JCN Journal of Clinical Nursing

Journal of Clinical Nursing

CLINICAL ISSUES

Nurses' performance in classifying heart failure patients based on physical exam: comparison with cardiologist's physical exam and levels of N-terminal pro-B-type natriuretic peptide

Jaquelini Sauer, Eneida R Rabelo, Raquel A Castro, Livia Goldraich, Luis E Rohde, Nadine Clausell and Luis Beck-da-Silva

Aim. The purpose of this study is to compare clinical assessment of congestion performed by a nurse to that performed by cardiologist and correlate them with NT-ProBNP levels.

Background. The nurses' role in heart failure has been strongly focused in therapeutic, educational and self-care interventions. The diagnostic performance of nurses in heart failure outpatients is not well explored. N-terminal pro-B-type natriuretic peptide is a cardiac marker that reflects elevated filling pressures.

Design. Cross-sectional contemporaneous study.

Methods. Heart failure outpatients underwent a systematic clinical assessment of clinical congestion score performed by cardiologist and nurse during the same visit. Assessments were performed independently and N-terminal pro-B-type natriuretic peptide levels obtained. The nurses' ability to classify patients in hemodynamic profile was compared to the cardiologist's.

Results. Eighty-nine assessments were performed in 63 patients with heart failure. The correlation of clinical congestion scores obtained by nurse with those obtained by cardiologist was $r_s = 0{\cdot}86$; $p < 0{\cdot}001$. The correlation of clinical congestion scores from nurse and cardiologist with levels of N-terminal pro-B-type natriuretic peptide were as follows: $r_s = 0{\cdot}45$; $p < 0{\cdot}0001$ and $r_s = 0{\cdot}51$, respectively, $p < 0{\cdot}0001$. Patients with clinical congestion score ≥3 had levels of NT-ProBNP significantly higher than those with clinical congestion score <3, in the assessment performed by the cardiologist (1866 SD 1151 vs. 757 SD 988 pg/ml; $p < 0{\cdot}0001$) and by the nurse (1720 SD 1228 vs. 821 SD 914 pg/ml; $p < 0{\cdot}0001$). The nurse and cardiologist had similar capacity in classifying patients in congested quadrants ($p = 0{\cdot}027$) or in dry quadrants ($p = 0{\cdot}03$), according to the levels of N-terminal pro-B-type natriuretic peptide. Area under the receiver-operating characteristic curve of the nurse and cardiologist to detect congestion was, respectively, 0·77 and 0·72.

Conclusions. Our data suggests that nurses trained in heart failure may have a similar performance to that of the cardiologist for the clinical detection of congestion and assessment of the hemodynamic profile in patients with chronic heart failure.

Authors: *Jaquelini Sauer*, MSc, RN, MSc Student, Division of Cardiology and Post-Graduation Program in Cardiovascular Science, Hospital de Clínicas de Porto Alegre, Federal University of Rio Grande do Sul (UFRGS), Medical School; *Eneida R Rabelo*, RN, ScD, Professor, Heart Failure and Cardiac Transplantation Unit and Division of Cardiology and Post-Graduation Program in Cardiovascular Science, Hospital de Clínicas de Porto Alegre, Federal University of Rio Grande do Sul (UFRGS), Medical School; *Raquel A Castro*, RN, Clinical Nurse, Division of Cardiology and Post-Graduation Program in Cardiovascular Science, Hospital de Clínicas de Porto Alegre, Federal University of Rio Grande do Sul (UFRGS), Medical School; *Livia Goldraich*, MD, Staff Cardiologist, Heart Failure and Cardiac Transplantation Unit and Division of Cardiology and Post-Graduation Program in Cardiovascular Science, Hospital de Clínicas de Porto Alegre, Federal University of Rio Grande do Sul (UFRGS), Medical School; *Luis E Rohde*, MD, ScD, Professor, Heart Failure and Cardiac Transplantation Unit and Division of Cardiology and Post-Graduation Program in Cardiovascular Science, Hospital de Clínicas de Porto Alegre, Federal University of Rio Grande do Sul (UFRGS), Medical School; *Nadine Clausell*, MD, PhD, Professor, Heart Failure and Cardiac Transplantation Unit and Division of Cardiology and Post-Graduation Program in Cardiovascular Science, Hospital de Clínicas de Porto Alegre, Federal University of Rio Grande do Sul (UFRGS), Medical School; *Luis Beck-da-Silva*, MD, ScD, Staff Cardiologist, Heart Failure and Cardiac Transplantation Unit and Division of Cardiology and Post-Graduation Program in Cardiovascular Science, Hospital de Clínicas de Porto Alegre, Federal University of Rio Grande do Sul (UFRGS), Medical School, Porto Alegre-RS, Brazil

Correspondence: Luis Beck-da-Silva, Staff Cardiologist, Cardiology Division, Hospital de Clínicas de Porto Alegre, Rua Ramiro Barcelos, 2350 Suite 2060, CEP: 90035-903, Porto Alegre-RS, Brazil. Telephone: +55 51 33596322.

E-mail: lbneto@hcpa.ufrgs.br

doi: 10.1111/j.1365-2702.2010.03403.x

Relevance to clinical practice. Considering that consistent clinical assessment can identify congested or hypovolemic patients with reasonable reliability, as well as patients with low or normal cardiac output, our results may help confirm nurses' capability in performing reliable clinical assessment in heart failure patients. While nurses' led heart failure programmes are usually focused on the management of patients, nurses' ability to perform accurate assessment would expand nurses' role in these programmes. As many institutions now focus on home visits by heart failure nurses, accurate assessment would benefit patients and improve their clinical outcomes.

Key words: BNP, clinical assessment, heart failure, natriuretic peptides, NT-Pro-BNP, nursing

Accepted for publication: 8 June 2010

Introduction

Heart failure (HF) has reached epidemic proportions in all parts of the world (Fonarow 2008). Because of the high complexity and great service demands of patients with HF, multidisciplinary programmes have been progressively implemented worldwide. In fact, these actions were associated with clinically relevant benefits including reduction of hospital readmission and mortality rates (Krumholz *et al.* 2002, McAlister *et al.* 2004, Ducharme *et al.* 2005, Holland *et al.* 2005). In addition, several reported experiences demonstrate the cost-effectiveness of such initiatives (Rich *et al.* 1995, Capomolla *et al.* 2002, Inglis *et al.* 2006).

Nurses rely on anamnesis and physical exam for diagnosis and management of HF patients. These classic tools combine low cost, high feasibility and are able to separate patients with completely different prognoses (Drazner *et al.* 2001, Rohde *et al.* 2004). Furthermore, by means of a consistent clinical assessment, it is also possible to identify congested or hypovolemic patients with reasonable reliability, as well as patients with low or normal cardiac output (Shah *et al.* 2001, Nohria *et al.* 2003). Moreover, the importance of the clinical assessment for HF in defining hemodynamic profile quadrants involves the fact that they can determine distinct therapeutic pathways, as well as characterise different patients' prognoses. However, the nurses' role in assisting HF patients has been strongly focused in therapeutic, educational and self-care interventions. Hence, the diagnostic and clinical performance of nurses in ambulatory patients with HF is not well explored. The nurses' role expansion by means of providing an accurate clinical assessment would help overstretched health care systems, would ease HF doctors to make decisions based on nurses' assessments and would benefit patients and improve their clinical outcomes (Blue & McMurray 2005).

Plasmatic levels of N-terminal pro-B-type natriuretic peptide (NT-ProBNP), a hormone produced by mechanically distended cardiomyocytes, have been used as a marker of congestion in HF patients (Richards *et al.* 2005, Chen *et al.* 2006). From a clinical viewpoint, this peptide has been used to discard or confirm the presence of congestion in patients with acute dyspnoea (Maisel *et al.* 2002).

Considering the perspectives of increased number of patients with HF, the logistic difficulties that an adequate diagnosis requires and the high cost involved in HF care, simple, available and low-cost management strategies are desirable, mainly in developing countries. Therefore, the purpose of this study is to compare a systematic clinical assessment for a congestion estimate in HF patients performed by a nurse to that performed by a cardiologist and correlate them with levels of NT-ProBNP.

Patients and methods

Study population and design

This is a prospective cross-sectional study performed in patients with HF that were consecutively treated at the HF clinic at a tertiary university hospital. Eligible patients that agreed to participate were included between June 2006–September 2007. Eligibility criteria were age ≥18 years, diagnosis of chronic HF of any aetiology and systolic dysfunction (left ventricular ejection fraction (LVEF) ≤45%) treated at the HF clinic. Patients who had had acute myocardial infarction in the two previous months, or who had been submitted to a myocardial revascularisation surgery one month before; or with cognitive neurological sequel or who did not agree to participate in the study were excluded. Prior to enrolment, all patients provided written consent. The study protocol was approved by the Institution's Ethics Committee.

Clinical and laboratorial data were obtained through a structured instrument. Each patient had a systematic clinical assessment according to a protocol previously published by the HF group from the same institution (Rohde *et al.* 2004). New York Heart Association (NYHA) classification was used in the functional class assessment (Heart Failure Society Of America 2006).

Structured examination protocol

Clinical assessments were performed in a silent room, with the patient lying down on an adjustable bed with head up to 45°. All patients were examined by the nurse and cardiologist in a consecutive and independent manner and both filled in a clinical assessment form.

The following clinical aspects were observed and classified: pulmonary rales, third heart sound, jugular distension, peripheral oedema, history of orthopnea, systemic arterial pressure, heart rate, hepatojugular reflux and NYHA functional class. The orthopnea symptom was investigated during the patient assessment and scored from 0–4, with zero indicating whether one pillow or less was required and four indicating the patient had spent at least one night sleeping on a sitting position. Pulmonary rales were scored from zero (none) to four (if present in all fields). The central venous pressure (CVP) was scored as zero with no visible jugular distension above clavicles, on both internal and external jugular veins and four if the jugular distension level was visible near the ear lobe with the patient reclining at 45°. The hepatojugular reflux was evaluated during normal breathing applying continued pressure for one minute onto the right hypochondria while observing the level of jugular veins. The peripheral oedema was scored from 0–4, according to the height of palpable oedema over the legs. The presence or absence of third heart sound was studied by applying the stethoscope disc onto the left ventricle apex. At the end of the exam, a clinical congestion score (CCS) was calculated by adding the values obtained in the clinical assessment of HF signs and symptoms (orthopnea: 0–4, pulmonary rales: 0–4, increased central venous pressure: 0–4, peripheral oedema: 0–4 and third heart sound: 0–1, hepatojugular reflux: 0–1, functional class according to NYHA (1–4). The clinical congestion score could vary from 1–22 (Appendix 1).

Each patient was classified into one of four hemodynamic profiles after each clinical assessment. Identification of these parameters defined different clinical scenarios: A: dry and warm (desirable profile); B: congested and warm (preserved cardiac output); C: congested and cold (low cardiac output); D: dry and cold (hypovolemic and low cardiac output) (Nohria *et al.* 2003).

Measurement of NT-proBNP

The NT-ProBNP was analysed using the Elecsys 2010 analyser (Roche Diagnostics, Indianapolis, Indiana) in total blood via electrochemiluminescence technology. Blood samples for the measurement of NT-ProBNP levels were collected simultaneously to the physical exam. The nurse and the cardiologist were blind to the NT-ProBNP values during the assessment.

Study logistics and instrument application

Prior to study start, researcher JMS attended training sessions on clinical examination at the HF clinic. The training constituted of an evaluation of 80 consecutive HF patients under direct supervision of HF clinic cardiologists. No data were collected during the training period. Each clinical sign of the clinical examination of these 80 patients was detected by both staff cardiologist and the nurse. All doubts were discussed and cleared during the physical exam. During the study, patients that met the study inclusion criteria and agreed to participate were examined. The nurse (or cardiologist) performed the clinical exam and immediately after that, the cardiologist (or the nurse) performed his clinical assessment in an independent manner. The first professional to assess the patient was defined randomly, to avoid a consistent learning effect. All patients were assessed by both professionals during the same office visit. Patients who returned for follow-up visit could be clinically reassessed, by both professionals. In this case, a new pair of assessments was counted. Data were collected using a clinical form and a clinical congestion score form, which has been previously published (Rohde *et al.* 2004).

Statistical analysis

Continuous variables with normal distribution were expressed as mean and standard deviation. The categorical variables were expressed in percentages and as absolute numbers. Data were analysed using Student's *t*-test for continuous variables and chi-square for categorical variables. According to parametrical or non-parametrical assumptions, we used Pearson's and Spearman's correlations. Kappa interobserver agreement (Landis & Koch 1977) was used to compare the categorical variables of the clinical assessment performed by the nurse to those obtained by the cardiologist. To determine a reasonable cut-off point in the clinical congestion score, a two-graph receiver-operating characteristic (TG-ROC) plot was built. This approach is simply a plot of the sensitivity and specificity against a range of different cut-off points defined about the possible outcomes of the diagnostic test (Martinez & Louzada-Neto 2008). To determine the capacity of cardiologist and nurse to detect congestion through the physical exam (clinical congestion score), we undertook receiver-operating characteristic (ROC) curve analysis and determined overall accuracy of the clinical congestion score and area under the ROC curve. Statistical analyses were performed using the statistical package SAS for Windows (version 8·02; SAS Institute Inc., Cary, NC, USA). For all analyses, a value of two-tailed $p < 0{\cdot}05$ was considered as statistically significant.

Sample size calculation

A pilot study with 10 patients was performed to calculate the sample size for the correlation between the clinical congestion score obtained by both the nurse and the cardiologist and serum levels of NT-ProBNP. Assuming that the lowest correlation between them was $r = 0{\cdot}715$ (between NT-ProBNP and clinical score of the cardiologist), for 90% power and significance level of 5%, 17 patients would be required for the study. However, considering that the secondary purpose of the study was the correlation between the nurses' and cardiologist's ability to classify HF patients into hemodynamic profile quadrants, the number of clinical assessments required was then recalculated. Assuming the agreement between the cardiologist and the nurse of at least 70% (Kappa >0·7), 85 assessments would be required. The ten patients included in the pilot study did not participate in the main study data analysis.

Results

Demographic and clinical characteristics of the patients

The study included 63 patients with the mean age of 59 (SD 12) years, 65% men, 33% of ischaemic aetiology and mean left ventricular ejection fraction of 30 (SD 9) %. Comorbidities mostly associated with HF were systemic arterial hypertension in 17 (27%), atrial fibrillation in 14 (22%) and diabetes mellitus in 11 (17%) patients. Table 1 shows patients' demographic and clinical characteristics.

Table 1 Demographic and clinical characteristics of the patients

Characteristics*	
n	63
Age (years)	58·7 ± 12·1
Gender (male)	41 (65)
Race (Caucasian)	49 (78)
Weight	74 ± 39·1
Body mass index (kg/m^2)	25·8 ± 4·3
Heart failure aetiology	
Ischaemic	21 (33)
Idiopathic	18 (28)
Hypertensive	10 (16)
Valvular	5 (8)
Others	9 (15)
Left ventricular ejection fraction (%)	30 ± 9
NT-proBNP (pg/ml)	1467·3 ± 1213·7
Comorbidities	
Arterial hypertension	17 (27)
Atrial fibrillation	14 (22)
Diabetes mellitus	11 (17)
Urea (mg/dl)	58·6 ± 37·9
Creatinine (mg/dl)	1·3 ± 0·8
Sodium (mEq/l)	138·6 ± 18·2
Potassium (mEq/l)	4·7 ± 0·7
Haemoglobin (g/dl)	12·9 ± 1·6
Hematocrit (%)	39·4 ± 5·1
Total cholesterol (mg/dl)	160 ± 51·7
Triglycerides (mg/dl)	155·4 ± 91·4
High-density lipoprotein (mg/dl)	55 ± 23

*Continuous variables expressed as mean ± standard deviation and categorical variables expressed as *n* (%).
NT-proBNP, N-terminal pro-B-type natriuretic peptide.

Clinical characteristics of patients' assessments

The study consisted of 89 pairs (nurse and cardiologist) of standardised clinical assessments; totalling 178 clinical assessments of 63 patients with HF. Twenty-six patients were assessed by both nurse and cardiologist twice. Patients' mean body weight was 74 (SD 39) kg. The mean plasmatic level of NT-ProBNP concomitant to the 89 assessments was 1467 (SD 1214) pg/ml. Table 2 shows the characteristics of all 89 clinical assessments performed by both the nurse and the cardiologist, as well as the measurement of Kappa inter-observer agreement to each clinical assessment component. Systolic and diastolic blood pressure, heart rate and proportional pulse pressure were not statistically different between clinical assessments performed by the nurse or the cardiologist (Table 2).

Congestion score

When comparing the clinical scores of congestion obtained by the nurse with those obtained by the cardiologist, a correlation was found of $r_s = 0{\cdot}86$; $p \le 0{\cdot}001$ (Table 3). The mean clinical congestion score obtained by the cardiologist was 4·2 (SD 3·2), and the mean clinical congestion score obtained by the nurse was 4·6 (SD 3·4) ($p = 0{\cdot}3$).

Clinical history and physical assessment

The correlation between clinical findings for congestion estimate such as third heart sound, jugular swelling (cm), pulmonary rales (0–4) and orthopnea (0–4) found by both

Table 2 Clinical characteristics of the assessments, measurement of Kappa agreement to each clinical assessment component (n = 89)

Characteristics*	Nurse	Cardiologist	
Rales n (%)			
None	56 (63)	67 (75)	k = 0·379
< ¼ pulmonary fields (bases)	29 (32)	18 (20)	
¼ to ½ of pulmonary fields	4 (5)	4 (5)	
≥ ½ of pulmonary fields	0	0	
Entire pulmonary field	0	0	
Peripheral oedema n (%)			
No oedema	62 (70)	70 (78)	k = 0·575
Only on ankles	15 (17)	11 (13)	
On legs	9 (10)	7 (8)	
Reaching the knees	3 (3)	1 (1)	
Reaching tights	0	0	
Orthopnea n(%)			
One pillow on a flat bed	30 (34)	40 (45)	k = 0·597
+ of a pillow to sleep	36 (40)	29 (33)	
At least an episode of PND	8 (9)	8 (9)	
Multiple episodes of PND	7 (8)	9 (10)	
At least one night sleeping on a sitting position	8 (9)	3 (3)	
Hepatojugular reflux (presence) n (%)	24 (27)	19 (21)	k = 0·420
Jugular venous pressure n (%)			
≤ 5 (cmH_2O)	71 (80)	72 (81)	k = 0·674
> 5 (cmH_2O)	18 (20)	17 (19)	
NYHA functional class n (%)			
I	35 (39)	33 (37)	k = 0·316
II	38 (43)	30 (34)	
III	11 (12)	25 (28)	
IV	5 (6)	1 (1)	
Third heart sound (present) n(%)	4 (4·5)	6 (7)	k = 0·789

*Categorical variables expressed as n (%). Agreement between nominal variables expressed by means of Kappa (k).
NYHA, New York Heart Association; PND, Paroxysmal Nocturnal Dyspnoea.

nurse and cardiologist is shown in Table 3. Figure 1 shows the graphic representation of the correlation between the congestion score obtained by the nurse with that obtained by the cardiologist. In addition, when considering CVP as a continuous variable, as clinically estimated by both the nurse and the cardiologist, a positive and significant correlation (r = 0·83; $p \leq$ 0·0001) was found.

Among the 89 assessments, the presence of the third heart sound was detected by the cardiologist in six of them. The nurse detected a third heart sound in four of them. The agreement between the presence of third heart sound in the assessments performed by both the nurse and the cardiologist produced a value of k = 0·79. The six patients with a third heart sound in the medical assessment had NT-ProBNP levels significantly higher than the patients without this finding (2689 SD 2044 vs. 1379 SD 1204 pg/ml, p = 0·0002). The four patients with a third heart sound in the nurses' assessments also had NT-ProBNP levels significantly higher than the patients without this finding (2773 SD 454 vs. 1406 SD 1205 pg/ml, p = 0·03).

NT-ProBNP and clinical congestion estimate

There was excellent correlation between the clinical congestion scores and serum levels of NT-ProBNP for both the nurse and cardiologist.: r_s = 0·45; p < 0·0001 and r_s = 0·51; p < 0·0001. Each individual component of the congestion score was also significantly related to serum NT-ProBNP for both clinical evaluations. When we compared the levels of NT-ProBNP with the various levels of orthopnea according to the assessment made by the nurse and the cardiologist, we obtained a positive and significant correlation: r_s = 0·29; p = 0·006 and r_s = 0·30; p < 0·004; respectively.

Table 3 Comparison of the clinical congestion score (n = 89)

	MD				
RN	JVP (cm)	Orthopnea	S3	Rales	Clinical congestion score
JVP (cm)	k = 0·696 p = 0·0001				
Orthopnea		k = 0·597 p = 0·0001			
S3			k = 0·789 p = 0·001		
Rales				k = 0·379 p = 0·0001	
Clinical congestion score					r_s = 0·86 p = 0·001

MD, cardiologist; RN, registered nurse; JVP, jugular venous pressure; S3, third heart sound.

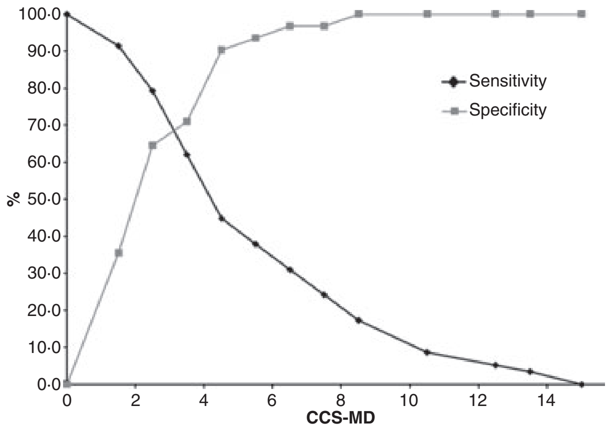

Figure 1 Two-graph receiver-operating characteristic curve of the sensitivity and specificity of the cardiologist clinical congestion score to detect NT-ProBNP > 400 pg/ml. CCSMD, clinical congestion score by cardiologist.

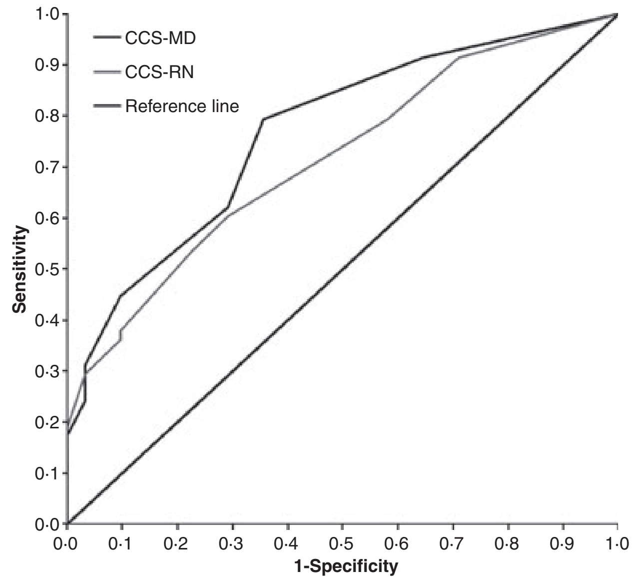

Figure 2 Receiver-operating characteristic curve for clinical congestion score obtained by cardiologist or by nurse for the detection of NT-ProBNP > 400 pg/ml. CCS-MD, clinical congestion score by cardiologist; CCS-RN, clinical congestion score by nurse.

Patients with a CVP estimated by the cardiologist ≥5 cm H_2O had levels of NT-ProBNP significantly higher than those with a CVP estimated < 5 cm H_2O (2129 SD 1122 vs. 1300 SD 1186 pg/ml; $p = 0{\cdot}009$). Patients with a CVP estimate by the nurse ≥5 cm H_2O had levels of NT-ProBNP significantly higher than those with a CVP estimated < 5 cm H_2O (2316 SD 965 vs. 1267 SD 1185 pg/ml; $p = 0{\cdot}001$).

A TG-ROC plot was constructed to provide a graph of the sensitivity and specificity against a range of cut-off points related to the cardiologist clinical congestion score. A clinical congestion score of 3 was chosen as the best cut-off point value to detect congestion, as per NT-ProBNP > 400 pg/ml (Fig. 1).

Patients with a clinical congestion score ≥3 as estimated by the cardiologist had levels of NT-ProBNP significantly higher than those with clinical congestion score < 3 (1866 SD 1151 vs. 757 SD 988 pg/ml; $p < 0{\cdot}0001$). Similarly, patients with a clinical congestion score ≥3 as estimated by the nurse had levels of NT-ProBNP significantly higher than those with clinical congestion score < 3 (1720 SD 1228 vs. 821 SD 914 pg/ml; $p < 0{\cdot}0001$).

Diagnostic performance to detect congestion

The clinical congestion score obtained by the cardiologist and by the nurse was plotted in a conventional ROC curve. The area under the curve (AUC) of cardiologist and nurse to detect a NT-ProBNP > 400 pg/ml (a surrogate of clinical congestion (Lainchbury *et al.* 2003)) was, respectively, 0·77 and 0·72 (Fig. 2).

Hemodynamic profile quadrants according to the clinical assessment

Patients classified as quadrants B and C (congested) by the nurse had NT-ProBNP significantly higher than those classified as quadrants A and D (dry) (1862 SD 1124 vs. 1144 SD 968 pg/ml; $p = 0{\cdot}027$). Similarities were found by the cardiologist for quadrants B and C and A and D, respectively (1607 SD 1187 vs. 1018 SD 915 pg/ml; $p = 0{\cdot}03$).

Discussion

This study compared findings of a systematic clinical assessment performed by a nurse to a systematic clinical assessment performed by a cardiologist and to the results of NT-ProBNP in outpatients with HF. Our results demonstrate that an experienced HF nurse has a similar performance to that of the cardiologist in the detection of congestion and evaluation of the hemodynamic profile. This similarity was maintained when the assessments of the nurse and the cardiologist were compared to the levels of NT-ProBNP.

The clinical congestion score used in this study consisted of an objective method for clinical assessment for HF patients converting almost all findings into numerical variables, thus facilitating comparisons between patients and examiners. This clinical congestion score could identify, in a previous study, patients with different levels of congestion and different prognoses within six-month follow-up (Rohde *et al.* 2004).

The findings of the clinical assessment that provide greater diagnostic accuracy for congestion estimate, such as jugular distension, third heart sound and orthopnea (Drazner *et al.* 2001, Beck da Silva *et al.* 2004), were highly correlated between the assessments performed by cardiologist and nurse. Our study could also demonstrate a high correlation between nurses' and cardiologist's CVP estimate. It suggests that such data from the physical assessment of HF patients, if judiciously examined, may be reproducible. In addition, as other previous studies have shown a high correlation between clinically estimated CVP and hemodynamic parameters estimated by echocardiography (Rohde *et al.* 2004), our study found that patients with different categories of CVP ($<$ or ≥ 5 cm H_2O) presented statistically different levels of NT-ProBNP. This relation was similar in the assessments of both cardiologist and nurse.

Also interestingly, the clinical congestion score, when categorised as above or below 3, was able to identify groups with significantly different NT-ProBNP levels, in both clinical and statistical perspectives. The systematic clinical assessment of ambulatory patients with HF is known to provide information on the ventricular filling pressures (Rohde *et al.* 2004), natriuretic peptide levels (Richards *et al.* 2005) and on prognosis (Drazner *et al.* 2001, Rohde *et al.* 2004). This study corroborates the association of clinical findings with NT-ProBNP and suggests that the high correlation of the clinical findings obtained by nurse and cardiologist may also be of value to manage HF patients.

Finally, after the clinical assessment for congestion estimate, the examiners classified each case into a hemodynamic profile quadrant. The relevance of this classification for the clinical practice of HF is in fact that it can define different prognoses and distinct therapeutic pathways for HF patients (Nohria *et al.* 2003). Here, again the ability of both examiners (cardiologist and nurse) to detect the congestive component of patients was evidenced by the significantly higher values of NT-ProBNP in quadrants B and C (Sauer *et al.* 2008).

We believe the nurses' role expansion by means of providing an accurate clinical assessment could have an impact to nurse led programmes based on home visits, heart failure clinics as well as to inpatients' HF care (Blue & McMurray 2005). Therefore, it could have a positive impact on the worldwide burden of dealing with HF patients.

Our paper is original, as we could not find studies that have systematically evaluated the clinical diagnostic performance of nurses in ambulatory patients with HF.

Study limitations

This study compared the clinical performance of a single nurse (JMS) to a clinical assessment performed by a cardiologist. This aspect may limit the generalisation of results to other nurses not involved in a study protocol or eventually less motivated.

Our results are restricted to the performance of nurses in estimating congestion level of patients with established diagnosis of HF. For this reason, the HF diagnosis performance was not assessed. Measurement of NT-ProBNP, used here as a comparative test to the physical assessment, could not be considered as gold-standard for congestion assessment because of its high variability and susceptibility to confounding factors (Packer 2003, Krauser *et al.* 2005). However, at an ambulatory care level, it is a viable and convenient tool, because invasive assessments of congestion are not practical in ambulatory patients and other non-invasive measurements provide similar performance of NT-ProBNP (Dokainish *et al.* 2004a,b). The fact that a small number of patients were reassessed could be potentially disputed. However, as HF patients may present significant different congestion levels in separate occasions, this may in fact not compromise the study objective of comparing performances in estimating congestion levels by two professionals.

Conclusions

The results of this study suggest that the nurse, after specific training, has similar performance to that of the cardiologist in detection of congestive conditions of HF outpatients. The clinical congestion scores, as well as the isolated congestion signs and symptoms obtained by nurse or cardiologist, were highly related and detected similar levels of NT-ProBNP.

Relevance to clinical practice

Considering that consistent clinical assessment can identify congested or hypovolemic patients with reasonable reliability, as well as patients with low or normal cardiac output, our results may help confirm nurses' capability in performing reliable clinical assessment in HF patients. While nurses' led HF programmes are usually focused on the management of patients, nurses' ability to perform accurate assessment would expand nurses' role in these programmes. As many institutions now focus on home visits by HF nurses, accurate assessment would benefit patients and improve their clinical outcomes.

Acknowledgement

The authors acknowledge the invaluable help of Lisa M Mielniczuk MD for reviewing the manuscript and English editing.

This study was funded by *Fundo de Incentivo à Pesquisa do Hospital de Clínicas de Porto Alegre – FIPE*. (Incentive Fund to Research of Hospital de Clínicas de Porto Alegre).

Contributions

Study design: JS, LBS, ERR, LER; data collection and analysis: JS, LBS, LG, RAC and manuscript preparation: JS, LBS, ERR, NC.

Conflict of interest

There is no conflict of interest to declare.

References

Beck da Silva L, Mielniczuk L, Laberge M, Anselm A, Fraser M, Williams K & Haddad H (2004) Persistent orthopnea and the prognosis of patients in the heart failure clinic. *Congestive Heart Failure* **10**, 177–180.

Blue L & McMurray J (2005) How much responsibility should heart failure nurses take? *European Journal of Heart Failure* **7**, 351–361.

Capomolla S, Febo O, Ceresa M, Caporotondi A, Guazzotti G, La Rovere M, Ferrari M, Lenta F, Baldin S, Vaccarini C, Gnemmi M, Pinna G, Maestri R, Abelli P, Verdirosi S & Cobelli F (2002) Cost/utility ratio in chronic heart failure: comparison between heart failure management program delivered by day-hospital and usual care. *Journal of the American College of Cardiology* **40**, 1259–1266.

Chen A, Wood MJ, Krauser D, Baggish A, Tung R, Anwaruddin S, Picard MH & Januzzi JL (2006) NT-proBNP levels, echocardiographic findings and outcomes in breathless patients: results from the ProBNP Investigation of Dyspnoea in the Emergency Department (PRIDE) echocardiographic substudy. *European Heart Journal* **27**, 839–845.

Dokainish H, Zoghbi WA, Lakkis NM, Al Bakshy F, Dhir M, Quinones MA & Nagueh SF (2004a) Optimal noninvasive assessment of left ventricular filling pressures: a comparison of tissue doppler echocardiography and B-type natriuretic peptide in patients with pulmonary artery catheters. *Circulation* **109**, 2432–2439.

Dokainish H, Zoghbi WA, Lakkis NM, Quinones MA & Nagueh SF (2004b) Comparative accuracy of B-type natriuretic peptide and tissue Doppler echocardiography in the diagnosis of congestive heart failure. *The American Journal of Cardiology* **93**, 1130–1135.

Drazner MH, Rame JE, Stevenson LW & Dries DL (2001) Prognostic importance of elevated jugular venous pressure and a third heart sound in patients with heart failure. *The New England Journal of Medicine* **345**, 574–581.

Ducharme A, Doyon O, White M, Rouleau JL & Brophy JM (2005) Impact of care at a multidisciplinary congestive heart failure clinic: a randomized trial. *Canadian Medical Association Journal* **173**, 40–45.

Fonarow G (2008) Epidemiology and risk stratification in acute heart failure. *American Heart Journal* **155**, 200–207.

Heart Failure Society Of America (2006) Executive summary: HFSA 2006 comprehensive heart failure practice guideline. *Journal of Cardiac Failure* **12**, 10–38.

Holland R, Battersby J, Harvey I, Lenaghan E, Smith J & Hay L (2005) Systematic review of multidisciplinary interventions in heart failure. *Heart* **91**, 899–906.

Inglis SC, Pearson S, Treen S, Gallasch T, Horowitz JD & Stewart S (2006) Extending the Horizon in Chronic Heart Failure: Effects of Multidisciplinary, Home-Based Intervention Relative to Usual Care. *Circulation* **114**, 2466–2473.

Krauser D, Lloyd-Jones DM, Chae C, Cameron R, Anwaruddin S, Baggish A, Chen A, Tung R & Januzzi JL (2005) Effect of body mass index on natriuretic peptide levels in patients with acute congestive heart failure: A ProBNP Investigation of Dyspnea in the Emergency Department (PRIDE) substudy. *American Heart Journal* **149**, 744–750.

Krumholz HM, Amatruda J, Smith GL, Mattera JA, Roumanis SA, Radford MJ, Crombie P & Vaccarino V (2002) Randomized trial of an education and support intervention to prevent readmission of patients with heart failure. *Journal of the American College of Cardiology* **39**, 83–89.

Lainchbury JG, Campbell E, Frampton CM, Yandle TG, Nicholls MG & Richards AM (2003) Brain natriuretic peptide and n-terminal brain natriuretic peptide in the diagnosis of heart failure in patients with acute shortness of breath. *Journal of the American College of Cardiology* **42**, 728–735.

Landis JR & Koch GG (1977) The measurement of observer agreement for categorical data. *Biometrics* **33**, 159–174.

Maisel AS, Krishnaswamy P, Nowak RM, McCord J, Hollander JE, Duc P, Omland T, Storrow AB, Abraham WT, Wu AHB, Clopton P, Steg PG, Westheim A, Knudsen CW, Perez A, Kazanegra R, Herrmann HC, McCullough PA & the Breathing Not Properly Multinational Study I (2002) Rapid measurement of B-type natriuretic peptide in the emergency diagnosis of heart failure. *The New England Journal of Medicine* **347**, 161–167.

Martinez EZ & Louzada-Neto F (2008) TG-ROC plots with confidence. *Biometric Brazilian Journal* **26**, 87–89.

McAlister FA, Stewart S, Ferrua S & McMurray JJ (2004) Multidisciplinary strategies for the management of heart failure patients at high risk for admission a systematic review of randomized trials. *Journal of the American College of Cardiology* **44**, 810–819.

Nohria A, Tsang SW, Fang JC, Lewis EF, Jarcho JA, Mudge GH & Stevenson LW (2003) Clinical assessment identifies hemodynamic profiles that predict outcomes in patients admitted with heart failure. *Journal of the American College of Cardiology* **41**, 1797–1804.

Packer M (2003) Should B-type natriuretic peptide be measured routinely to guide the diagnosis and management of chronic heart failure? *Circulation* **108**, 2950–2953.

Rich MW, Beckham V, Wittenberg C, Leven CL, Freedland KE & Carney RM (1995) A multidisciplinary intervention to prevent the readmission of elderly patients with congestive heart failure. *The New England Journal of Medicine* **333**, 1190–1195.

Richards AM, Troughton R, Lainchbury J, Doughty R & Wright S (2005) Guiding and monitoring of heart failure therapy with NT-ProBNP: concepts and clinical studies. *Journal of Cardiac Failure* **11**, S34–S37.

Rohde LE, Beck da Silva L, Goldraich L, Grazziotin T, Palombini DV, Polanczyk CA & Clausell NO (2004) Reliability and prognostic value of traditional signs and symptoms in outpatients with congestive heart failure. *The Canadian Journal of Cardiology* **20**, 697–702.

Sauer JM, Rabelo E, Castro RA, Clausell N, Rohde LE & Beck da Silva L (2008) Nurse's performance in classifying heart failure patients based on physical exam: comparison with cardiologist's physical exam and levels of NT-ProBNP. *Journal of Cardiac Failure* **14**, S105.

Shah MR, Hasselblad V, Stinnett SS, Gheorghiade M, Swedberg K, Califf RM & O'Connor CM (2001) Hemodynamic profiles of advanced heart failure: association with clinical characteristics and long-term outcomes. *Journal of Cardiac Failure* **7**, 105–113.

Appendix 1

CLINICAL CONGESTION SCORE (CCS)

Patient Initials: _ _ _
Assessment performed by:
RN ( ) Date: ________ Time:_______
MD ( ) Date: ________ Time:_______

Pulmonary rales
[ ] 0 = none
[ ] 1 = ¼ pulmonary fields (bases)
[ ] 2 = ¼ a ½ of pulmonary fields
[ ] 3 = ½ of pulmonary fields
[ ] 4 = presence of rales up to pulmonary apices
Third heart sound (S3)
[ ] 0 = none [ ] 1 = present
Jugular distension. To divide the whole extension of the patients neck in four parts and grade from 0 to 4
(0-4) [ ] _________
Peripheral edema
[ ] 0 = no edema
[ ] 1 = only on ankles
[ ] 2 = on legs
[ ] 3 = reaching the knees
[ ] 4 = reaching the thighs
History of orthopnea in the last week
[ ] 0 = sleeping with one pillow on a flat bed
[ ] 1 = needing more than one pillow to sleep
[ ] 2 = at least one episode of PND (paroxysmal nocturnal dyspnea)
[ ] 3 = multiple episodes of PND
[ ] 4 = at least one night sleeping on a sitting position
Hepatojugular reflux. To press the liver continuously for one minute while observing the neck.
[ ] 0= none [ ] 1= Present
Functional Class – New York Heart Association
[ ] 1 = class I [ ] 2 = class II
[ ] 3 = class III [ ] 4 = class IV

TOTAL CCS:_________