

Comparison of cognitive dysfunction between patients admitted in intensive cardiac care unit and general medical ward in a tertiary care centre

K. Monicka

Assistant Professor, Dept. of Psychiatry, ESIC MC & PGIMSR, Chennai, Tamil Nadu, Chennai, India

*Corresponding Author: K. Monicka

Email: medicomons83@yahoo.co.in

Abstract

Introduction: A substantial decline in cognitive function has been found to be associated with the diagnoses of cardiovascular diseases in the general population.

Aims and Objective: To compare the cognitive dysfunctions in patients with heart disease admitted in the intensive cardiac care unit (ICCU) with that of the patients admitted in general medical wards with heart diseases.

Materials and Methods: The study is a cross-sectional study done on a total of 30 patients admitted to ICCU and 30 patients with heart disease admitted in general medical ward of a tertiary care hospital. The tools used were a semi-structured proforma, Hospital anxiety-depression scale, Standardized Mini-Mental Status Examination, and Brief Cognitive Rating Scale. Statistical tests used were Student 't' test and Chi-Square test using SPSS software.

Results: Comparison of the two groups illustrates that patients with heart disease admitted in ICCU had greater levels of anxiety ($p=0.00$). These two groups differ statistically significantly in all five items of the BCRS-concentration, recent memory, remote memory, orientation, functioning with $p=0.00$ in each item and with respect to Orientation to time ($p=0.00$), orientation to city ($p=0.01$) and orientation to floor of building ($p=0.00$), in Registration. ($p=0.03$), Spelling WORLD backward ($p=0.00$), Recall ($p=0.026$), Identifying Wristwatch. ($p=0.039$), repeat "No ifs, and or buts". ($p=0.0004$), Reading. ($p=0.009$) using SMMSE.

Conclusion: The study has shown that heart disease patients admitted in ICCU have more cognitive impairment compared to those admitted in general medical ward and that early intervention can potentially revert the condition to improve the quality of life in heart disease patients.

Keywords: Heart disease, Cognitive impairment, Intensive cardiac care unit.

Introduction

Mental processing scientifically termed as cognition includes attention, memory, speaking and understanding the language, solving problems, and making decisions. Patients with end-stage heart disease are reported to a high prevalence of cognitive dysfunction. Worsening cognitive performance is related to older age and lower indices of left ventricular function. The link between aging, left ventricular systolic function, and cognitive performance remains undiscerned¹ whilst Hypertension and Diabetes mellitus is positively associated with cognitive decline over 6 years in the late middle-aged patients. Interventions aimed at managing hypertension or diabetes that begins before age 60 lower the burden of cognitive dysfunction in later life.² Metabolic Syndrome is associated with cognitive decline even in a multi-ethnic population.³ This study has been done to understand the influence of ICCU stays on the cognitive functioning of patients. Conditions for which patients are generally admitted to ICCU are chest pain, acute coronary syndromes, acute myocardial infarction, heart failure, pulmonary hypertension, arrhythmias, and cardiogenic shock. Other conditions that require admission to ICCU are adult congenital heart diseases, valvular heart diseases, aortic diseases, hypertensive emergency, cardiac tamponade, and pulmonary embolism. ICCU is the post-reperfusion unit for treating complications of therapy, older and more complex patients who require more intensive care.⁴ The mechanism of cognitive deficit in cardiac patients remains unclear and it may be related to multiple infarcts, acute or chronic hypoxic damage secondary to arrhythmias, cardiac failure, or small vessel disease of the brain.⁵ Low-output states such as

systemic hypotension⁶ and low ejection fraction⁷ have also been implicated as causes of cognitive decline in patients with heart disease. Some studies show that during hospitalization in the ICCU up to 72% of the patients had mild to severe impairment in one or more cognitive areas, delayed recall being the most common deficit. Six months later, 29% of the patients continued to be impaired and all had deficits in delayed recall.⁸ In patients with chronic heart disease, the cognitive functions that are most often impaired are short-term verbal memory, short term visual-spatial memory, differed verbal memory, verbal learning, and visual-spatial logical ability. Memory deficits have chances of compromising the patient's adherence to the treatment prescribed.⁹ Verbal memory impairment in older patients with low ejection fraction has a greater risk of poor treatment outcomes through the effect of cognitive dysfunction on medication management, compliance with a treatment plan, and the patient's ability to accurately remember and report important symptoms to their physicians. Psychological problems after ICU stay were reported by the patients, i.e. fear, inability to concentrate, complaints of depression and hallucinations.¹⁰ Conversely, a substantial decline in cognitive function has been found to be associated with the diagnoses of cardiovascular diseases in the general population.¹¹

Routine screening is therefore essential to ensure that cognitive impairment is detected and addressed as quickly as possible as the prevalence and incidence of heart diseases have been rapidly increasing.

Aims

To compare the cognitive dysfunctions in patients with heart disease admitted in the intensive cardiac care unit with that of the patients admitted in general medical wards with heart diseases.

Materials and Methods

A cross-sectional study was conducted in a tertiary care hospital on 30 patients admitted to ICCU (cases) with heart disease and 30 patients with heart disease admitted in general medical wards (controls). People with known psychiatric disorders and patients with multiple chronic diseases causing cognitive impairment were excluded from the study. The tools used were a Semi-structured proforma, Hospital anxiety-depression scale(HADS), Standardized Mini-Mental Status Examination (SMMSE)and Brief Cognitive Rating Scale(BCRS), Statistical tests used were Student‘t’ test and Chi-Square test.

Tools

Semi-structured proforma contained information relating to socio-demographic data, medical and psychiatric history, and other relevant clinical variables.

Hospital anxiety-depression scale (HADS)¹² scale assesses the persons' symptoms in the past week. It consists of 14 items- 7 in depression and 7 in anxiety symptoms. It has a sensitivity of 0.9 for anxiety and 0.8 for depression. It has a specificity of 0.8 for both depression and anxiety. The scale focusses on the non-somatic symptoms suited for screening in patients with physical problems.

The Standardized Mini-Mental State Examination (SMMSE)¹³ is used for comprehensive assessments of older adults. It provides a global score of cognitive ability that correlates with function in activities of daily living. The Standardized Mini-Mental State Examination takes approximately 10 minutes to administer, provides a baseline score of cognitive function, and pinpoints specific deficits that can aid in forming a diagnosis.

Brief Cognitive Rating Scale (BCRS)¹⁴ was developed by Barry Reisberg, M.D. This scale has five items and they are Concentration, Recent Memory, Past memory, Orientation, Functioning, and self-care.

Patients admitted in ICCU with heart disease for more than 3 days as well as a patient admitted in general medical ward with heart disease in the age group of 20-64 years willing to give informed consent were included in the study. The assessment was usually done on the third day of admission in the afternoon around 3 pm.

Statistical Analysis

The data obtained were entered into an excel sheet. Comparison between these two groups was made using Chi-square test and student t-test using SPSS version 18. The p-value was set at 0.05. The study and its design were approved by the Ethics Committee of the institution of origin of the study.

Results

Comparing the age and gender between patients with heart disease admitted in ICCU and general medical wards, it was found that there was no statistically significant difference between the two groups. The two groups differed in marital status. The proportion of married people among patients with heart disease admitted in ICCU was great compared with those admitted in the general medical ward and this difference is statistically significant. (p=0.04). These two groups were comparable for their affiliation to religious groups and there was no statistically significant difference. Patients with heart disease admitted in ICCU had an urban domiciliary status, whereas those in the general medical ward, hailed predominantly from rural areas. This difference was statistically significant (p=0.00). Patients with heart disease admitted in ICCU were more educated and had a higher secondary level of education unlike those in the general ward and this difference was statistically significant (p=0.01). Though there was no statistically significant difference in the occupational status of the two groups, those in the ICCU had a higher income.

Table 1: Comparison of various socio-demographic features between patients with heart disease admitted in ICCU and general medical ward

S. No	Variable	Chi square value	P value
1.	Sex gender	0.0757	0.78
2.	Marital status	6.000	0.0498
3.	Religion	2.99	0.224
4.	Domicile	8.0123	0.0043
5.	Education	12.1663	0.016
6.	Occupation	4.1189	0.398
7.	Income	8.085	0.0176
8.	Alcohol use	0.000	1.000
9.	Smoking	2.4583	0.1138

Both groups are comparable for the use of alcohol. 30% of patients in both groups having a history of alcohol consumption. Comparing the two groups for smoking, it was seen that 50% of patients in ICCU smoked compared to 30% of patients admitted in the general medical ward. Though not statistically significant.

Patients in ICCU and general medical ward did not show a statistically significant difference in years of alcohol intake as well as years of smoking (Table 2).

Table 2: Comparison of age and years of substance use between patients with heart disease admitted in ICCU and general medical wards

S. No	Variable	Group	Mean	S.D	T value	P value
1.	Age	ICCU	55.1	12.34	1.4070	0.1648
		M W	50.1	14.8		
2	Years of alcohol	ICCU	25	13.18	0.0196	0.9845
		M W	25.1	11.31		
3.	Years of smoking	ICCU	9.93	7.547	0.7565	0.4524
		M W	8.63	5.623		

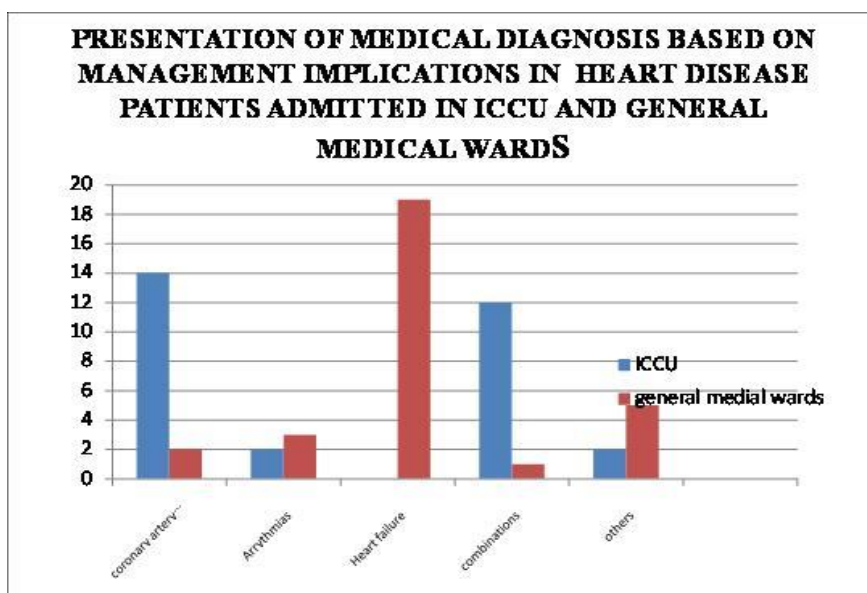


Fig. 1

It is seen from the above illustration that two-thirds of those admitted in general medical wards have congestive cardiac failure as the primary diagnosis. The predominant medical diagnosis for heart disease patients admitted in ICCU was Coronary Artery Disease, specifically Myocardial Infarction. (46.67%) and Arrhythmias (40%). (Fig. 1)

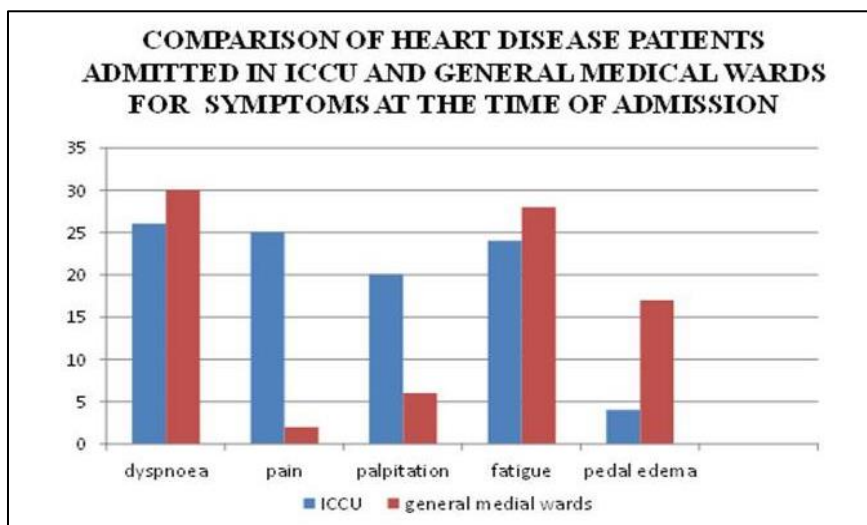


Fig. 2

83.3% of patients admitted to ICCU, presented with dyspnoea on exertion as the predominant symptom at the time of admission followed by chest pain, which was present in 80%. Whereas in the general medical ward, almost half the patients presented with a combination of dyspnoea on exertion, fatigue and pedal edema. (Fig. 2)

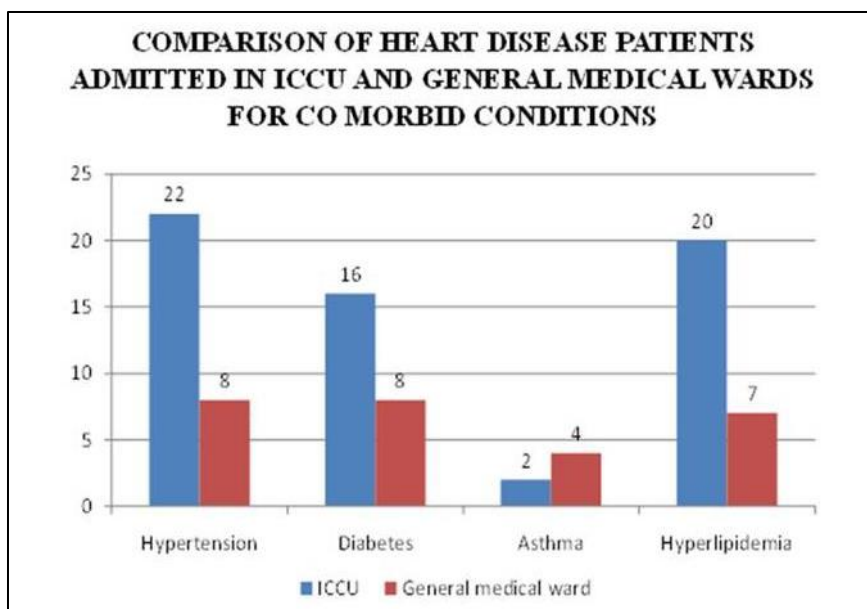


Fig. 3

Compared with the general medical ward patients admitted for heart disease, the ICU patients were more likely to have co-morbid conditions such as hypertension, hyperlipidemia and diabetes mellitus. (Fig. 3)

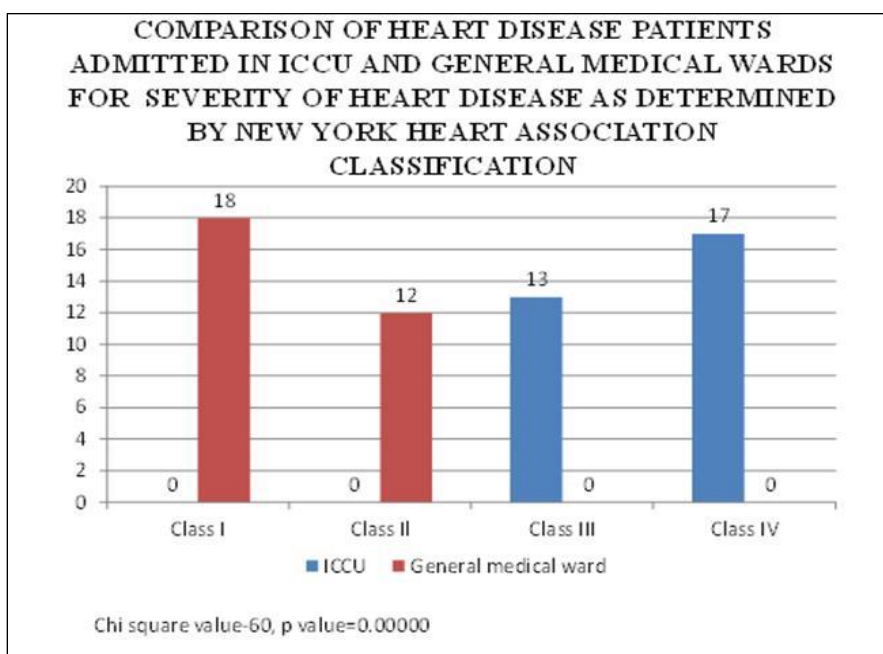


Fig. 4

It is important to note that all the thirty patients in ICU had New York Heart Association class IV(56.6%) and class III(43.3%) severity of heart disease in comparison with patients in general medical wards, who were in class I and class II severity. (Fig. 4).

Comparing the two groups illustrates that the patients with heart disease admitted in ICU had high total score on seven anxiety symptoms in Hospital Anxiety and Depression Scale indicating that they have greater levels of anxiety(P=

0.00), and had comparable total score on the seven depressive symptoms in Hospital Anxiety and Depression Scale (Table 3).

Table 3: Comparison of anxiety and depression score of Hospital Anxiety and Depression scale in patients with heart disease admitted in ICCU and general medical wards

S. No	Variable	Group	Mean	S.D	T value	P value
1.	HADS-anxiety	ICCU	15.8	2.86	4.95	0.00
		M W	12.2	2.86		
2.	HADS-Depression	ICCU	12.7	2.62	1.12	0.26
		M W	11.9	2.41		

The heart disease patients admitted in ICCU and general medical wards were studied and compared for their cognitive function using the Brief Cognitive Rating Scale. These two groups differ statistically significantly in all five items of the Brief Cognitive Rating Scale-concentration (P= 0.00), recent memory (P= 0.00), remote memory (P= 0.00), orientation (P= 0.00), functioning (P= 0.00) (Table 4).

Table 4: Comparison of brief cognitive rating scale (BCRS) between patients with heart disease admitted in ICCU and general medical wards

S. No	Variable	Group	Mean	S.D	T value	P value
1.	BCRS I	ICCU	4.0	1.46	5.57	0.00
		M W	2.16	1.05		
2.	BCRS II	ICCU	3.5	1.4	6.34	0.00
		M W	1.6	0.08		
3.	BCRS III	ICCU	2.6	1.66	3.33	0.00
		MW	1.5	0.93		
4.	BCRS IV	ICCU	3.0	1.43	6.03	0.00
		MW	1.26	0.63		
5.	BCRS V	ICCU	4.3	1.6	6.16	0.00
		M W	2.06	1.17		

Standardized Mini-Mental Status Examination has 12 items. It is revealed that there is a significant difference between two groups with respect to Orientation to time (Orientation to year. (P= 0.00), season (P= 0.00), month (P= 0.00), date (P= 0.00), day of week (P= 0.00). Also, it is seen that there is a statistically significant difference between heart disease patients admitted in ICCU and general medical

wards, in Orientation to the city(P= 0.01) and floor of the building(P= 0.00). The following items were also significantly different between the two groups- Registration. (P= 0.03), Spelling WORLD backward (P=0.00). Recall. (P= 0.026), Identifying Wristwatch. (P= 0.039), repeat "No ifs, and or buts". (P= 0.0004), Reading. (P= 0.009) (Table 5).

Table 5: Comparison of standardized mini-mental state examination (SMMSE) between patients with heart disease admitted in ICCU and general medical wards

S.No	Variable	Group	Mean	S.D	T value	P value
1.	SMMSE 1a	ICCU	0.46	0.5	5.07	0.00
		M W	0.96	0.18		
2.	SMMSE1b	ICCU	0.16	0.37	7.47	0.00
		MW	0.86	0.34		
3	SMMSE1c	ICCU	0.66	0.47	3.80	0.0003
		M W	1.0	0.00		
4	SMMSE1d	ICCU	0.53	0.50	3.39	0.0013
		M W	0.90	0.30		
5	SMMSE1e	ICCU	0.4	0.49	5.22	0.00
		M W	0.93	0.25		
6	SMMSE2a	ICCU	0.86	0.34	0.39	0.69
		M W	0.9	0.30		
7	SMMSE2b	ICCU	0.83	0.37	1.73	0.08
		M W	0.96	0.18		
8	SMMSE2c	ICCU	0.83	0.37	2.4	0.019
		M W	1.0	0.00		
						Continued...

9	SMMSE2d	ICCU	0.86	0.34	0.85	0.39
		M W	0.93	0.25		
10	SMMSE2e	ICCU	0.23	0.43	5.24	0.00
		M W	0.80	0.40		
11	SMMSE3	ICCU	2.2	1.18	2.10	0.039
		M W	2.7	0.53		
12	SMMSE4	ICCU	2.13	1.27	5.49	0.00
		M W	3.76	1.0		
13	SMMSE5	ICCU	1.53	1.04	2.27	0.026
		M W	2.10	0.88		
14	SMMSE6	ICCU	0.86	0.34	2.11	0.039
		M W	1.00	0.00		
15	SMMSE8	M W			3.7	0.00
		ICCU	0.20	0.40		
16	SMMSE9	M W	0.63	0.49	2.69	0.00
		ICCU	0.8	0.4		
17	SMMSE10	M W	1.0	0.0	1.40	0.16
		ICCU	2.5	1.07		
18	SMMSE 11	M W	2.8	0.46	0.51	0.61
		ICCU	0.5	0.508		
19	SMMSE 12	M W	0.56	0.504	0.82	0.41
		ICCU	0.26	0.449		

Discussion

The socio-demographic characteristics of two groups namely patients with heart disease admitted in ICCU and general medical wards did not differ significantly for age, religion, education, and occupation. Marital status, urban domiciliary status, and higher income are significantly associated with patients with heart disease in ICCU. It can be argued that there could be a relationship for urban living, higher income, and lifestyle that may contribute to metabolic derangement and severity of heart disease necessitating ICCU admission. These findings are in concordance with the Northern Manhattan study- the metabolic syndrome and cognitive performance. The metabolic syndrome is a risk factor for diabetes, stroke, myocardial infarction, and increased mortality, and has been associated with lower cognition in some populations.¹⁵ The two groups are comparable for substance use in that both groups had 30% of patients admitting to alcohol consumption. Even though half of the patients in ICCU had a history of smoking compared to 30% in the medical ward group the difference was not statistically significant. Similarly, the two groups were comparable for the duration of alcohol and tobacco intake. The study findings reveal that most of the patients in ICCU had a combination of dyspnoea on exertion and chest pain. The prime medical diagnosis in ICCU patients was Coronary heart disease. In addition, the ICCU patients had comorbid conditions like hypertension, hyperlipidemia, and diabetes. These findings are in concordance with the Northern Manhattan study.¹⁵ The patients with heart disease in ICCU exhibited greater levels of anxiety symptoms as compared with general ward patients. Most of them were very definite that they got a sort of frightened feeling. Given the acute and severe nature of the disorder, many of them spent a great deal of the time with worrying thoughts going through their mind, in addition, they

also reported that they cannot sit at ease and feel relaxed. Another symptom which was reported by most of them was sudden feelings of panic. Review of the literature clearly indicated that the stress in patients of ICCU can be equated with the patients of Post-traumatic stress with reference to their agony.^{16,17} On the other hand, both the groups were comparable for depressive symptoms. A study was done by Peris, Bonizzoli, Iozzelli, 2011¹⁸ reveals that psychological disorders were frequent among ICU survivors. The two groups were compared for cognitive functioning using the Brief Cognitive Rating Scale. The findings indicate that the impairment in concentration, recent memory, past memory, orientation and functioning, and self-care is markedly impaired in heart disease patients admitted in ICCU, compared to those admitted in general medical ward. It may be hypothesized that significant impairment and cognitive dysfunction is associated with the severity of heart disease. Other factors that would have contributed to the statistically significant difference to the cognitive dysfunction was the higher prevalence of co-morbid conditions such as hypertension, hyperlipidemia, and diabetes. Brief Cognitive Rating Scale showed a statistically significant deficit in the domain of concentration in an Indian study that was recently done in Haryana in India¹⁹ and also in a previous study by Sauve et al, 1996.¹⁶ Further, the two groups were evaluated for cognitive functioning using the Standardised Mini-Mental Status Examination. The results indicated that the two groups differed statistically significantly for orientation to year, season, month, date and day of the week. Additionally, the two groups differed statistically significantly for orientation to city and orientation to the floor of the building. The study from Haryana in India¹⁹ also showed that orientation was impaired in patients admitted to ICCU. Moreover patients admitted in ICCU had statistically significant disturbance to

registration, recall, reading, spelling backward, identifying wristwatch, and repeating 'no, ifs, and or buts.' Similar findings of disturbance to different domains of cognitive functions demonstrated in the study by Batla et al.¹⁹ In this study, no statistical difference was obtained for writing, apraxia, and copying design, whereas in the Haryana study¹⁹ patients in ICCU had impairment to constructional ability. Overall the study demonstrated that cognitive functioning is disturbed in patients admitted to the intensive care unit.

It is possible that in view of high levels of anxiety that are found among patients with heart disease in ICCU, some of the disturbance to cognitive domains such as attention and concentration may be linked, but in this group, disturbance in cognitive functions extends beyond attention, concentration and includes domains of orientation. Furthermore marked impairment in all five axes of Brief Cognitive Rating Scale—namely concentration, recent memory, remote memory, orientation, functioning, and self-care, was found in ICCU patients and hence the cognitive dysfunctions are more related to the severity of the disease and comorbid conditions.

Conclusion

This study demonstrated that there was a significant impairment to all five cognitive domains of concentration, recent memory, remote memory, orientation, functioning and self-care of the Brief Cognitive Rating Scale, in heart disease patients admitted in ICCU. Moreover, these patients had disturbance to cognitive domains such as orientation, attention and recent memory, as seen through Standardised Mini-Mental Status Examination. A significant level of anxiety was observed in patients in ICCU. The study has shown that heart disease patients admitted in ICCU, who had more severe heart disease and co-occurrence of medical conditions like hypertension, hyperlipidemia and diabetes had more cognitive impairment compared to those admitted in general medical ward and that early intervention can potentially revert the condition to improve the quality of life in heart disease patients. Persistence of psychological symptoms such as anxiety could impact on the quality of life of patients and can be helped by measures such as psychoeducation and the potential therapeutic interventions, reassurance, supportive measures, family education. Given the high disease burden of heart-related diseases in our country, it would be of good public health importance to understand cognitive dysfunction and its associated factors in order to suggest appropriate interventions that will mitigate it effectively.

Limitations

The study has certain limitations. During the time that was available to conduct this study, it was possible to recruit 30 heart disease patients each from ICCU and general medical ward. Larger sample size could have helped us to divide this study group based on parameters such as age, gender, and medical diagnosis. Some factors could potentially affect cognitive impairment and this includes drug and nutritional status of the individuals, presence of infections and fluid and electrolyte imbalance, presence of anxiety and depressive

symptoms. It was difficult to collect the number of medications that the people have taken before admission to the hospital and some of the necessary medical diagnosis and laboratory investigations were not captured in the medical records. Though anxiety and depressive symptoms were evaluated symptomatically, it was difficult to evaluate diagnosable depression and anxiety disorder, as patients were assessed within 3 days of admission.

Acknowledgements: Nil.

Conflict of Interest: Nil.

Source of Funding: Nil.

References

1. Zuccala G, Cattel C, Manes-Gravina E, Di-Niro MG, Cocchi A, Bernabei R. Left ventricular dysfunction: A clue to cognitive impairment in older patients with heart failure. *J Neurol Neurosurg Psychiatry* 1997;63:509-12.
2. Knopman D, Boland LL, Mosley T, Howard G, Liao D, Szklo M et al. Cardiovascular risk factors and cognitive decline in middle-aged adults. Atherosclerosis Risk in Communities (ARIC) Study Investigators. *Neurol* 2001;56(1):42-8.
3. Vieira JR, Elkind MS, Moon YP, Rundek T, Boden-Albala B, Paik MC, et al. The Metabolic Syndrome and Cognitive Performance: The Northern Manhattan Study. *Neuroepidemiol* 2011 Oct 15;37(3-4):153-9.
4. Shepard D, Weiner, LeRoy E, Rabbani, Cardiac Intensive Care Unit Admission Criteria; Cardiac Intensive Care Unit Admission Criteria; Citation DataCardiac Intensive Care, Page: 25-35; Publication Year 2010.
5. Barclay LL, Weiss EM, Mattis S, Bond O, Blass JP. Unrecognized cognitive impairment in cardiac rehabilitation patients. *J Am Geriatr Soc* 1988;36:22-8.
6. Rengo F, Acanfora D, Trojano L, Scognamiglio P, Ciaburri F, Ceriello A, et al. Congestive heart failure and cognitive impairment in elderly. *Arch Gerontol Geriatr* 1995;20:63-8.
7. Almeida OP, Tamai S. Clinical treatment reverses attentional deficits in congestive heart failure. *BMC Geriatr* 2001;1:2.
8. Sauve MJ, Walker JA, Massa SM, Winkle RA, Scheinman MM. Patterns of cognitive recovery in sudden cardiac arrest survivors: The pilot study. *Heart Lung* 1996;25:172-81.
9. Callegari S, Mujani G, Giardini A, Pierobon A, Opasich C, Cobelli F, et al. Relationship between cognitive impairment and clinical status in chronic heart failure patients. *Monaldi Arch Chest Dis* 2002;58:19-25.
10. Hofhuis JG, Spronk PE, van Stel HF, Schrijvers AJ, Rommes JH, Bakker J. Experiences of critically ill patients in the ICU Intensive. *Crit Care Nurs* 2008; 24(5):300-13.
11. Breteler MM, Claus JJ, Grobbee DE, Hofman A. Cardiovascular disease and distribution of cognitive function in elderly people: The Rotterdam study. *BMJ* 1994;308:1604-8.
12. Zigmond AS, Smith RP. The Hospital Anxiety and Depression scale. *Acta Psychiatr Scand* 1983; 67:361-70.
13. Molloy DW, Alemayehu E, Roberts R. Reliability of Standardized Mini-Mental State Examination (SMMSE) compared with the traditional Mini-Mental State Examination. *Am J Psychiatry* 1991;148:102-5.
14. Reisberg B, Ferris SH. Brief Cognitive Rating Scale (BCRS). *Psychopharmacol Bull* 1988;24:629-36.
15. Vieira JR, Elkind MS, Moon YP, Rundek T, Boden-Albala B, et al. The Metabolic Syndrome and Cognitive Performance: The Northern Manhattan Study. *Neuroepidemiol* 2011;37(3-4):153-9.

16. Scragg P, Jones A, Fauvel N. Psychological problems following ICU treatment. *Anaesth* 2001;56(1):9-14.
17. Samuelson KA, Lundberg D, Fridlund B. Stressful memories and psychological distress in adult mechanically ventilated intensive care patients - a 2-month follow-up study. *Acta Anaesthesiol Scand* 2007;51(6):671-8.
18. Peris A, Bonizzoli M, Iozzelli D, Migliaccio ML, Zagli G, Bacchereti A et al. Early intra-intensive care unit psychological intervention promotes recovery from post-traumatic stress disorders, anxiety and depression symptoms in critically ill patients. *Crit Care* 2011;15(1):R41.
19. Bathla M, Murthy KK, Chandna S. Cognitive dysfunctions in the intensive cardiac care unit. *Indian J Psychiatry* 2010;52(2):159-63.
20. Sauve MJ, Walker JA, Massa SM, Winkle RA, Scheinman MM. Patterns of cognitive recovery in sudden cardiac arrest survivors: The pilot study. *Heart Lung* 1996;25:172-81.
21. Viswanathan A, Gschwendtner A, Guichard JP, Buffon F, Cumurciuc R, O'Sullivan M et al. Lacunar lesions are independently associated with disability and cognitive impairment in CADASIL. *Neurol* 2007;69(2):172-4.