Intra-abdominal pressure and its relationship with markers of congestion in patients admitted for acute decompensated heart failure.

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Background: Systemic congestion is one of the mechanisms involved in acute decompensated heart failure (ADHF). Increased intraabdominal pressure (IAP), elicited by abdominal congestion, has been related to acute kidney injury and prognosis. Nonetheless, the link between diuretic response, surrogate markers of congestion and renal function remains poorly understood.

Methods and results: We measured IAP in 43 patients from a non-interventional, exploratory, prospective, single center study carried out in patients admitted for ADHF. IAP was measured with an calibrated electronic manometer through a catheter inserted in the bladder. Normal IAP was defined as < 12 mmHg. At baseline, median IAP was 15 mmHg, with a reduction over the next 72 hours to a median of 12 mmHg. A higher IAP at admission was associated with higher baseline blood urea (83 mg/dL [62 - 138] vs. 50 mg/dL [35 – 65]; p=0.007) and creatinine (1.30 mg/dL vs 0.95 mg/dL; p=0.027), and with poorer diuretic response 72 hours after admission, either measured by diuresis (14.4 mL/mg vs. 21.6 mL/mg; [p = 0.005]) or natriuresis (1.2 mEqNa/mg vs. 2.0 mEqNa/mg; [p = 0.008]). A higher incidence for one-year all-cause mortality (45.0% vs 16.7%; log-rank test = 0.041) was observed among those patients with IAP>12mmHg at 72 hours.

Conclusions: In patients with ADHF, higher IAP at admission is associated with poorer baseline renal function and impaired diuretic response. The persistence of IAP at 72 hours above 12 mm Hg associates to longer length of hospital stay and higher one-year all-cause mortality.

Introduction

During the last few years, the importance of systemic venous congestion in heart failure (HF) has received increasing attention[1–3]. Most patients admitted for acute decompensated heart failure (ADHF), show signs or symptoms of congestion[4,5], hence guidelines recommend its prompt detection and treatment to improve outcomes[6].

However, up to one third of the patients still have some degree of clinical congestion at discharge[7,8], a situation termed residual clinical congestion, which is directly associated with a worse prognosis[8–10]. Residual clinical congestion is potentially caused by many factors, such as diuretic resistance[11] or persistent redistribution of fluid in interstitial space[12], situations leading to an increase in readmissions and mortality due to HF in a short and long-term basis[9].

Given the deleterious effect of residual clinical congestion and the limitations of physical examination for its assessment[13], new tools to evaluate congestion have been suggested. Biomarkers, such as carbohydrate antigen 125 (CA125)[14–16] or Bio-Adrenomedullin (Bio-ADM)[17,18], have shown a good correlation with clinical congestion. Additionally, some ultrasonographic (US) techniques are useful in refining prognostic assessment in HF. Both diameter and degree of collapse of inferior cava vein (ICV) have been associated with prognosis[19], as well as the presence of **B lines in lungs**, which presence during ADHF or its persistence after diuretics, confers poorer prognosis[20–23]. Hence, a combined assessment of congestion, including clinical, biochemical and US measurements, have been recommended by the European Society of Cardiology (ESC) for decision making and guided therapy in patients with acute HF[24].

Intrabdominal pressure (IAP) is another biological parameter of potential interest in HF since it is directly linked to central venous pressure (CVP) and abdominal congestion[25]. The American Society of Surgeons defined physiological IAP below 12 mm Hg, when a bladder catheter is used for this measurement [26–28]. In the context of HF, an increased IAP has been suggested as a leading mechanism underlying worsening of renal function (WRF) in ADHF

patients[25]. *Mullens et al*[29], showed changes in IAP correlated with serum creatinine in patients with HF and severely reduced left ventricular ejection fraction (LVEF). *Abu-Saleh et al*[30], demonstrated that increased IAP contributes to kidney dysfunction by using a HFrEF mice model. Nevertheless, there is no evidence about the interaction between IAP and markers of congestion (measured by physical examination, biomarkers or US), or about how IAP influences renal function and diuretic response in patients with mild reduced LVEF or even HFpEF. Patients admitted for ADHF at Internal Medicine wards have higher rates of comorbidities and/or HFpEF[31], what allows studying IAP in a different context never explored.

The PIA study (from Spanish for intra-abdominal pressure) was designed to examine relationships between IAP, systemic venous congestion and renal function impairment in the context of ADHF. The objectives of this study were: (1) quantify IAP, and its changes after diuretic therapy, in patients admitted for ADHF; (2) analyze the relationship between systemic congestion and IAP; (3) establish the relationship between IAP and the development of worsening renal function.

Patients and methods

The PIA (for its name in Spanish, *Presión Intra Abdominal*) study is an observational, non-interventional, descriptive and prospective study, carried out at the Internal Medicine department of the Hospital Clínico Universitario "Lozano Blesa", Zaragoza, Spain, **in two different periods (January 2016 to July 2016 and May 2017 to May 2018).** Inclusion criteria were: 1) Patients older than 18 years with a diagnosis of ADHF, either "de novo" or decompensated chronic HF; 2) NT-proBNP > 1000 pg / ml in the first 36 hours after admission; 3) Estimated glomerular filtration rate (eGFR) ≥ 20 ml / min / 1.72 m2 by Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI-Creatinine formula) and 4) Written informed consent. Exclusion criteria were: 1) Admission to the intensive care unit. 2) Significant valve disease (severe aortic stenosis, severe mitral stenosis or mitral regurgitation); 3) Advanced COPD (spirometry with FEV1 <30%) and 4) ADHF due to arrhythmias (except atrial/flutter fibrillation). **5) Loop diuretic e.v. treatment ≥ 24 hours after admission to internal medicine ward.**

Systemic congestion was estimated by different methods, detailed below: 1) A clinical congestion score (CCS) previously described[9]. 2) Ultrasonographic measurement of diameter and collapse of IVC. 3) Bio-impedance vector analysis (BiVA) of body water content and 4) Blood biomarkers of congestion (NT-ProBNP and CA125).

Baseline moment was defined as the first 24 hours after being admitted at the Internal Medicine ward.

A 2D echocardiography performed between 6 months before admission and one month after discharge was required. Left ventricular ejection fraction (LVEF) was calculated by Simpson biplane method.

The study complied with the fundamental guidelines of the Helsinki International Declaration and was approved by the Clinical Research Ethics Committee of Aragón (CEICA, Ref. C.P.-C.I. PI15 / 0227 to date September 9, 2015). Written informed consent was obtained from all patients.

Intraabdominal pressure measurement

IAP was calculated by an indirect method, according to *Cheatham ML et al* [26,27]. Briefly, the method consisted in placing a Foley catheter into the bladder, filled with 50 cc of saline solution, connected to a digital manometer (DM2Plus®,Fluke Biomedical, units: mmHg)[27]. IAP values obtained through this procedure has been shown to correlate adequately with actual IAP[28] and had been validated by the American Society of Surgeons[26]. Measurements were taken at 24, 48 and 72 hours after admission, always by the same researcher, with a minimum interval of 2 hours after food intake and with the patient placed in supine position. All patients signed a specific informed consent to perform this procedure in case a bladder catheter had not been placed at the Emergency Ward. Four urinary catheters had to be removed; three after 48 hours, due to revoked consent and one after 24 hours because of an uncomplicated urinary tract infection.

Diuretic response and worsening renal function

During the first 72 hours after admission, an exhaustive analysis of renal function was performed, including 24-, 48- and 72-hours total diuresis and urine analysis (all patients had bladder catheterization for IAP measurement). Blood analyses were performed at baseline and before discharge to evaluate renal function. In addition, cumulative dose of intra venous (i.v.) furosemide (mg) was registered at 24, 48 and 72 hours.

For diuretic response (DR), three formulae based on weight, diuresis or natriuresis, respectively, were used: 1) Δ weight kg at 72 h/40 mg furosemide[11]. 2) Urine output during the first 72 h (Total diuresis at 72 h [mL]/Total intravenous furosemide [mg] 72 hours) and 3) Total urinary sodium at 72 h (mEq/L)/Total intravenous furosemide (mg) 72 h.

Laboratory samples

Blood samples were withdrawn at admission and discharge. Serum biomarkers measured were NT-ProBNP (Modular Analytics Analyzer E601 Roche diagnostics GmbH, Mannheim, Germany), Cystatin C (Latex N Test, with BN II dade Behring GmbH, Marburg, Germany) and CA125 (Roche Diagnostics GmbH, Mannheim, Germany).

Urine samples were also collected daily, during the first 72 hours and assessed for urinary Kidney Injury Molecule 1 (KIM-1) concentrations following manufacturer instructions (kit DKM100; R&D Systems Europe, UK).

Analysis of inferior cava vein

During the first 72 hours from inclusion, measurements of the diameter of IVC and the degree of inspiratory collapse were taken daily in long axis. The LOGIQ F6 (General Electrics Healthcare ©) and the G3S 1.7-3.8 MHz transducer probes were used for this purpose. IVC was assessed, with patient in supine position and with the least elevation of the upper body. IVC diameter was calculated from the cross sections of IVC by M-mode in both inspiration and expiration using the formula: 1 – ([IVC diameter inspiration/IVC diameter expiration] x 100).

Bio-impedance vector analysis

Bio-impedance vector analysis (BiVA) was performed using an EFG-electrofluidgraph (Akern©). Two electrodes were placed on the ventral side of the hand and foot of the same side of the body, daily during the first three days after admission and 24 h. prior to discharge. Body composition values were calculated based on size and weight determined daily at 24, 48 and 72 h. The variables obtained by this technique were total body water (TBW), total extracellular water (TEW) and body mass index (BMI).

Clinical congestion score

A previously validated CCS[8,9] was calculated at admission and discharge. The score included orthopnea, the presence of edema and jugular vein distension (JVD). The weight of each variable was distributed as follows: orthopnea (0 to 3), peripheral edema (0 to 3) and JVD (0 to 2). Patients with a CCS ≥ 1 at discharge were considered as having "residual congestion".

Outcomes

Time-to event, all-cause mortality and HF-readmissions were registered. To the purpose of the survival analysis, follow-up started after discharge. Outcomes were identified by reviewing medical records of each included patient. Occurrence of WRF during hospitalization was surveyed as an additional outcome.

Statistical Analysis

Continuous variables were expressed by mean or median depending on the normality of each variable. Categorical variables were expressed as a percentage. The t-Student's or ANOVA test was used for comparisons between continuous and normally distributed variables. Variables not normally distributed were compared with U-Mann Whitney or Kruskal-Wallis test. For categorical variables comparison, the chi-squared test was used. Correlation analysis was performed using the Pearson or Spearman test, according to normality.

The confidence intervals included were 95% (CI95%), establishing the statistical significance for p values lower than 0.05. Statistical analysis was performed with the Statistical Package for the Social Sciences (SPSS) version 24.0 for Windows.

Results

Baseline characteristics

A total of 43 patients completed the PIA study **(Flow chart is shown in Supplementary figure 1).** Mean age was 80.1 ± 8.4 years, with a higher proportion of females (62.8%) and patients with a previous admission for ADHF (60.5%). The most prevalent comorbidities were arterial hypertension (83.7%), atrial fibrillation/flutter (67.4%), hypercholesterolemia (51.2%), diabetes mellitus (39.5%) and chronic kidney disease (CKD) (39.5%) (Table S1, in supplementary material).

Intrabdominal pressure analysis

A high proportion of patients (33 patients [76.7%]) showed increased IAP (≥ 12 mmHg) at baseline. Baseline median IAP was 15.0 (11.0 – 17.0). IAP significantly declined at 72 hours (12.0 [10.0 – 15.0]; p = < 0.001). At 72 hours, IAP remained elevated (> 12 mmHg) in 19 patients (48.7%). IAP time-line changes for each individual are shown in Figure 1.

Intrabdominal pressure at baseline (Table 1).

Patients with baseline IPA above 12 mm Hg, showed higher prevalence of CKD (48.5% vs. 10.0%: p=0.029), higher concentrations of baseline serum creatinine (1.30 mg/dL vs. 0.95 mg/dL; p=0.007) and uric acid (8.1 mg/dL vs. 5.2 mg/dL; p=0.002), as well as larger IVC diameter at admission (19.7 mm vs. 13.2 mm; p=0.013).

The incidence of WRF and signs of tubular damage (urine concentrations of KIM-1) were similar in both groups, regardless baseline IAP.

Intrabdominal pressure after 72 hours of admission (Table 2).

Patients with a remaining elevated IAP (>12 mm Hg) 72 h after admission, had received higher doses of i.v. furosemide during that period of time (190 mg [140 – 320] vs. 130 mg [97.5 – 160.0]; p=0.001) and their diuretic response was impaired, either measured by total diuresis (14.4 mL/mg [9.1 – 23.8] vs. 21.6 mL/mg [14.3 – 29.9]; p= 0.050) or natriuresis (1.2 mEq/mg [0.5 - 1.8] vs. 2.0 mEq/mg [1.7 – 2.5]; p=0.008). The group of patients with persistently high IAP at 72 h, showed a larger diameter of IVC at any measurement during hospitalization: baseline (20.2 mm vs. 15.0 mm; p=0.046), 72 hours (17.0 mm vs. 16.0 mm; p=0.028) and discharge (17.1 mm vs. 12.4 mm; p=0.032). **Of note, there were no differences in right ventricle systolic function, as expressed by TAPSE, nor in PASP, depending on the level of remaining IAP at 72 h.**

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Furthermore, the group with remaining high IAP at 72 h had a larger volume of total body water (41.6 L [40.9 – 43.5] vs. 35.0 L [31.5-47.0]; p=0.001) and total extracellular water (22.4 L [21.1 – 30.6] vs. 20.8 L [15.0 – 28.0]; p=0.005) at 72 h.

Intrabdominal pressure and renal function

As compared to patients with normal renal function at admission, those with impaired function (eGFR < 60 mL/min/1.73m^2 [CKD-EPI-Creatinine]) had lower BMI (27.9 kg/m^2 vs. 32.0 kg/m^2; p=0.005) and had been treated in a lower proportion with mineralocorticoid receptor antagonists (9.2% vs 15.4%; p = 0.034). Hemoglobin (11.5 g/L vs. 12.3 g/L; p=0.031) and bicarbonate concentrations (22.9 vs. 26.1 mmol/L; p=0.018) were lower, whilst CA125 (49.3U/mL vs. 36.1 U/mL; p= 0.028) was significantly higher among patients with renal dysfunction.

There were no differences in IAP at baseline (15.6 mm Hg vs. 14.9 mm Hg; p=0.613) or at 72 hours (12.5 mm Hg vs. 12.1 mm Hg; p=0.791), in IVC diameter and its degree of collapse, and in total body water and total extracellular water, with regard to admission eGFR (A complete data set is shown in Table S2, supplementary material).

Intraabdominal pressure and outcomes

During follow-up, 12 deaths (29.3%) and 26 readmissions (61.9%) were registered. One-year all-cause mortality was significantly higher among those patients whose IAP after 72 hours of admission, remained elevated (45.0 % vs. 16.7%; Log-rank test = 0.041) (Figure 2). This group also had a longer hospital stay (9.0 days vs. 5.5 days; p=0.005).

Seven patients (17.9%) developed WRF during admission. This group had higher concentrations at admission of NT-proBNP (8929 pg/mL vs. 3092 pg/mL; p=0.004), creatinine (1.67 mg/dL vs. 1.03 mg/dL; p=0.017) and cystatin C (2.17 U/mL vs. 1.51 U/mL; p=0.013). Baseline water content (total body water and total extracellular water), IVC diameter, its degree of collapse and IAP (baseline and at 72 hours) did not differ between patients with or without WRF (a complete data set is shown in Table S3, supplementary material).

Discussion

Our study showed that elevated IAP was present in the majority of patients who were hospitalized for ADHF. Increased IAP levels at admission were associated with poorer baseline renal function and a poorer diuretic response. A higher all-cause mortality was observed in patients with persistently increased IAP after 72 hours. To our knowledge, there are no previous studies simultaneously addressing systemic venous congestion, diuretic response and IAP. Our findings may contribute to a better understanding on the role of congestion and IAP in the pathophysiology of ADHF.

IAP as a surrogate marker of systemic venous congestion

According to the criteria of the American Society of Surgeons, that established 12 mm Hg as the cut-off value of normalcy for IAP[27,32], we found that roughly two thirds of ADHF patients in our cohort presented with elevated IAP at admission. More interestingly, in half of them, IAP remained increased 72 h later, after i.v. diuretics had been administered and signs and symptoms of congestion had relieved.

Most of the surrogate markers of congestion (IVC diameter, CA125 and BiVA) were higher in the group of patients with elevated IAP as compared to those with normal values. Of note, admission IAP was positively correlated to the diameter of IVC, body water content by BiVA and CCS; even more, the correlation was still significant for IVC and BiVA 72 h after admission. This time-line change reflects a parallel pattern of behavior of systemic venous congestion and IAP, lending experimental support to the notion that IAP is an additional surrogate marker of systemic congestion.

The relationship between IAP and systemic congestion should be interpreted in the context of water and salt retention and volume expansion taking place in HF. Altogether, those alterations give rise to an increase in CVP reflected through the enlargement of IVC diameter and physical signs of congestion. Extracellular volume expansion is partially compensated by a redistribution of volemia, including a shift to the splanchnic bed that accounts for the increase in IAP, which can be easily measured through a urine catheter. **The absence of differences in TAPSE and PSAP regarding the levels of remaining IAP at 72 h. may partly be explained by the high proportion of patients with HFpEF in our cohort. Nonetheless, we think that it also points to the importance of the role of peripheral vascular bed, specially the splacnic venous territory, in the pathophysiology of decompensations of HF.**

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Our results suggest that quantification of IAP through a simple maneuver, such as the insertion of a urine catheter, provides an objective measure of the degree of systemic congestion and their changes under diuretic therapy. Although further studies are required, it is plausible to think that measuring IAP can be especially useful to guide diuretic therapy during the early phase of admission, especially in patients in whom physical examination is more difficult due to obesity or comorbidities.

Intrabdominal pressure and renal function

The interest on the relationships between IAP and cardiorenal syndrome in ADHF is recent, and the evidence scarce[25]. It is known that IAP correlates with changes in serum creatinine

concentrations in patients with cardiogenic shock and LVEF below 20%[29]. In a recent primary study[30], based on a HFrEF mice model, IAP has been correlated with kidney dysfunction in both chronic heart failure and myocardial infarction models. However, these results[29,30] do not prove a causal relationship and probably cannot be extrapolated to patients with other causes of acute HF or with preserved LVEF.

Damman et al[33], found a narrow relationship between CVP and renal function impairment during ADHF. Furthermore, several subanalyses of large clinical trials, have shown residual clinical congestion and WRF to be related, conferring to these patients worse prognosis[34–36]. These results reinforce the hypothesis of a link between systemic congestion and renal dysfunction in ADHF.

In our cohort, renal function was poorer in patients with an admission IAP above normal values. These patients showed higher prevalence of previous CKD and concentrations of blood urea, creatinine and cystatin C significantly higher at admission. Surprisingly, we were not able to find any relationship between IAP, either at admission or after 72 h, and worsening renal function. Our data, hence, do not support a pathophysiological link between IAP and renal dysfunction. We could not find differences in IAP in our population, either at baseline or at 72 h, depending on whether admission eGFR was below or above 60 mL/min/1.73 m^2 (Table S4, supplementary material),. Moreover, the occurrence of WRF did not differ between patients with normal or elevated IAP, either at admission or at 72 h (Table S3, supplementary material). The most plausible explanation is that the increase in IAP is the consequence of an insufficient diuretic response leading to a higher degree of remaining congestion, which in turn impairs renal function[29,30]. In this context, IAP appears merely as a surrogate marker of systemic congestion, the true protagonist in cardiorenal interactions during decompensations. As a matter of fact, the persistence of high IAP at 72 h was still associated to a lower response to loop diuretics, despite the higher doses of i.v. diuretics accumulated in this group.

Diuretic resistance is a common observation in congestive ADHF[11,37,38]. As a surrogate marker for congestion, persistent elevation of IAP after diuretic therapy indicates a

higher degree of remaining systemic congestion, as indicated for concomitant persistence of increased IVC diameter and body water content (Table 3). Current evidence[24,39,40] suggests diuretic response is affected by congestion itself, but the mechanisms linking diuretic resistance to congestion are unknown and deserve further investigation.

Prognostic significance of elevated Intrabdominal pressure

Baseline (admission) IAP had no impact on prognosis; either in one-year all-cause mortality, or in HF-readmissions, nor on the incidence of WRF. However, a higher incidence of one-year all-cause mortality was observed among patients with persistent IAP above normal levels at 72h. These results could be explained if we interpret IAP as a surrogate marker of congestion (Table 3). Several studies have shown the prognostic importance of residual congestion and diuretic response during the early phase after admission. *Valente et al*.[41], found that diuretic response (defined as negative Δ weight kg/40 mg furosemide) was predictive of death and readmissions for HF in PROTECT[42] a study designed to assess the efficacy of rolofylline on treating congestion and renal function in ADHF.

To the best of our knowledge, our study is the first showing a higher mortality in patients with persistently elevated IAP after intensive diuretic therapy (first 72 hours).

Intraabdominal pressure, residual congestion and diuretic response.

A comprehensive view of our results reflects a rather complex relationship between IAP, water content and diuretic response that eventually result in decongestion. If our interpretation is correct, IAP is merely a marker of congestion without pathophysiological relation to the development of WRF or death. The persistence of high IAP accounts for residual congestion, a clinical fact that has been consistently linked to increases in mortality[8,43]. Changes in water content by BiVA were similar irrespective of IAP. Nonetheless, the dose of diuretics was much higher in the high IAP group, reflecting the impairment of diuretic response probably mediated by systemic congestion. If this interpretation is correct, the key to achieve an adequate decongestion during ADHF relies on the kidneys themselves. Probably, diuretic response during ADHF is the result

of previous renal function and i.v. diuretic titration, all of them dependent of local hemodynamic factors regulated by renin-angiotensin system, natriuretic peptides and others such as adenosine. A better understanding of cardio-renal interactions and new diuretic strategies —including the addition of new decongestive therapies, such as sodium-glucose linked transporter inhibitors(SLGT2i)[44]— will allow clinicians to improve outcomes in ADHF by targeting systemic venous congestion.

According to our results, the measurement of IAP during the early phase of admission may be of clinical interest to, by predicting the risk of residual congestion, implement optimal strategies to achieve a proper decongestion before discharge. There are several practical advantages of measuring IAP. First, the simplicity of its measurement; second, the objective threshold of normality; third, the prognostic yielded by IAP; and fourth, the possibility of monitoring the early changes in congestion occurring immediately after admission. Other proven useful biomarkers of congestion are rather variable, such as NT-proBNP[45,46], or lack of a clear cut-off for interpretation, as happens with CA125[47,48], and their time-line changes cannot be discriminated over a few days, thus not being useful to monitor the prompt and quick variations in the degree of congestion early after admission[13].

To summarize, we propose that IAP is a surrogate marker of systemic congestion, independent of baseline renal function and its persistence at 72 h, after intensive diuretic treatment, has negative prognostic implications.

5. Limitations

The study has been carried out in a single center so its results cannot be generalizable. The sample size is small, although the systematic approach, the wide range of the procedures used to measure congestion, as well as the rigor in its execution, mitigate, at least in part, this limitation. **The utility of IVC diameter to assess right atrial pressure could be limited by increased intraabdominal pressure and the presence of ascites (the grade of ascites was not registered).** Finally, the pathophysiological mechanisms analyzed in this study are not well defined, so it can

be considered a pioneering study. More studies are needed to better understand the link between IAP, systemic congestion and diuretic response. Probably, a larger study, assessing the effectiveness of guiding diuretic treatment through intra-abdominal pressure would be interesting to clarify the usefulness of this measurement during acute heart failure admission.

6. Conclusions

The great majority of patients who were hospitalized for ADHF had elevated intra-abdominal pressure. A significant correlation was observed between baseline IAP, 72h IAP and surrogate markers of congestion (composite CCS, IVC and BiVA). Increased IAP at baseline was associated with poorer renal function and a poorer diuretic response. Patients with elevated IAP at 72 hours were hospitalized for a longer stay and showed higher rates for all-cause mortality.

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Conflicts of interest

The authors declare no conflict of interest.

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Figure 1: Intraabdominal development from baseline to 72 hours after admission.

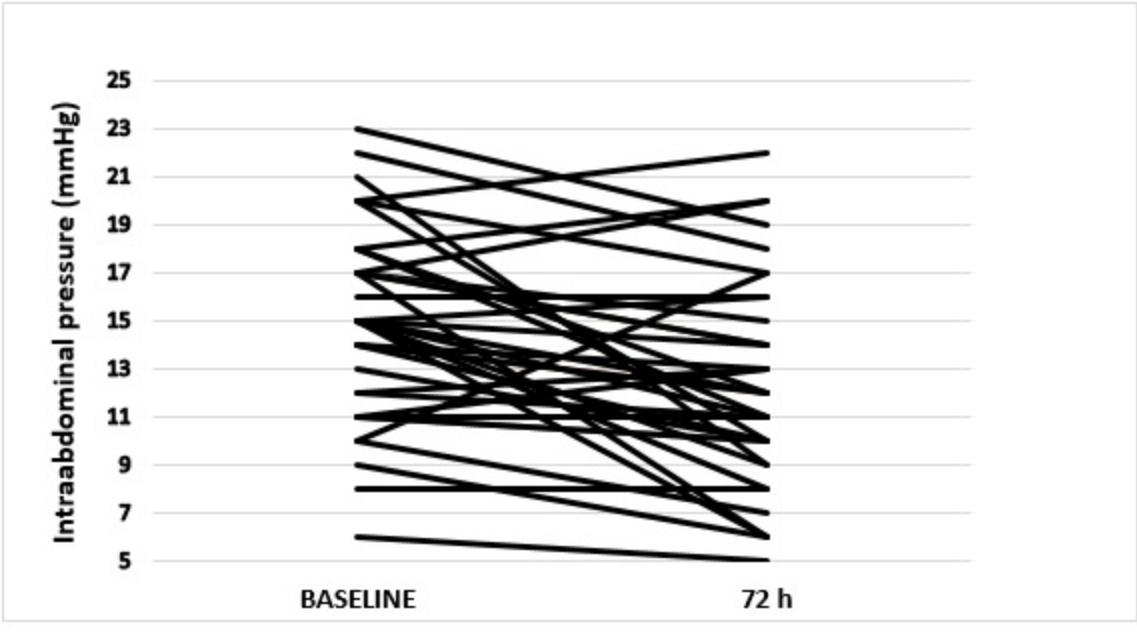

Table 1: Baseline clinical characteristics according to normal (< 12 mmHg) or elevated IAP (≥ 12 mm Hg) at admission.

Variable	Normal IAP	Elevated IAP	p-value
N (%)	10 (23.3)	33 (76.7)	
Age (years)	82.0 ± 8.5	79.6 ± 8.4	0.437
Female (n[%])	8 (80.0)	19 (57.6)	0.199
BMI (Kg/m^2)	28.7 ± 7.1	30.6 ± 5.9	0.408
SBP (mm Hg)	142.9 ± 22.8	137.6 ± 21.8	0.451
DBP (mm Hg)	84.9 ± 12.3	77.1 ± 13.0	0.099
HR (b.p.m)	82.6 ± 12.3	80.1 ± 17.5	0.744
LVEF (%)	55.9 ± 14.7	45.7 ± 14.5	0.064
TAPSE (mm)	22.0 ± 2.1	19.4 ± 5.6	0.338
PASP (mmHg)	42.8 ± 16.4	46.9 ±18.1	0.626
Length of stay (days)	5.5 (4.7 – 8.5)	9.0 (8.0 – 16.5)	**0.005**
HF treatment (n[%])			
• ACEi/ARBs	8 (80.0)	23 (69.7)	0.525
• B-blockers	4 (40.0)	19 (57.6)	0.329
• MRA	1 (10.0)	7 (21.2)	0.425
• Loop diuretic	6 (60.0)	25 (75.8)	0.330
Commorbidities (n[%]):			
• HF admissions	7 (70.0)	19 (57.6)	0.481
• Hypertension	7 (70.0)	29 (87.9)	0.180
• Dyslipemia	5 (50.0)	17 (51.5)	0.933
• Chronic coronary disease	2 (20.0)	12 (36.4)	0.333
• Diabetes mellitus	3 (30.0)	14 (42.4)	0.481
• Atrial fibrillation/flutter	7 (70.0)	22 (66.7)	0.844
• COPD/Asthma	1 (16.7)	5 (15.2)	0.680
• Chronic kidney disease	1 (10.0)	16 (48.5)	**0.029**
• PCI	2 (4.7)	14 (42.4)	0.199
• Pacemaker	2 (20.0)	3 (9.1)	0.346

ACEi: Angiotensin-converting-enzyme inhibitor; ARBs: Angiotensine recepctor blockers; BMI: Body mass index; b.p.m.: beats per minute; COPD: Chronic obstructive pulmonary disease; DBP: Diastolic blood pressure; HF: Heart failure; HR: Heart rate; LVEF: Left ventricular ejection fraction; MRA: Mineraloid receptor antagonists; PASP: Pulmonary artery systolic pressure; PCI: Percutaneous coronary intervention. SBP: Systolic blood pressure; ***TAPSE: Tricuspid annular plane systolic excursion***

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Table 1 (cont.): Baseline clinical characteristics according to normal (< 12 mmHg) or elevated IAP (≥ 12 mm Hg) at admission.

Variable	Normal IAP	Elevated IAP	p-value
N (%)	10 (23.3)	33 (76.7)	
Renal function data and diuretic response			
• **Urea at admission (mg/dL)**	40 (31 – 59)	58 (44 – 92)	0.056
• **Urea at discharge (mg/dL)**	50 (35 – 65)	83 (62 – 38)	**0.007**
• **Creatinine at admission (mg/dL)**	0.95 ± 0.31	1.30 ± 0.56	**0.027**
• **Creatinine at discharge (mg/dL)**	0.87 (0.68 – 1.18)	1.18 (0.96 – 1.99)	0.060
• **Cystatin-C at admission (mg/dL)**	1.41 ± 0.45	1.73 ± 0.61	0.235
• **Cystatin-C at discharge (mg/dL)**	1.60 ± 0.71	1.83 ± 0.76	0.592
• **eGFR at admission (CKD-EPI- Creatinine)**	58.0 (53.8 – 85.5)	48.5 (30.5 – 74.9)	0.196
• **eGFR at discharge (CKD-EPI- Creatinine)**	63.6 (51.3 – 85.5)	50.0 (28.3 – 62.8)	**0.019**
• **Uric acid (mg/dL)**	5.2 ± 2.4	8.1 ± 2.3	**0.002**
• **Potassium (mEq/L)**	4.1 ± 0.8	4.3 ± 0.5	0.955
• **KIM-1 at admission (ng/mL)**	367.7 (123.2 – 663.4)	287.1 (130.0 – 589.0)	0.818
WRF at discharge (n[%])			
• **Defined as increase in creatinine ≥ 0.3 mg/dL**	0 (0.0)	2 (6.9)	0.394
Surrogate congestion markers			
• **CCS at admission (points)**	4.5 (4.0 – 5.7)	6.0 (5.0 – 7.0)	0.080
• **IAP at 72 hours (mmHg)**	9.8 ± 3.5	13.1 ± 4.1	**0.030**
• **IAP decrease (%)**	-0.5 (-1.5 – 0.5)	-3.0 (-6.0 - -1.0)	**0.015**
• **IVC diameter at admission (mm)**	13.2 (11.1 – 17.7)	19.7 (16.9 – 25.4)	**0.013**
• **IVC diameter at 72 hours (mm)**	18.2 (14.3 – 20.2)	19.5 (17.1 – 24.2)	0.082
• **NT-proBNP at admission (pg/mL)**	5767 (2133 – 7442)	3404 (2312 – 8926)	0.530
• **CA125 at admission (U/mL)**	39.4 (13.9 – 62.7)	43.6 (28.8 – 146.3)	0.078
• **TBW at admission (L)**	39.6 ± 6.4	43.1 ± 13.2	0.059
• **TBW at 72 h (L)**	33.5 ± 3.9	44.5 ± 12.5	**0.044**
• **TEW at admission (L)**	22.2 ± 9.5	25.0 ± 7.2	**0.041**
• **TEW at 72 h (L)**	22.0 ± 8.9	24.4 ± 5.9	**0.036**

CA 125: Carbohydrate antigen 125; CCS: Composite congestion score; eGFR: Estimated-glomerular filtration rate; IAP: Intraabdominal Pressure; IVC: Inferior vena cava; KIM-1: Kidney injury molecule 1; NT-proBNP: amino terminal fragment of brain natriuretic peptide; TBW: Total body water; TEW: Total Extracellular water; WRF: Worsening renal function.

Table 2: Baseline characteristics according to normal (< 12 mmHg) or elevated IAP (≥ 12 mm Hg) at 72 hours

Variable	Normal IAP	Elevated IAP	p-value
N (%)	19 (48.7)	20 (51.3)	
Age (years)	83.0 (77.0 – 88.0)	81.5 (77.7 – 84.0)	0.304
Female (n[%])	13 (68.4%)	11 (55.0)	0.389
BMI (Kgs/m2)	28.8 ± 6.6	31.4 ± 5.9	0.214
SBP (mmHg)	140.5 ± 20.5	139.7 ± 20.3	0.894
DBP (mmHg)	80.1 ± 14.0	80.1 ± 10.9	0.998
HR (b.p.m)	85.1 ± 17.4	76.9 ± 13.5	0.109
LVEF (%)	44.6 ± 15.5	38.4 ± 15.8	0.446
TAPSE (mm)	20.1 ± 3.4	19.7 ± 6.1	0.767
PASP (mmHg)	47.2 ± 20.9	43.1 ± 19.3	0.693
Lenght of stay (days)	8 (5 – 10)	10 (6 – 19)	0.189
HF treatment (n[%])			
• ACEi/ARBs	14 (73.7)	14 (73.7)	0.798
• B-blockers	9 (47.4)	13 (65.0)	0.267
• MRB	5 (26.3)	1 (5.0)	0.065
• Loop diuretic	15 (78.9%)	14 (70.0)	0.522
Comorbidities (n[%]):			
• HF admissions	11 (57.9)	13 (65.0)	0.648
• Hypertension	16 (84.2)	6 (80.0)	0.732
• Dislipemia	9 (47.4)	12 (60.0)	0.429
• Chronic coronary disease	6 (31.6)	7 (35.0)	0.821
• Diabetes mellitus	7 (36.8)	10 (50.0)	0.408
• Atrial fibrillation/flutter	15 (78.9)	11 (55.0)	0.113
• COPD/Asthma	3 (15.8)	3 (15.0)	0.946
• Chronic kidney disease	6 (31.6)	10 (50.0)	0.242
• PCI	6 (31.6)	9 (45.0)	0.389
• Pacemaker	3 (15.8)	1 (5.0)	0.267

ACEi: Angiotensin-converting-enzyme inhibitor; ARBs: Angiotensine recepctor blockers; BMI: Body mass index; b.p.m.: beats per minute; COPD: Chronic obstructive pulmonary disease; DBP: Diastolic blood pressure; HF: Heart failure ; HR: Heart rate; LVEF: Left ventricular ejection fraction; MRB: Mineraloid receptor blockers; PASP: Pulmonary artery systolic pressure; PCI: Percutaneous coronary intervention. SBP: Systolic blood pressure; **TAPSE: Tricuspid annular plane systolic excursion**

Table 2 (cont.): Baseline characteristics according to normal (< 12 mmHg) or elevated IAP (≥ 12 mm Hg) at 72 hours

Variable	Normal IAP	Elevated IAP	p-value
Total (n[%])	19 (44,2)	24 (55.8)	
WRF at discharge (n[%])			
• Defined as increase in creatinine ≥ 0.3 mg/dL	1 (5.6)	1 (5.9)	0.967
Biomarkers			
• NT-proBNP at admission (pg/mL)	5767 (2476 – 7442)	3331 (2156 – 13264)	0.815
• NT-proBNP at discharge (pg/mL)	2166 (1817 – 3616)	2552 (1065 – 6570)	0.925
• Cystatin-C at admission (mg/dL)	1.53 (1.28 – 2.11)	1.51 (1.26 – 1.94)	0.275
• Cystatin-C at discharge (mg/dL)	1.46 (1.39 – 2.33)	1.48 (1.28 – 2.15)	0.980
• CA125 at admission (U/mL)	43.6 (30.7 – 128.1)	39.9 (16.2 – 103.4)	0.692
• CA125 at discharge (U/mL)	38.7 (24.0 – 130.2)	50.9 (22.1 – 182.7)	0.963
• KIM-1 at admission (ng/mL)	240.1 (129.7 – 626.5)	406.4 (129.4 – 566.1)	0.555
Diuretic response (during first 72 h after admission)			
• Total natriuresis (mEq/mL)	91.5 ± 22.6	81.3 ± 27.4	0.320
• Total i.v. loop diuretic dose (mg)	130 (97.5 – 160.0)	190.0 (140.0 – 320.0)	**0.001**
• Diuretic response by weight (Δweight at 72 hours/ 40mg e.v. furosemide	-0.52 (-0.98 - -0.01)	-0.22 (-0.64 – 0.0)	0.180
• Diuretic response diuresis (mL urine /mg furosemide i.v.)	21.6 (14.3 – 29.9)	14.4 (9.1 – 23.8)	**0.050**
• Diuretic response natriuresis (mEq Na / mg furosemide i.v.)	2.0 (1.7 – 2.5)	1.2 (0.5 – 1.8)	**0.008**
Congestion surrogate markers			
• IVC diameter at admission (mm)	15.0 ± 3.5	20.2 ± 4.6	**0.046**
• IVC diameter at 72 h (mm)	16.0 ± 4.4	17.0 ± 2.5	**0.028**
• IVC diameter at discharge (mm)	12.4 ± 3.3	17.1 ± 3.9	**0.032**
• TBW at admission (L)	36.4 (30.9 – 49.3)	42.4 (39.1 - 43.5)	0.054
• TBW at 72 h (L)	35.0 (31.5 – 47.0)	41.6 (40.9 – 43.5)	**0.001**
• TBW at discharge (L)	34.2 (31.9 – 40.1)	39.9 (35.5 – 41.5)	0.371
• TEW at admission (L)	18.0 (15.0 – 31.1)	28.1 (20.1 – 33.9)	**0.002**
• TEW at 72 h (L)	20.8 (15.0 – 28.0)	22.4 (21.1 – 30.6)	**0.005**
• TEW at discharge (L)	19.6 (16.0 – 32.1)	24.5 (20.3 – 29.6)	0.569

CA 125: Carbohydrate antigen 125; CCS: Composite congestion score; e-GFR: estimated Glomerular filtration rate; IAP: Intraabdominal Pressure; I.v.: intravenous**;** IVC: Inferior vena cava; KIM-1: Kidney injury molecule 1; NT-proBNP: amino terminal fragment of brain natriuretic peptide TBW: Total body water; TEW: Total Extracellular water; WRF: Worsening renal function.

Figure 2: Cumulative survival curve by IAP at 72 hours for all-cause mortality at one-year.

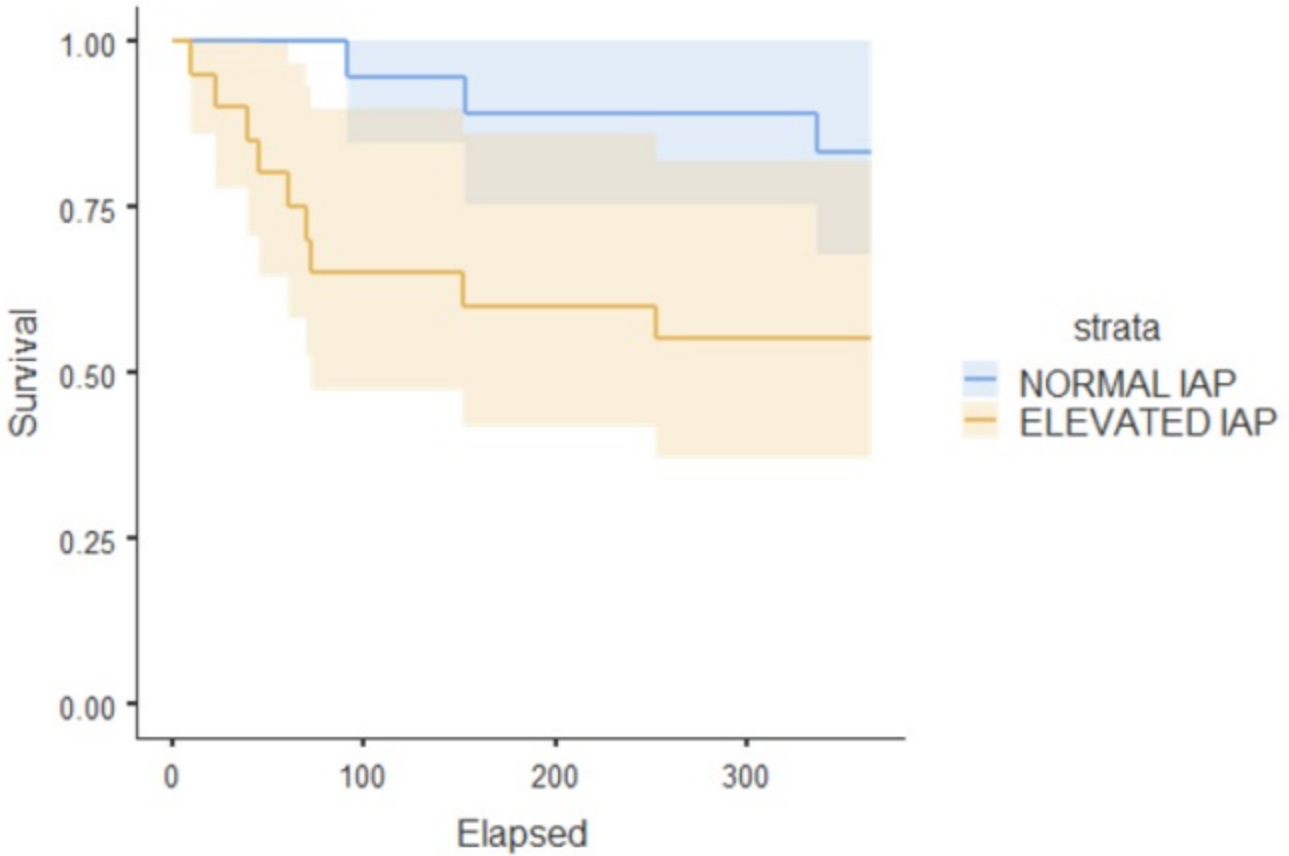

Table 3: Correlation between changes in IAP and surrogate markers of congestion.

	IAP at baseline		**IAP at 72 hours**	
Variable	**Pearson coefficient**	**P-value**	**Pearson coefficient**	**P-value**
LVEF (%)*	-0.299	0.068	-0.163	0.351
CCS at baseline (points)*	0.451	**0.006**		
B Kerley lines at baseline (total number)*	0.249	0.276		
B Kerley lines at 72 hs (total number)*			0.425	0.130
TBW at baseline (L)*	0.422	**0.005**		
TEW at baseline (L)*	0.438	**0.004**		
TBW at 72 hours(L)*			0.363	**0.030**
TEW at 72 hours (L)*			0.210	0.219
IVC diameter at baseline (mm)*	0.553	< **0.001**		
IVC diameter at 72 hs (mm)*			0.399	**0.014**

CCS: Composite congestion score; IVC: Inferior vena cava; LVEF: Left ventricular ejection fraction; TBW: Total body water; TEW: Total extracellular water.

** Variables have been transformed by fractional polynomials.*

Supplementary figure 1: Flow chart of PIA study.

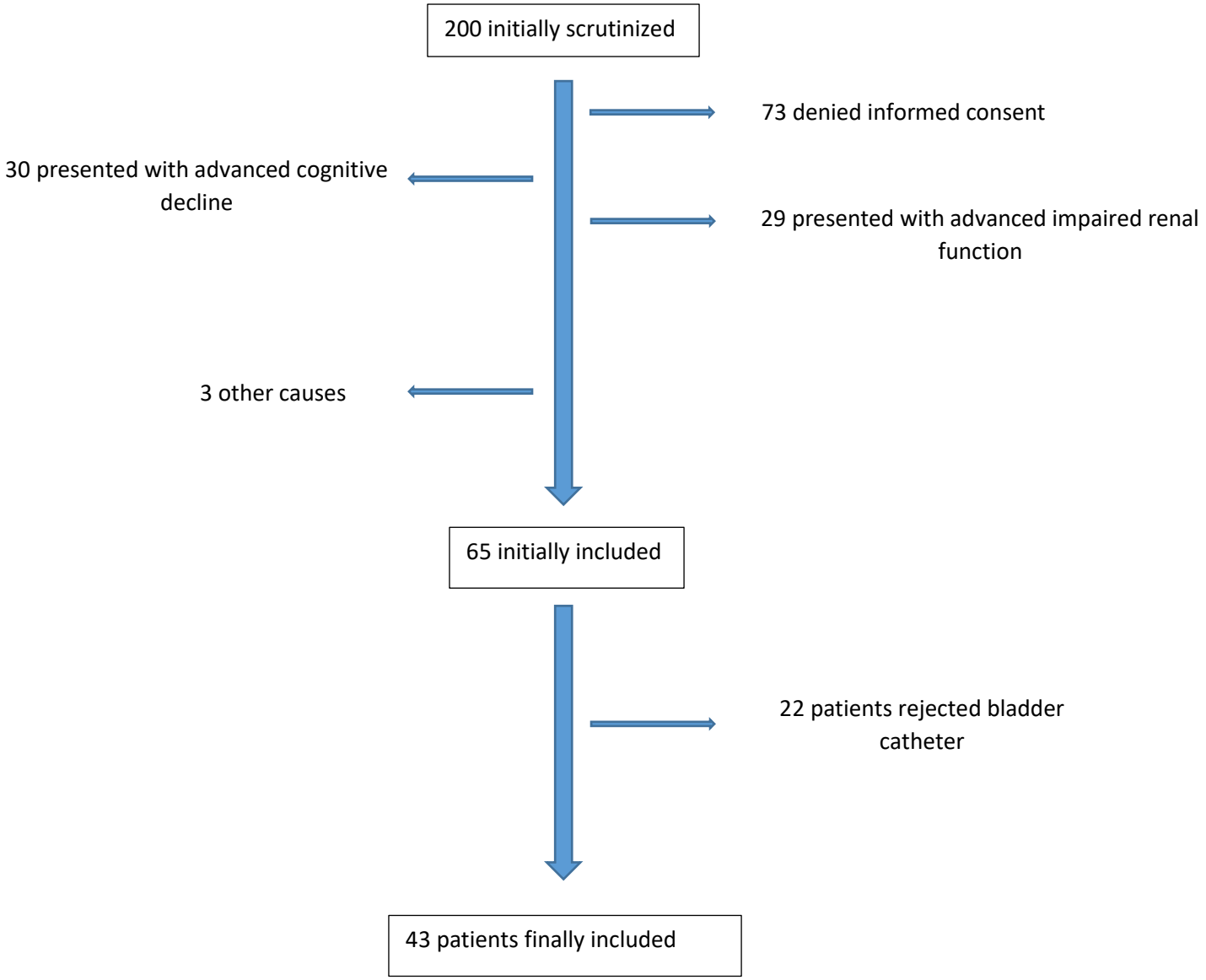

Table S1: Baseline clinical characteristics	
N (%)	43 (100.0%)
Age (years)	80.1 ± 8.4
Female (n[%])	27 (62.8)
BMI (Kg/m2)	29.6 (27.0 – 34.7)
SBP (mm Hg)	138.2 ± 22.1
DBP (mm Hg)	78.9 ± 13.0
HR (b.p.m)	81.0 ± 16.3
LVEF (%)	48.4 ± 15.0
TAPSE (mm)	19.9 ± 5.2
PASP (mmHg)	45.9 ± 17.5
Length of stay (days)	9 (6 – 15)
HF treatment (n[%])	
• ACEi/ARBs	31 (72.1)
• B-blockers	23 (53.5)
• MRA	8 (18.6)
• Loop diuretic	31 (72.1)
Commorbidities (n[%]):	
• HF admissions	26 (60.5)
• Hypertension	36 (83.7)
• Dyslipemia	22 (51.2)
• Chronic coronary disease	14 (32.6)
• Diabetes mellitus	17 (39.5)
• Atrial fibrillation/flutter	29 (67.4)
• COPD/Asthma	6 (14.0)
• Chronic kidney disease	17 (39.5)
• PCI	16 (37.2)
• Pacemaker	5 (11.6)
Renal function data and diuretic response	
• Urea at admission (mg/dL)	57 (3.8 – 8.4)
• Urea at discharge (mg/dL)	75 (5.4 – 11.3)
• Creatinine at admission (mg/dL)	1.21 ± 0.53
• Creatinine at discharge (mg/dL)	1.11 (0.80 – 1.86)
• Cystatin-C at admission (mg/dL)	1.65 ± 0.58
• Cystatin-C at discharge (mg/dL)	1.77 ± 0.74
• eGFR at admission (CKD-EPI- Creatinine)	52.4 (37.3 – 76.6)
• eGFR at discharge (CKD-EPI- Creatinine)	51.4 (29.3 – 66.8)
• Uric acid (mg/dL)	7.37 ± 2.69
• Potassium (mEq/L)	4.19 ± 0.66
• KIM-1 at admission (ng/mL)	337 (129 – 602)
WRF at discharge (n[%])	
• Defined as increase in creatinine ≥ 0.3 mg/dL	7 (17.9)
Surrogate congestion markers	
• CCS at admission (points)	5.5 (4.2 – 6.0)
• IAP at baseline (mmHg)	14.7 ± 3.9
• IAP at 72 hours (mmHg)	12.2 ± 4.2
• IAP decrease (%)	-15 (-30.0 – 0.0)
• IVC diameter at admission (mm)	21.9 ± 6.6
• IVC diameter at 72 hours (mm)	19.4 (16.7 – 22.7)
• NT-proBNP at admission (pg/mL)	3780 (2306 – 8929)
• CA125 at admission (U/mL)	44.3 (22.8 – 116.0)
• TBW at admission (L)	41.7 ± 10.0
• TBW at 72 h (L)	39.3 ± 10.1
• TEW at admission (L)	21.8 ± 6.5
• TEW at 72 h (L)	21.7 ± 6.3

ACEi: Angiotensin-converting-enzyme inhibitor; ARBs: Angiotensine recepctor blockers; BMI: Body mass index; b.p.m.: beats per minute; CA 125: Carbohydrate antigen 125; CCS: Composite congestion score; COPD: Chronic obstructive pulmonary disease; DBP: Diastolic blood pressure; eGFR: Estimated-glomerular filtration rate; HF: Heart failure ; HR: Heart rate; IAP: Intraabdominal Pressure; IVC: Inferior vena cava; KIM-1: Kidney injury molecule 1; LVEF: Left ventricular ejection fraction; MRA: Mineraloid receptor antagonists; NT-proBNP: amino terminal fragment of brain natriuretic peptide; PASP: Pulmonary artery systolic pressure; PCI: Percutaneous

coronary intervention. SBP: Systolic blood pressure; TAPSE: Trycuspidic annulus systolic excursion. TBW: Total body water; TEW: Total Extracellular water; WRF: Worsening renal function.

Table S2: Baseline characteristics according to the presence of chronic kidney disease at admission (CKD-EPI < 60mL/min/1.73m2)

Variable	eGFR ≥ 60 mL/min	eGFR < 60 mL/min	P-value
Total (n[%])	26 (40.0)	39 (60.0)	
Age (years)	75.8 ± 10.5	81.9 ± 7.2	**0.015**
Males (n[%])	11 (16.9)	18 (27.7)	0.760
BMI (Kg/m2)	32.0 ± 5.7	27.9 ± 5.0	**0.005**
Weight (Kg)	84.2 (72.7 – 98.3)	75.7 (65.3 – 81.7)	**0.009**
SBP at admission (mmHg)	131.0 ± 20.0	136.2 ± 21.7	0.412
DBP at admission (mmHg)	75.9 ± 15.5	77.1 ± 12.6	0.722
HR (B.p.m.)	82.6 ± 13.6	79.3 ± 18.1	0.438
NYHA (n[%]):			0.075
• I	5 (7.7)	6 (9.2)	
• II	18 (27.7)	17 (26.2)	
• III	3 (4.5)	14 (21.5)	
• IV	0 (0.0)	2 (3.1)	
HF treatment (n[%])			
• ACEi/ARBs	17 (26.2)	27 (41.5)	0.745
• B-blockers	15 (23.1)	22 (33.8)	0.919
• MRB	10 (15.4)	6 (9.2)	**0.034**
• Loop diuretics	17 (26.2)	31 (47.7)	0.205
Commorbidities (n[%]):			
• HF admissions	17 (26.2)	24 (36.9)	0.753
• Hypertension	22 (33.8)	31 (47.7)	0.602
• Dislipemia	11 (16.9)	25 (38.9)	0.083
• Chronic coronary disease	7 (10.8)	12 (18.5)	0.738
• Diabetes mellitus	10 (15.4)	17 (26.2)	0.681
• Atrial fibrillation/flutter	20 (30.8)	23 (35.4)	0.134
• COPD/Asthma	4 (6.2)	5 (7.7)	0.769
• Chronic kidney disease	2 (3.1)	19 (29.2)	**0.001**
• PCI	10 (15.4)	13 (20.0)	0.672
• Pacemaker	2 (3.1)	5 (7.7)	0.513
Echographic variables			
• LVEF (%)	48.0 ± 14.6	50.1 ± 15.7	0.630
• IVC diameter (mm)	21.9 ± 6.9	21.1 ± 6.1	0.604
• IVC colapsability (%)	32.0 (12.1 – 48.0)	38.1 (16.9 – 40.0)	0.603
Clinical variables			
• CCS (points)	5.0 (3.0 – 6.0)	5.0 (4.0 – 6.0)	0.599
• Mean stay (days)	8.0 (5.7 – 10.0)	8.0 (6.0 – 14.2)	0.592
• IAP (mmHg)	15.6 ± 4.7	14.9 ± 4.1	0.613
• IAP at 72 hours (mmHg)	12.5 ± 3.2	12.1 ± 4.7	0.791
• Urea (mg/dL)	40 (29 – 54)	64 (55 – 101)	**<0.001**
• Creatinine (mg/dL)	0.79 (0.65 – 0.91)	1.38 (1.10 – 1.76)	**<0.001**

• Cystatin C (mg/L)	1.1 (0.78 – 1.35)	1.74 (1.39 – 2.15)	**<0.001**
• Uric acid (mg/dL)	7.0 ± 2.9	8.0 ± 2.1	0.123
• Total proteins (g/dL)	6.4 ± 0.3	6.6 ± 0.8	0.422
• Total cholesterol (mg/dL)	135.8 ± 24.0	137.1 ± 35.6	0.877
• Triglicerides (mg/dL)	81.0 (65.5 – 107.0)	88.0 (71.0 – 115.2)	0.382
• Albnmin (mg/dL)	3.16 ± 037	3.06 ± 0.40	0.348
• Sodium (mEq/L)	140.8 (139.4 – 143.6)	140.6 (138.5 – 143.6)	0.746
• Potassium (mEq/L)	3.9 ± 0.5	4.3 ± 0.5	**0.004**
• Chloride (mEq/L)	97.5 ± 4.1	98.9 ± 5.3	0.270
• Bicarbonate (mmol/L)	26.1 (24.6 – 31.2)	22.9 (21.6 – 27.9)	**0.018**
• Hemoglobin (g/L)	12.3 ± 2.0	11.5 ± 1.1	**0.031**
• Hematocritum (%)	37.8 ± 5.7	35.4 ± 3.1	0.058
Surrogate congestion markers			
• NT-proBNP (pg/mL)	2476 (1662 – 3474)	6876 (3221 – 12850)	**<0.001**
• CA125 (U/mL)	36.1 (15.0 – 62.2)	49.3 (29.3 – 103.6)	**0.028**
Bioelectrical impedance vector analysis			
• TBW (L)	44.4 ± 11.7	41.4 ± 8.6	0.233
• TEW (L)	26.2 ± 11.2	23.3 ± 6.8	0.209

ACEi: Angiotensin-converting-enzyme inhibitor; AKI: Acute kidney injure; ARBs: Angiotensine recepctor blockers; BMI: Body mass index; b.p.m.: beats per minute; CA 125: Carbohydrate antigen 125; CCS: Composite congestion score; COPD: Chronic obstructive pulmonary disease; DBP: Diastolic blood pressure; e-GFR: Glomerular filtration rate; HF: Heart failure ; HR: Heart rate; IAP: Intraabdominal Pressure; IVC: Inferior vena cava; LVEF: Left ventricular ejection fraction; MRB: Mineraloid receptor blockers; NT-proBNP: amino terminal fragment of brain natriuretic peptide; PCI: Percutaneous coronary intervention; TBW: Total body water; TEW: Total Extracellular water.

Table S3: Baseline characteristics according to the presence of worsening renal function at discharge (defined as the increase of ≥ 0.3 mg/dL of creatinine).

Variable	NOT WRF	WRF	P-value
Total (n[%])	32 (82.1)	7 (17.9)	
Age (years)	79.6 ± 9.4	83.4 ± 3.7	0.304
Females (n[%])	20 (62.5)	4 (57.1)	0.792
BMI (Kgs/m2)	30.8 ± 6.4	27.3 ± 6.9	0.202
Weight (Kg)	78.8 (67.7 – 86.6)	71.0 (61.6 – 86.0)	0.487
SBP at admission (mmHg)	137.9 ± 20.8	130.0 ±27.0	0.395
DBP at admission (mmHg)	77.5 ±13.4	79.7 ± 10.1	0.698
HR (B.p.m.)	72.5 (65.2 – 95.5)	85.0 (71.0 – 102.0)	0.389
NYHA (n[%]):			0.107
• I	6 (18.8)	0 (0.0)	
• II	18 (56.3)	2 (28.6)	
• III	7 (21.9)	4 (57.1)	
• IV	1 (3.1)	1 (14.3)	
HF treatment (n[%])			
• ACEi/ARBs	23 (71.9)	5 (71,4)	0.987
• B-blockers	19 (59.4)	2 (28.6)	0.139
• MRB	4 (12.5)	3 (42.9)	0.058
• Loop diuretics	22 (68.8)	6 (85.7)	0.366
Commorbidities (n[%]):			
• HF admissions	17 (53.1)	5 (71.4)	0.376
• Hypertension	26 (81.3)	6 (85.7)	0.780
• Dislipemia	16 (50.0)	4 (57.1)	0.732
• Chronic coronary disease	11 (34.4)	3 (42.9)	0.672
• Diabetes mellitus	11 (34.4)	3 (42.9)	0.672
• Atrial fibrillation/flutter	22 (68.8)	5 (71.4)	0.889
• COPD/Asthma	3 (9.4)	3 (42.9)	0.026
• Chronic kidney disease	11 (34.4)	6 (85.7)	0.013
• PCI	13 (40.6)	2 (28.6)	0.553
• Pacemaker	4 (12.5)	1 (14.3)	0.898
Echographic variables			
• LVEF (%)	49.3 ± 14.5	47.6 ± 20.1	0.805
• IVC diameter (mm)	21.3 ± 6.0	24.0 ± 8.1	0.351
• IVC colapsability (%)	34.5 (17.0 – 75.9)	27.3 (6.3 – 49.7)	0.711
Clinical variables			
• CCS (points)	6 (5 – 6)	5 (4- 6)	0.699
• IAP (mmHg)	14.8 ± 4.2	14.6 ± 3.7	0.570
• IAP at 72 hours (mmHg)	12.3 ± 4.6	11.8 ± 3.7	0.814
• Urea (mg/dL)	52 (36 - 63)	100 (64 – 110)	**0.006**
• Creatinine (mg/dL)	1.03 (0.78 – 1.28)	1.67 (1.29 – 1.96)	**0.017**
• Cystatin C (mg/dL)	1.51 ± 0.53	2.17 ± 0.69	**0.013**

• KIM-1 (ng/mL)	273 (109 – 457)	602 (129 – 961)	0.107
• Uric acid (mg/dL)	7.06 ± 2.7	8.2 ± 1.6	0.261
• Total proteins (g/dL)	6.4 ± 0.5	6.1 ± 0.2	0.326
• Total cholesterol (mg/dL)	137.8 ± 33.0	124.4 ± 24.4	0.321
• Triglicerides (mg/dL)	96.1 ± 36.6	83.1 ± 12.6	0.354
• Albnmin (mg/dL)	3.09 ± 0.40	2.86 ± 0.15	0.676
• Sodium (mEq/L)	140 ± 4	142 ± 4	0.321
• Potassium (mEq/L)	4.08 ± 0.62	4.68 ± 0.73	**0.034**
• Chloride (mEq/L)	98.2 ± 5.3	100.4 ± 3.2	0.304
• Bicarbonate (mmol/L)	25.4 ± 3.9	24.2 ± 4.5	0.462
• Hemoglobin (g/L)	11.8 ± 1.7	11.7 ± 0.9	0.893
• Hematocritum (%)	36.6 ± 5.5	36.7 ± 3.6	0.980
Surrogate congestion markers			
• NT-proBNP (pg/mL)	3092 (2158 – 6345)	8929 (7041 – 32700)	**0.004**
• CA125 (U/mL)	41.2 (17.0 – 75.7)	60.8 (37.6 – 417.2)	0.194
Bioelectrical impedance vector analysis			
• TBW (L)	41.6 ± 9..6	43.5 ± 12.3	0.672
• TEW (L)	22.1 ± 7.0	23.0 ± 8.6	0.794

ACEi: Angiotensin-converting-enzyme inhibitor; AKI: Acute kidney injure; ARBs: Angiotensine recepctor blockers; BMI: Body mass index; b.p.m.: beats per minute; CA 125: Carbohydrate antigen 125; CCS: Composite congestion score; COPD: Chronic obstructive pulmonary disease; DBP: Diastolic blood pressure; e-GFR: Glomerular filtration rate; HF: Heart failure ; HR: Heart rate; IAP: Intraabdominal Pressure; IVC: Inferior vena cava; LVEF: Left ventricular ejection fraction; MRB: Mineraloid receptor blockers; NT-proBNP: amino terminal fragment of brain natriuretic peptide; PCI: Percutaneous coronary intervention; TBW: Total body water; TEW: Total Extracellular water.