Muscular work requires the integration of cardiopulmonary mechanisms for gas exchange and O2 delivery. In patients with chronic cardiac failure, the response of these mechanisms may be impaired, and the pattern of O2 utilization (VO2) and gas exchange during exercise would thus provide an objective assessment of the severity of heart failure. Accordingly, rates of air flow, O2 uptake, CO2 elimination and minute ventilation were determined during progressive treadmill exercise in 62 patients with stable heart failure. Exercise cardiac output, systemic O2 extraction and lactate production were measured directly in 40 patients with heart failure of varying severity. As the severity of heart failure increased from class A to D, there was a progressive decrease in exercise capacity (from 1157 +/- 154 to 373 +/- 157 seconds) and maximum VO2 (23 +/- 3.2 to 8.4 +/- 1.5 ml/min/kg). These decreases corresponded with the reduced maximum cardiac output and stroke volume during exercise. The appearance of anaerobic metabolism (580 +/- 17 to 157 +/- 7 seconds of exercise) and the corresponding anaerobic threshold (17 +/- 0.34 to 7.1 +/- 1.5 ml/min/kg), determined noninvasively, were reproducible and correlated with the rise in mixed venous lactate concentration. No apparent untoward effects were experienced during or after the progressive exercise test. We conclude that the measurement of respiratory gas exchange and air flow during exercise is an objective, reproducible and safe noninvasive method for characterizing cardiac reserve and functional status in patients with chronic cardiac failure.