DISCUSSIONS

The coronary artery disease is increasing with incidence due to change in lifestyle of people in India. The prevalence of the Myocardial infarction and surgical revascularisation are on increase these days. As there is ongoing development in survival rate, better and evidence based methods of Cardiac conditioning are need of the hour to attain optimal physical health and Quality of Life (Madan, Babu et al. 2014).

The socio-economic changes in the community plays vital role in adaptation and implementation of such programs as per conditions prevailing in India(Contractor 2011). The upcoming insurance coverage with long-term survival, morbidity benefits as indicators for repayments, clinical evidence and relevance of such training program needs to be verified and established in developing country like India.

Cardiac rehabilitation and efforts targeted at exercise, lipid management, hypertension control, and smoking cessation can reduce cardiovascular mortality (Oldridge, Guyatt et al. 1988, O'Connor, Buring et al. 1989), improve functional capacity(Williams, Maresh et al. 1985), attenuate myocardial ischemia, retard the progression, the reversal of coronary atherosclerosis earlier (Blankenhorn, Nessim et al. 1987, Schuler, Hambrecht et al. 1992) and reduce
the risk of further coronary events (Cavender, Rogers et al. 1992, Fletcher, Blair et al. 1992).

As such, cardiac rehabilitation is standard care that should be integrated into the overall treatment plan of patients with CAD. The prime goal of cardiac rehabilitation is to attain and sustain the optimal physical, physiological, psycho-social, and occupational status (1993).

This study was an exercise based Randomized Controlled Trial conducted following Post CABG patients during Phase-II period of CR. Among 114 patients included in this study 96 patients completed the trial. The sample consisted of 59 in control group and 55 in study group.

The demographic analysis (Table 1) shows the mean age was 55.12 and 57.55 in the control and study group respectively. With regard to gender, the proportion of male exceeded that of females which in concurrence with natural history of Coronary artery disease. The socio-economical distribution was also equivocal in both test groups.

The sample was evenly distributed in both the groups in terms of number of people with smoking habit, dyslipidemia, hypertension, anemia and obesity (Table 2). This provides a balanced sample distribution in this study population.

The groups had similar level of functional capacity before training; The Study group improved in six minute walk distance than the control group after
training, which was statistically significant (Table 3). The co morbidities among the subjects were similar in both the groups and the study subjects have shown more improvement than the control group, which may be due to positive training effect of exercise training.

Previous studies have also shown to have potential health benefits leading to increase in survival rate with more improvements inpatients receiving structured or supervised training programs. These trails also predominately contained male subjects than females in their studies (Williams, Maresh et al. 1985, Kannel, Belanger et al. 1986, Paffenbarger, Hyde et al. 1986, Leon, Connett et al. 1987, Cannistra, Balady et al. 1992).

5.1 DISCUSSIONS ON FUNCTIONAL CAPASITY-(OBJECTIVE-1)

According to our first objective (To find out the effectiveness of supervised exercise based Cardiac Rehabilitation over control group having conventional unsupervised home based self-monitored exercise training program on functional capacity), the results in Table 3 show the groups had similar level of functional capacity before training; The Study group improved in six minute walk distance than the control group after training, which was statistically significant.

In this study, the supervised exercise based cardiac rehabilitation showed significant improvement in functional capacity in the study group than the
control group (Table 3). This is in concurrence with most of the guidelines which gives an evidence of level I in increasing the functional capacity on supervised exercise based training during cardiac rehabilitation. The MCID for six minute walk test is 28 meters for CAD. The minimal mean improvement in SMWD 49.69 meters in our study after training period, which in turn signifies the benefit of supervised exercise training.

There are changes in circulatory mechanisms, physiological cardiac and skeletal muscle hypertrophy, improved hormonal and humoral responses; improved oxygenation, delivery and uptake due to exercise training. All these changes results in the improvement in the functional capacity of the individual (Balady 1988). The deconditioned subjects gain the maximum benefits from exercise training than untrained, healthy people (Clausen 1976, Thompson 1988). The improved endurance is characterized with lowered heart rate at rest in previous studies too as in the present study (Balady 1998). These changes in cardiovascular responses along with musculoskeletal adaptations results in overall increase in physical capacity and functional capacity of the patients after exercise training. Hence all the above desirable changes occur as functional capacity improved in our study group significantly.

5.2 DISCUSSIONS ON QUALITY OF LIFE WHO-QOL BREF--(OBJECTIVE-2)
According to our second objective (To find out the effectiveness of supervised exercise based Cardiac Rehabilitation over control group having conventional home based self-monitored exercise training program on functional capacity), on the Quality of Life using WHO-QOL BREF) the results in Table 4 shows there was a statistically significant improvement in the study group than the control group in the physical, Psychological, social and environmental aspects of QOL (Table 4). In this study, the quality of life analysis showed improvement in all the dimensions of QOL improved in concurrence to the study done by Leon, Franklin et al (2005). The benefits of exercise training include quality of life in all domains, improvements are perceived by patients in of in physical, social, and emotional status. Similar to this study results, previous studies have shown that Cardiac Rehabilitation improves QOL to larger extent (Pina, Apstein et al. 2003, Karoff, Held et al. 2007).

Furthermore, the results of present study is supported by the systematic review (Shepherd and While 2012) on the effectiveness of Cardiac Rehabilitation on QOL, which has shown that cardiac rehabilitation improves physical well-being and levels of physical activity and thereby improved levels of physical fitness. Both physical and psychological domain outcomes suggest that hospital based, supervised training was superior to home-based interventions. Whereas relatively few trials reported on quality of life within the
social domain to favour the home-based intervention than hospital based interventions. The review concludes that cardiac rehabilitation improves the quality of life for coronary heart disease patients and that quality of life improvements have a bi-directional relationship with increased physical activity and vocational status.

5.3 DISCUSSIONS ON PHYSIOLOGICAL PARAMETERS--(OBJECTIVE-3)

According to our third objective (To find out the effectiveness of supervised exercise based Cardiac Rehabilitation over control group having conventional home based self-monitored exercise training program exercise training on Physiological determinants of Cardio-Respiratory function), our results shows that Significant improvement was seen in SMWD in the study group than the control group in patients with and without Resting ECG changes (Table 5). Studies show that there was a reduction in CAD risk factors. Risk factors like BMI, triglycerides reduced, increase in HDL-cholesterol and decrease in total cholesterol / HDL- Cholesterol ratio, increase in insulin sensitivity and glucose tolerance, enhanced fibrinolysis activity, decreased stress levels and ventricular fibrillation as a result of increase in exercise plasma catecholamine levels which is a positive sign according to Leon, Franklin et al ((Leon, Franklin et al. 2005)).
The difference in improvement of **Left Ventricular Ejection Fraction** (LVEF) between the groups was not statistically significant in this study group (Table 6), even though there was a positive correlation between the LVEF and **Six Minute Walk Test** (SMWT) in the study group (Table 10.1). The impact of exercise on coronary artery disease (CAD) patients with left ventricular dysfunction is still not fully understood. A study by MasoumehSadeghi, et al showed that LV remodeling due to Cardiac rehabilitation in post-MI patients with LV dysfunction may have beneficial effects on cardiac function and does not cause adverse cardiac events. Due to subjectivity in determination of LVEF, the changes with exercise training may not be reflected in ECHO findings. Moreover, the Low risk group subjects were predominately available in this study and this could have affected the sensitivity to change in improvements.

Both the groups were similar in their resting heart rate at pre-training and after training the study group had significantly lower resting heart rate whereas the control group showed an elevated resting heart rate, which was statistically significant (Table 7). The stroke volume is increased because of good venous return and end diastolic volume due to physical activity and improves myocardial contractility following exercise training. In the presence of coronary artery disease, there is improvement in blood supply to heart muscle by surgical revascularization lead to increased efficacy of myocardium and hence reduced rate of contraction which indicates the positive effect of supervised exercise training over conventional training.
There was a statistically significant positive correlation between the LVEF and SMWD in the post-training period in this study sample (Table 10.1). Even though the difference in LVEF improvement was similar in both the groups, the functional translation of improvement in LVEF is greater and linear in the study group which indicates the consistency in performance up gradation due to the supervised training than the conventional training.

**Rate pressure product** (RPP) is a major determinant of cardiac oxygen consumption. It is an important indicator of ventricular function. RPP varies with exercise. The analysis of RPP (Rate Pressure Product) between the groups showed a statistically significant difference between them, with the study group attaining more RPP than the control group after training (Table 8). There was a statistically significant Correlation between RPP and SMWD; and the study group showed significant improvement than the control group (Table 10.3). The rate pressure product gives an accurate reflection of the myocardial oxygen demand and myocardial workload during exercise and in this study population has shown greater improvement with supervised exercise training over convention training.

**5.4 DISCUSSIONS ON PHYSICAL PARAMETERS(OBJECTIVE-4)**

According to our fourth objective (To find out the effectiveness of supervised exercise based Cardiac Rehabilitation over control group having conventional home based self-monitored exercise training program on Physical
determinants of Cardio-Respiratory function) Results shows in Table 9 (COMPARISON OF PHYSICAL VARIABLES) there was a statistically significant Correlation between the Body Mass Index (BMI) and Six Minute Walk Test (SMWD) in the pre-training period in this study sample. In the Post training the difference was not statistically significant. (Table 10.2). This could be due change in the BMI following training and affected by overall improvement in general well-being in both groups of patients.

The difference in the BMI between the groups was statistically not significant in pre-training and it was significantly different in the post training (Table 9). Exercises bring about structural and functional changes in gross working muscles, with increased metabolic reserve and utilize carbohydrate and fat efficiently. It also leads to have an ability to extract more oxygen from circulating blood (Leon, Franklin et al. 2005). The increased utilization of body fuels would have led to reduction in BMI post training in both the groups as the physical activity would have increased in all patients due to uplift of their general well-being.

5.5 DISCUSSIONS ON COMPLIANCE TO PHASE II CARDIAC REHABILITATION--(OBJECTIVE-5)

According to our fifth objective (To explore the barriers in patient compliance to Phase II Cardiac rehabilitation, Exercise based training) our results shows that there is the lack of awareness / knowledge (Barrier 1), lack
familial support (Barrier 2) and transport/commutation (Barrier 3) were found to be barriers to patient participation to phase II training in this study. Among the three factors, Transportation/Commutation remain the common and significant barrier to Phase II CR (Table 11). This may be due to increase in nuclear family prototype in Indian society and increasing economic constraints, which hinders the elderly people from regularly attending the Phase II cardiac Rehabilitation (Grace, Shanmugasegaram et al. 2009).

The long-term success of secondary prevention program depends upon the patient compliance. Data are available regarding adherence rates to cardiac rehabilitative exercise programs indicate that the short term programs have better adherence rates (i.e., the number of persons who remain active in a program at a given time compared with the total number of persons who began the program) for exercise training programs (Mann, Garrett et al. 1969, Miller, Haskell et al. 1984, Oldridge and Jones 1986) As found in this study, many factors that contribute to noncompliance including lack of attention to individual needs, inconvenient location or scheduling, inadequate leadership, and lack of provision for progress and feedback assessment to patients have been noted in previous studies (Dishman 1988). Patient-related factors associated with noncompliance include cigarette smoking, physically inactive leisure time, history of two previous MIs, blue-collar employment, and sedentary occupations as found in few studies needs to be studied in detail in future research activities (Hamm LFetal. 1993).
Thus, the Cardiac rehabilitation programs needs to adopt strategies that provide convenient and individualized exercise training with periodic follow-up along with progress reporting for both the patient and referring physician. The programs should have effective and varied exercise regimens with group involvement. The therapist needs skill to identify and focus on patients whose medical and social profiles predict noncompliance.

5.6 DISCUSSIONS ON SAFETY AND FEASIBILITY OF OUT--PATIENT EXERCISE TRAINING PROGRAM (OBJECTIVE-6)

According to our sixth objective (to determine the safety and feasibility of outpatient exercise training program), our results shows The Exercise Based cardiac Rehabilitation following CABG during Phase two (from Discharge to 12 weeks) was safe.

This study reflects the importance of supervised exercise based Phase I and Phase II cardiac rehabilitation and one of the largest RCTs. Even though the effect of Exercise Based Cardiac Rehab was established with parameters like Lipid levels, Obesity, Hypertension, Smoking and Psychological improvement, this study focused more on physical and physiological parameters like BMI, physiological factors like rest ECG, resting heart rate, systolic BP and ejection fraction, anemia, pulmonary function, valve dysfunction, autonomic function, oxygen saturation, peripheral arterial disease. This study has to be continued in
different type of cardiac patients like valve replacement, pacemaker implanted patients, cardiac failure patients and even post-transplant patients with more physiological factors which can conform the outcome.
5.7 FUTURE ISSUES

The Cardiac rehabilitation gains clinical support for having a significant effect on secondary prevention, reduced disability, increased productivity, improved quality of life, and associated influences on health care costs. Such compelling evidences needs to urge the government, the insurance industry, private health care agencies, and academic institutions to foster and support research in these areas.

The effects of exercise training and risk factor modification on the pathophysiologic mechanisms such as coronary vasomotor reactivity, blood flow rheology and clotting mechanisms needs to be studied. The effects of training on autonomic nervous system response are less evaluated; it’s worth to investigate physiological basis of changes in cardiac adaptation in different population. The infarct remodeling, ventricular adaptations and medication effects need to be studied.

The variations need in Cardiac rehabilitation exercise training for other surgical interventions such as valve repair, replacement and anatomical corrective surgeries need to be investigated.

Finally, well-designed, prospective cost-effective studies should be conducted. These should include evaluation of supervised cardiac rehabilitation programs, office or work-based care, and supervised home programs with
regard to improvements in functional capacity, modification of risk factors, long-term compliance, rehospitalization, quality of life, and medical costs incurred. Productivity assessment needs to include the attainment of self-sufficiency and independence in persons disabled by cardiac illness and not only in return to some job. The program design should include family members or care taker to be really an active participant of rehabilitation and not just attending counselling sessions. In this context, the establishment of a national cardiac rehabilitation database for the analysis of data collected in the daily delivery of cardiac rehabilitation services among urban, suburban, and rural populations may provide considerable useful information and serve as an important scientific and clinical frame of reference.