(9.6 ± 1.2 to 7.6 ± 0.7 cm, $p < 0.05$) and in CI (676 ± 79 to 536 ± 65 cm/min, $p < 0.05$). SD and CI were unchanged after captopril in normals (SD, 7.7 ± 1.3 to 7.4 ± 0.6 cm; CI, 579 ± 117 to 571 ± 69 cm/min, both ns). There was no reduction in forearm or digital skin vascular resistance after captopril in either group. Basal PRA in AF was similar to normals, but did not rise after captopril (691 ± 217 to 681 ± 221 pg/ml/hr, ns), unlike normals (813 ± 103 to 1360 ± 290 pg/ml/hr, $p < 0.05$). NORAD was unchanged after captopril in both groups.

We conclude that, captopril lowers blood pressure in AF, unlike normals. The depressor response in AF occurs independently of plasma renin levels and sympathetic nervous activity, suggesting that alternative mechanisms, including accumulation of bradykinin and prostaglandins, may be responsible.

788 Evaluation of Exercise Function in Heart Failure

Wednesday, March 22, 1995, 10:30 a.m.–Noon
Ernest N. Morial Convention Center, Room 22

10:30

788-1 The 6-Minute Walk Test Predicts Maximal Oxygen Consumption and Survival in Advanced Heart Failure

Lawrence P. Cahalin, Thomas G. Di Salvo, Michael M. Mathier, Dennis M. McNamara, Marc J. Semigran, G. William Dec *Massachusetts General Hospital, Harvard Medical School, Boston, MA*

Although maximal oxygen consumption (MVO_2) is useful in predicting prognosis and need for cardiac transplantation (TX) in patients with advanced heart failure (HF), its determination requires sophisticated equipment. The six-minute walk test (6-MW) is a simple indirect measure of functional capacity, and predicts survival in moderate HF. To assess the predictive value of the 6-MW, MVO_2, and percent predicted age-sex adjusted MVO_2 ($\%MVO_2$) in advanced HF, 45 pts (age 49 ± 8 yrs mean ± SD, LVEF 0.20 ± 0.06, RVEF 0.31 ± 0.11) underwent cardiopulmonary exercise testing (cycle ergometry) and the 6-MW during TX evaluation. Mean 6-MW distance ambulated was 310 ± 100 meters, MVO_2 12.2 ± 4.5 ml/kg/min, and $\%MVO_2$ 38 ± 11%. Multivariate analysis of patient characteristics, resting hemodynamics and 6-MW (age, sex, weight, peak HR and BP during the 6-MW, right and left ventricular ejection fraction, right atrial pressure, mean pulmonary artery pressure, and cardiac index) identified distance ambulated during the 6-MW as the strongest predictor of MVO_2 ($p < 0.000$) and $\%MVO_2$ ($p < 0.000$). In univariate survival analysis, 6-MW > 300 meters predicted survival to the combined end-point death or hospital admission for inotropic/mechanical support (IN) as a bridge to TX ($p < 0.05$), but not overall survival ($p = 0.075$). In multivariate proportional hazards survival analysis designed to compare $\%MVO_2$, MVO_2, and 6-MW, MVO_2 was selected as the best predictor of overall survival, and $\%MVO_2$ as the best predictor of IN-free survival. 6-MW was not selected in any multivariate analysis. *Conclusions:* In pts with advanced HF evaluated for TX, distance ambulated during the 6-MW predicts 1) MVO_2 and $\%MVO_2$ and 2) IN-free survival but not overall survival. MVO_2 and $\%MVO_2$ may be superior to the 6-MW as predictors of survival in these pts: however, further studies to establish the prognostic utility of the 6-MW in pts with advanced HF are warranted.

10:45

788-2 Six Minute Walk Test Gives Prognostic Information in Severe Hear Failure

Karl Swedberg, Robert M. Califf, Kirkwood Adams, Mihai Gheorghiade, Frank B. Harrel, William McKenna, Kenneth Schulman, Jorge Soler-Soler, Barry Uretsky, F. Zannad, FIRST investigators. *Östra Hospital, Göteborg University, Göteborg, Sweden*

Distance walked in Six minute walk test (SMWT) has been shown to give prognostic information in moderate heart failure. We studied the value of SMWT in 359 patients with severe CHF (NYHA III–IV) in a multicenter trial of continuous epoprostenol infusions. SMWT was performed in a 30 m long corridor. Perceived symptoms were evaluated by the Borg scale. Follow up was performed at 2 weeks, 1, 3, 6 and 9 months.

Results: SMWT at baseline was significantly related to survival ($p = 0.0001$). When SMWT distance was below median, 210 m, 6 month mortality was 50% vs 20% above median ($p < 0.001$). Median Borg scale at end of exercise was 3.2. A test with a Borg scale above median value was 174 m vs 230 m below median ($p < 0.001$). When all tests performed at baseline and during follow up were included ($n = 1291$) and related to changes in NYHA class, there was a significant relationship to NYHA class ($p = 0.0001$).

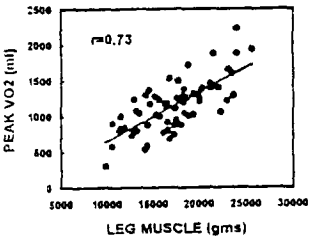
Conclusion: In severe CHF Six minute walk test is related to symptoms and perceived exertion. The test also gives prognostic information and it is related to functional classification.

11:00

788-3 Effect of Body Composition on Exercise Performance in Patients with Heart Failure

John R. Wilson, Glenn Rayos, Jane Smith, Patricia Gothard, T.K. Yeoh. *Vanderbilt University, Nashville, TN*

Changes in fat and skeletal muscle volume may contribute to the exercise intolerance reported by patients with heart failure. To test this hypothesis, we measured hemodynamic and ventilatory responses to exercise in 65 patients with chronic heart failure. Body composition was determined by dual-energy x-ray absorptiometry. Peak exercise VO_2 averaged 13.2 ± 2.9 ml/min/kg, peak exercise cardiac index 4.5 ± 1.1 L/min/m^2, lean body weight 55 ± 12 kg, lean leg weight 17.2 ± 3.8 kg and total fat 27 ± 11 kg. Thirty-eight (58%) of the patients were obese, as defined by a percentage fat >30%. Twenty-four patients (37%) exhibited lean body wt/height <300 gm/cm, consistent with muscle atrophy. Peak exercise VO_2 correlated closely with total leg muscle:



There was no relationship between VO_2/gm leg muscle and the lean body wt/height index, suggesting that muscle atrophy does not affect muscle performance/unit of muscle. VO_2/kg muscle was higher in obese vs non-obese patients (72 + 14 vs 59 + 13 ml/min/kg ($p < 0.01$) whereas peak VO_2/kg body weight was similar (13.0 + 3.3 vs 13.2 + 2.6 ml/min/kg), since body weight includes fat. These findings suggest that skeletal muscle volume influences exercise capacity in patients with heart failure. Exercise capacity in obese patients is underestimated by normalizing for body weight.

11:15

788-4 Does Low Level Training Increase Peak Aerobic Capacity in Patients with Congestive Heart Failure?

Laura Demopoulos, Rachel Bijou, Icilma Fergus, Marco Gentilucci, Leslie Panzarino, Margaret Jones, Marie Galvao, Edmund H. Sonnenblick, Thierry H. LeJemtel. *Albert Einstein College of Medicine, Bronx, New York*

Conventional high level exercise training at a workload consistent with 75% of peak oxygen consumption (pVO_2, ml/min/kg) in patients with congestive heart failure (CHF) improves peak aerobic capacity and limb vasodilatory capacity. However, training at this workload may promote left ventricular dilatation in patients with CHF by prolonged exposure to substantially elevated filling pressure (PCWP). Whether training at low level, i.e., at a workload consistent with <50% pVO_2, would result in limited increases in PCWP while still improving peak aerobic capacity and peripheral vasodilatory function is unknown. Accordingly, 15 patients with stable advanced CHF underwent measurement of 1) the PCWP response to low vs high level exercise, and 2) the change in peak aerobic capacity and limb vasodilatory capacity resulting from participation in a low level training program. PCWP was measured by right heart catheterization at rest, and during low and high level exercise. Patients then performed 12 weeks of low level training, utilizing a semi-recumbent bicycle. Pre- and post-training evaluations included pVO_2, calf and forearm peak hyperemic blood flow (PHBF, ml/min/100 ml), and resting heart rate (HR, b/min).

Results: 1)PCWP rose to 20 mmHg during low level exercise (Δ54% vs rest), and 34 mmHg during high level exercise (Δ162% vs rest). 2)Pre- and post-training data are as follows:

	pVO_2	calf PHBF	forearm PHBF	HR
pre-train	9.9	18	23	99
post-train	14.1	36	20	80
p value	0.02	<0.01	NS	0.02

Conclusions: 1) The rise in PCWP is significantly less during low level exercise than during high level exercise. 2) Training at a workload consistent with ≤50% of pVO_2 significantly improves peak aerobic capacity. 3) PHBF in the trained calf increases 100% from baseline, while it does not change in the untrained forearm. Enhanced vasodilatory responses in exercising muscle