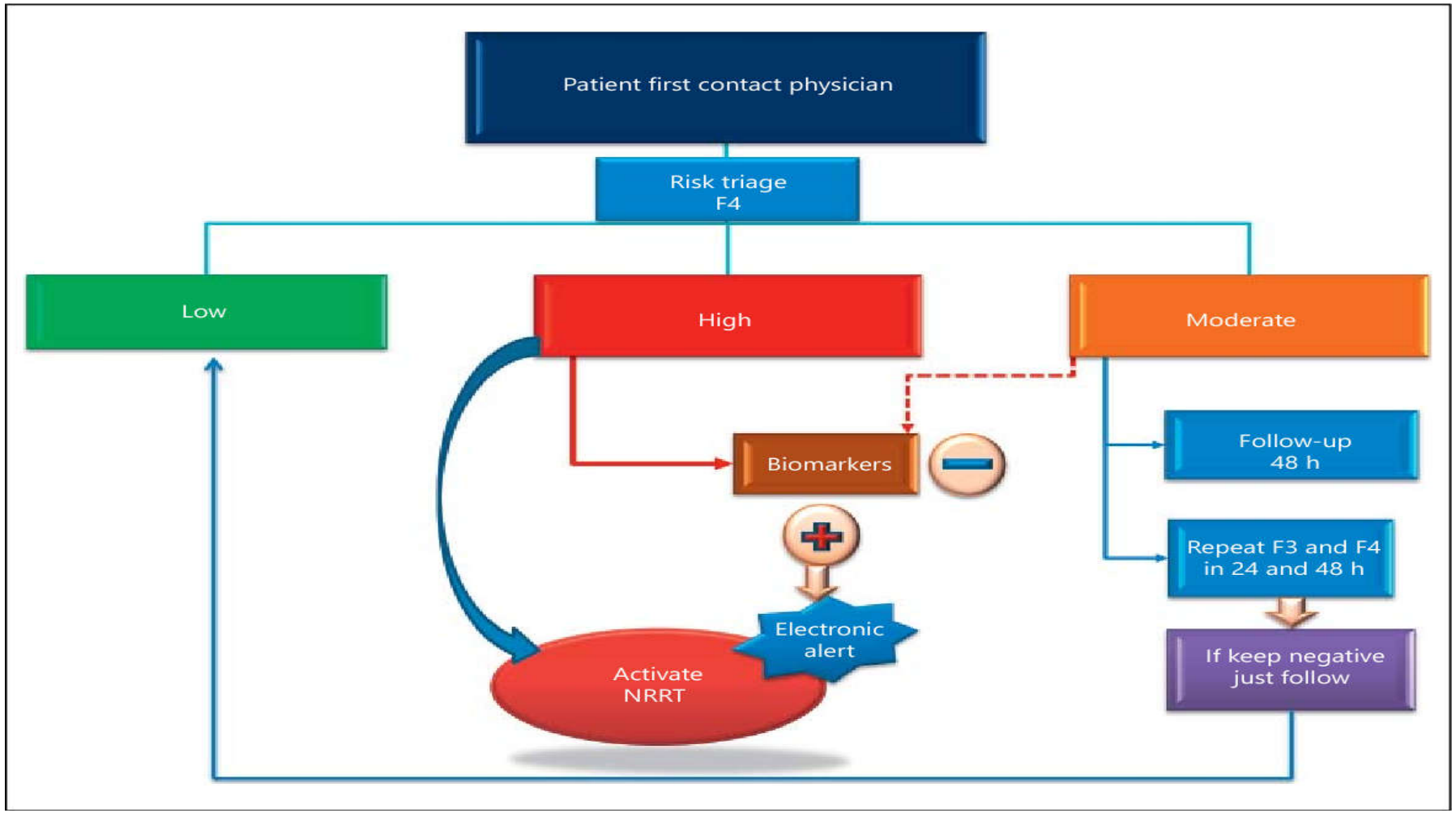
Actions after risk triage



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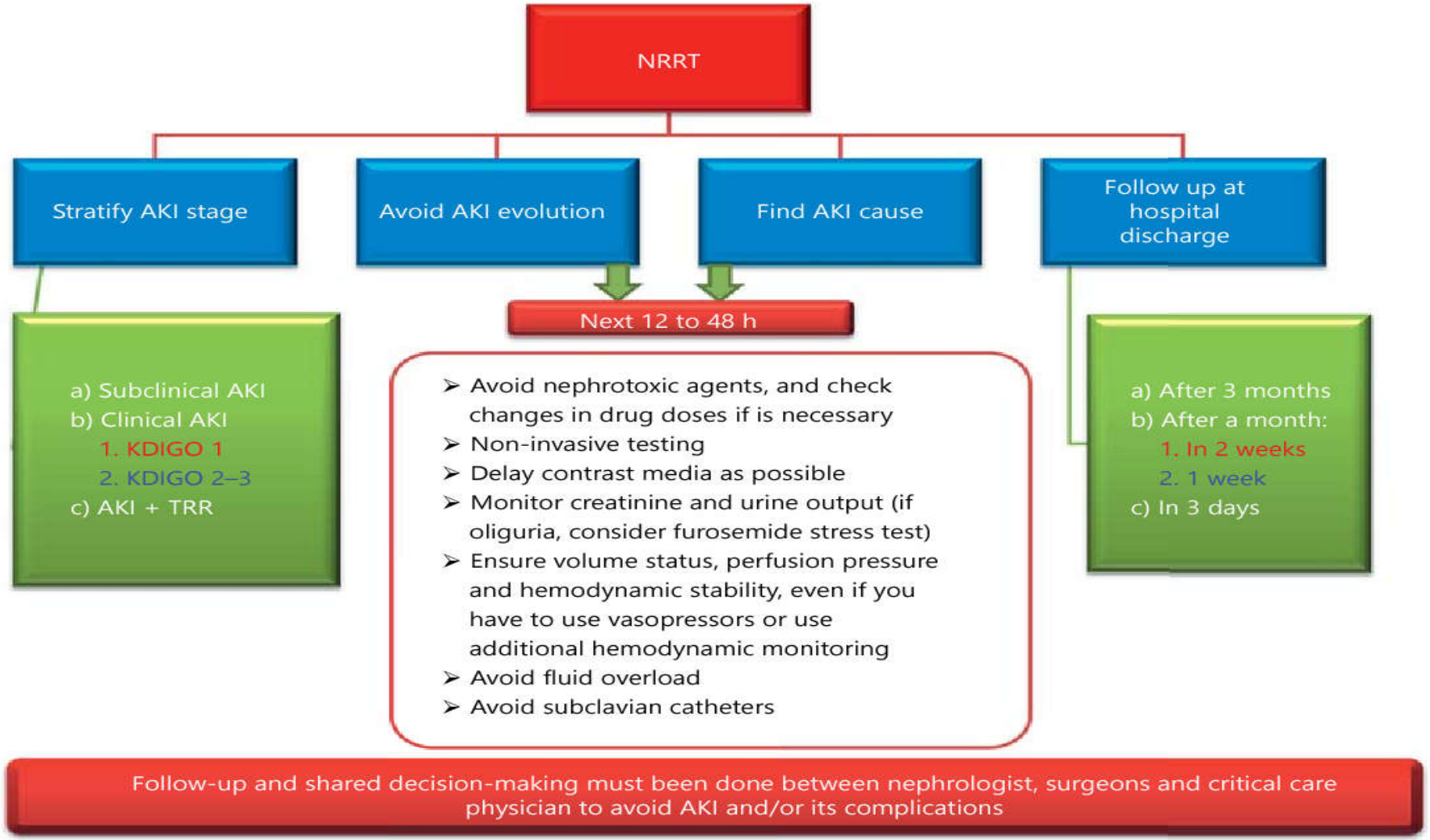
Actions after risk triage Cont.



Rizo-Topete, L.M., Rosner, M.H., & Ronco, C. (2016). Acute Kidney Injury Risk Assessment and the Nephrology Rapid Response Team. *Blood Purification, 43*, 82 - 88.

Determinants of AKI Renal Outcomes

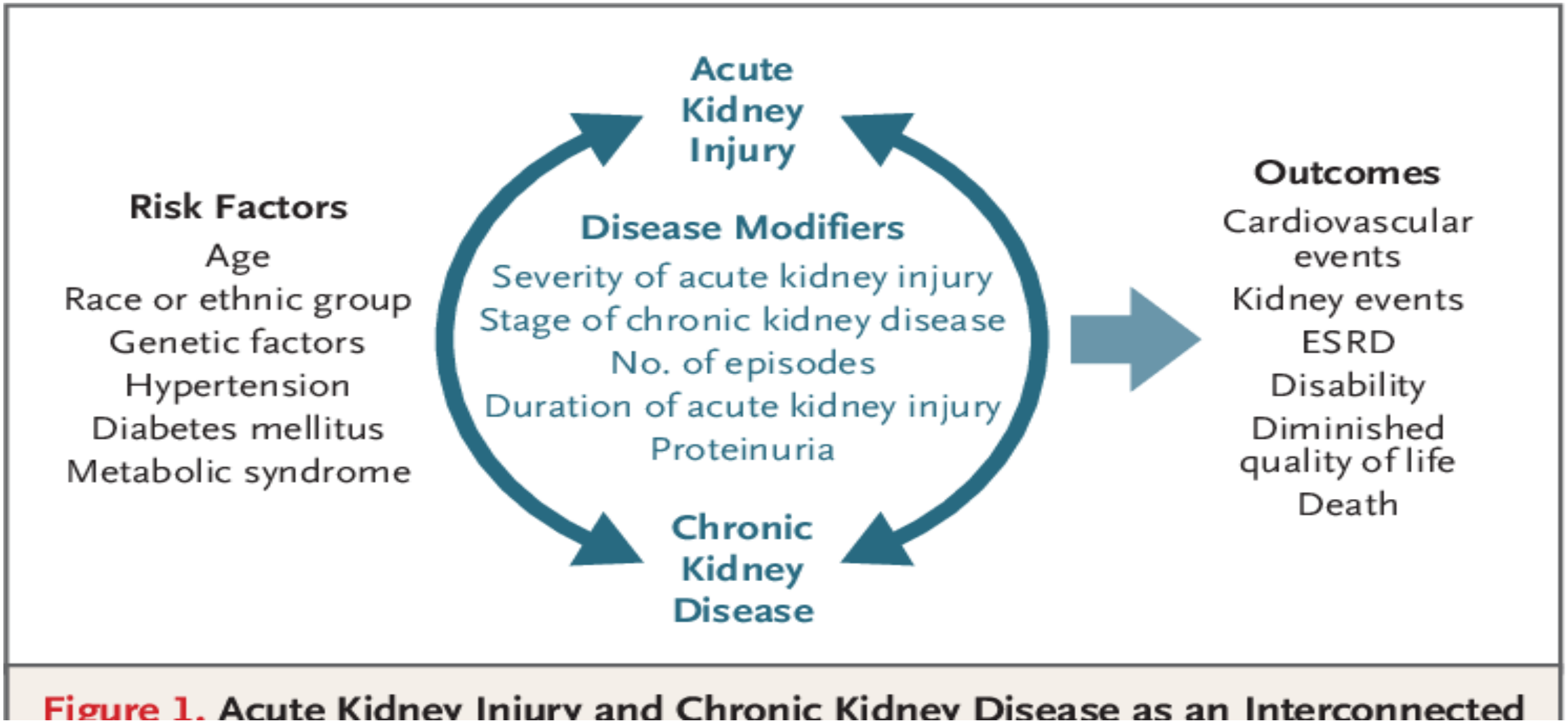
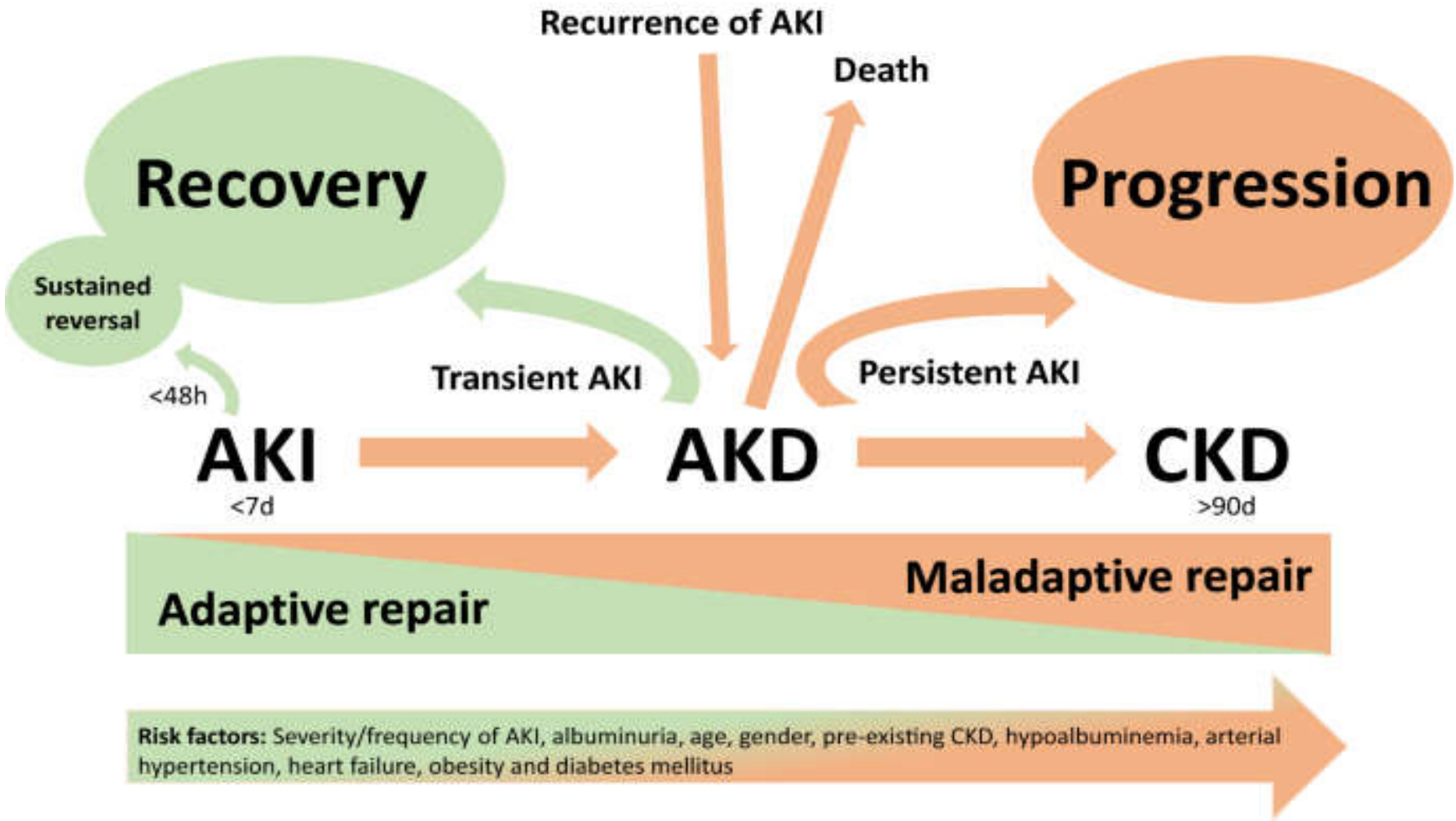
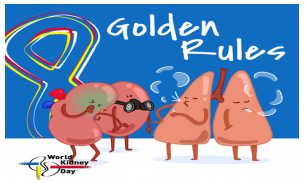


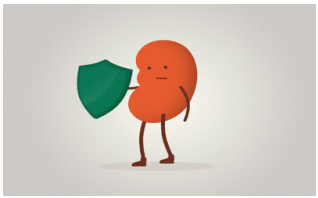
Figure 1. Acute Kidney Injury and Chronic Kidney Disease as an Interconnected

Chawla, L.S., Eggers, P., Star, R.A., & Kimmel, P.L. (2014). Acute kidney injury and chronic kidney disease as interconnected syndromes. *The New England journal of medicine, 371 1*, 58-66 .

Determinants of AKI Renal Outcomes Cont.

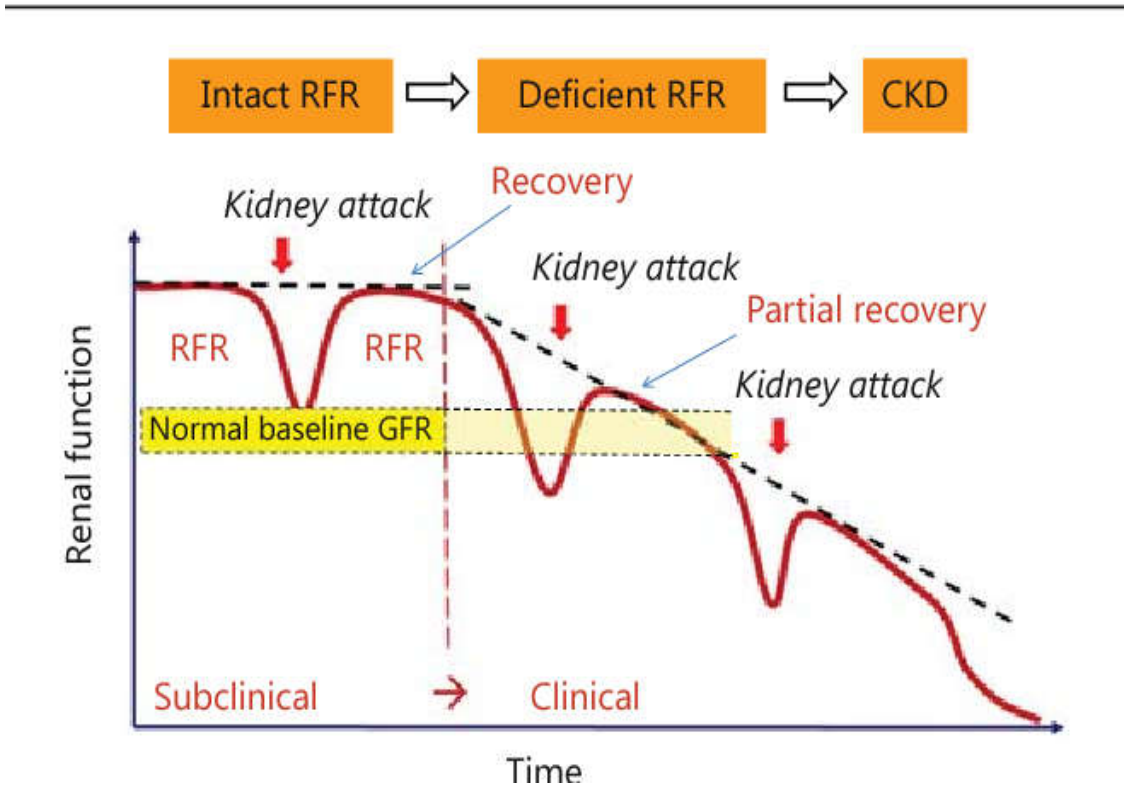




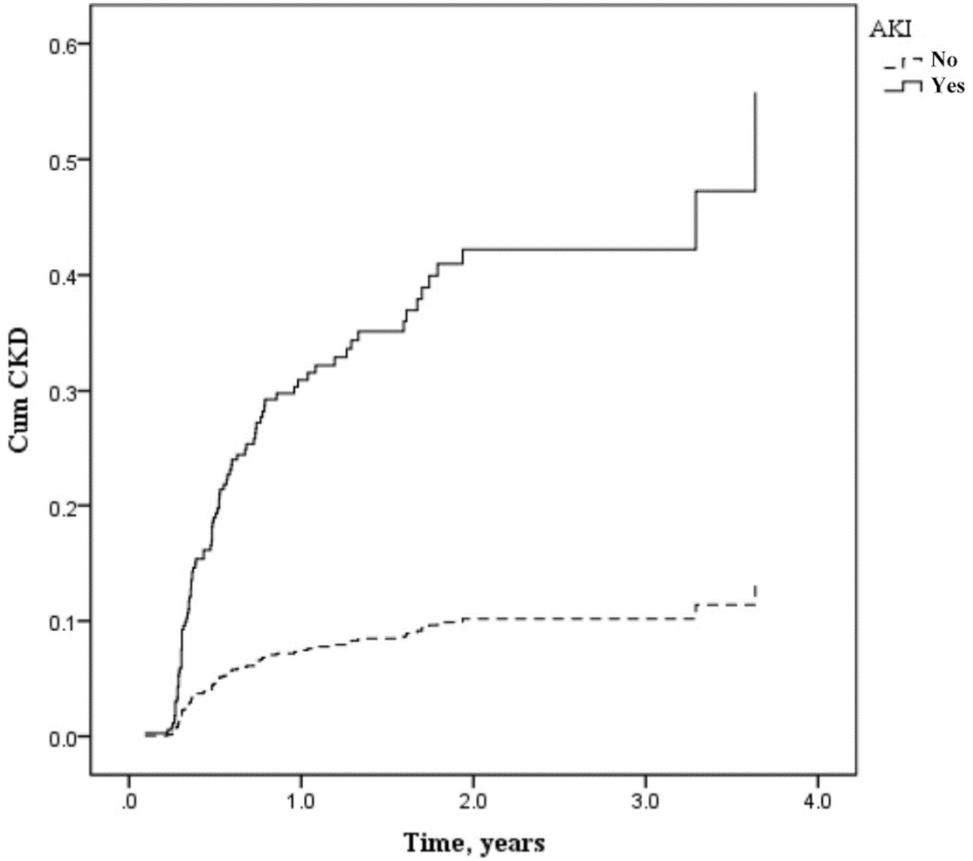


Kurzhagen, J.T., Dellepiane, S., Cantaluppi, V. *et al.* AKI: an increasingly recognized risk factor for CKD development and progression. *J Nephrol* **33,** 1171–1187 (2020).

AKI and future CKD



Sharma, A., Mucino, M.J., & Ronco, C. (2014). Renal Functional Reserve and Renal Recovery after Acute Kidney Injury. *Nephron Clinical Practice, 127*, 94 - 100.

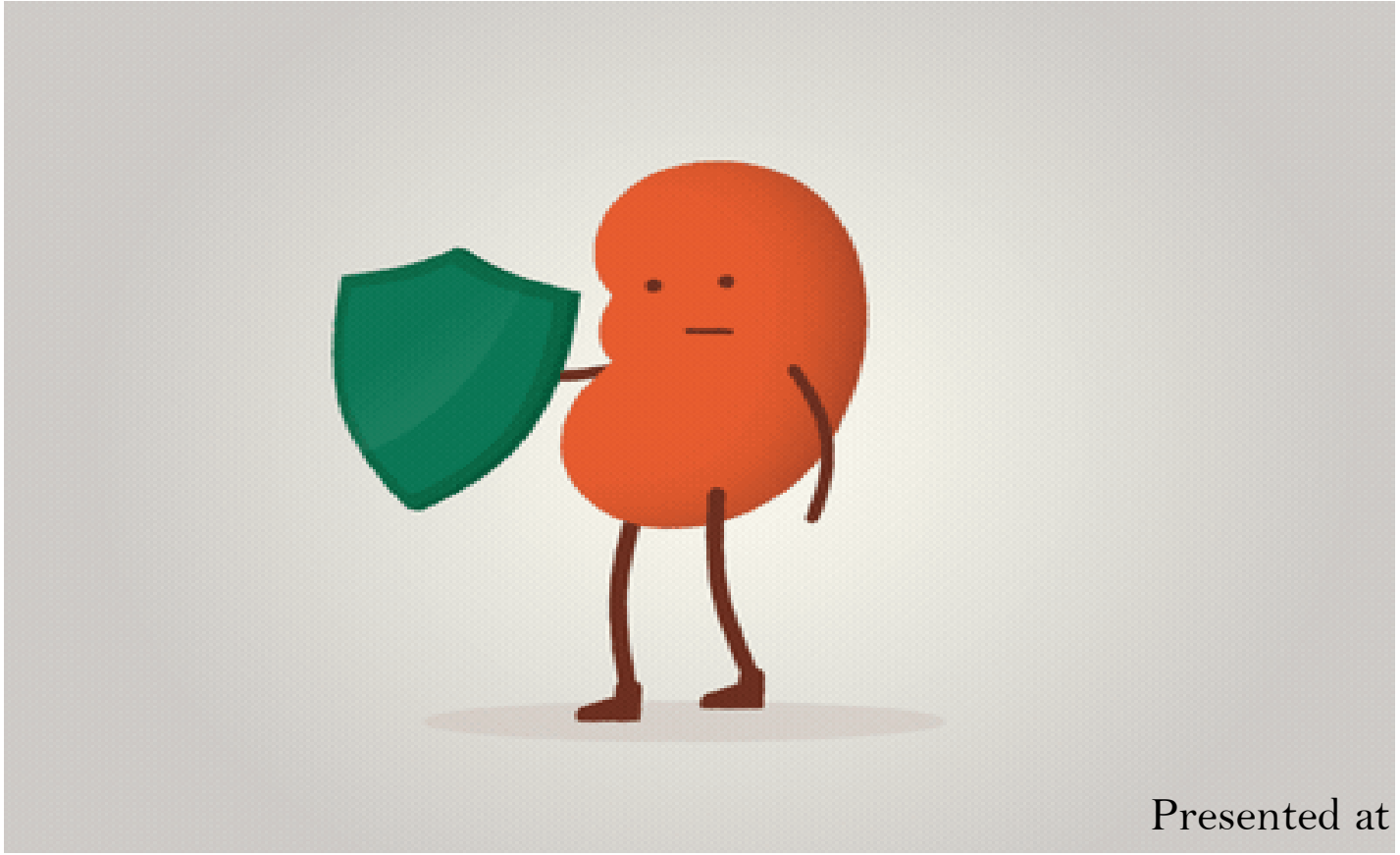


Xu, L., Li, C., Zhao, L. *et al.* Acute kidney injury after nephrectomy: a new nomogram to predict postoperative renal function. *BMC Nephrol* **21,** 181 (2020)

Outcomes in AKI

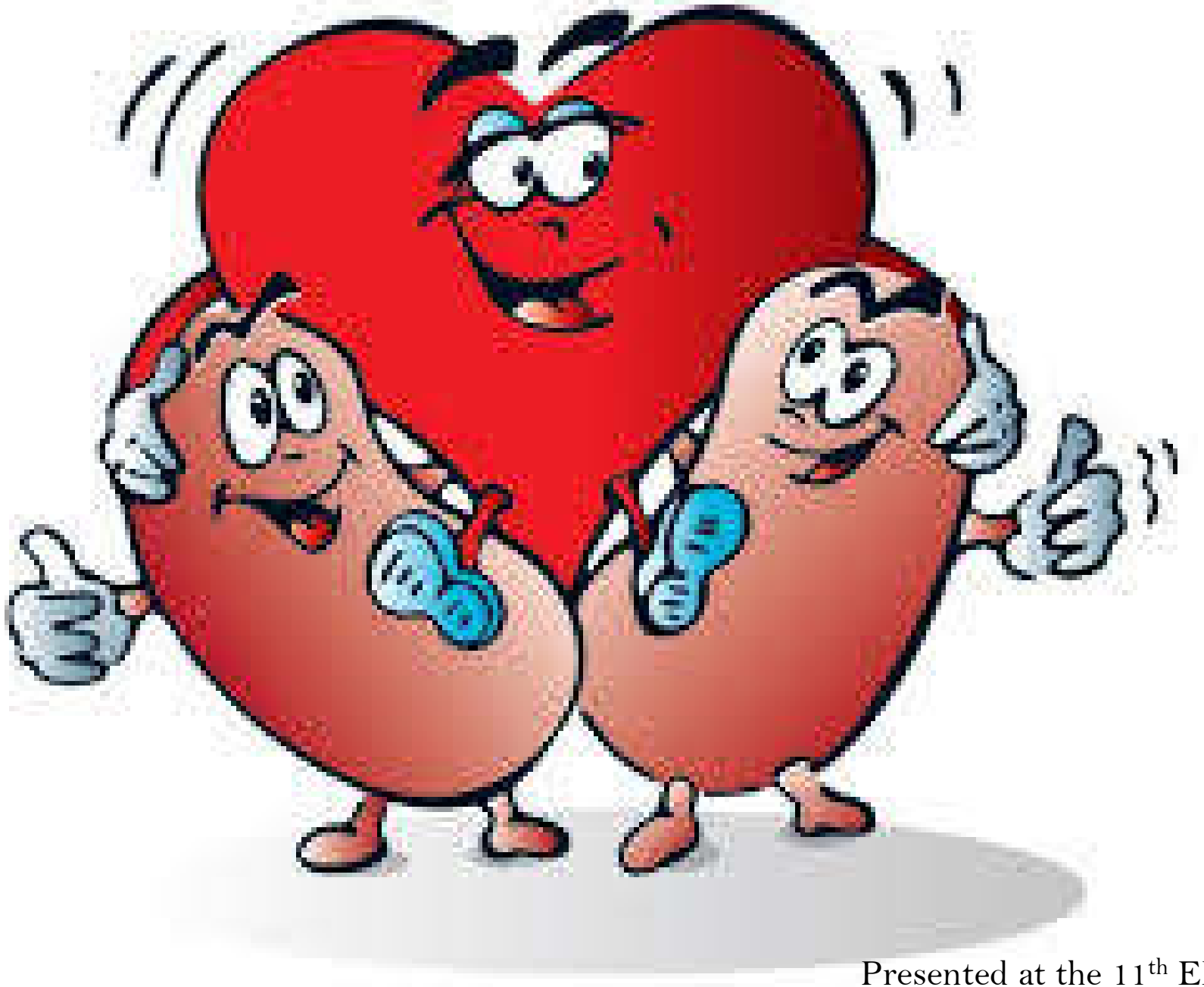
- Consequences not only during acute phase, but also in subsequent phases leading to
  - Progressive Acute and chronic kidney disease (CKD)
    - 16% acute kidney disease (AKD) children surviving severe malaria (Namazzi et al 2022)
  - End-stage kidney disease (ESKD) requiring dialysis or transplantation
- Mortality and morbidity remain high in AKI
  - Suggests current diagnostic and therapeutic methods are suboptimal
    - Ronco C, Rosner MH: Acute kidney injury and residual renal function. Crit Care 2012;16:144
  - Late recognition is likely to lead to delayed interventions and management with increased morbidity and mortality
- AKI mortality
  - 17.5% among children surviving severe malaria with AKD (Namazzi et al 2022)
    - 3.7% among those without AKD
  - 57.5% ICU with AKI requiring hemodialysis. Kwizera et al, 2016
  - 21% among sepsis-related AKI. Bagasha et al, 2015

Protect that kidney from drugs, sepsis, volume loss, obstruction, toxins……
Let it have the best smile, remove any offenders as early as possible



Conclusion

- AKI commonly occurs
- An independent risk factor for morbidity and mortality
- Prevention is critical to improve outcomes
- Use available clinical assessment and tests to detect those at risk of AKI as early as possible and to prevent further damage
- Constitutive integration and application of assessment tools and multidisciplinary team approach (NRRT) is critical to success
- Involve the renal team early



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