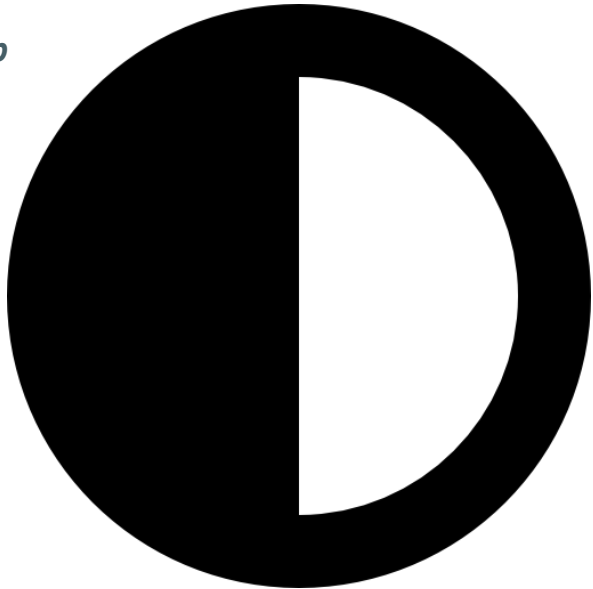# Eliminating Post-contrast Acute Kidney Injury in Patients with Advanced Kidney Disease: Guideline Adherence and Quality Improvement

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(LUMC, The Netherlands; 2021)

A single institution effort to analyze and improve guideline adherence regarding PC-AKI prevention.

Patients with an estimated eGFR <30 undergoing a contrast-enhanced CT-scan in the LUMC. **500 patients** with **713 CECT-scans** were included.

Main queries based on the previously quality indicators detailed in "Safe Use of Contrast Media":
- Do patients eligible for pre-/post-hydration (as described in the PC-AKI guidelines) receive hydration?
- Is kidney function (routinely) established both pre- and **post** contrast administration?

(statistical) analysis of these patients based on characteristics and variables as previously described in literature on PC-AKI (e.g. comorbidities, state of hydration, nephrotoxic medication).

Background

- "Contrast-induced Nephropathy" definition: Serum Creatinine increase of 25% or absolute increase of 0.5 g/dL from baseline.

- Assumed leading cause of acute renal failure in hospitalized patients

- Estimated incidence ranging from <1% to 30%

- Predisposing factors: DM, hypotension, nephrotoxic medication

- Challenges in Assessing Contrast-Induced Nephropathy

Current SOP
-Intravenous administration of **250mL 1.4% NaHCO3 one hour before** contrast administration with
- optional post-hydration consisting of **500mL NaHCO3** administered in **six hours after** contrast administration for patients with an eGFR below 30 ml/min/1.73m2.

- Recent pre-contrast KFA

- Post-contrast KFA between 2-7 days

Key Findings

- No cases were found where time between contrast-administration and pre-contrast KFA exceeded the absolute limit (365 days).

- Pre CA kidney function in cases involving acute kidney injury is routinely assessed before the imposed time limit with no registered outliers.

- Pre CA kidney function is adequately assessed in patients with stable CKD with few outliers.

Pre-Contrast KFA (N = 709)

Time between pre-contrast KFA and contrast administration (days)

Do patients eligible for pre-/post-hydration receive hydration? (N = 713)

Key Findings

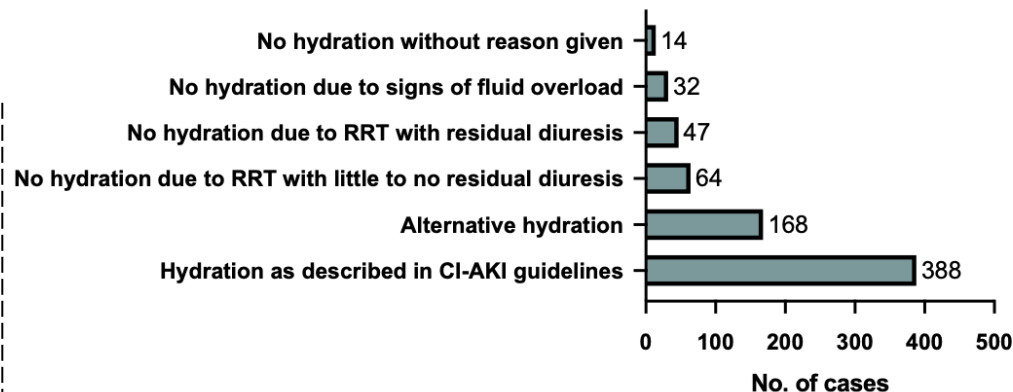Intravenous hydration given in **556 cases** (78% of total)

- Hydration as described in CI-AKI guidelines given in **347/556 cases** (70% of hydrated)

- Alternative hydration (e.g. not in addition to IV hydration with NaBic) given in **168 cases** (30% of hydrated, 24% of total)

Key Findings

No intravenous hydration given in **157** cases (23% of total)

- Hydration withheld due to RRT with no spontaneous diuresis in **64 cases** (40% of no hydration, 9% of total)

- Hydration withheld due to RRT with spontaneous diuresis in **47 cases** (30% of no hydration, 6% of total)

- Hydration withheld due to signs of fluid overload in **32 cases** (20% of no hydration, 4% of total)

- No reason given for withholding hydration in **14 cases** (9% of no hydration, 2% of total)

Hydrated vs. Unhydrated (N = 713)

Category	No. of cases
No hydration without reason given	14
No hydration due to signs of fluid overload	32
No hydration due to RRT with residual diuresis	47
No hydration due to RRT with little to no residual diuresis	64
Alternative hydration	168
Hydration as described in CI-AKI guidelines	388

No. of cases

Is kidney function established routinely post contrast-administration? (N = 713)

Key Findings

- Kidney function assessed between two and seven days in **497 cases** (70%)

- Forgoing KFA due to patient death or transition into EoL care between two and seven days in **35 cases** (5%)

- Forgoing KFA with no valid reason in **181 cases** (25%).

- Majority of missing KFA can be ascribed to outpatient cases (KFA between two and seven days in only **34%** of total outpatient cases as opposed to ER (**76%**) and inpatient (**95%**) cases.

**Kidney Function Assessment After Contrast-Administration (N = 713)**
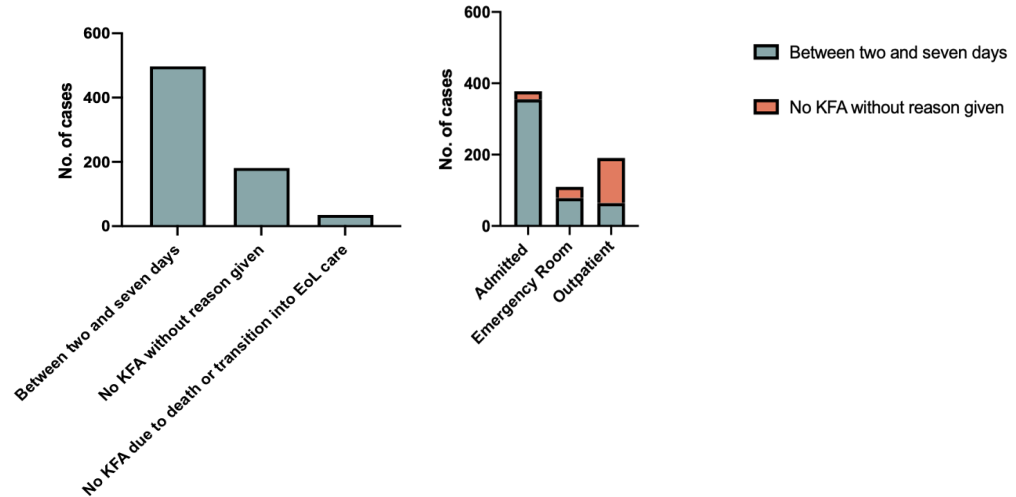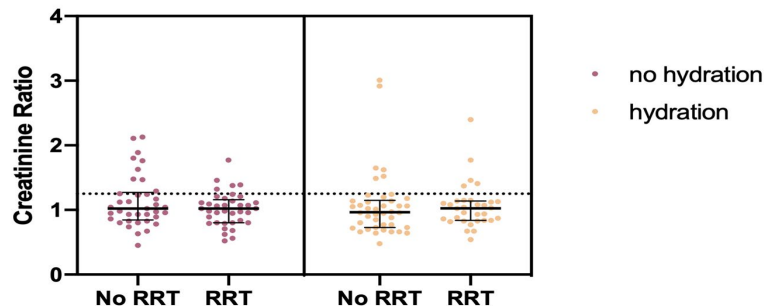

Key Findings

- In total, **117 cases** (17%) involved a kidney function deterioration fitting of the serum creatinine-based criteria of PC-AKI (SCr increase of at least 25% from baseline or absolute SCr increase of 0.5 mg/dl).

- Based on manual case review, a different etiology (e.g. dialysis-related or natural fluctuation, SIRS, hypovolemia, drug reaction, GvH) was deemed significantly more likely than PC-AKI in **91 cases** (77%).

- In total, PC-AKI was deemed a likely cause of kidney function deterioration in **27 cases** (of which **26** cases involved admitted patients (P 0.010).

Further analysis of cases deemed potential CIN based on Serum Creatinin Criteria (N = 117)
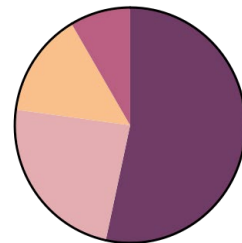
- ■ Decrease most likely due to dialysis-related or natural fluctuation, **N = 63 (53%)**
- ■ Alternative cause most likely (e.g. SIRS, hypovolemia, drug reaction, GvH), **N = 28 (24%)**
- ■ Contrast-induced nephropathy deemed likely cause of KF decrease, **N = 17 (14%)**

Creatinine Ratio (N = 148)

- no hydration
- hydration

Incidence of PC-AKI (N = 446)

Key Findings

- A "crude" comparison of outpatient and inpatient groups using Student's T Test, Pearson's Chi-Square test and Mann-Whitney U test for binomial, parametric, and non-parametric variables, respectively.

- Inpatient cases more frequently involved **AKI at baseline**, **unstable kidney functions**.

- The median time between CA and post CA KFA is significantly longer in the outpatient than in inpatient group.

- Interestingly, SCreat-based PC-AKI is similar in both groups, while "true" PC-AKI differs significantly.

- The proportion of intravenously hydrated patients significantly differs both in frequency and quality.

- Groups are not comparable at baseline (!)

	Outpatient cohort	Inpatient cohort	P value
No. of scans	105	341	N/A
Age (y)	69 (64-75)	66 (56-73)	**.000**
Body Mass Index (kg/m²)	26 (23-30)	26 (23-30)	.508
Sex: female	35 (33)	130 (38)	.523
History of CKD	104 (99)	202 (59)	**<.001**
Hydration conforming to guideline	87 (83)	203 (60)	**<.001**
Hydration not conforming to guideline	3 (3)	78 (22)	**<.001**
No hydration	15 (14)	60 (17)	.428
ΔsCr (pre-CA sCr – previous sCr)	10 (-20-32)	24 (-8-74)	**.002**
RRT	22 (21)	59 (17)	.396
Time between CA and post-contrast KFA (d)	8 (4-23)	2 (2-2)	**<.001**
eGFR prior to contrast administration	21 (12-26)	20 (12-25)	.347
sCr-based PC-AKI	19 (18)	73 (21)	.463
MCR-based PC-AKI	1 (1)	26 (8)	**0.010**

Propensity Score Matching

In total, 148 patients were matched using 1:1 propensity score matching (*FUZZY Extension for SPSS 26.0, IBM, Armonk, NY, USA*).

- As expected, the proportion of cases involving patients with signs of fluid overload **differed significantly** different between the two groups

- All other baseline characteristics were similar following matching.
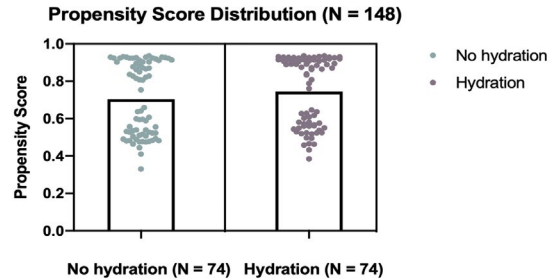
- After "double robust" correction using both propensity score matching and conditional logistic regression, ORs were established.

- Again, no statistically significant differences were found in any of the primary or secondary outcomes after correction.

- The width of the 95% CI-intervals can be ascribed to potential bias resulting from the relatively small sample size.

Propensity Score Distribution (N = 148)

- No hydration
- Hydration

No hydration (N = 74)   Hydration (N = 74)

	Unhydrated	Hydrated	Odds Ratio (95%-CI)	P value
No. of scans	74	74		
sCr-based PC-AKI	27 (36)	19 (26)	1.73 (0.360-8.141)	.498
MCR-based PC-AKI	6 (8)	4 (5)	3.403 (0.113-95.069)	.489
Death in 30 days after contrast administration	14 (19)	8 (11)	.758 (0.048-9.124)	.758
Emergent dialysis in 30 days after contrast administration	15 (20)	6 (8)	.078 (0.003-1.946)	.121

PC-AKI (based on SCr criteria) and PC-AKI (Manual Case Review) were separately analyzed using conditional logistic regression due to multicollinearity

Protocol recommendations

- Be critical of what can be considered "unconfounded" PC-AKI

- Know which factors contribute to deviation from the current protocols and consider adjusting your protocol accordingly

- Consider kidney function assessment a shared responsibility

- Include specific guidelines for patients undergoing dialysis with residual diuresis based on expert opinion