



Preventing AKI in Cardiac Surgery

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DISCLOSURES

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KDIGO

Our old standard protocol for patients with no creatinine rise on POD #1

- Patients maintained on vasopressors and inotropes prn to keep MAP >65 and CI >2.0
- Full dose potentially nephrotoxic medications (antibiotics, ACE-I's, ARB's)
- High threshold for blood transfusion (no transfusions for HCT > 21)
- Maintain > 30 cc/hr of urine output with a combination of Lasix and fluids (often at the same time)
- Swan or minimally invasive (FloTrac) monitor, central line and arterial lines, and Foley all removed and patients transferred to telemetry the morning after surgery.

LIMITATIONS:

- Serum creatinine has been shown to be a lagging indicator of AKI development and it is easily influenced by many factors, including sex, muscle mass and other medications.
- Urine output is monitored in most critical care settings, however, the ability of urine output to predict subsequent AKI complications after cardiac surgery is limited.

KDIGO VERSUS STS DEFINITION OF AKI

Section 2: AKI Definition

- 2.1.1: AKI is defined as any of the following (*Not Graded*):
- Increase in SCr by ≥ 0.3 mg/dl (≥ 26.5 μ mol/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
 - Urine volume < 0.5 ml/kg/h for 6 hours.

2.1.2: AKI is staged for severity according to the following criteria (Table 2). (*Not Graded*)

Table 2 | Staging of AKI

Stage	Serum creatinine	Urine output
1	1.5–1.9 times baseline OR ≥ 0.3 mg/dl (≥ 26.5 μ mol/l) increase	< 0.5 ml/kg/h for 6–12 hours
2	2.0–2.9 times baseline	< 0.5 ml/kg/h for ≥ 12 hours
3	3.0 times baseline OR Increase in serum creatinine to ≥ 4.0 mg/dl (≥ 353.6 μ mol/l) OR Initiation of renal replacement therapy OR, In patients < 18 years, decrease in eGFR to < 35 ml/min per 1.73 m ²	< 0.3 ml/kg/h for ≥ 24 hours OR Anuria for ≥ 12 hours

Classifications of Loss and End-stage disease are beyond the current scope of follow-up. Code yes if the patient meets the highlighted RIFLE Failure criteria or if dialysis was newly required post op.

Risk (R) - Increase in serum creatinine level X 1.5 or decrease in GFR by 25%, or UO < 0.5 mL/kg/h for 6 hours

Injury (I) - Increase in serum creatinine level X 2.0 or decrease in GFR by 50%, or UO < 0.5 mL/kg/h for 12 hours, or decrease in GFR by 75%; UO < 0.3 mL/kg/h for 24 hours, or anuria for 12 hours

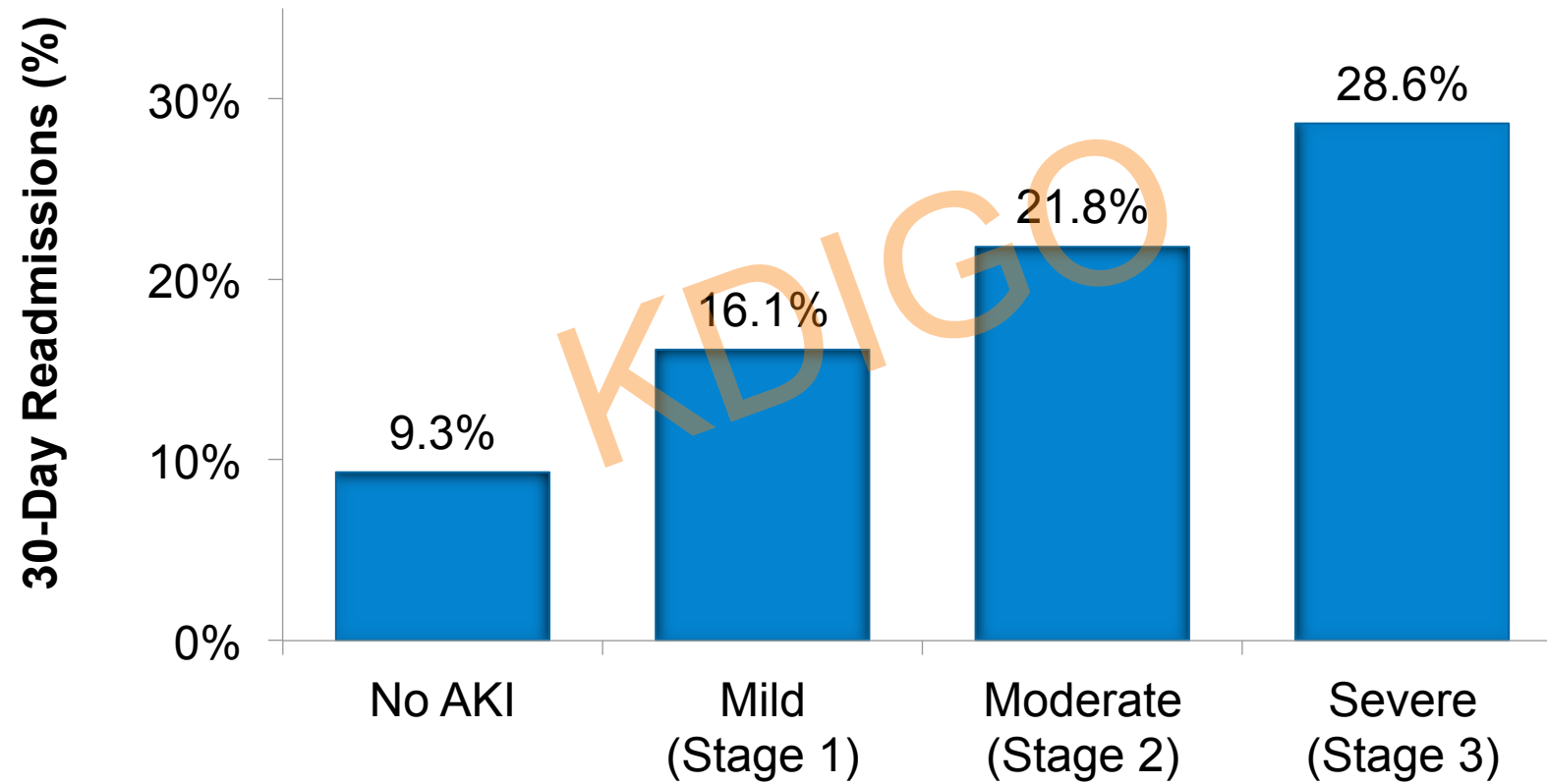
Failure (F) – Increase in serum creatinine level X 3.0, or serum creatinine $\geq$ mg/dL with at least a 0.5 mg/dL rise, or decrease in GFR by 75%; UO < 0.3 mL/kg/h for 24 hours, or anuria for 12 hours.

Loss (L) - Persistent ARF, complete loss of kidney function > 4 weeks

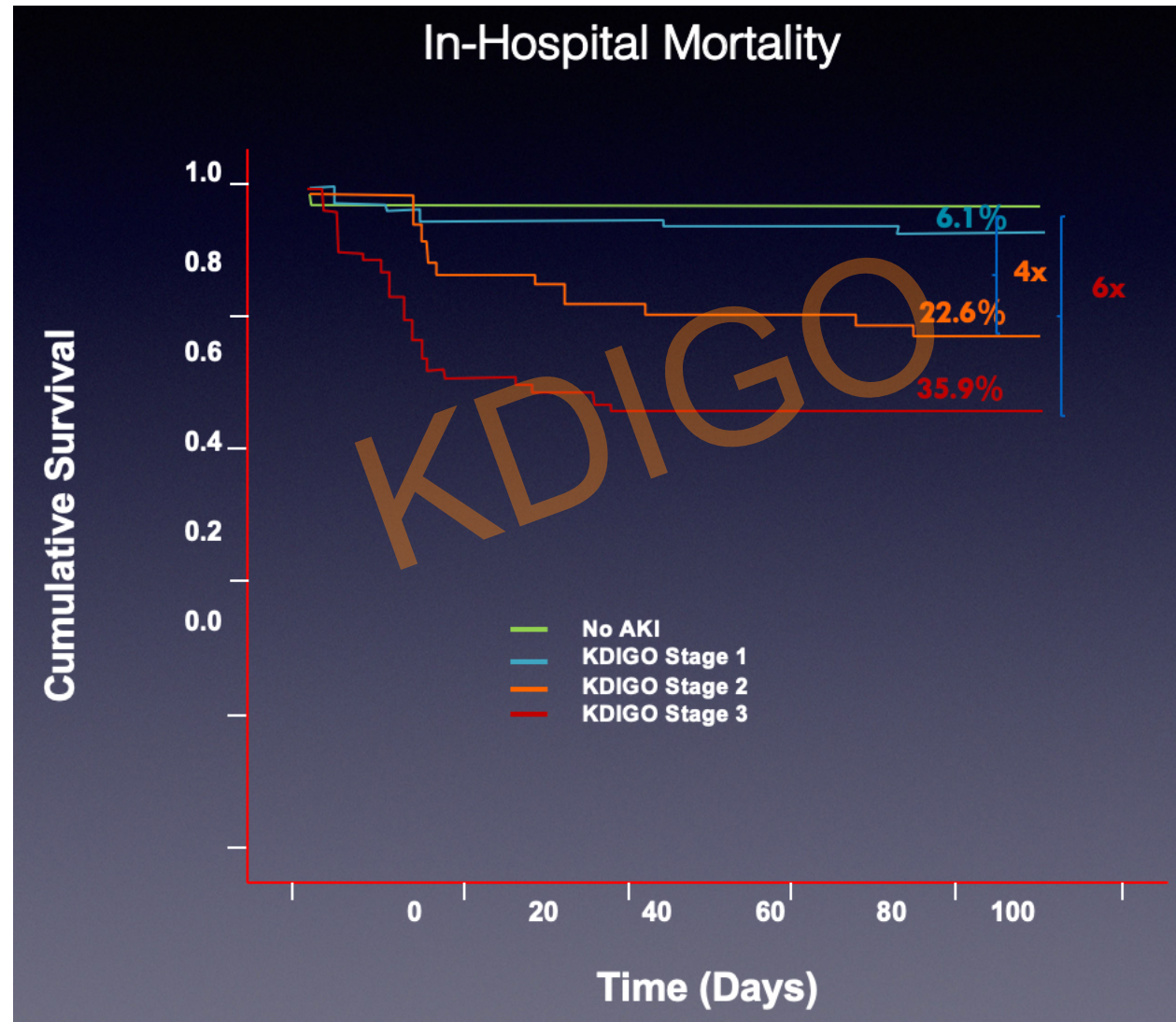
AKI PREVALENCE AFTER CARDIAC SURGERY

Type of CT Surgery	No AKI	Mild AKI (Risk)	Moderate AKI (Injury)	Severe AKI (Failure)
All Types	1708 (57%)	637 (22%)	386 (13%)	242 (8%)
Isolated CABG	901 (63%)	328 (23%)	136 (10%)	58 (4%)
Valve surgery	324 (51%)	151 (24%)	99 (15%)	66 (10%)
Aortic surgery	213 (45%)	86 (18%)	92 (19%)	84 (18%)
Thoracic surgery	268 (67%)	63 (16%)	49 (12%)	21 (5%)
Heart transplant	2 (6%)	9 (26%)	10 (29%)	13 (38%)

READMISSION RATES



REDUCED SHORT-TERM SURVIVAL



30-DAY MORTALITY INCREASES

J Am Soc Nephrol 15: 1597–1605, 2004

Minimal Changes of Serum Creatinine Predict Prognosis in Patients after Cardiothoracic Surgery: A Prospective Cohort Study

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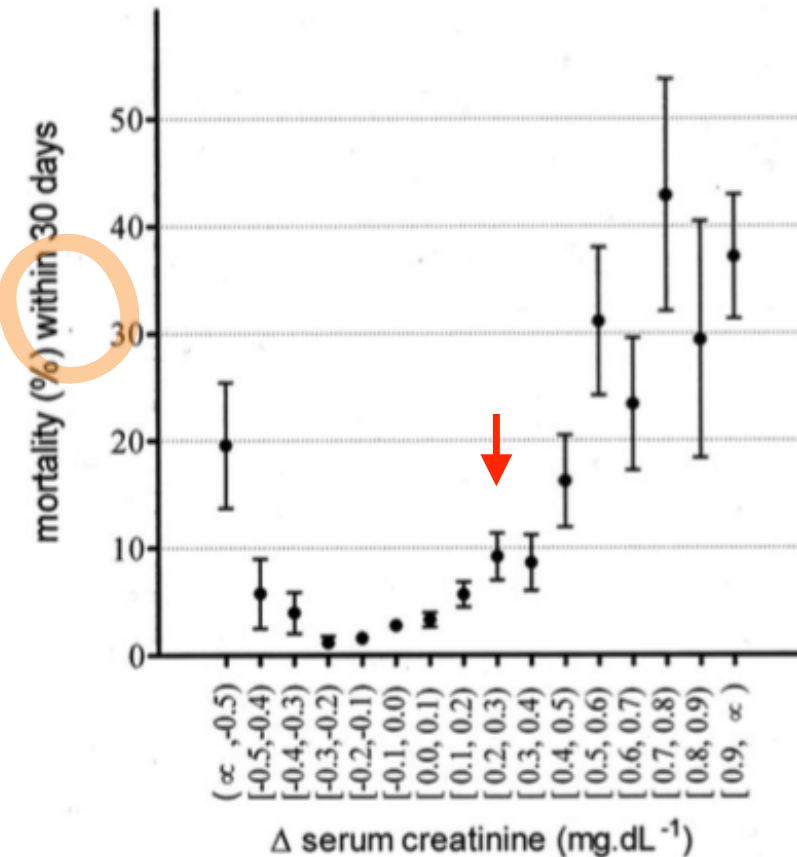
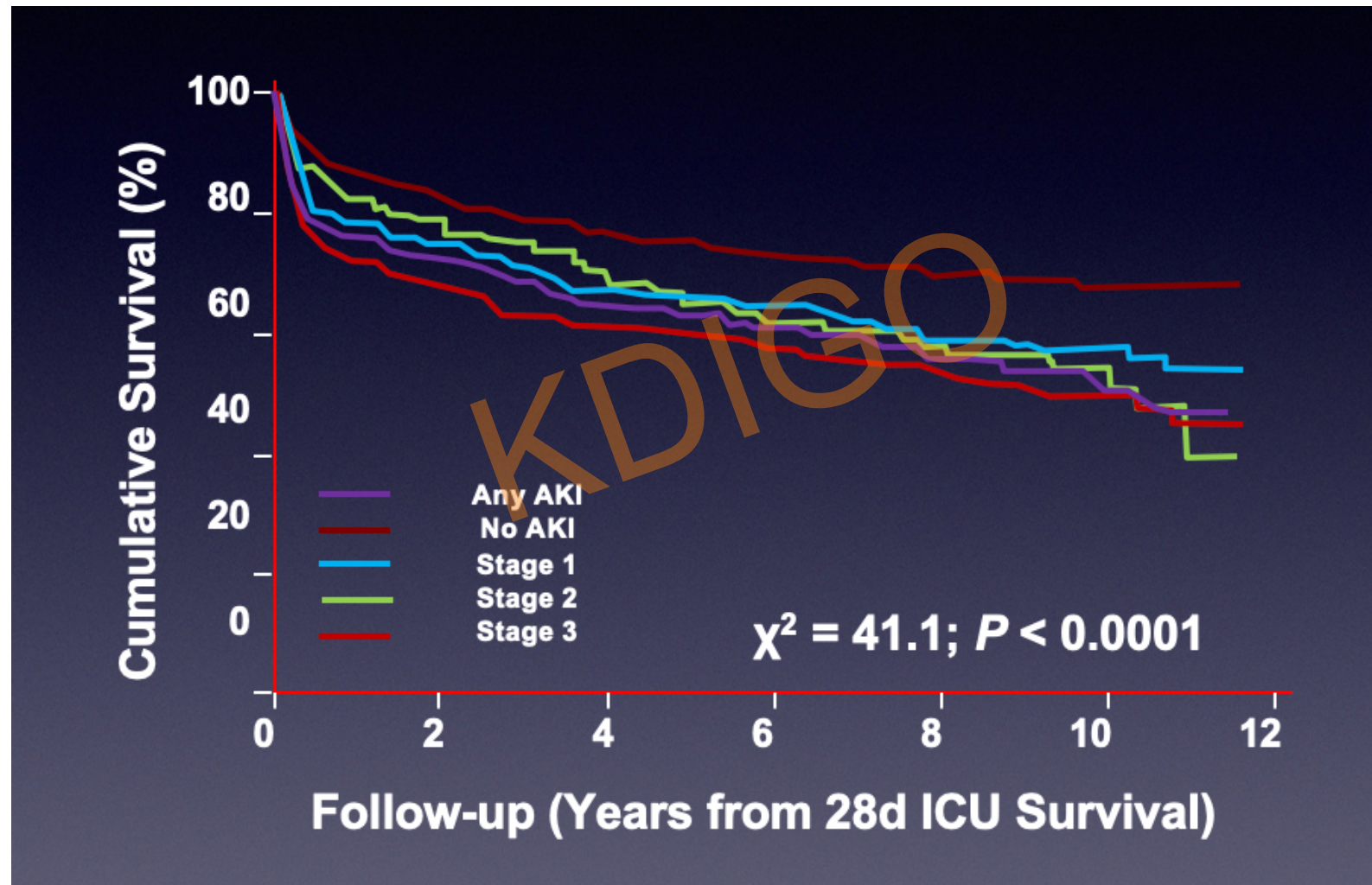


Figure 1. Thirty-day mortality and change in serum creatinine (Δ Crea) within 48 h after cardiac surgery. Distribution of Δ Crea (top) and mortality rates calculated for intervals of Δ Crea 0.1 mg/dl. Data are presented as mean $\pm$ SEM.

LONG-TERM SURVIVAL



THE AKI EFFECT

The Acute Kidney Injury Effect



THE ACUTE KIDNEY RESPONSE TEAM (AKRT)

- *So what do we do and how do we do it?*
- Developed a protocol to integrate the use of NephroCheck into a multidisciplinary Acute Kidney Response Team (AKRT) to potentially reduce AKI development, severity and the number of patients who need dialysis.
- Designed a stepped alarm system for surgeons, advanced practitioners, nephrologists, critical care physicians and nurses that starts with the drawing of the urinary biomarker at 5:30 am the morning.

Our Multidisciplinary Approach to Reduce AKI

- Cardiac Surgeons
- Nephrologist
- Cardiologist
- Advanced Practitioners
- Pharmacist
- Critical Care Nurses



POCKET CARDS



THE NEPHROCHECK TEST 2.0 (Feb 2019)

Intended to aid in assessing the risk of moderate to severe acute kidney injury (AKI)

WHO TO TEST

All cardiac surgery patients on post-op day 1 at 05:30

WHO NOT TO TEST

Pre-op creatinine >2, on dialysis or received methylene blue

STAGES OF ACUTE KIDNEY INJURY (AKI)

	Serum Creatinine	Urine Out
2	Increase of 2.0 – 2.9 x baseline	<0.5 ml/kg/h for 12 hours
3	Increase of >3x baseline or increase of <u>SCr</u> to >4mg/dL or initiation of RRT	<0.3 ml/kg/h for 24 h or anuria for 12 h

WHEN & HOW TO TEST

1. Pt meets test inclusion: at 0530 POD1 collect **fresh urine** specimen (at least 10 ml)
2. **Results** will show up in CIS chemistry section under urine miscellaneous – click for value range. Lab will report results in time for HVCC 08:00 team rounds

AKI ACTION PLAN (on back of card)

NC/ACUTE KIDNEY RESPONSE TEAM (AKRT) 2.0		
NEG <0.3	LOW (+) 0.3 -0.7	HIGH (+) >0.7
FAST TRACK	TELE UNIT @ 4PM	ACTIVATE AKRT
Remove Foley, arterial line, central line. Transfer to telemetry if meeting all other criteria (Cl/HR/Resp. <u>fxn</u>) liberal diuretics.	Keep Foley and monitor hourly UO until afternoon rounds. Transfer to telemetry (after 4PM) if all other transfer criteria are met (Cl/HR/Resp. <u>fxn</u>) and no oliguria treatment was required.	Keep Foley and monitor hourly UO. Maintain hemodynamic monitoring.
May use: ARBs/ACE-I, Toradol prn (if pre-op GFR>60) Consider holding diuretics if Toradol given.	AVOID NEPHROTOXINS NSAIDs, ARBs/ACE-I, <u>Vanco/Gentamycin</u> Transfusion threshold Hgb <7.0 unless oliguric.	AVOID NEPHROTOXINS NSAIDs, ARBs/ACE-I <u>Vanco/Gent</u> Renal dosing of medications
Transfusion threshold Hgb <7.0 Check <u>SCr</u> daily	IF PT BECOMES OLIGURIC: (UO <.5 cc/kg/hr X 3 hours) activate AKRT/Nephrology consult. Use lactated ringers boluses if CVP<8; PAD<14; Hold Lasix unless pulmonary edema. Repeat NC in 24hr	Goal directed therapy (keep PAD>14 with LR, No diuretics unless PAD>20 or CHF), reassess transfusion threshold. CI >2.5, SBP>130. Monitor SVO2, Echo if <55% Nephrology Consult Repeat NC in 24hr

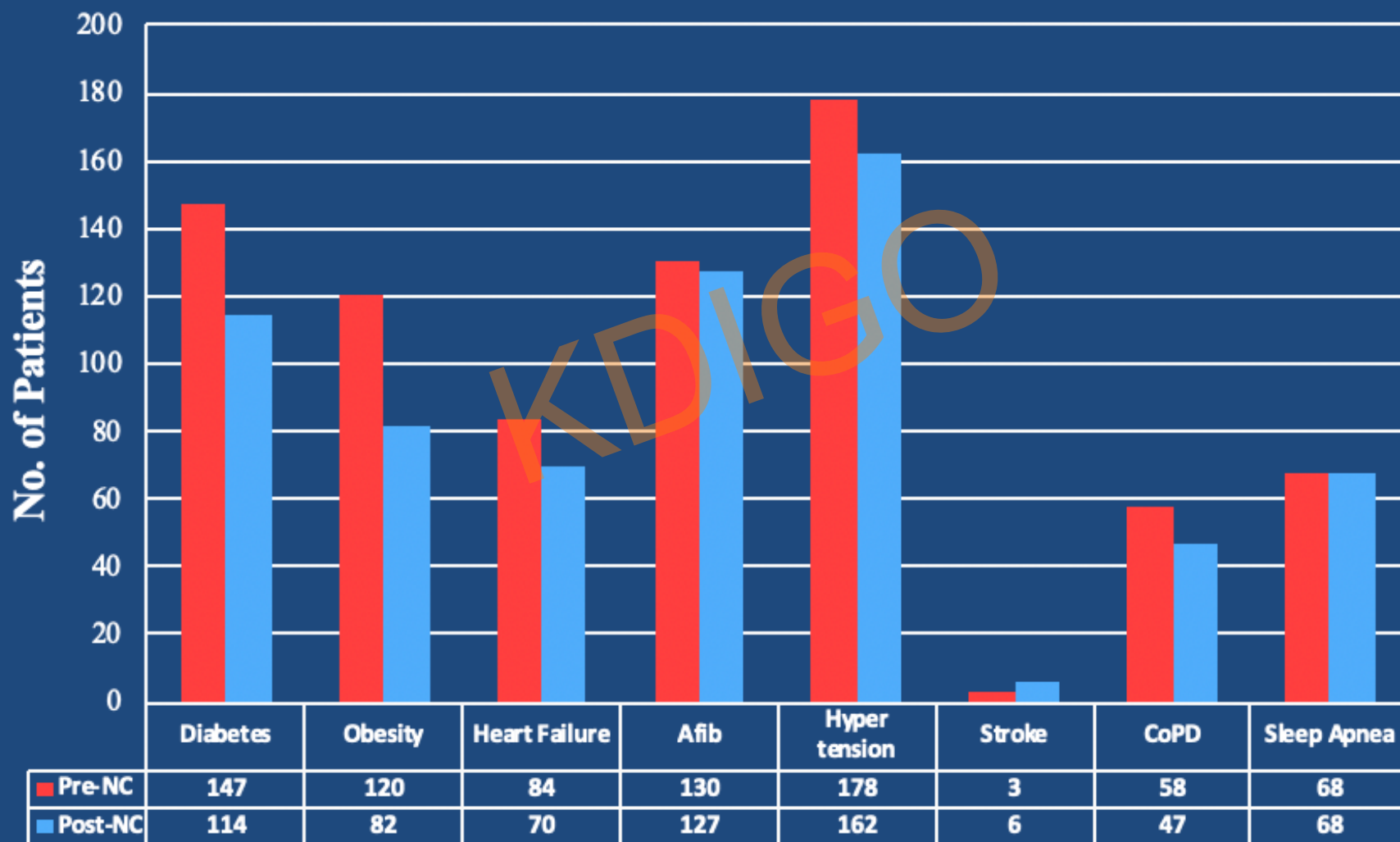
ISOLATED CABG PATIENTS (PRESENTED AT ASN)

Sample Size		
Exclusion Criteria	Pre- NC (Initial N = 302)	Post NC (Initial N = 274)
Patient with Baseline <u>Scr</u> >2 (CKD & ESRD)	17	19
Final Sample Size	285	255

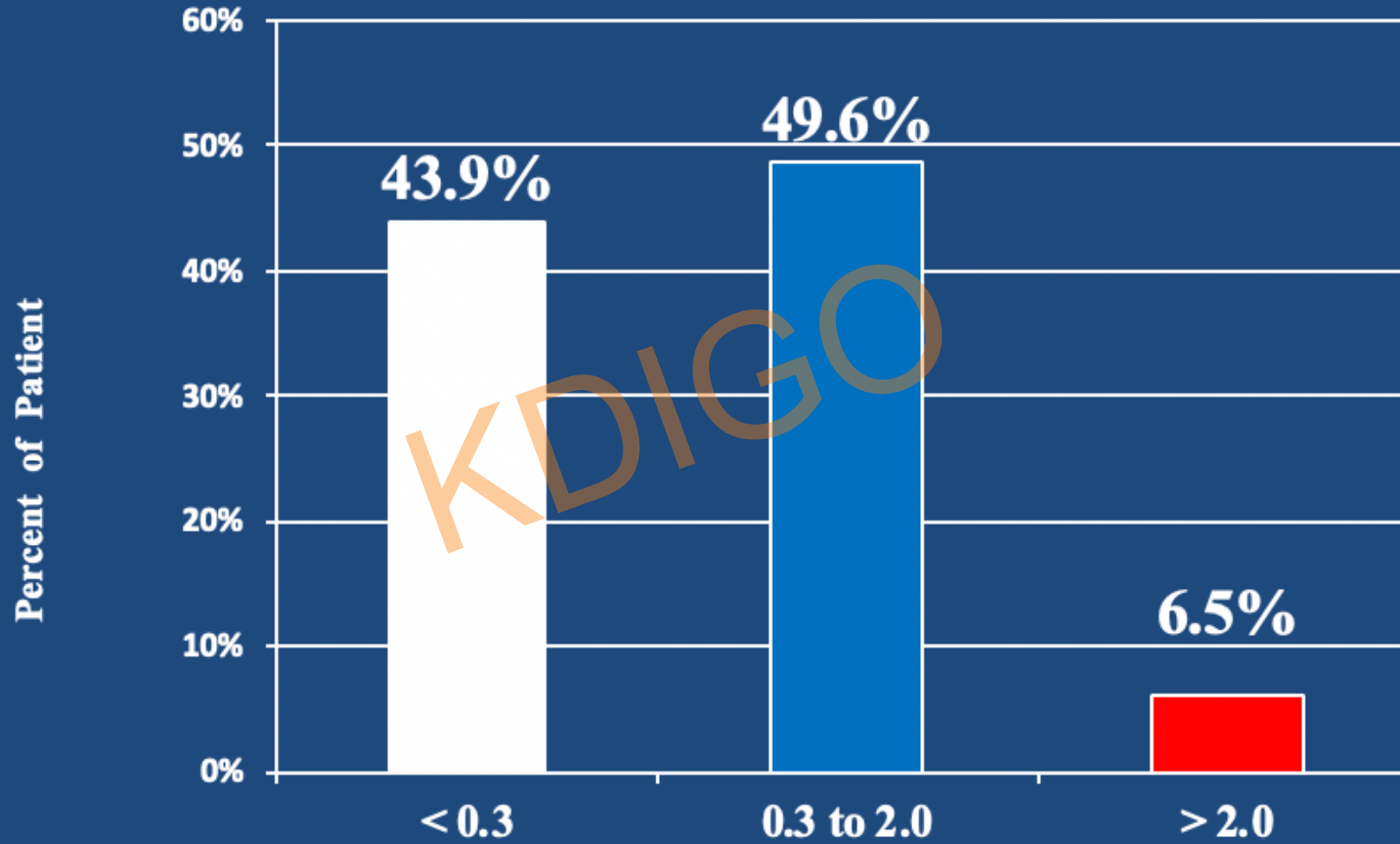
Demographics

	Pre-NC (Count = 302)	Post-NC (Count = 274)
Gender		
Female	74	53
Male	228	221
Age Group		
Under 50	14	17
50's	60	47
60's	105	97
70's	99	89
80's	24	24
Race		
American Indian or Alaska Native	1	1
Asian	2	3
Black or African American	4	4
Hispanic	26	27
Unknown	12	12
White	257	227

Comorbidity

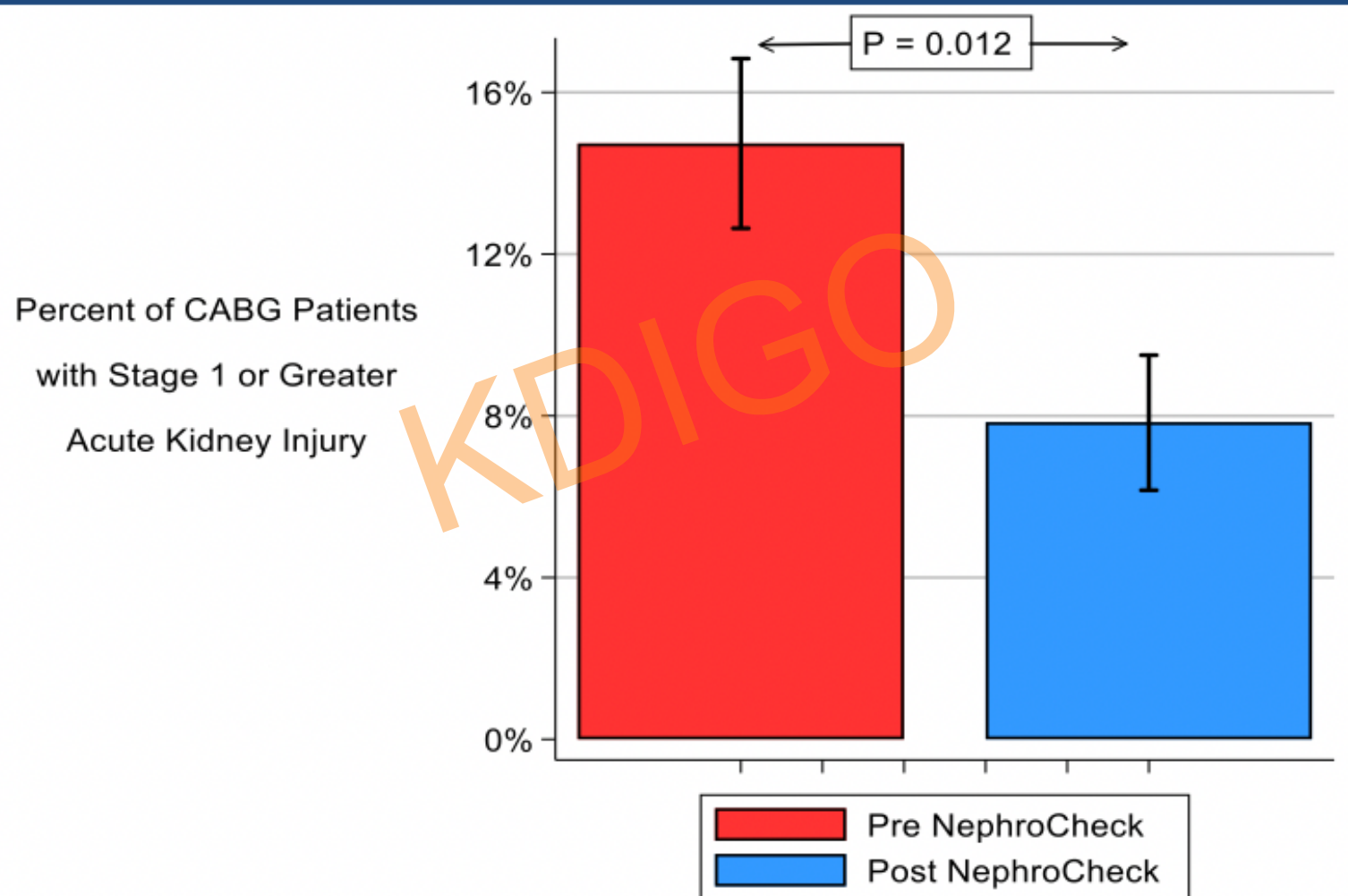


NephroCheck® Results

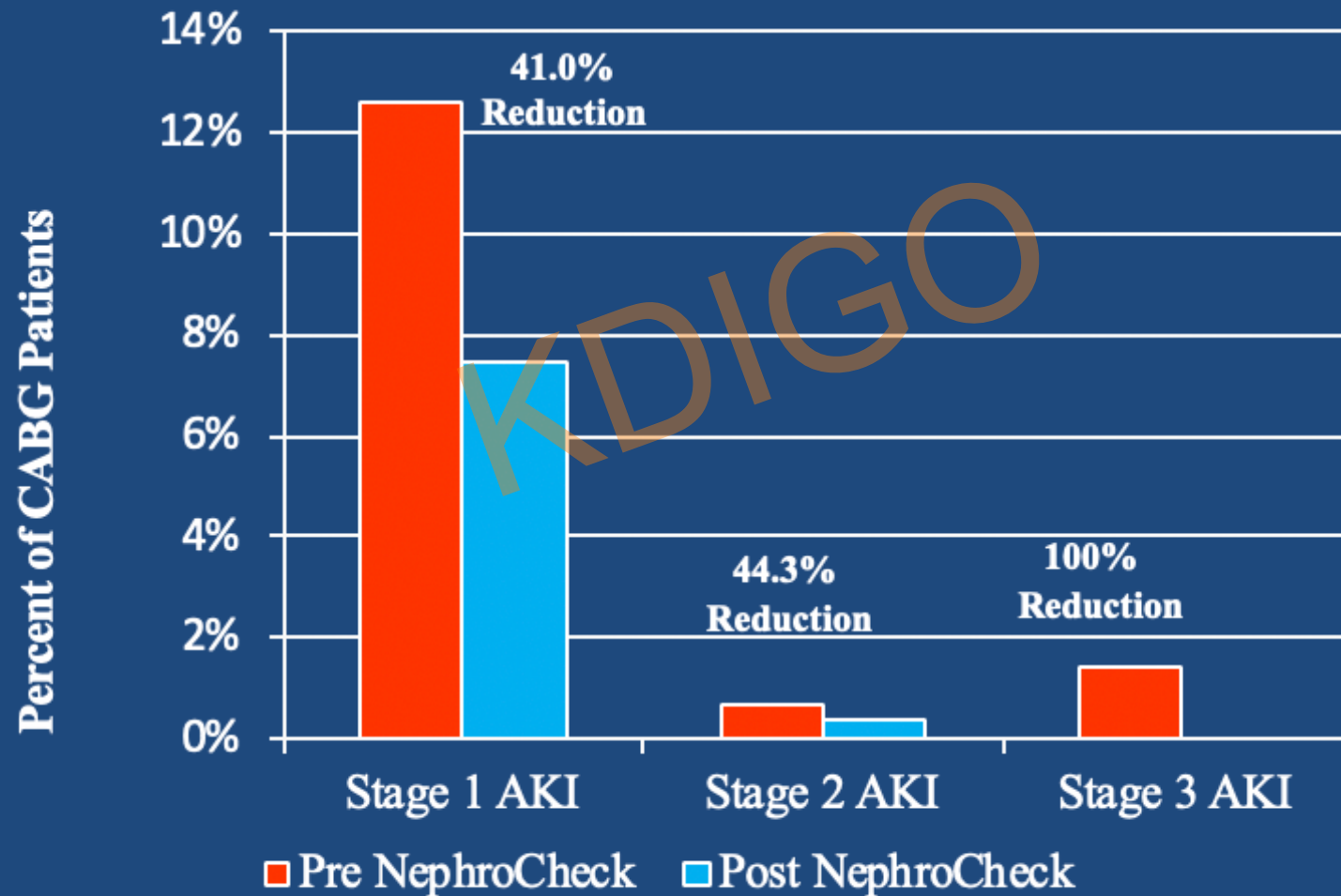


NephroCheck Value

AKI Results (all stages combined)



AKI Results by KDIGO Stage



Length of Stay

Variable	Pre-NC Mean (SD)	Post NC Mean (SD)	P-Value
Post-Surgical LOS	7.8 (4.8)	7.8 (6.6)	0.90

MOST COMMON INTERVENTIONS

- Avoiding over-diuresis on POD #1
- Discontinuing nephrotoxins.
- Raising the PAD pressure to 14-16 mm/Hg with balanced crystalloid.
- Instituting inotropes for depressed cardiac function to keep $CI > 2.5$ & $SBP > 130$.
- Prolonging hemodynamic monitoring.
- Increasing the frequency of urine output monitoring.
- Obtaining an early nephrology consultation.

FURTHER THOUGHTS....

- As the negative predictive value (NPV) with a NC threshold of 0.3 was 100%:
 - These patients may be candidates for liberal early use of potentially nephrotoxic agents such as: aggressive diuresis, ACE-I's, ARB's, Antibiotics, Toradol, etc
- Is the “positive NC” value of .3 too low? (Too many false negatives)
- A higher positive value (i.e. 0.7) may reduce “false positives” without significantly compromising patient safety.

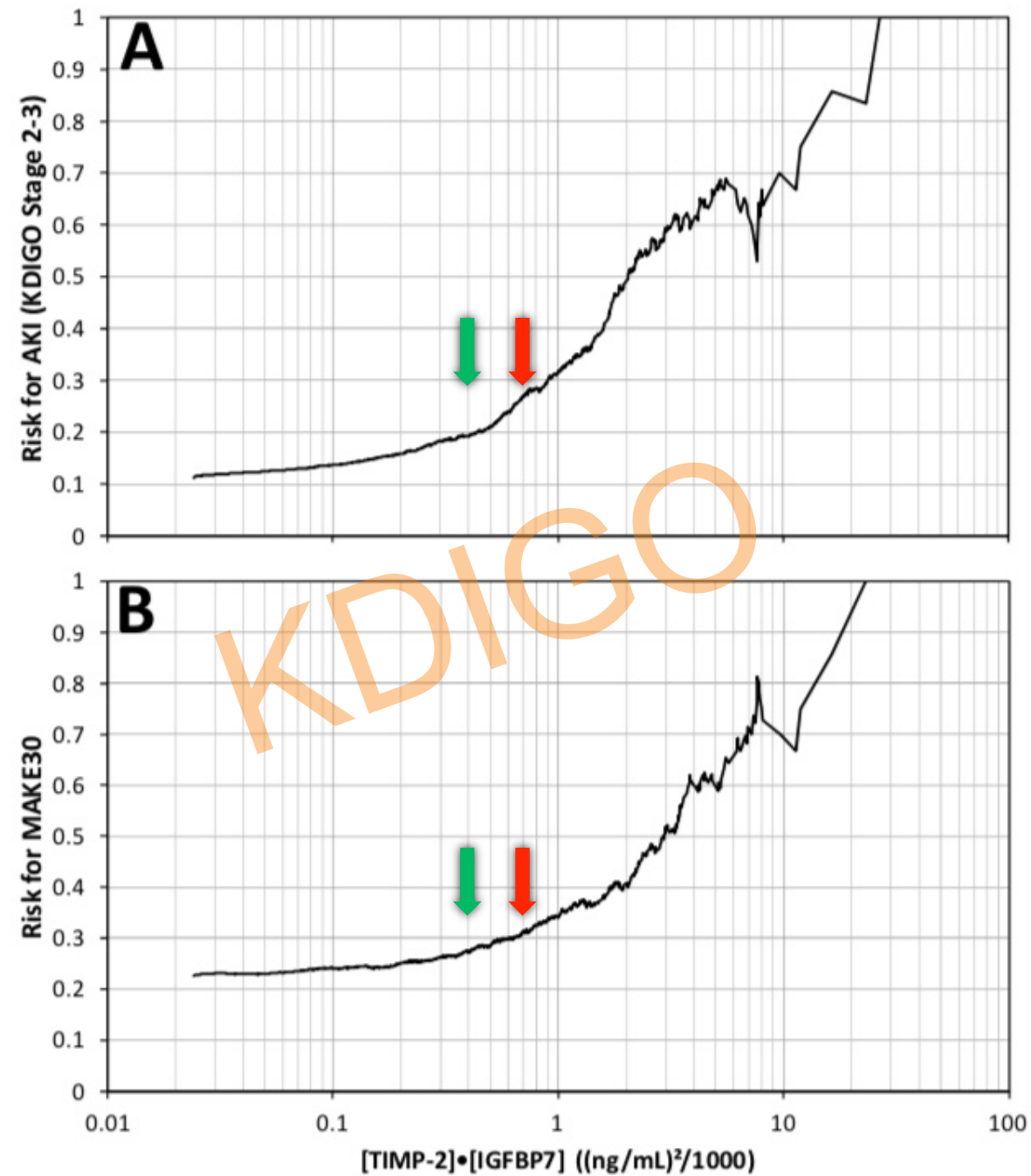


Figure 4 Risk for KDIGO stage 2 to 3 AKI (A) and MAKE₃₀ (B) as a function of urine [TIMP-2]•[IGFBP7]. Risk at each [TIMP-2]•[IGFBP7] value :

CONCLUSIONS

- An Acute Kidney Response Team (AKRT) triggered by NephroCheck and implementation of AKI stress modulators reduced the progression to AKI.
- The success of the AKRT is related to the successful formation and coordination of a multidisciplinary team.
- Future research is needed to determine the optimal NephroCheck threshold to trigger the AKRT team.

ERAS CARDIAC SOCIETY - MISSION

To optimize perioperative care of cardiac surgical patients through collaborative discovery, analysis, expert consensus, and dissemination of best practices.

- A research-based approach using selected pre-, intra-, and post-operative interventions in concert to optimize outcomes and the patient experience.
- ERAS programs have been a standard practice in Europe for many years and consist of up to 21 different components.
- These enhanced recovery programs have demonstrated significant reductions in LOS, blood loss, time to ambulation, and complications; and increases in patient satisfaction around pain.
- They and are being used in 95% of surgery patients in the UK.

We are a “Disruptive” Society

- Suggesting that standard accepted perioperative practices may be wrong:
 - Elective patients should be optimized with 4 weeks of prehab prior to surgery.
(Especially those with malnutrition, anemia, frailty, ETOH/smoking)
 - Ending preop dietary restrictions
 - Wire cerclage versus rigid sternal fixation
 - Ambulation restrictions
 - Chest tube management strategies
 - Increased ambulation and less dietary restrictions
- “Perioperative Medicine”
 - Includes preoperative period
 - May be **more** important to outcomes than the intraoperative component of CT Surgery
- What is Patient-Centered “Value”?