Pseudonormal Mitral Filling Pattern Predicts Hospital Re-Admission in Patients With Congestive Heart Failure

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OBJECTIVES

We sought to investigate whether pseudonormal (PN) filling was associated with death or hospital admission in patients with congestive heart failure (CHF).

BACKGROUND

The high mortality rate associated with CHF is related to many clinical and echocardiographic variables. In particular, a short mitral deceleration time and restrictive diastolic filling predict death and/or hospital admission. We hypothesized that differentiating patients with nonrestrictive filling might identify an intermediate PN group that may be associated with intermediate risk.

METHODS

A total of 115 patients admitted to the hospital for exacerbation of CHF symptoms underwent pre-discharge Doppler echocardiography to determine mitral inflow (before and after preload reduction) and pulmonary venous return. Patients were followed up for one year, and all-cause mortality and re-admission data were analyzed.

RESULTS

The classification of filling patterns was: abnormal relaxation (AR) in 46 (40%) patients, pseudonormal (PN) filling in 42 (36.5%) patients and restrictive filling pattern (RFP) in 27 (23.4%) patients. When comparing the RFP group with the AR group, all-cause mortality was higher (50.0% vs. 17.4%, p = 0.033), hospital admission was higher (70.3% vs. 54.3%, p = 0.073), death/hospital admission was higher (77.8% vs. 56.5%, p = 0.02), and death/CHF hospital admission was higher (62.9% vs. 26.1%, p = 0.0005). Mortality in the PN group was not significantly different from that in the two other groups, but re-admissions were higher than the AR group (76.2% vs. 54.3%, p = 0.006), as was death/re-admission (78.6% vs. 56.5%, p = 0.004) and death/CHF re-admission (47.6% vs. 26.1%, p = 0.03). Re-admissions in the PN and RFP groups were comparable.

CONCLUSIONS

In a general hospital population of older patients with CHF, PN filling was associated with hospital admission rates similar to those seen with restrictive filling. The combined end point of death/CHF hospital admission was similar for restrictive filling and AR. Measurement of these variables is easy to add to routine clinical echocardiography and may provide important prognostic information in a wide range of patients with CHF.

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Despite optimal medical therapy, mortality associated with congestive heart failure (CHF) remains high (1,2). Several clinical and functional variables predict survival, including New York Heart Association (NYHA) functional class (3), peak oxygen uptake (4,5) end-systolic volume (6), ejection fraction (EF) (3,4,7), creatinine clearance (8) and echo-Doppler indexes of diastolic filling (9–13).

Pulsed wave Doppler (PWD) assessment of the mitral valve is routinely used in clinical practice to assess left ventricular (LV) diastolic filling noninvasively. Five progressive filling categories have been described: normal, abnormal relaxation (AR), pseudonormal (PN), reversible restrictive filling and nonreversible restrictive filling, based on early (E) and late (A) peak filling velocities and E-wave deceleration time (DT) (14–17). On its own, mitral PWD does not permit differentiation between true normal and PN filling patterns. Pulmonary venous PWD, when used in conjunction with mitral inflow, helps to differentiate between true normal and PN filling and is useful for estimating left atrial (LA) pressure (16,18–21). However, trans-thoracic pulmonary venous Doppler recordings are frequently suboptimal (22), and other methods are required. A preload reduction, achieved with the Valsalva maneuver or sublingual glyceryl trinitrate, can assist in the differentiation between PN and true normal patterns (16,23,24) and can also differentiate reversible from nonreversible restrictive filling.

Differentiating a restrictive filling pattern (RFP) from a non–RFP provides important independent prognostic infor-
The primary end points for this report were all-cause mortality, hospital admission and a combined end point of mortality and first hospital admission at one year. Outcome data were collected from the hospital records, primary care records and death certificates.

Echocardiographic methods. All patients were examined while lying on their left side, and images were obtained according to a standard protocol, using one of two ultrasound machines (ATL HDI-3000, ATL Ultrasound, Bothell, Washington or Acuson XP128, Acuson Corp., Mountainview, California). Images were recorded onto videotape and digitally acquired for off-line analysis (NovaMicrosonics, Kodak Eastman, Allendale, New Jersey). Mitral valve PWD recordings were obtained from the apical four-chamber view with a 5-mm PWD sample volume placed distal (5 to 10 mm) to the mitral annulus between the mitral valve leaflets (35). The PWD interrogation beam was carefully aligned with the direction of mitral flow. Pulmonary venous PWD was attempted in all subjects by placing a 5-mm PWD sample volume in the right upper pulmonary vein in the apical four-chamber view. The isovolumic relaxation time was recorded by placing the sample volume adjacent to the anterior mitral valve leaflet in the LV outflow tract in a five-chamber view. The signal was considered optimal when a clear aortic valve closure click was observed, as well as the onset of early mitral flow. All PWD recordings were optimized to maximize the signal on the screen, eliminate excess gain and minimize wall filters and were recorded at 100 mm/s; only end-expiratory signals were analyzed.

Patients were instructed in the performance of the Valsalva maneuver, which they practiced at least once. Mitral valve inflow PWD was then recorded during the Valsalva maneuver. Preload reduction was considered adequate if the mitral velocities dropped by 20%. The Valsalva maneuver was repeated up to three times to obtain adequate signals. In addition, a full clinical echocardiogram was obtained. M-mode echocardiographic recordings (parasternal long-axis view) were used to calculate LV size, wall thickness, mass and fractional shortening. The LV volumes and EF were measured using Simpson’s biplane method from the apical four- and two-chamber views. The LA area was measured in the apical four-chamber view at end-systole. All images were obtained by specially trained research sonographers, who had no knowledge of the patients’ clinical details.

Abbreviations and Acronyms

AR = abnormal relaxation
CHF = congestive heart failure
DT = deceleration time
E/A = ratio early to late filling ratio
ECG = electrocardiogram
EF = ejection fraction
LA = left atrium
LV = left ventricle
NYHA = New York Heart Association
PN = pseudonormal
PWD = pulsed wave Doppler
RFP = restrictive filling pattern

mation (9–13). When RFP is further categorized into reversible (responsive to pharmacologic preload reduction) or nonreversible (unresponsive), the latter is associated with a worse outcome (25–27). Peak oxygen uptake is also reduced in patients with CHF who have RFP (28), and the combination of RFP and reduced peak oxygen uptake provides additional prognostic information (10).

Recently, in patients with a first myocardial infarction and normal systolic function, the presence of PN filling within 24 h of the myocardial infarction predicted cardiac death and LV dilation (29). The effect fell between that observed for patients with RFP and AR. Similarly, a short DT is associated with adverse remodeling (30) and the development of CHF after infarction (31,32). The presence of RFP is the single best predictor of cardiac death (33).

We hypothesized that intermediate PN filling would provide additional prognostic information in patients with CHF, beyond the simple classification of non-RFP or RFP, which most studies have used. Thus, the aim of this study was to investigate whether the distinction of different patient groups, based on filling patterns, was associated with survival or re-admission in a chronic heart failure population.

METHODS

Study group. Patients included were those enrolled in a randomized, controlled trial of integrated heart failure management, carried out at our institution between 1996 and 1999 (34). The intervention had a beneficial effect on multiple re-admission rates, bed days and quality of life, but not on mortality (34). All patients admitted to the general medical wards at Auckland Hospital with a primary diagnosis of CHF were eligible. Exclusion criteria were: 1) a surgically remediable cause of heart failure, such as severe valve disease; 2) consideration for transplantation; 3) the inability to provide informed consent; 4) terminal cancer; and 5) participation in any other clinical trial. For the current analyses, only patients in sinus rhythm at the baseline echocardiographic examination were included. Congestive heart failure was diagnosed on the basis of typical symptoms and signs, with a review of the chest radiograph, electrocardiogram (ECG) and echocardiogram. The Auckland Ethics Committee approved the study, and written, informed consent was obtained from each patient during the index hospital admission. Details of the patients’ clinical history, physical examination, blood biochemistry results and ECG and chest radiographic findings were recorded before discharge.

Patients were instructed in the performance of the Valsalva maneuver, which they practiced at least once. Mitral valve inflow PWD was then recorded during the Valsalva maneuver. Preload reduction was considered adequate if the mitral velocities dropped by 20%. The Valsalva maneuver was repeated up to three times to obtain adequate signals. In addition, a full clinical echocardiogram was obtained. M-mode echocardiographic recordings (parasternal long-axis view) were used to calculate LV size, wall thickness, mass and fractional shortening. The LV volumes and EF were measured using Simpson’s biplane method from the apical four- and two-chamber views. The LA area was measured in the apical four-chamber view at end-systole. All images were obtained by specially trained research sonographers, who had no knowledge of the patients’ clinical details.

Echocardiographic measurements. Triplicate measurements of all variables were made off-line (Nova Microsonics, Kodak Eastman) by one observer who was blinded to
RESULTS

Patients. One hundred and fifteen patients were followed up for 12 months (average duration of follow-up: 0.87 ± 0.28 years). The mean age at study entry was 73 ± 10.8 years. Three quarters of the patients were classified as being in NYHA functional class IV on hospital admission, but all patients improved sufficiently to be discharged. The cause of CHF was considered to be ischemic heart disease in 54% of patients, and the remainder was classified as non-ischemic, although many of these patients had multiple potential causes of CHF, with the exact cause often uncertain. Of all patients, 46% had a documented prior myocardial infarction, 52% had previous hypertension and 29% had diabetes; 52% had a previous admission for CHF before the index admission. Most were receiving furosemide, and 88% were receiving an angiotensin-converting enzyme inhibitor. The average LVEF was 32 ± 13%. In 90% of patients, LVEF was <50%, and in 77% it was <40%. Renal function was impaired, with average creatinine clearance 48.9 ± 24 ml/min (normal range 90 to 140 ml/min).

Mitral filling pattern. No patients had a normal filling pattern; 46 (40%) were classified as having AR, 42 (37%) as PN filling and the remaining 27 (24%) as RFP (Table 1). There were no statistically significant differences in age, previous CHF admissions, heart rate, sodium, creatinine, creatinine clearance or angiotensin-converting enzyme inhibitor dose between the three groups. When comparing the AR group with the PN group, the LA area was smaller, the E/A ratio was lower and the deceleration and isovolumic relaxation times were longer. When comparing the AR group with the RFP group, the systolic and diastolic blood pressures were higher, the furosemide dose was lower, the LA area was smaller, the E/A ratio was lower and the deceleration and isovolumic relaxation times were longer (Table 1). The mitral A-wave duration time was longer, but the pulmonary atrial reversal duration was not. When comparing the PN group with the RFP group, both systolic and diastolic blood pressures were higher, the E/A ratio was higher and the DT was prolonged (Table 1). Figure 1 summarizes the flow of patients in the study and shows the exclusions (14%) and final mitral filling classification based on the full PWD measurements and events in each group.

Hospital admission. Seventy-six patients (66%) were hospitalized. Re-admission rates were similar between the non-RFP group (57 re-admissions [65%]) and the RFP group (19 re-admissions [70%], p = 0.48). In the non-RFP group, there was a significant difference between those with AR (25 events [54%]) and those with PN filling (32 re-admissions [76%], p = 0.0057), as well as a trend between the AR and RFP groups (19 re-admissions [70%), p = 0.073), but there was no difference between the PN group (32 re-admissions [76%) and the RFP group (19 re-admissions [70%), p = 0.52) (Fig. 2).

Of the 76 first re-admissions, 31 (41%) were for worsening CHF. Admissions for worsening CHF were higher in the RFP group (11 CHF admissions [41%]) than in the non-RFP group (20 CHF admissions [23%], p = 0.046). In the non-RFP group, those with AR (7 CHF admissions [15%]) had fewer CHF admissions than those with RFP (11 CHF admissions [41%], p = 0.011), but the non-RFP group was not statistically different from the PN group (13 CHF admissions [31%], p = 0.078). The CHF admissions were not different between the PN group (13 CHF admis-
sions [31%]) and the RFP group (11 CHF admissions [41%], \( p = 0.35 \)) (Fig. 2).

**All-cause mortality.** In total, there were 28 deaths (24.3%). Mortality was significantly different between the non-RFP group (18 deaths [21%]) and the RFP group (10 deaths [37%], \( p = 0.035 \)). In the non-RFP group, mortality was lower in those with AR (8 deaths [17%]), compared with the RFP group (10 deaths [37%], \( p = 0.033 \)), but it was not different from that in the PN group (10 deaths [24%], \( p = 0.47 \)). Survival in the PN group (10 deaths

### Table 1. Clinical and Echocardiographic Variables at the Time of Discharge From the Hospital, After Stabilization With Medication (n = 115)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Abnormal Relaxation (n = 46)</th>
<th>Pseudonormal Filling (n = 42)</th>
<th>Restrictive Filling (n = 27)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>73.5 ± 11.4</td>
<td>71.8 ± 9.8</td>
<td>69.6 ± 13.2</td>
</tr>
<tr>
<td>NYHA functional class</td>
<td>1.7 ± 0.6</td>
<td>1.9 ± 0.5</td>
<td>2.0 ± 0.6</td>
</tr>
<tr>
<td>Previous infarction</td>
<td>24 (52%)</td>
<td>21 (51%)</td>
<td>13 (48%)</td>
</tr>
<tr>
<td>No. of previous admissions</td>
<td>1.1 ± 1.4</td>
<td>1.3 ± 1.8</td>
<td>1.3 ± 1.7</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>82.1 ± 13.2</td>
<td>78.2 ± 11.1</td>
<td>80.1 ± 11.1</td>
</tr>
<tr>
<td>Systolic BP (mm Hg)</td>
<td>130.5 ± 22.7</td>
<td>128.0 ± 19.2</td>
<td>113.4 ± 19.3*</td>
</tr>
<tr>
<td>Diastolic BP (mm Hg)</td>
<td>71.8 ± 10.5</td>
<td>74.2 ± 12.2</td>
<td>63.7 ± 10.7†</td>
</tr>
<tr>
<td>Plasma sodium (mmol/l)</td>
<td>138.8 ± 3.5</td>
<td>139.2 ± 3.7</td>
<td>137.6 ± 6.9</td>
</tr>
<tr>
<td>Plasma creatinine (mmol/l)</td>
<td>0.12 ± 0.03</td>
<td>0.13 ± 0.05</td>
<td>0.14 ± 0.06</td>
</tr>
<tr>
<td>Creatinine clearance (ml/min)</td>
<td>49.6 ± 29.9</td>
<td>49.6 ± 19.8</td>
<td>49.2 ± 25.6</td>
</tr>
<tr>
<td>Furosemide (mg)</td>
<td>87.1 ± 62.1</td>
<td>112.2 ± 86.7</td>
<td>155.6 ± 73.9*</td>
</tr>
<tr>
<td>ACE inhibitor (mg/day)</td>
<td>9.4 ± 5.8</td>
<td>11.1 ± 6.6</td>
<td>10.6 ± 6.8</td>
</tr>
<tr>
<td>LVEDV (ml)</td>
<td>165.6 ± 71.8</td>
<td>181.0 ± 62.4</td>
<td>206.4 ± 83.2</td>
</tr>
<tr>
<td>LVESV (ml)</td>
<td>117.1 ± 66.2</td>
<td>125.9 ± 57.3</td>
<td>154.5 ± 75.4</td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>32.8 ± 13.6</td>
<td>32.0 ± 11.4</td>
<td>28.7 ± 12.5</td>
</tr>
<tr>
<td>LA area (cm²)</td>
<td>24.3 ± 5.0</td>
<td>28.2 ± 4.3‡</td>
<td>28.2 ± 5.8*</td>
</tr>
<tr>
<td>E/A ratio</td>
<td>0.7 ± 0.15</td>
<td>1.3 ± 0.3‡</td>
<td>2.5 ± 0.8‡</td>
</tr>
<tr>
<td>Deceleration time (s)</td>
<td>0.269 ± 0.103</td>
<td>0.191 ± 0.053‡</td>
<td>0.132 ± 0.038*‡</td>
</tr>
<tr>
<td>A-wave duration (s)</td>
<td>0.164 ± 0.024</td>
<td>0.153 ± 0.025</td>
<td>0.140 ± 0.024*</td>
</tr>
<tr>
<td>Atrial reversal duration (s)</td>
<td>0.131 ± 0.024</td>
<td>0.155 ± 0.33</td>
<td>0.146 ± 0.037</td>
</tr>
<tr>
<td>Isovolumic relaxation time (s)</td>
<td>0.073 ± 0.022</td>
<td>0.059 ± 0.017‡</td>
<td>0.053 ± 0.022*</td>
</tr>
</tbody>
</table>

\(^*p < 0.05\) for abnormal relaxation versus restrictive filling. \(^{†}p < 0.05\) for pseudonormal filling versus restrictive filling. Data are presented as the mean value ± SD or number (%) of patients.

ACE = angiotensin converting enzyme; BP = blood pressure; E/A ratio = ratio of early passive to late active mitral filling.

LA = left atrium; LVEDV = left ventricular end-diastolic volume; LVESV = left ventricular end-systolic volume; LVEF = left ventricular ejection fraction; NYHA = New York Heart Association.

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**Figure 1.** Flow chart of patients and events according to inclusion/exclusion criteria and final mitral filling pattern classification. CHF = congestive heart failure; readm = readmission.
[24%]) was not statistically different from that in the RFP group (10 deaths [37%], p = 0.15) (Fig. 3).

**All-cause mortality and hospital admission.** Eighty patients (70%) either died or were admitted to the hospital for any cause. There was no difference between the non-RFP group (59 events [67%]) and the RFP group (21 events [78%], p = 0.23) for the combined end point of death and/or hospital admission. However, in the non-RFP group, there was a significant difference between those with AR (26 events [57%]) and PN filling (33 events [79%], p = 0.004) and RFP (21 events [78%], p = 0.02), but there was no difference between the PN (33 events [79%]) and RFP groups (21 events [78%], p = 0.78) (Fig. 3). Fifty-nine patients (51%) either died or were admitted to the hospital for worsening CHF. There was a significant difference between those with AR (12 events [26.1%]) and PN filling (20 events [48%], p = 0.03) and RFP (17 events [63%], p = 0.0005), but there was no difference between the PN (20 events [48%]) and RFP groups (17 events [63%], p = 0.15) (Fig. 3).

In the first three months after hospital discharge, there were 12 deaths (10%) and 47 re-admissions (41%). When comparing the non-RFP and RFP groups, there was a significant difference in early mortality (5 [6%] vs. 7 [26%], p = 0.0035) (Fig. 3), but no difference in re-admissions (34 [39%] vs. 13 [48%], p = 0.42) (Fig. 2) or the combined end point of death and/or re-admission (34 [39%] vs. 14 [52%], p = 0.27) (Fig. 3). However, when the non-RFP group was further classified into PN filling and AR, the AR subgroup (11 admissions [24%]) had fewer re-admissions than the PN subgroup (23 admissions [55%], p = 0.004) or the RFP group (13 admissions [48%], p = 0.02), and the PN subgroup (23 admissions [55%]) was not different from the RFP group (13 admissions [48%], p = 0.78) (Fig. 2).

Figure 2. Event-free survival plots for all-cause and congestive heart failure (CHF) hospital admissions; time to first event analysis by the Kaplan-Meier method. AR = abnormal relaxation; PN = pseudonormal; RFP = restrictive filling pattern.
DISCUSSION

Patients with LV dysfunction and CHF have a very poor prognosis (1,2) and frequent hospital re-admissions (36). End-systolic volume (6) and LVEF (4) are both very useful echocardiographic measurements for predicting survival in patients with CHF. However, once severe LV dysfunction is established, further prognostic differentiation is difficult. Previous work in this area has highlighted the need to differentiate those patients with an RFP from those with a non-RFP, as the former is associated with poor survival (9–13,25–27) and higher hospital admissions in patients with CHF (37).

Figure 3. Event-free survival plots for all-cause death and hospital admissions; time to first event analysis by the Kaplan-Meier method. AR = abnormal relaxation; CHF = congestive heart failure; PN = pseudonormal; RFP = restrictive filling pattern.
This is the first study to demonstrate that using a preload reduction to differentiate non-RFP provides additional prognostic information. In particular, the time to re-admission in patients with PN filling was comparable to that observed in patients with RFP, and both were higher than that observed in patients with an AR pattern. Mortality was higher in patients with PN filling, and was intermediate between that observed in the AR and RFP groups, although not statistically different from either, which probably reflects the small number of events in each group. However, the PN group had hospital re-admission rates as high as those observed in patients with RFP, and both were nearly double that observed in the AR group. Nearly two-thirds of the re-admissions occurred in the first three months after the index admission in the RFP and PN groups, compared with approximately one-fourth in the AR group. These data suggest that further differentiation of patients with CHF who have a non-RFP pattern provides both short- and intermediate-term prognostic information.

Despite an older, heterogeneous CHF population, the current study demonstrated better survival in the non-RFP group compared with the RFP group, in keeping with many other published studies (9,11–13). In a larger study of patients with CHF, similar differences between non-RFP and RFP were seen for total mortality, CHF hospital admission and death and/or CHF admission and short DT, such as might be seen with RFP, the best single predictor of outcome (11). However, differentiation into AR or PN filling was not possible, as the study was conducted before the introduction of contemporary echocardiographic methods. Our data are in agreement with this study (11), but extend the findings by further differentiating the non-RFP group, in particular.

Mitral filling pattern and LA pressure. The mitral valve E/A ratio and DT are closely associated with mean LA pressure in patients with systolic dysfunction (38,39). In patients with chronic CHF and severely impaired LV function, DT is the best predictor of pulmonary artery wedge pressure (40). It also provides important prognostic information in addition to clinical variables, especially when used to differentiate patients on the basis of RFP and non-RFP (10–12,25,41). The RFP is correlated with NYHA functional class (42) and may be the single best predictor of cardiac death in patients with dilated cardiomyopathy (12). Recently, in patients with ischemic cardiomyopathy, a prolonged DT was shown to be related to myocardial viability and to predict improvement in LVEF after revascularization (43). Thus, DT is important for differentiating RFP from non-RFP, but, to date, it has not been useful for further differentiation and risk stratification of the subgroups within the non-RFP group. Identification of RFP by echocardiography appears to be a surrogate for mean LA or LV end-diastolic pressure (20,38–40), and categorizing patients on the basis of the mitral filling pattern identifies subgroups with a progressively higher pressure. Thus, it follows that if a patient with PN filling has a higher LA pressure, higher event rates may be anticipated.

Generalizability of results. This study included a mixed population of patients admitted to the hospital for exacerbation of CHF symptoms and are representative of those patients in a general hospital setting. Other similar studies often included younger patients, referred for evaluation of heart transplantation, usually with severely impaired systolic function (10,11,13,25–27). These differences are reflected in the high event rate in our study. Because of the nature of the study, patients with tachycardia, atrial fibrillation or implantable pacemakers were excluded from this analysis; thus, these results may have limited generalizability in those groups.

Study limitations. Many patients with CHF have functional mitral regurgitation, so we included them in this study. Three patients with severe valve disease requiring surgical intervention were excluded from this study. Some previous studies have excluded patients on the basis of significant mitral regurgitation, as it might lead to misleading results (10,20,33). However, in one study of patients with dilated cardiomyopathy (both ischemic and nonischemic), an excellent correlation between mitral DT and pulmonary venous recordings was observed, even in patients with significant mitral regurgitation (40).

Invasive measurements of the LA pressure would have confirmed the hypothesis that these findings reflect an incrementally higher LA pressure in each group. However, we believe there is considerable experimental data to support the hypothesis that PN filling is associated with a higher LA pressure and, likewise, RFP.

A further limitation is the use of the mitral filling pattern for assessment of diastolic filling, which is affected by heart rate, loading conditions and age. Heart rate was not significantly different between the groups. Cardiovascular medications may affect loading conditions, but all of the patients were receiving optimal medical therapy and had been stabilized in the hospital before study entry. Thus, it is unlikely that major alterations in preload would have affected our results. Angiotensin-converting enzyme inhibition was similar between the groups, as was beta-blocker use. Use of diuretics was incrementally higher in each of the groups: PN filling was higher than AR, and, likewise, RFP was higher than PN filling. If anything, the greater use of diuretics would have tended to lower the LA pressure in those groups, and probably reflects the higher symptomatic
status of those patients. Tissue Doppler imaging and, in particular, the ratio of the mitral inflow E velocity to the mitral annular velocity may have shown similar results and would potentially be a more powerful continuous variable. It also may be useful in patients with atrial fibrillation, who are, by necessity, excluded from the methods used in the current study.

Conclusions. This study extends the existing data on the relationship between the mitral filling pattern and death or hospital admission in patients with CHF. In particular, PN filling was associated with re-admission rates comparable to those observed in the RFP group, and death and/or hospital admission was similar to that observed with RFP and AR. The current approach, using a preload reduction, is relatively easy to add to routine clinical echocardiography and may provide important prognostic information in a wide range of patients with CHF, who might otherwise have been overlooked. Whether the mitral filling pattern can be used to guide the management of patients with CHF to improve long-term outcome remains uncertain.

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