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Data Article

Magna Graecia transcatheter aortic valve implantation registry: data on contrast medium osmolality and postprocedural acute kidney injury

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ABSTRACT

A comprehensive description of baseline characteristics, procedural features and outcomes related to the development of acute kidney injury (AKI) after transcatheter aortic valve implantation (TAVI) is reported in our research paper (*Impact of contrast medium osmolality on the risk of acute kidney injury after transcatheter aortic valve implantation: insights from the Magna Graecia TAVI registry. Int J Cardiol. DOI: 10.1016/j.ijcard.2020.12.049*). Three Italian heart centers were involved in this multicentric observational study.

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Keywords:
Transcatheter aortic valve implantation
Acute kidney injury
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Osmolality
Risk factor
Mortality
Multivariate analysis

Between March 2011 and February 2019, a total of 888 patients underwent TAVI; according to the inclusion and exclusion criteria, 697 patients were included in the post-hoc analysis. This Data in Brief paper aims to report demographic, clinical, laboratory, echocardiographic, intraprocedural, periprocedural, postprocedural and follow-up data; all of them were prospectively collected from each patient's health record, whereas the analysis was performed retrospectively. Targets of this data analysis were: 1) to evaluate the impact of contrast medium (CM) osmolality on TAVI-related AKI; 2) to identify the most of risk factors involved in the development of such complication, and consequently in the occurrence of 1-year mortality; 3) to estimate the impact of CM osmolality on AKI in specific patient subgroups.

Specifications Table

Subject	Cardiology and Cardiovascular Medicine
Specific subject area	Structural Interventional Cardiology, Valvular Heart Disease
Type of data	Table, Figure
How data were acquired	Each of the participating centers is maintaining a prospective database of all TAVI patients treated at that center, using the same dedicated archiving software.
Data format	Raw, analysed
Parameters for data collection	Among all consecutive patients undergoing TAVI, those ones died intraprocedurally, or with chronic kidney disease (CKD) requiring hemodialysis, or with recent pre-TAVI acute renal failure, or who did not receive any CM during TAVI, or who received CM, nephrotoxic agents and/or n-acetylcysteine within 5 days prior and/or 72 h after TAVI as well as those ones whose serum creatinine (SCr) level before TAVI was not available, were excluded.
Description of data collection	All baseline demographics, clinical, laboratory, electro- and echocardiographic, intra- and postprocedural data, and hospital complications and outcomes were prospectively collected from each patient's health record, whereas the analysis was performed retrospectively. Pre-TAVI mortality risk scores were retrospectively calculated online, using the official calculators. Data on events occurring after discharge and re-hospitalizations for all causes were derived from follow-up outpatient visits or by telephonic interview with the patient, the relatives or the responsible physicians.
Data source location	• Policlinico University Hospital, Bari, Italy • "Santa Maria" Clinic, Bari, Italy • "Montevergine" Clinic, Mercogliano, Italy
Data accessibility	With the article (raw data are available upon individual request)
Related research article	F. Iacovelli, A. Pignatelli, A. Cafaro, E. Stabile, L. Salemme, A. Cioppa, A. Pucciarelli, F. Spione, F. Loizzi, E. De Cillis, V. Pestrichella, A.S. Bortone, T. Tesorio, G. Contegiacomo. Impact of contrast medium osmolality on the risk of acute kidney injury after transcatheter aortic valve implantation: insights from the Magna Graecia TAVI registry. Int J Cardiol. DOI:10.1016/j.ijcard.2020.12.049

Value of the Data

TAVI-related AKI is a common complication, and associated with adverse outcomes and mortality. The relationship between CM osmolality and AKI has not been established in patients undergoing TAVI yet. Our dataset aims to evaluate new predictors for both AKI and 1-year mortality after TAVI, as well as to identify the setting of patients that mostly benefits of a kind of CM according to its osmolality.

Considering the progressive expansion of TAVI indication to low surgical risk patients too, these data are surely beneficial for the whole interventional cardiology community: choosing the CM based on its osmolality and tailoring such choice according to patient's TAVI-related AKI risk could be very important.

Our data might promote the development of larger, long-term, randomized clinical studies to confirm the correlation between CM osmolality, rather than other physicochemical properties, and the incidence of TAVI-related AKI, as well as the advantages of iso-osmolar CM (IOCM) administration in specific subgroups of patients.

1. Data Description

This dataset gives relevant details and explanations about the enrolled population/procedures and statistical analysis techniques. The data are expressed as figures and tables, and are available upon individual request.

Fig. 1 shows the study flow-chart. Fig. 2 puts in evidence the variations of main renal function parameters, i.e. creatinine clearance (CrCl) and estimated glomerular filtration rate (eGFR), from baseline to both postprocedural and hospital discharge values, according to CM osmolality. After subgroup analysis, Fig. 3 illustrates the differences in the incidence of AKI between IOCM and low-osmolar CM (LOCM) in high and low AKI risk patients, stratifying them according to their age, operative mortality risk scores, amount of dye received as well as to the presence of diabetes, anemia, coronary artery disease (CAD) history, CKD, chronic or persistent atrial fibrillation and left ventricular ejection fraction (LVEF) $\leq$35%.

Table 1 describes the baseline characteristics (not included in the main paper) and procedural features of the study population according to AKI incidence and CM osmolality (*t*-test, Mann Whitney's *U* test, Fisher's exact test or $\chi 2$ test). Thanks to univariate and multivariate logistic regression (and logit interaction test), Table 2 points out AKI and 1-year mortality predictors, and their interactions. Table 3 highlights once again the differences in the incidence of TAVI-related AKI between IOCM and LOCM in the several patients' subgroups: such analysis has been performed with *t*-test, Mann Whitney's *U* test, Fisher's exact test or $\chi 2$ test too.

2. Experimental Design, Materials and Methods

2.1. Study population

This prospective multicentric observational study [1] assessed all consecutive patients who underwent TAVI at 3 Italian heart centers (Policlinico University Hospital of Bari, "Santa Maria" Clinic of Bari and "Montevergine" Clinic of Mercogliano) involved into the "Magna Graecia" TAVI registry. Such all-comers study protocol was firstly approved by the Independent Ethical Committee (study number 6244) of the Policlinico University Hospital of Bari, Italy, in accordance with the Declaration of Helsinki.

Between March 2011 and February 2019, a total of 888 patients underwent TAVI; according to the inclusion and exclusion criteria from such post-hoc analysis, the final study population consisted of 697 patients (Fig. 1).

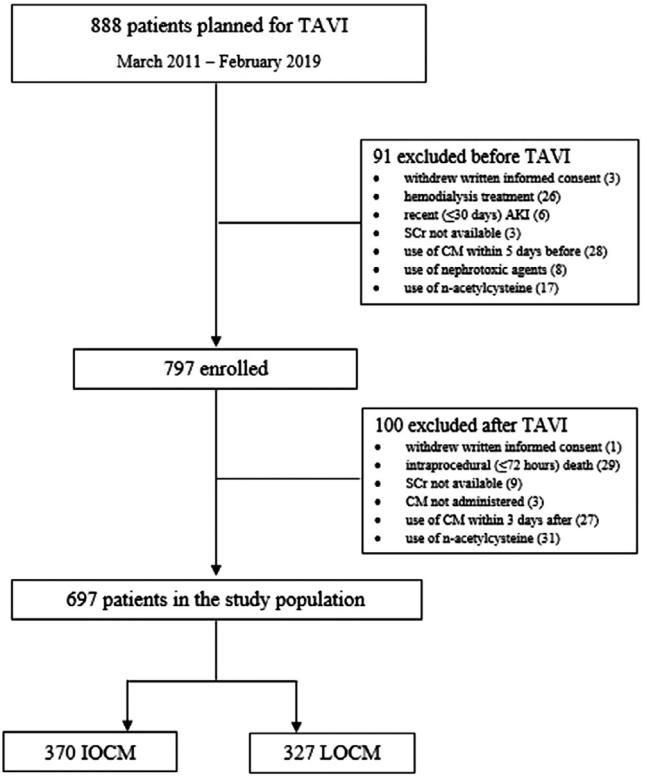

Fig. 1. Study flowchart. TAVI = transcatheter aortic valve implantation; AKI = acute kidney injury; SCr = serum creatinine; CM = contrast medium; IOCM = iso-osmolar contrast medium; LOCM = low-osmolar contrast media.

All patients referred for consideration of TAVI underwent a systematic assessment including transthoracic echocardiography, coronary angiography, computed tomography scan of the heart, aorta and peripheral vasculature, pulmonary function testing, carotid artery ultrasonography and multidisciplinary evaluation by both a cardiac surgeon and an interventional cardiologist.

Details on the TAVI procedure are provided elsewhere [2]. The majority of procedures were performed under local anesthesia and analgesia, under fluoroscopic guidance in a standard cardiac catheterization laboratory with surgical back-up by a dedicated team of experienced operators. Type of TAVI device implanted was defined as balloon-expandable (Edwards Sapien XT and Sapien 3; Meril Myval), self-expandable (Medtronic CoreValve, Engager, Evolut R and Evolut PRO; Boston Acurate and Acurate neo; Abbott Portico; JenaValve) and others (Boston Lotus; Direct Flow Medical).

In diabetic patients on metformin treatment, this drug was suspended 48 h before and re-administered 48 h after TAVI. All patients had intravenous hydration therapy for 24 h before the procedure, and continued 48 h after TAVI: 1 mL/kg/h of 0.9% NaCl solution, at a rate of 40 to 100 mL/h (according to the individual left ventricular function, pulmonary artery pressure, and combined valvular disease). The decision to give or hold diuretics preoperatively, was individualized to each patient aiming for an euvolemic state.

Each of the participating centers is maintaining a prospective database of all TAVI patients treated at that center, using the same dedicated archiving software. All baseline demographics, clinical, laboratory, echocardiographic, intraprocedural and postprocedural data, and hospital outcomes were prospectively collected from each patient's health record, whereas the analysis was performed retrospectively. Pre-TAVI Logistic european system for cardiac operative risk

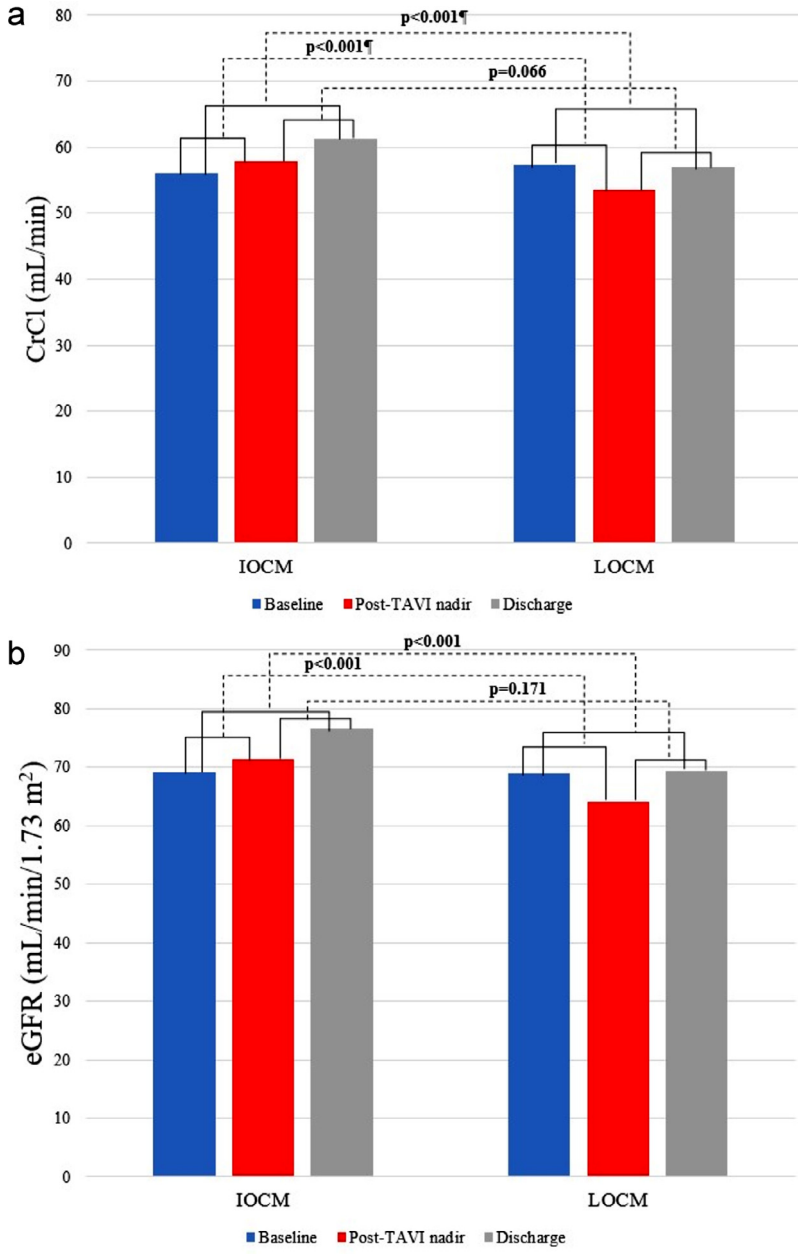

Fig. 2. Variations in CrCl and eGFR according to CM osmolality. CrCl = creatinine clearance; eGFR = estimated glomerular filtration rate; IOCM = iso-osmolar contrast medium; LOCM = low-osmolar contrast media; TAVI = transcatheter aortic valve implantation.

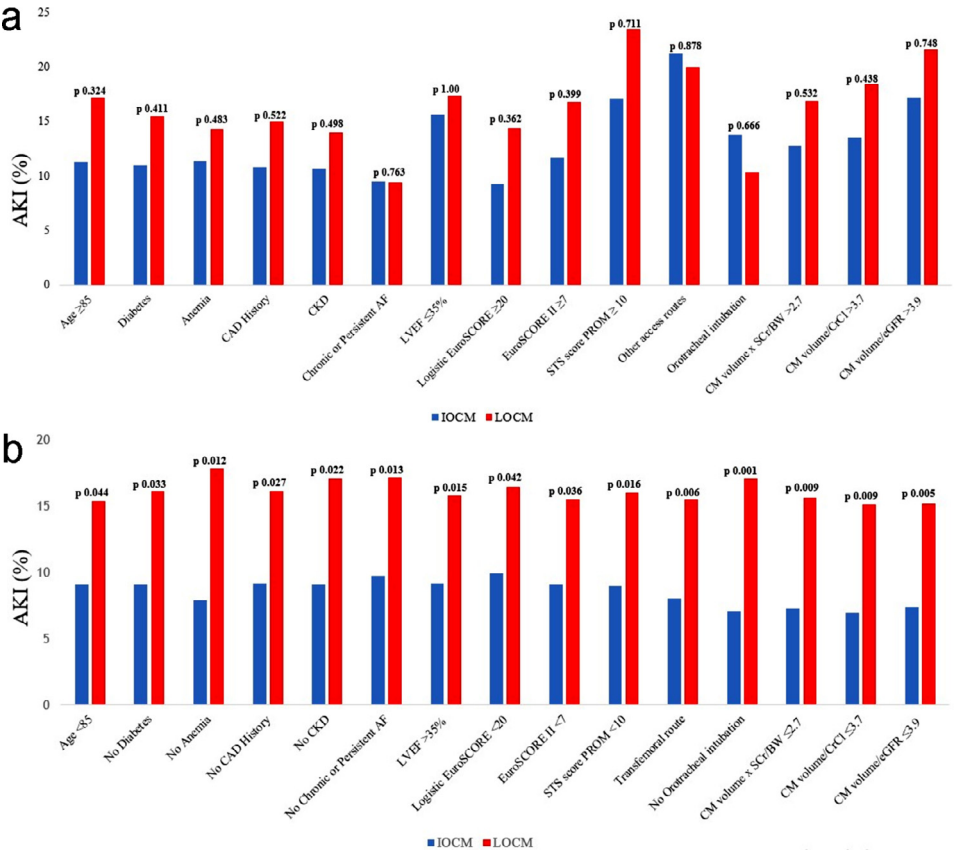

Fig. 3. Subgroup analysis of differences in the incidence of AKI between IOCM and LOCM: high (a) and low (b) AKI risk patients. AF = atrial fibrillation; AKI = acute kidney injury; BW = body weight; CAD = coronary artery disease; CKD = chronic kidney disease; CrCl = creatinine clearance; eGFR = estimated glomerular filtration ratio; EuroSCORE = european system for cardiac operative risk evaluation; IOCM = iso-osmolar contrast medium; LOCM = low-osmolar contrast media; LVEF = left ventricular ejection fraction; SCr = serum creatinine; STS-PROM = Society of Thoracic Surgery predictive risk of mortality.

evaluation (EuroSCORE) mortality risk, EuroSCORE II mortality risk and STS-PROM score were retrospectively calculated online using the official websites and calculators based on previously published data. The number of rapid pacing runs, the occurrence of any complication leading to severe sustained hypotension, and/or the need for hemodynamic support (e.g. pharmacological, aortic counterpulsation balloon and extracorporeal circulation) were recorded.

Data on follow-up echocardiography were extracted from each center's echocardiography database, while data on events occurring after discharge and re-hospitalizations for all causes were derived from follow-up outpatient visits or by telephonic interview. Physicians responsible for the patients were contacted and/or medical charts were reviewed to determine the causes of re-hospitalization and/or death when necessary.

In order to assemble a unified database, all data required for the study were sent back to the first author (FI), who compiled the final database used for the statistical analysis. No extramural funding was used to support the study. The authors wrote the manuscript and are responsible for the completeness and accuracy of data gathering and analysis.

Table 1
Other baseline characteristics and procedural features of the study population according to AKI incidence and CM osmolality ($n = 697$).

Variable	All	AKI		p	Osmolality		p
		Yes ($n = 88$)	No ($n = 609$)		IOCM ($n = 370$)	LOCM ($n = 327$)	
Anamnesis							
Severe liver disease	23 (3.30%)	1 (1.14%)	22 (3.61%)	0.370	13 (4.05%)	8 (2.45%)	0.330
Critical preoperative state	38 (5.45%)	6 (6.82%)	32 (5.26%)	0.724	16 (4.32%)	22 (6.73%)	0.220
Prior myocardial revascularization	172 (24.68%)	20 (22.73%)	152 (24.96%)	0.748	105 (28.38%)	67 (20.49%)	0.020
PCI	96 (13.77%)	14 (15.91%)	82 (13.47%)	0.648	57 (15.41%)	38 (11.93%)	0.223
CABG	44 (6.31%)	2 (2.27%)	42 (6.90%)	0.152	26 (7.03%)	18 (5.51%)	0.504
PCI + CABG	32 (4.59%)	4 (4.55%)	28 (4.60%)	0.802	22 (5.95%)	10 (3.06%)	0.102
Myocardial revascularization for TAVI	87 (12.48%)	15 (17.05%)	72 (11.82%)	0.225	45 (12.16%)	42 (12.84%)	0.875
PCI	84 (12.05%)	15 (17.05%)	69 (11.33%)	0.172	43 (11.62%)	41 (12.54%)	0.799
CABG	2 (0.29%)	0 (0.00%)	2 (0.33%)	0.598	2 (0.54%)	0 (0.00%)	0.534
PCI + CABG	1 (0.14%)	0 (0.00%)	1 (0.16%)	0.260	0 (0.00%)	1 (0.31%)	0.951
Prior PM/ICD/CRT implantation	81 (11.62%)	17 (19.32%)	64 (10.51%)	0.026	41 (11.08%)	40 (12.23%)	0.723
Baseline renal function assessment							
SCr (mg/dL)	1.08±0.42	1.11±0.54	1.07±0.40	0.621	1.09±0.50	1.07±0.39	0.907
CrCl (mL/min)	56.53±22.81	56.50±24.81	56.66±22.54	0.972	56.08±23.29	57.28±22.29	0.394
eGFR (mL/min/1.73 m^2)	69.03±25.63	70.06±30.32	68.88±24.90	0.878	69.14±26.17	68.91±25.03	0.939
Electrocardiography							
Sinus rhythm	533 (76.47%)	67 (76.14%)	466 (76.52%)	0.956	287 (77.57%)	246 (75.23%)	0.524
Atrial fibrillation / flutter	116 (16.64%)	11 (12.50%)	107 (17.57%)	0.335	63 (17.03%)	53 (16.21%)	0.851
PM-induced rhythm	48 (6.89%)	10 (11.36%)	38 (6.24%)	0.121	20 (5.41%)	28 (8.56%)	0.135
Echocardiography							
LVEF (%)	52.86±11.13	52.09±11.91	52.97±11.02	0.502	53.24±12.16	52.44±9.83	0.932
Maximum aortic gradient (mmHg)	76.20±20.76	76.41±22.05	76.17±20.60	0.959	72.41±19.91	80.23±20.93	<0.001
Mean aortic gradient (mmHg)	46.92±14.39	45.76±14.66	47.09±14.35	0.547	45.43±13.88	48.58±14.78	0.004
Moderate-to-severe mitral regurgitation	162 (23.24%)	23 (26.14%)	139 (22.82%)	0.581	105 (28.38%)	57 (17.43%)	<0.001
Pulmonary arterial systolic pressure (mmHg)	40.01±12.76	40.53±12.38	39.93±12.83	0.678	39.42±12.35	40.59±13.15	0.419

(*continued on next page*)

Table 1 (*continued*)

Variable	All	AKI			Osmolality		
		Yes ($n=88$)	No ($n=609$)	p	IOCM ($n=370$)	LOCM ($n=327$)	p
CT-guided procedure	652 (93.54%)	81 (92.05%)	571 (93.76%)	0.704	353 (95.41%)	299 (91.44%)	0.049
Procedural details							
Transfemoral access route	620 (88.95%)	71 (81.82%)	548 (89.98%)	0.036	323 (87.30%)	297 (90.82%)	0.173
Other access routes	77 (11.05%)	16 (18.18%)	61 (10.02%)	0.036	47 (12.70%)	30 (9.17%)	0.173
transsubclavian	21 (3.01%)	1 (1.14%)	20 (3.28%)	0.442	4 (1.08%)	17 (5.20%)	0.003
transapical	50 (7.17%)	11 (12.50%)	39 (6.40%)	0.064	40 (10.81%)	10 (3.06%)	<0.001
direct aortic	6 (0.86%)	4 (4.45%)	2 (0.33%)	<0.001	3 (0.81%)	3 (0.92%)	0.796
Orotracheal intubation	203 (29.12%)	26 (29.55%)	177 (29.06%)	0.974	145 (39.19%)	58 (17.74%)	<0.001
Valve-in-valve	19 (2.73%)	0 (0.00%)	19 (3.12%)	0.184	10 (2.70%)	9 (2.75%)	0.847
Predilation	425 (60.98%)	39 (44.32%)	233 (38.26%)	0.331	253 (68.38%)	172 (52.59%)	<0.001
Valve kind							
balloon-expandable	436 (62.55%)	59 (67.05%)	377 (61.90%)	0.416	209 (56.49%)	227 (69.42%)	<0.001
self-expandable	228 (32.71%)	28 (32.82%)	200 (32.84%)	0.945	139 (37.57%)	89 (27.22%)	0.005
others	33 (4.73)	1 (1.14%)	32 (5.26%)	0.152	22 (5.94%)	11 (3.36%)	0.155
Valve size							
≤26 mm	533 (76.47%)	65 (73.86%)	468 (76.85%)	0.630	270 (72.97%)	263 (80.43%)	0.026
>26 mm	164 (23.53%)	23 (26.14%)	141 (23.15%)	0.630	100 (27.03%)	64 (19.57%)	0.026
Postdilation	86 (12.34%)	11 (12.50%)	75 (12.32%)	0.901	61 (16.49%)	25 (7.64%)	<0.001
CM volume (mL)	166.10±60.61	171.60±72.44	165.30±70.36	0.475	185.34±71.83	144.32±62.52	<0.001
CM volume x SCr/BW	2.50±1.39	2.70±1.69	2.47±1.34	0.602	2.81±1.42	2.15±1.26	<0.001
CM volume x SCr/BW >2.7	235 (33.72%)	33 (37.50%)	202 (33.17%)	0.495	164 (44.32%)	71 (21.71%)	<0.001
CM volume/CrCl	3.40±2.03	3.77±2.54	3.34±1.94	0.292	3.83±2.12	2.91±1.79	<0.001
CM volume/CrCl >3.7	231 (33.14%)	35 (39.77%)	196 (32.18%)	0.196	155 (41.89%)	76 (23.24%)	<0.001
CM volume/eGFR	2.74±1.58	3.05±1.96	2.70±1.51	0.359	3.05±1.58	2.40±1.50	<0.001
CM volume/eGFR >3.9	124 (17.79%)	23 (26.13%)	101 (16.58%)	0.041	87 (23.51%)	37 (11.31%)	<0.001
Mehran score ≥11	482 (69.15%)	62 (70.45%)	420 (68.97%)	0.873	280 (75.68%)	202 (61.77%)	<0.001
IOCM	370 (53.08%)	36 (40.91%)	334 (54.84%)	0.020			
LOCM	327 (46.92%)	52 (59.09%)	275 (45.16%)	0.020			
iopromide	130 (18.65%)	11 (12.50%)	119 (19.54%)	0.005			
iobitridol	92 (13.20%)	16 (18.18%)	76 (12.48%)	0.770			
iohexol	80 (11.48%)	18 (20.45%)	62 (10.18%)	0.093			
iomeprol	25 (3.59%)	7 (7.95%)	18 (2.96%)	0.151			

(*continued on next page*)

Table 1 (*continued*)

Variable	All	AKI			Osmolality		
		Yes ($n=88$)	No ($n=609$)	p	IOCM ($n=370$)	LOCM ($n=327$)	p
Post-TAVI and discharge renal function assessment							
Post-TAVI peak SCr (mg/dL)	1.12±0.51	1.72±0.87	1.03±0.35	<0.001	1.08±0.51	1.16±0.50	0.001
Post-TAVI peak – basal ΔSCr (mg/dL)	0.04±0.35	0.61±0.63	−0.04±0.18	<0.001	−0.01±0.33	0.09±0.37	<0.001
Post-TAVI nadir CrCl (mL/min)	55.80±24.01	38.09±19.13	58.37±23.56	<0.001	57.80±26.28	53.51±20.92	0.115
Basal – post-TAVI nadir ΔCrCl (mL/min)	0.84±12.30	18.40±14.67	−1.70±9.55	<0.001	−1.72±13.17	3.76±10.52	<0.001
Post-TAVI nadir eGFR (mL/min/1.73 m^2)	67.94±27.31	44.64±22.73	71.31±26.26	<0.001	71.37±29.63	64.05±23.88	0.002
Basal – post-TAVI nadir ΔeGFR (mL/min/1.73 m^2)	1.09±16.83	25.41±19.62	−2.42±13.08	<0.001	−2.24±18.17	4.86±14.29	<0.001
Discharge SCr (mg/dL)	1.06±0.47	1.37±0.83	1.01±0.38	<0.001	1.03±0.49	1.07±0.46	0.008
Discharge – basal ΔSCr (mg/dL)	−0.35±0.35	0.26±0.68	−0.07±0.24	<0.001	−0.06±0.35	0.00±0.34	<0.001
Discharge – post-TAVI peak ΔSCr (mg/dL)	−0.07±0.31	−0.35±0.64	−0.03±0.19	<0.001	−0.06±0.30	−0.09±0.32	0.045
Discharge CrCl (mL/min)	59.32±25.67	49.42±25.43	60.75±25.41	<0.001	61.36±28.27	57.02±22.19	0.240
Basal – discharge ΔCrCl (mL/min)	−2.92±12.55	7.08±16.92	−4.38±11.07	<0.001	−5.27±13.93	0.27±10.16	<0.001
Discharge – post-TAVI nadir ΔCrCl (mL/min)	3.76±10.68	11.33±14.48	2.67±9.55	<0.001	3.55±12.01	4.00±8.98	0.066
Discharge eGFR (mL/min/1.73 m^2)	73.24±29.42	60.67±33.41	75.06±28.37	<0.001	76.61±32.58	69.42±24.87	0.007
Basal – discharge ΔeGFR (mL/min/1.73 m^2)	−4.21±17.42	9.38±23.99	−6.17±15.37	<0.001	−7.47±19.65	−0.52±13.73	<0.001
Discharge – post-TAVI nadir ΔeGFR (mL/min/1.73 m^2)	5.30±15.09	16.03±20.42	3.75±13.49	<0.001	5.24±16.83	5.37±12.86	0.171

AKI = acute kidney injury; CM = contrast medium; IOCM = iso-osmolar contrast medium; LOCM = low-osmolar contrast media; PCI = percutaneous coronary intervention; CABG = coronary artery by-pass grafting; TAVI = transcatheter aortic valve implantation; PM = pacemaker; ICD = implantable cardioverter-defibrillator; CRT = cardiac resynchronization therapy; SCr = serum creatinine; CrCl = creatinine clearance; eGFR = estimated glomerular filtration ratio; LVEF = left ventricular ejection fraction; CT = computed tomography; BW = body weight.

Table 2
AKI and 1-year mortality predictors.

	Univariate OR (95% CI)	*p* value	Multivariate OR (95% CI)	*p* value	*p*-interaction (LOCM)
AKI predictors					
PAD	1.25 (0.77–2.01)	0.362	1.03 (0.60–1.77)	0.911	0.046
STS-PROM score	1.03 (1.00–1.05)	0.018	1.00 (0.99–1.01)	0.793	0.022
Non-transfemoral access route	2.00 (1.09–3.65)	0.025			
CM volume/eGFR >3.9	1.78 (1.06–3.00)	0.030	2.01 (1.20–3.67)	0.010	0.445
LOCM	1.75 (1.11–2.76)	0.015	1.97 (1.21–3.21)	0.006	
Any bleeding	3.41 (2.15–5.42)	<0.001			
Any transfusion	4.19 (2.49–7.06)	<0.001	4.22 (2.49–7.34)	<0.001	0.991
New-onset AF/flutter	2.39 (1.18–4.82)	0.015	1.97 (0.94–4.14)	0.072	0.419
1-year mortality predictors					
Anemia	2.62 (1.45–4.74)	0.001	2.28 (1.24–4.21)	0.008	0.789
LVEF ≤35%	2.51 (1.19–5.27)	0.015	2.47 (1.14–5.33)	0.021	0.485
EuroSCORE II	1.05 (1.02–1.09)	0.003			
LOCM	2.51 (1.44–4.38)	0.001	2.62 (1.48–4.62)	0.001	
AKI	2.52 (1.34–4.73)	0.004			
Any transfusion	2.03 (1.05–3.93)	0.035	1.60 (0.80–3.21)	0.179	0.928

AKI = acute kidney injury; OR = odds ratio; CI = confidence interval; LOCM = low-osmolar contrast medium; PAD = peripheral artery disease; STS-PROM = Society of Thoracic Surgery predictive risk of mortality; CM = contrast medium; eGFR = estimated glomerular filtration ratio; AF = atrial fibrillation; LVEF = left ventricular ejection fraction; EuroSCORE = european system for cardiac operative risk evaluation.

2.2. CM and renal function assessment, and definitions

The choice of the type of CM to be used for the procedure was institution- and physician-dependent; the CM were: (1) iodixanol, iodinated non-ionic iso-osmolar, dimeric, (2) iopromide, (3) iobitridol, (4) iohexol and (5) iomeprol, all iodinated non-ionic low-osmolar, monomeric. According to CM osmolality, the population was retrospectively divided in 2 groups: IOCM group ($n = 370$) and LOCM group ($n = 327$).

The amount of CM was recorded during all TAVI procedures. According to the previous investigations, the CM volume x SCr/body weight, CM volume/CrCl and CM volume/eGFR ratios were used to evaluate the degree of CM dose in individual patients [3–5].

Isotope diluition mass spectroscopy was used to measure SCr level at the admission (at least 1 day before the procedure), on the procedure day (after continuing the overnight hydration), and then daily until the discharge. Baseline SCr was defined as the SCr measured before and closest to the time of TAVI procedure. If there was >1 measurement post-TAVI available, the greater SCr value within 48 h was included in the analysis. Via a Foley catheter or an external collection device, urine output (UO) was evaluated through at least 72 h after TAVI or until hospital discharge if that occurred earlier than 72 h after TAVI. eGFR was calculated with the simplified Modification of Diet in Renal Disease formula [6], while CrCl rate using Cockcroft-Gault formula. For the present analysis, CKD was defined as baseline eGFR of <60 mL/min/1.73 m^2.

AKI was defined as stage 1, 2 or 3 by AKI Network from the SCr- and UO-based criteria; according to such system [7]:

- stage 1: increase in SCr of 150–199% (1.5–1.99 × increase compared with baseline) or increase of ≥0.3 mg/dL (≥26.4 mmol/L) or UO <0.5 mL/kg/h for >6 h but <12 h;
- stage 2: increase in SCr of 200–299% (2.0–2.99 × increase compared with baseline) or UO <0.5 mL/kg/h for >12 h but <24 h;
- stage 3: increase in SCr of ≥300% (>3 × increase compared with baseline) or SCr of ≥4.0 mg/dL (≥354 mmol/L) with an acute increase of at least 0.5 mg/dL (44 mmol/L) or UO <0.3 mL/kg/h for >24 h or anuria for >12 h.

Table 3
Subgroup analysis of differences in the incidence of TAVI-related AKI between IOCM and LOCM.

Subgroup	IOCM	LOCM	*p*
Age ≥85 years (*n*)	106	93	
basal SCr (SD)	1.06±0.42	1.04±0.38	0.888
AKI, *n* (%)	12 (11.32%)	16 (17.20%)	0.324
Age <85 years (*n*)	264	234	
basal SCr (SD)	1.16±0.50	1.13±0.42	0.990
AKI, *n* (%)	24 (9.09%)	36 (15.38%)	0.044
Diabetes (*n*)	118	116	
basal SCr (SD)	1.11±0.47	1.06±0.38	0.697
AKI, *n* (%)	13 (11.02%)	18 (15.52%)	0.411
No diabetes (*n*)	252	211	
basal SCr (SD)	1.08±0.44	1.07±0.40	0.832
AKI, *n* (%)	23 (9.13%)	34 (16.11%)	0.033
Anemia (*n*)	193	181	
basal SCr (SD)	1.19±0.52	1.15±0.44	0.570
AKI, *n* (%)	22 (11.40%)	26 (14.37%)	0.483
No anemia (*n*)	177	146	
basal SCr (SD)	0.98±0.33	0.97±0.29	0.839
AKI, *n* (%)	14 (7.91%)	26 (17.81%)	0.012
COPD (*n*)	136	98	
basal SCr (SD)	1.13±0.47	1.10±0.44	0.461
AKI, *n* (%)	12 (8.82%)	14 (14.29%)	0.271
No COPD (*n*)	234	229	
basal SCr (SD)	1.06±0.43	1.05±0.37	0.621
AKI, *n* (%)	24 (10.26%)	38 (16.59%)	0.062
PAD (*n*)	118	63	
basal SCr (SD)	1.22±0.56	1.12±0.42	0.315
AKI, *n* (%)	10 (8.48%)	12 (19.05%)	0.067
No PAD (*n*)	252	264	
basal SCr (SD)	1.03±0.37	1.05±0.38	0.290
AKI, *n* (%)	26 (10.32%)	40 (15.15%)	0.131
CAD history (*n*)	120	73	
basal SCr (SD)	1.13±0.37	1.01±0.31	0.019
AKI, *n* (%)	13 (10.83%)	11 (15.07%)	0.522
No CAD history (*n*)	250	254	
basal SCr (SD)	1.07±0.49	1.08±0.41	0.171
AKI, *n* (%)	23 (9.20%)	41 (16.14%)	0.027
NYHA functional class III-IV (*n*)	348	272	
basal SCr (SD)	1.09±0.45	1.06±0.40	0.450
AKI, *n* (%)	32 (9.20%)	44 (16.18%)	0.012
NYHA functional class I-II (*n*)	22	55	
basal SCr (SD)	1.00±0.43	1.09±0.34	0.056
AKI, *n* (%)	4 (18.18%)	8 (14.55%)	0.734
CKD (*n*)	150	128	
basal SCr (SD)	1.45±0.49	1.41±0.38	0.753
AKI, *n* (%)	16 (10.67%)	18 (14.06%)	0.498
No CKD (*n*)	220	199	
basal SCr (SD)	0.84±0.18	0.85±0.18	0.744
AKI, *n* (%)	20 (9.09%)	34 (17.09%)	0.022
Chronic or persistent AF (*n*)	63	53	
basal SCr (SD)	1.09±0.37	1.09±0.41	0.799
AKI, *n* (%)	6 (9.52%)	5 (9.43%)	0.763
No chronic or persistent AF (*n*)	307	274	
basal SCr (SD)	1.09±0.47	1.06±0.39	0.986
AKI, *n* (%)	30 (9.77%)	47 (17.15%)	0.013
LVEF ≤35% (*n*)	32	23	
basal SCr (SD)	1.16±0.35	1.35±0.51	0.103
AKI, *n* (%)	5 (15.63%)	4 (17.39%)	1.00
LVEF >35% (*n*)	338	304	
basal SCr (SD)	1.08±0.46	1.05±0.37	0.742
AKI, *n* (%)	31 (9.17%)	48 (15.79%)	0.015

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Table 3 (*continued*)

Subgroup	IOCM	LOCM	*p*
Logistic EuroSCORE ≥20%	108	90	
basal SCr (SD)	1.08±0.85	1.11±0.82	0.591
AKI, *n* (%)	10 (9.26%)	13 (14.44%)	0.362
Logistic EuroSCORE <20%	262	237	
basal SCr (SD)	1.04±0.40	1.01±0.33	0.764
AKI, *n* (%)	26 (9.92%)	39 (16.46%)	0.042
EuroSCORE II ≥7%	103	95	
basal SCr (SD)	1.30±0.56	1.22±0.48	0.204
AKI, *n* (%)	12 (11.65%)	16 (16.84%)	0.399
EuroSCORE II <7%	267	232	
basal SCr (SD)	1.01±0.37	1.01±0.33	0.495
AKI, *n* (%)	24 (9.10%)	36 (15.52%)	0.036
STS-PROM score ≥10%	35	17	
basal SCr (SD)	1.33±0.96	1.35±1.00	0.961
AKI, *n* (%)	6 (17.14%)	4 (23.53%)	0.711
STS-PROM score <10%	335	310	
basal SCr (SD)	1.05±0.40	1.05±0.36	0.731
AKI, *n* (%)	30 (8.96%)	48 (15.98%)	0.016
Other access routes (*n*)	47	30	
basal SCr (SD)	1.17±0.47	1.17±0.35	0.904
AKI, *n* (%)	10 (21.28%)	6 (20.00%)	0.878
Transfemoral route (*n*)	323	297	
basal SCr (SD)	1.08±0.45	1.06±0.39	0.872
AKI, *n* (%)	26 (8.05%)	46 (15.49%)	0.006
Orotracheal intubation (*n*)	145	58	
basal SCr (SD)	1.13±0.48	1.15±0.41	0.453
AKI, *n* (%)	20 (13.79%)	6 (10.35%)	0.666
No orotracheal intubation (*n*)	225	269	
basal SCr (SD)	1.06±0.43	1.05±0.38	0.939
AKI, *n* (%)	16 (7.11%)	46 (17.10%)	0.001
CM volume x SCr/BW >2.7 (*n*)	164	71	
basal SCr (SD)	1.24±0.44	1.45±0.47	<0.001
AKI, *n* (%)	21 (12.81%)	12 (16.90%)	0.532
CM volume x SCr/BW ≤2.7 (*n*)	206	256	
basal SCr (SD)	0.96±0.42	0.96±0.28	0.213
AKI, *n* (%)	15 (7.28%)	40 (15.63%)	0.009
CM volume/CrCl >3.7 (*n*)	155	76	
basal SCr (SD)	1.24±0.44	1.41±0.47	0.004
AKI, *n* (%)	21 (13.55%)	14 (18.42%)	0.438
CM volume/CrCl ≤3.7 (*n*)	215	251	
basal SCr (SD)	0.97±0.42	0.96±0.29	0.362
AKI, *n* (%)	15 (6.98%)	38 (15.14%)	0.009
CM volume/eGFR >3.9 (*n*)	87	37	
basal SCr (SD)	1.37±0.48	1.65±0.52	0.004
AKI, *n* (%)	15 (17.24%)	8 (21.62%)	0.748
CM volume/eGFR ≤3.9 (*n*)	283	290	
basal SCr (SD)	1.00±0.40	0.99±0.30	0.390
AKI, *n* (%)	21 (7.42%)	44 (15.17%)	0.005
Mehran score ≥11	244	191	
basal SCr (SD)	1.20±0.50	1.17±0.43	0.771
AKI, *n* (%)	27 (11.07%)	29 (15.18%)	0.259
Mehran score <11	126	136	
basal SCr (SD)	0.87±0.21	0.92±0.27	0.182
AKI, *n* (%)	9 (7.14%)	23 (16.91%)	0.026
Any bleeding (*n*)	99	66	
basal SCr (SD)	1.11±0.59	1.06±0.41	0.829
AKI, *n* (%)	20 (20.20%)	21 (31.82%)	0.132
No bleedings (*n*)	271	261	
basal SCr (SD)	1.08±0.39	1.07±0.39	0.713
AKI, *n* (%)	16 (5.90%)	31 (11.88%)	0.023

(*continued on next page*)

Table 3 (*continued*)

Subgroup	IOCM	LOCM	*p*
Any transfusion (*n*)	52	39	
basal SCr (SD)	1.19±0.61	1.12±0.47	0.776
AKI, *n* (%)	16 (30.77%)	12 (30.77%)	0.818
No transfusions (*n*)	318	288	
basal SCr (SD)	1.07±0.42	1.06±0.38	0.990
AKI, *n* (%)	20 (6.29%)	40 (13.89%)	0.003
Any vascular complication (*n*)	64	38	
basal SCr (SD)	1.11±0.58	1.16±0.41	0.183
AKI, *n* (%)	7 (10.94%)	7 (18.42%)	0.445
No vascular complications (*n*)	306	289	
basal SCr (SD)	1.08±0.42	1.06±0.39	0.529
AKI, *n* (%)	29 (9.48%)	45 (15.57%)	0.033
Post-TAVI moderate-to-severe residual AR (*n*)	105	57	
basal SCr (SD)	1.21±0.59	1.10±0.49	0.275
AKI, *n* (%)	15 (14.29%)	8 (14.04%)	0.848
Post-TAVI trivial-to-mild residual AR (*n*)	265	270	
basal SCr (SD)	1.04±0.37	1.06±0.37	0.410
AKI, *n* (%)	21 (7.93%)	44 (16.30%)	0.005
New-onset AF/flutter (*n*)	17	33	
basal SCr (SD)	0.97±0.33	1.06±0.39	0.396
AKI, *n* (%)	2 (11.77%)	10 (30.30%)	0.175
No new-onset AF/flutter (*n*)	257	200	
basal SCr (SD)	1.06±0.39	1.10±0.48	0.518
AKI, *n* (%)	27 (9.51%)	35 (14.89%)	0.081

TAVI = transcatheter aortic valve implantation; AKI = acute kidney injury; IOCM = iso-osmolar contrast medium; LOCM = low-osmolar contrast media; SCr = serum creatinine; SD = standard deviation; COPD = chronic obstructive pulmonary disease; PAD = peripheral artery disease; CAD = coronary artery disease; NYHA = New York Heart Association; CKD = chronic kidney disease; eGFR = estimated glomerular filtration ratio; AF = atrial fibrillation; LVEF = left ventricular ejection fraction; EuroSCORE = european system for cardiac operative risk evaluation; STS-PROM = Society of Thoracic Surgery predictive risk of mortality; BW = body weight; CrCl = creatinine clearance; AR = aortic regurgitation.

Patients receiving renal replacement therapy were considered to meet stage 3 criteria irrespective of other criteria. The indications for renal replacement therapy included fluid overload with heart failure, hyperkalemia, hypercalcemia, metabolic acidosis, uremic symptoms, and oliguria or anuria (UO <200 mL/12 h or UO <50 mL/12 h, respectively).

Preprocedural anemia was defined by the World Health Organization definition of anemia: hemoglobin <12 g/dL for women and <13 g/dL for men [8]. Nadir hemoglobin was defined as the lowest hemoglobin measured after TAVI until discharge.

All other complications as well as device success and early safety were defined according to the Valve Academic Research Consortium-2 standardized criteria [9].

2.3. Statistical analysis

Statistical analyses were performed using SigmaStat 3.5 and STATA 13.1. Continuous variables are expressed as mean ± standard deviation or median (interquartile range) of absolute numbers. Categorical variables are reported as frequencies and percentages. The data reported in Table 1 were analysed by *t*-test, Mann Whitney's *U* test, Fisher's exact test or $\chi 2$ test, as appropriate [10,11]. For all regression analyses (Table 2), the most of variables with a *p*-value of <0.05 in univariable analysis were incorporated in the multivariable model, if not covariates [12]. Odds ratios with 95% confidence intervals were estimated, and then tests for interaction were performed, as appropriate [13]. All statistical tests were two-sided. For all tests, a *p*-value <0.05 was considered statistically significant. About subgroup analysis, odds ratios with 95% confidence intervals were first calculated and plotted in a Forest graph with effects sizes, and then tests for interaction were performed too, as appropriate. A *p*-value <0.025 was considered statistically

significant for interaction. The subgroup analysis in Table 3 was performed with *t*-test, Mann Whitney's *U* test, Fisher's exact test or $\chi 2$ test, as appropriate.

Ethics Statement

The study protocol was in accordance with the institutional ethics committee of each participating center as well as the Declaration of Helsinki, and all patients gave informed written consent for the procedures.

CRediT Author Statement

Fortunato Iacovelli, Vincenzo Pestrichella and **Gaetano Contegiacomo:** Conceptualization, Methodology, Software; **Francesco Spione, Eugenio Stabile** and **Antonio Pignatelli:** Data curation; **Francesco Loizzi** and **Emanuela De Cillis:** Writing- Original draft preparation; **Angelo Cioppa** and **Armando Pucciarelli:** Visualization, Investigation; **Tullio Tesorio:** Supervision; **Alessandro Cafaro:** Software, Validation; **Luigi Salemme** and **Alessandro Santo Bortone:** Writing- Reviewing and Editing.

Declaration of Competing Interest

Gaetano Contegiacomo serves as transcatheter heart valve proctor for Abbott and Meril; the remaining authors have no conflicts of interest to declare. This research received no specific grants from any funding agency in the public, commercial or not-for-profit sectors.

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