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Original Research Article.

Cardiometabolic Risk Factors in Relation to Serum NT-Pro-BNP level: A Cross-Sectional Study Among CKD Patients

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ABSTRACT

Introduction: CKD patients suffer from increased rate of mortality and morbidity due to cardiovascular diseases, compared to general population. Cardiometabolic biomarker N-Terminal Pro-BNP has become a useful tool for quick screening and assessment for cardiovascular diseases. The aim of the present study is to find out the relationship between serum NT-Pro-BNP level and cardiometabolic risk factors among CKD patients without symptoms or history of cardiac diseases.

Materials & Methods: This cross-sectional study among 149 CKD patients was conducted from January to December 2020 at National Institute of Kidney Diseases and Urology (NIKDU), Dhaka. Anticoagulant free venous blood samples were assayed for serum NT-Pro-BNP by electrochemiluminescence immunoassay. Serum creatinine, total cholesterol, triglyceride, high-density lipoprotein, calcium, phosphate, uric acid, eGFR, albumin and total protein of the study population were assessed and recorded during data collection.

Results: Mean age of study population was 50.0 ± 12.4 years, male predominant (53%). Mean serum NT-Pro-BNP level was lowest (335.7 ± 213.3 pg/ml) for patients with CKD stage 1 and highest (15644.6 ± 2197.5 pg/ml) for patients with CKD stage 5. Mean serum creatinine was lowest (1.55 ± 1.54 mg/dl) for CKD stage 1 patients and highest (5.71 ± 2.75 mg/dl) for CKD stage 5 patients and this was statistically significant ($p < 0.05$). Mean serum total cholesterol, triglyceride, phosphate and uric acid were increased with disease severity and this increase was statistically significant ($p < 0.05$). Mean eGFR, serum albumin and total protein were decreasing with disease severity, and this decrease was also statistically significant ($p < 0.05$). Serum NT-Pro-BNP had significant positive correlation ($r = 0.61$, $p < 0.05$) with serum creatinine and significant negative correlation with total cholesterol, triglycerides, serum phosphorus, serum uric acid, eGFR and serum albumin.

Conclusion: Serum NT-Pro-BNP could be the potential screening tool for CKD with cardiovascular diseases and can provide prognostic information of major cardiovascular events.

Keywords: NT-Pro-BNP, Cardiometabolic Risk Factors, CKD.

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INTRODUCTION

Plasma concentrations of N-terminal pro-brain natriuretic peptide (NT-Pro-BNP) has been firmly associated with cardiac function.[1] NT-Pro-BNP is the inactive fragment of B-Type Natriuretic Peptide (BNP), and is released from cardiac myocytes into the circulation in response to pressure and volume overload.[2,3] Therefore, measurement of the increased serum levels of NT-Pro-BNP may have the potential to facilitate the accuracy of diagnosis and prognosis for patients with heart failure. The risk of cardiovascular complications is significantly higher among patients with CKD compared to general population.[4] Studies have shown elevated serum NT-Pro-BNP levels to be associated with the advancement of CKD.[5]

Prior studies among CKD patients showed an association between serum NT-Pro-BNP levels and prevalent cardiovascular complications, offering the potential for early detection and risk assessment for cardiac diseases and serve as a prognostic parameter.[6–10] Since serum NT-Pro-BNP clearance depends on renal function, there is a high prevalence of elevated serum NT-Pro-BNP level in asymptomatic patients with chronic kidney disease (CKD), due to reduced renal clearance.[6,11–13] Serum NT-Pro-BNP has been shown to predict cardiovascular events in apparently healthy individuals, where elevated serum NT-Pro-BNP level is often followed by poor cardiac outcome among patients, irrespective of renal function.[8,9,14,15] Thus, NT-Pro-BNP is

recognized as diagnostically and prognostically meaningful biomarker for patients with heart failure.[16] In recent years, NT-Pro-BNP measurement has been widely recognized as an auxiliary diagnostic tool for heart failure.[17] The aim of the present study is to assess the relationship between serum NT-Pro-BNP level and cardiometabolic risk factors among a cohort of CKD patients without symptoms or history of cardiac diseases.

MATERIALS & METHODS

This was a cross-sectional study among 149 CKD patients of stage 1 to 5 was conducted from January to December 2020 at National Institute of Kidney Diseases and Urology (NIKDU), Dhaka. Adult CKD patients age ≥ 18 years were included in the study. CKD patients with symptoms or history of cardiac diseases were excluded from the study, along with patients with malignancy, liver or thyroid dysfunction, nephrotic syndrome, history of organ transplant and on immunosuppressive medications. Purposive sampling technique was used. Ethical clearance was issued from the ethical review committee of NIKDU.

Aims and objectives of the study along with its procedure, risks and benefits of the study were explained to the respondent in easily understandable local language. Data were collected through face-to-face interview using a semi-structured questionnaire and data collection tools, only after Informed written consent was taken from the respondents. Serum NT-Pro-BNP levels were measured for each study subject. Anticoagulant free venous blood samples were assayed for serum NT-Pro-BNP by electrochemiluminescence immunoassay. Serum creatinine, total cholesterol, triglyceride, high-density lipoprotein, calcium, phosphate, uric acid, eGFR, albumin and total protein of the study population was assessed and recorded during data collection.

All data were compiled and processed with the help of statistician and were analysed using windows-based computer software with Statistical Packages for Social Sciences (SPSS-25) (SPSS Inc, Chicago, IL, USA). Quantitative data were expressed as mean & standard deviation. Categorical data were expressed as frequency and percentage. Comparison of variables were done by ANOVA and Chi-square test. For all statistical test, p-values less than 0.05 was considered significant.

Table I: Descriptive statistics of the study population (n = 149)

Variables	Value
Age (years)	50.0 ± 12.4
Age group (years)	
18 – 29	9 (6.0%)
30 – 44	40 (26.8%)
45 – 59	65 (43.6%)
60 – 69	35 (23.5%)
Sex	
Male	79 (53.0%)
Female	70 (47.0%)

Data are presented as n (%) or mean ± SD.

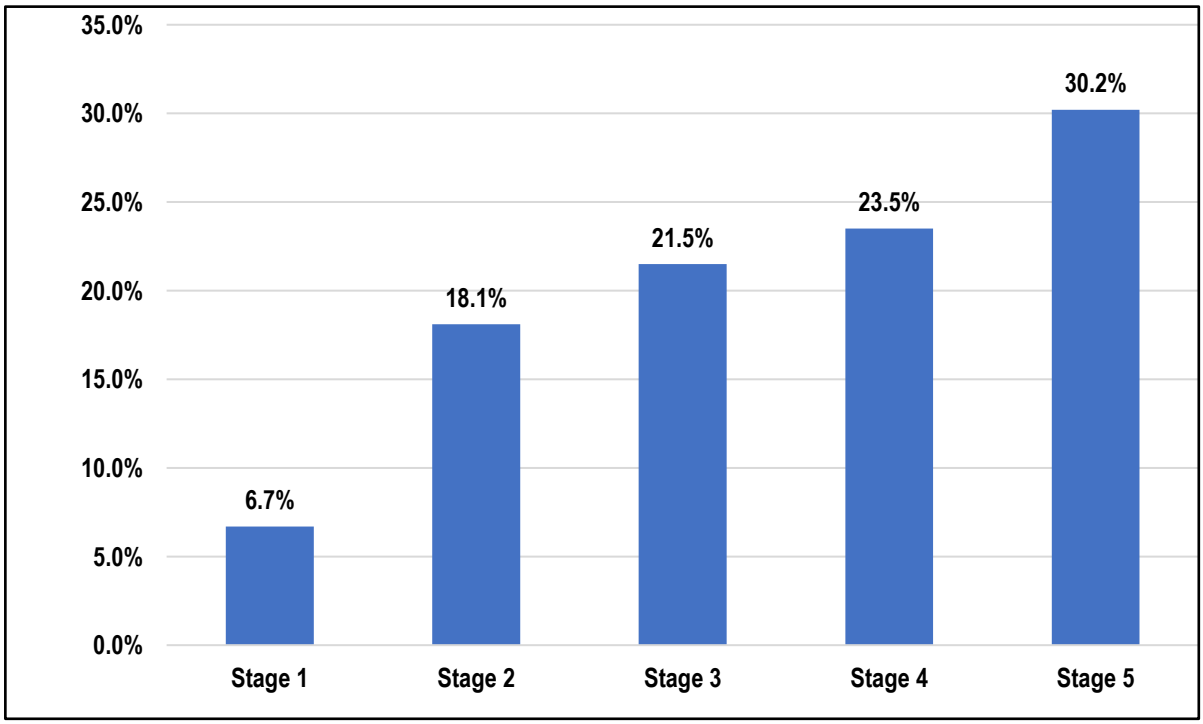

Figure 1: Distribution of study population according to CKD staging (n = 149)

Table II: Biochemical parameters of study population (n = 149)

Variables	CKD Stage 1 (n = 10)	CKD Stage 2 (n = 27)	CKD Stage 3 (n = 32)	CKD Stage 4 (n = 35)	CKD Stage 5 (n = 45)	Significance (p)
NT-Pro-BNP level (pg/ml)	335.70 ± 213.3	790.10 ± 330.5	2554 ± 1021.5	1144.1 ± 325.2	15644.6 ± 2197.5	< 0.05[a]
Serum Creatinine (mg/dL)	1.55 ± 1.54	1.72 ± 0.72	2.69 ± 2.03	3.04 ± 1.65	5.71 ± 2.75	< 0.05[a]
Total Cholesterol (mg/dl)	121.27 ± 29.91	183.21 ± 41.68	185.71 ± 65.08	204.57 ± 62.26	209.49 ± 74.95	< 0.05[a]
Triglyceride (mg/dl)	132.84 ± 87.63	153.66 ± 40.65	186.68 ± 78.95	214.67 ± 89.41	224.25 ± 114.92	< 0.05[a]
high-density lipoprotein (mg/dl)	45.45 ± 25.07	44.27 ± 20.72	40.18 ± 15.62	39.09 ± 18.93	38.19 ± 11.47	0.53
Calcium (mgm/dl)	10.26 ± 2.76	9.39 ± 1.74	9.20 ± 1.59	9.03 ± 2.06	8.94 ± 1.64	0.31
Phosphate (mg/dl)	3.70 ± 1.03	4.06 ± 0.97	4.40 ± 1.46	4.88 ± 1.41	5.47 ± 2.09	< 0.05[a]
Uric acid (mg/dL)	4.67 ± 1.45	5.03 ± 0.97	5.30 ± 1.32	5.67 ± 1.51	6.01 ± 2.02	< 0.05[a]
eGFR (ml/min/1.73m2)	90.80 ± 3.55	78.22 ± 11.08	45.53 ± 16.46	24.20 ± 6.1	10.18 ± 2.35	< 0.05[a]
Albumin (gm/dl)	45.66 ± 4.57	45.04 ± 5.72	46.00 ± 7.10	42.20 ± 7.74	38.81 ± 9.61	< 0.05[a]
Total Protein	8.88 ± 2.25	7.49 ± 2.92	6.42 ± 2.45	7.27 ± 1.8	6.95 ± 1.53	< 0.05[a]

Data are presented as mean ± SD.

[a] ANOVA was done and p values < 0.05 was considered statistically significant.

Table III: Association between serum NT-Pro-BNP and biochemical parameters (n = 149)

Variables	Pearson Correlation (r)	Significance (p)
S. Creatinine (mg/dL)	0.61	< 0.05[b]
Total cholesterol (mg/dl)	-0.32	< 0.05[b]
Triglyceride (mg/dl)	-0.38	< 0.05[b]
HDL (mg/dl)	-0.07	0.43
S. Calcium (mg/dL)	-0.08	0.34
S. Phosphorus (mg/dL)	-0.19	< 0.05[b]
S. Uric Acid (mg/dL)	-0.33	< 0.05[b]
eGFR (mL/min/1.73m²)	-0.41	< 0.05[b]
S. Albumin (g/dL)	-0.46	< 0.05[b]
S. Total protein (g/dL)	-0.08	0.34

[b] Pearson Correlation was done and p values < 0.05 was considered statistically significant.

RESULTS

Out of 149 CKD patients, 43.6% were from age group 45 – 59 years, followed by 26.8% from age group 30 – 44 years. Mean age of the study population was 50.0 ± 12.4 years (Table I). Study population was predominantly male (53%).

Study included patients from CKD stage 1 to 5 and highest proportion (30.2%) of the study population had CKD stage 5, followed by 23.5% with CKD stage 4 and 21.5% with CKD stage 3 (Figure 1).

Biochemical parameters of the study population were assessed (Table II). Mean NT-Pro-BNP level was lowest (335.7 ± 213.3 pg/ml) for patients with CKD stage 1, which increased with increasing CKD staging, reaching highest (15644.6 ± 2197.5 pg/ml) for patients with CKD stage 5. The difference in serum NT-Pro-BNP among patients with different CKD stages were found to be statistically significant ($p < 0.05$). Mean serum creatinine was lowest (1.55 ± 1.54 mg/dl) for CKD stage 1 patients and highest (5.71 ± 2.75 mg/dl) for CKD stage 5 patients. The difference in serum creatinine among patients with different CKD stages were found to be statistically significant ($p < 0.05$). Mean serum total cholesterol, triglyceride, phosphate and uric acid were increased with disease severity and this increase was statistically significant ($p < 0.05$). Mean eGFR, serum albumin and total protein were found to be decreasing with disease severity and this decrease was also statistically significant ($p < 0.05$).

Correlation of serum NT-Pro-BNP with biochemical parameters were observed (Table III). Serum NT-Pro-BNP had significant positive correlation ($r = 0.61$, $p < 0.05$) with serum creatinine and had significant negative correlation with total cholesterol, triglycerides, serum phosphorus, serum uric acid, eGFR and serum albumin.

DISCUSSION

Present study assessed the relationship between serum NT-Pro-BNP level and cardiometabolic risk factors among CKD patients without prior cardiovascular events. Mean age of the CKD patients enrolled in the study was 50.0 ± 12.4 years with 43.6% being from 45 – 59 years of age. This is consistent with a 2019 study where majority of the CKD patients were below 60 years of age with a mean age of 48.6 years.[18] Respondents in present study was predominantly male (53.0%). Similar findings have been shown in

previous studies among CKD patients where 62.9% study population were male.[19]

In present study, mean serum NT-Pro-BNP level was lowest (335.7 ± 213.3 pg/ml) for patients with CKD stage 1, which significantly increased with CKD staging, reaching highest (15644.6 ± 2197.5 pg/ml) for patients with CKD stage 5. This change in serum NT-Pro-BNP in relation to CKD staging is consistent with previous study among CKD patients.[20–22] Decreased clearance through kidney and volume overload, along with other comorbidities play crucial parts in this change in serum NT-Pro-BNP level.[23,24] Biochemical parameters of the study population were assessed. Mean NT-Pro-BNP level was lowest (335.7 ± 213.3 pg/ml) for patients with CKD stage 1, which increased with increasing CKD staging, reaching highest (15644.6 ± 2197.5 pg/ml) for patients with CKD stage 5. The difference in serum NT-Pro-BNP among patients with different CKD stages were found to be statistically significant ($p < 0.05$). This is consistent with a 2020 study, showing patients with higher NT-Pro-BNP having a significantly higher risk of eGFR decline of more than 40%, compared to patients with lower NT-Pro-BNP.[25] The main way of estimating GFR is a blood test to determine serum creatinine. As kidney function declines, the level of creatinine increases. In the present study, mean serum creatinine was lowest (1.55 ± 1.54 mg/dl) for CKD stage 1 patients and highest (5.71 ± 2.75 mg/dl) for CKD stage 5 patients. The difference in serum creatinine among patients with different CKD stages were found to be statistically significant ($p < 0.05$). Serum NT-Pro-BNP also had significant positive correlation ($r = 0.61$, $p < 0.05$) with serum creatinine. Prior studies showed higher NT-Pro-BNP levels were associated with an increased odds of having an increase in serum creatinine by ≥ 0.3 mg/dl, which is consistent with present study findings.[25–28]

Mean serum total cholesterol, triglyceride, phosphate and uric acid were increased with disease severity and this increase was statistically significant ($p < 0.05$). CKD patients are at increased risk of developing cardiovascular disease related morbidity and mortality.[29] Dyslipidemia, often present in this patient population, is an important risk factor for CVD development.[30] For cholesterol and triglyceride, specific quantitative and qualitative changes seen at different stages of renal impairment are associated with the degree of glomerular filtration rate decline. Although an elevated uric acid level is commonly observed among CKD patients, whether it is simply a biomarker of impaired kidney function or has a true pathogenic role in kidney function remains inconclusive.[31,32] As uric acid is primarily excreted by the kidneys, it is difficult to evaluate the causal influence of uric acid on the progression of CKD in epidemiological research. Mean eGFR, serum albumin and total protein were found to be decreasing with disease severity and this decrease was also statistically significant ($p < 0.05$). Correlation of serum NT-Pro-BNP with biochemical parameters was observed. Serum NT-Pro-BNP showed significant negative correlation with total cholesterol, triglycerides, serum phosphorus, serum uric acid, eGFR and serum albumin. This is consistent with prior study showing similar relationship between NT-Pro-BNP and total cholesterol and triglycerides.[33]

Prior studies showed that NT-Pro-BNP was negatively correlated with eGFR, which is consistent with present study findings.[34] As for serum albumin, significant negative correlation with NT-Pro-BNP has been shown in other studies, which is consistent with present study findings.[35–37]

CONCLUSION

This study was undertaken to evaluate serum NT-Pro-BNP level at different stages of CKD patients and observe its association with cardiometabolic risk factors. Given the significant association of NT-Pro-BNP with cardiometabolic risk factors like serum creatinine, total cholesterol, triglycerides, serum phosphorus, serum uric acid, eGFR and serum albumin found in present study; it was apparent that elevated serum NT-Pro-BNP could function as a screening tool for patients with CKD who should proceed to further evaluation. Serum NT-Pro-BNP has the potential to be used routinely as a screening tool for patients with CKD. Measurements of serum NT-Pro-BNP could provide prognostic information of major cardiovascular events beyond traditional risk factors.

REFERENCES

1. Mishra RK, Li Y, Ricardo AC, Yang W, Keane M, Cuevas M, Christenson R, deFilippi C, Chen J, He J, Kallem RR, Raj DS, Schelling JR, Wright J, Go AS, Shlipak MG; Chronic Renal Insufficiency Cohort Investigators. Association of N-terminal pro-B-type natriuretic peptide with left ventricular structure and function in chronic kidney disease (from the Chronic Renal Insufficiency Cohort [CRIC]). Am J Cardiol. 2013 Feb 1;111(3):432-8. doi: 10.1016/j.amjcard.2012.10.019. Epub 2012 Nov 22. PMID: 23178053; PMCID: PMC5261861.

2. Yasue H, Yoshimura M, Sumida H, Kikuta K, Kugiyama K, Jougasaki M, Ogawa H, Okumura K, Mukoyama M, Nakao K. Localization and mechanism of secretion of B-type natriuretic peptide in comparison with those of A-type natriuretic peptide in normal subjects and patients with heart failure. Circulation. 1994 Jul;90(1):195-203. doi: 10.1161/01.cir.90.1.195. PMID: 8025996.

3. Daniels LB, Maisel AS. Natriuretic peptides. J Am Coll Cardiol. 2007 Dec 18;50(25):2357-68. doi: 10.1016/j.jacc.2007.09.021. PMID: 18154959.

4. Sarnak MJ, Levey AS. Cardiovascular disease and chronic renal disease: a new paradigm. Am J Kidney Dis. 2000 Apr;35(4 Suppl 1):S117-31. doi: 10.1016/s0272-6386(00)70239-3. PMID: 10766010.

5. Untersteller K, Girerd N, Duarte K, Rogacev KS, Seiler-Mussler S, Fliser D, Rossignol P, Heine GH. NT-proBNP and Echocardiographic Parameters for Prediction of Cardiovascular Outcomes in Patients with CKD Stages G2-G4. Clin J Am Soc Nephrol. 2016 Nov 7;11(11):1978-1988. doi: 10.2215/CJN.01660216. Epub 2016 Aug 11. PMID: 27515593; PMCID: PMC5108187.

6. DeFilippi CR, Fink JC, Nass CM, Chen H, Christenson R. N-terminal pro-B-type natriuretic peptide for predicting coronary disease and left ventricular hypertrophy in asymptomatic CKD not requiring dialysis. Am J Kidney Dis. 2005 Jul;46(1):35-44. doi: 10.1053/j.ajkd.2005.04.007. PMID: 15983955.

7. Khan IA, Fink J, Nass C, Chen H, Christenson R, deFilippi CR. N-terminal pro-B-type natriuretic peptide and B-type natriuretic peptide for identifying coronary artery disease and left ventricular hypertrophy in ambulatory chronic kidney disease patients. Am J Cardiol. 2006 May 15;97(10):1530-4. doi:

10.1016/j.amjcard.2005.11.090. Epub 2006 Mar 31. PMID: 16679099.

8. Bursi F, Weston SA, Redfield MM, Jacobsen SJ, Pakhomov S, Nkomo VT, Meverden RA, Roger VL. Systolic and diastolic heart failure in the community. JAMA. 2006 Nov 8;296(18):2209-16. doi: 10.1001/jama.296.18.2209. PMID: 17090767.

9. Korenstein, D., Wisnivesky, J.P., Wyer, P. Adler, R, Ponieman, D, McGinn, T. The utility of B-type natriuretic peptide in the diagnosis of heart failure in the emergency department: a systematic review. BMC Emerg Med 2007 June 7; https://doi.org/10.1186/1471-227X-7-6

10. Bansal N, Katz R, Dalrymple L, de Boer I, DeFilippi C, Kestenbaum B, Park M, Sarnak M, Seliger S, Shlipak M. NT-proBNP and troponin T and risk of rapid kidney function decline and incident CKD in elderly adults. Clin J Am Soc Nephrol. 2015 Feb 6;10(2):205-14. doi: 10.2215/CJN.04910514. Epub 2015 Jan 20. PMID: 25605700; PMCID: PMC4317737.

11. Zoccali C, Mallamaci F, Benedetto FA, Tripepi G, Parlongo S, Cataliotti A, Cutrupi S, Giacone G, Bellanuova I, Cottini E, Malatino LS. Cardiac natriuretic peptides are related to left ventricular mass and function and predict mortality in dialysis patients. J Am Soc Nephrol. 2001 Jul;12(7):1508-1515. doi: 10.1681/ASN.V1271508. PMID: 11423580.

12. Tsutamoto T, Wada A, Sakai H, Ishikawa C, Tanaka T, Hayashi M, Fujii M, Yamamoto T, Dohke T, Ohnishi M, Takashima H, Kinoshita M, Horie M. Relationship between renal function and plasma brain natriuretic peptide in patients with heart failure. J Am Coll Cardiol. 2006 Feb 7;47(3):582-6. doi: 10.1016/j.jacc.2005.10.038. Epub 2006 Jan 18. PMID: 16458140.

13. McCullough PA, Duc P, Omland T, McCord J, Nowak RM, Hollander JE, Herrmann HC, Steg PG, Westheim A, Knudsen CW, Storrow AB, Abraham WT, Lamba S, Wu AH, Perez A, Clopton P, Krishnaswamy P, Kazanegra R, Maisel AS; Breathing Not Properly Multinational Study Investigators. B-type natriuretic peptide and renal function in the diagnosis of heart failure: an analysis from the Breathing Not Properly Multinational Study. Am J Kidney Dis. 2003 Mar;41(3):571-9. doi: 10.1053/ajkd.2003.50118. PMID: 12612980.

14. Kistorp C, Raymond I, Pedersen F, Gustafsson F, Faber J, Hildebrandt P. N-terminal pro-brain natriuretic peptide, C-reactive protein, and urinary albumin levels as predictors of mortality and cardiovascular events in older adults. JAMA. 2005 Apr 6;293(13):1609-16. doi: 10.1001/jama.293.13.1609. PMID: 15811980.

15. Anwaruddin S, Lloyd-Jones DM, Baggish A, Chen A, Krauser D, Tung R, Chae C, Januzzi JL Jr. Renal function, congestive heart failure, and amino-terminal pro-brain natriuretic peptide measurement: results from the ProBNP Investigation of Dyspnea in the Emergency Department (PRIDE) Study. J Am Coll Cardiol. 2006 Jan 3;47(1):91-7. doi: 10.1016/j.jacc.2005.08.051. Epub 2005 Dec 9. PMID: 16386670.

16. Gupta DK, Wang TJ. Natriuretic Peptides and Cardiometabolic Health. Circ J. 2015;79(8):1647-55. doi: 10.1253/circj.CJ-15-0589. Epub 2015 Jun 23. PMID: 26103984; PMCID: PMC4893202.

17. Seferović, P. M. & Polovina, M. M. When more is less and less is more: Is there an additional value of NT-proBNP in risk stratification in heart failure? European Journal of Preventive Cardiology. 2018 25; 885–888 https://doi.org/10.1177/2047487318767698 (2018).

18. Jacob SR, Raveendran R, Kannan S. Causes, comorbidities and current status of chronic kidney disease: A community perspective from North Kerala. J Family Med Prim Care. 2019 Sep 30;8(9):2859-2863. doi: 10.4103/jfmpc.jfmpc_478_19. PMID: 31681656; PMCID: PMC6820375.

19. Ishiwatari A, Yamamoto S, Fukuma S, Hasegawa T, Wakai S, Nangaku M. Changes in Quality of Life in Older Hemodialysis Patients: A Cohort Study on Dialysis Outcomes and Practice Patterns. Am J Nephrol. 2020;51(8):650-658. doi: 10.1159/000509309. Epub 2020 Jul 31. PMID: 32739911; PMCID: PMC7592938.

20. Vickery S, Price CP, John RI, Abbas NA, Webb MC, Kempson ME, Lamb EJ. B-type natriuretic peptide (BNP) and amino-terminal proBNP in patients with CKD: relationship to renal function and left ventricular hypertrophy. Am J Kidney Dis. 2005 Oct;46(4):610-20. doi: 10.1053/j.ajkd.2005.06.017. PMID: 16183415.

21. Luchner A, Hengstenberg C, Löwel H, Riegger GA, Schunkert H, Holmer S. Effect of compensated renal dysfunction on approved heart failure markers: direct comparison of brain natriuretic peptide (BNP) and N-terminal pro-BNP. Hypertension. 2005 Jul;46(1):118-23. doi: 10.1161/01.HYP.0000170140.36633.8f. Epub 2005 Jun 6. PMID: 15939804.

22. Tagore R, Ling LH, Yang H, Daw HY, Chan YH, Sethi SK. Natriuretic peptides in chronic kidney disease. Clin J Am Soc Nephrol. 2008 Nov;3(6):1644-51. doi: 10.2215/CJN.00850208. Epub 2008 Jul 16. PMID: 18632852; PMCID: PMC2572269.

23. Alter P, Rupp H, Rominger MB, Vollrath A, Czerny F, Klose KJ, Maisch B. Relation of B-type natriuretic peptide to left ventricular wall stress as assessed by cardiac magnetic resonance imaging in patients with dilated cardiomyopathy. Can J Physiol Pharmacol. 2007 Aug;85(8):790-9. doi: 10.1139/y07-076. PMID: 17901889.

24. Lukowicz TV, Fischer M, Hense HW, Döring A, Stritzke J, Riegger G, Schunkert H, Luchner A; MONICA Investigators. BNP as a marker of diastolic dysfunction in the general population: Importance of left ventricular hypertrophy. Eur J Heart Fail. 2005 Jun;7(4):525-31. doi: 10.1016/j.ejheart.2004.12.010. PMID: 15921790.

25. McCallum W, Tighiouart H, Testani JM, Griffin M, Konstam MA, Udelson JE, Sarnak MJ. Association of Volume Overload With Kidney Function Outcomes Among Patients With Heart Failure With Reduced Ejection Fraction. Kidney Int Rep. 2020 Jul 23;5(10):1661-1669. doi: 10.1016/j.ekir.2020.07.015. PMID: 33102958; PMCID: PMC7569703.

26. Pfister R, Müller-Ehmsen J, Hagemeister J, Hellmich M, Erdmann E, Schneider CA. NT-pro-BNP predicts worsening renal function in patients with chronic systolic heart failure. Intern Med J. 2011 Jun;41(6):467-72. doi: 10.1111/j.1445-5994.2010.02203.x. Epub 2010 Feb 26. PMID: 20214692.

27. Mullens W, Abrahams Z, Francis GS, Sokos G, Taylor DO, Starling RC, Young JB, Tang WHW. Importance of venous congestion for worsening of renal function in advanced decompensated heart failure. J Am Coll Cardiol. 2009 Feb 17;53(7):589-596. doi: 10.1016/j.jacc.2008.05.068. PMID: 19215833; PMCID: PMC2856960.

28. Damman K, van Deursen VM, Navis G, Voors AA, van Veldhuisen DJ, Hillege HL. Increased central venous pressure is

associated with impaired renal function and mortality in a broad spectrum of patients with cardiovascular disease. J Am Coll Cardiol. 2009 Feb 17;53(7):582-588. doi: 10.1016/j.jacc.2008.08.080. PMID: 19215832.
29. Ahmed, M. H. Ezetimibe and recent clinical trials: A look on the bright side. Expert Opinion on Drug Safety. 2010 9; 511–514. https://doi.org/10.1517/14740331003702376 (2010).
30. Mikolasevic I, Žutelija M, Mavrinac V, Orlic L. Dyslipidemia in patients with chronic kidney disease: etiology and management. Int J Nephrol Renovasc Dis. 2017 Feb 7;10:35-45. doi: 10.2147/IJNRD.S101808. PMID: 28223836; PMCID: PMC5304971.
31. Odden MC, Amadu AR, Smit E, Lo L, Peralta CA. Uric acid levels, kidney function, and cardiovascular mortality in US adults: National Health and Nutrition Examination Survey (NHANES) 1988-1994 and 1999-2002. Am J Kidney Dis. 2014 Oct;64(4):550-7. doi: 10.1053/j.ajkd.2014.04.024. Epub 2014 Jun 4. PMID: 24906981; PMCID: PMC4177300.
32. Nashar K, Fried LF. Hyperuricemia and the progression of chronic kidney disease: is uric acid a marker or an independent risk factor? Adv Chronic Kidney Dis. 2012 Nov;19(6):386-91. doi: 10.1053/j.ackd.2012.05.004. PMID: 23089273.
33. Spannella F, Giulietti F, Cocci G, Landi L, Borioni E, Lombardi FE, Rosettani G, Bernardi B, Bordoni V, Giordano P, Bordicchia M, Sarzani R. N-terminal pro B-Type natriuretic peptide is inversely correlated with low density lipoprotein cholesterol in the very elderly. Nutr Metab Cardiovasc Dis. 2018 Jun;28(6):629-635. doi: 10.1016/j.numecd.2018.02.013. Epub 2018 Feb 27. PMID: 29650297.
34. Poortvliet R, de Craen A, Gussekloo J, de Ruijter W. Increase in N-terminal pro-brain natriuretic peptide levels, renal function and cardiac disease in the oldest old. Age Ageing. 2015 Sep;44(5):841-7. doi: 10.1093/ageing/afv091. Epub 2015 Jul 25. PMID: 26209786.
35. Jensen J, Ma LP, Fu ML, Svaninger D, Lundberg PA, Hammarsten O. Inflammation increases NT-proBNP and the NT-proBNP/BNP ratio. Clin Res Cardiol. 2010 Jul;99(7):445-52. doi: 10.1007/s00392-010-0140-z. Epub 2010 Mar 13. PMID: 20229122.
36. Alsuwaida A. Influence of erythropoietin dose and albumin level on the plasma brain natriuretic peptide in hemodialysis patients. Saudi J Kidney Dis Transpl. 2006 Jun;17(2):171-6. PMID: 16903623.
37. Yi S, Chen M. Decreased albumin is associated with elevated N-terminal pro-brain natriuretic peptide and poor long-term prognosis in patients with chronic heart failure. Medicine (Baltimore). 2020 Dec 18;99(51):e23872. doi: 10.1097/MD.0000000000023872. PMID: 33371174; PMCID: PMC7748339.

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