

# Reduced readmission rate for alternating diagnoses of heart failure and pulmonary disease after implementation of B-type natriuretic peptide testing

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## Abstract

**Background:** Patients with heart failure (HF) or pulmonary diseases (PD) present with similar symptoms. Effective disease management requires an accurate diagnosis. B-type natriuretic peptide (BNP) is increased in patients with HF and is normal in PD patients without cardiac involvement. **Objective:** To determine if the readmission rate for patients with either HF or PD who later present with the alternate diagnosis (PD or HF) is decreased with the implementation of BNP testing at one hospital. **Methods:** We retrospectively determined the impact of BNP testing on reducing diagnostic ambiguities for patients admitted to an emergency department (ED) with these diseases. We compared a HF DRG (Diagnostic Related Group) (#428) and PD DRGs (#480–496) before vs. 1 and 2 y after implementation of BNP testing. **Results:** In a 12-month period before BNP, there were 42 total visits (15 cases) where a patient presented with a HF DRG and returned within 6 months with a PD DRG, and 41 visits (14 cases) where there was a PD→HF readmission. One year after BNP implementation, the corresponding number of visits decreased 52% to 20 visits (15 cases) for HF→PD, and 73% to 11 visits (8 cases) for PD→HF readmissions. A similar reduction in readmissions was observed in the second year after BNP testing. The total number of HF and PD cases in 1999 (1029 patients) was similar to 2001 (985), and was higher in 2002 (1350) during these time intervals. The ED length-of-stay (LOS) was slightly higher for the HF→PD cases with BNP testing, whereas there was no change in LOS for the PD→HF cases. **Conclusion:** We hypothesize that prior to BNP implementation, there may have been diagnostic ambiguities in the initial diagnosis of HF or PD, which contributed to a repeat visit for the alternate diagnosis (PD or HF). With BNP testing, the apparent number of inappropriate visits decreased. Reducing unnecessary ED admissions helps justify the costs for implementing BNP testing in the hospital.

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**Keywords:** B-type natriuretic peptide; Heart failure; Chronic obstructive pulmonary disease; Cost effective; Inappropriate admissions

## 1. Introduction

B-type natriuretic peptide is a circulating neurohormone that regulates water and electrolyte balance. Increased concentrations of BNP in blood is observed in patients with heart failure (HF) as the result of myocardial stretching, increased ventricular filling pressures, and fluid volume overload [1]. Patients who have pulmonary diseases (PD), such as chronic obstructive

pulmonary disease and pneumonia, present with similar symptoms as those with HF (dyspnea and shortness of breath), but in the absence of cardiac involvement, have normal BNP concentrations [2]. For patients with a confirmed diagnosis of HF, BNP correlates with the New York Heart Association Classification of disease severity [3]. BNP can also be used for risk stratification for patients with HF [4] and acute myocardial infarction [5]. Assays for BNP and the inactive metabolite, NT-proBNP [6] which exhibits similar clinical performance in patients with heart failure [7] are commercially available.

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## 2. Materials and methods

We tabulated the number of cases where a patient initially presented with a HF diagnosis and returned to the ED within 6 months with a PD diagnosis, and patients who presented with a PD diagnosis and returned with HF within 6 months, before and after BNP testing was implemented in the emergency department of the San Diego Veterans Administration Hospital. Patients presented with symptoms of dyspnea, weakness and shortness of breath. In the pre-BNP time period, diagnosis was based on data and evidence such as the clinical history, physical exam, electrocardiogram, echocardiogram, chest X-ray, etc., but no BNP results were available. In the post-BNP time period, results of BNP testing was added to the above criteria.

As there was no contact with any patients or their attending physicians, no review of medical records, and no names used or links to the patient's identity, this study was conducted without consent or knowledge of the patient. Two groups of discharge diagnoses were selected. The 'HF' group consisted of Diagnosis Related Group (DRG) #428 (heart failure) [8]. The 'pulmonary disease' (PD) group consisted of DRGs #480 through #496. B-type natriuretic peptide testing (Biosite Diagnostics, San Diego, CA) was implemented within the ED in October, 2000. Using this study population, we have previously shown that the Triage BNP assay at a cutoff of 100 pg/ml, had a clinical sensitivity and specificity of 94% and 94%, respectively, and positive and negative predictive values of 92% and 96%, respectively [9].

Three different study periods were used for the comparison. The single pre-BNP period included any patient who had their initial presentation for one DRG during the interval January 1, 1999 to December 31, 1999, and who presented with the alternate DRG within 6 months after the initial presentation (up to June 30, 2000). No data were available prior to 1999. There were two post-BNP periods, which included any patient who had their initial presentation for one DRG during January 1, 2001 to December 31, 2001, and January 1, 2002 to December 31, 2002, and who presented with the alternate DRG within 6 months after their initial presentation (up to June 30, 2002 and June 30, 2003, respectively). The secondary DRGs were also recorded with each primary admission. The number of days between the initial visit and readmission (up to 180 days), and the length of stay (LOS) for the initial visit were also tabulated. The total number of patients who were seen for pulmonary or HF DRGs were also recorded during these time periods. A Student's *t*-test was performed to determine if there was significant difference ( $P < 0.05$ ) in any of the results between the 3 study periods. With the exception of the use of BNP testing, the clinical practice patterns during these three time periods were not differ-

ent, e.g. no substantive changes in funding for this federal institution, no new clinical practice algorithms implemented for these DRGs, and an attending staff that was reasonably stable.

## 3. Results

Patients who initially or subsequently presented with pulmonary disease included bacterial pneumonia (DRG #482.9), chronic obstructive pulmonary disease (#496), bronchitis (#490–492), viral pneumonia (#480.9), pneumonia (#486) and emphysema (#492.8). Table 1 summarizes the results of this study. The total number of HF cases between the 3 time periods increased from 189 to 217 to 344. The number of patients with PD varied from 840 to 768 to 1006.

In terms of repeat visit with the alternate diagnosis, there were 42 different visits (15 patients) where a patient initially presented with a HF diagnosis and later presented within 6 months with a PD diagnosis. The number of repeat visits with the alternate diagnosis decreased to 20 visits (15 patients) in the first year after BNP implementation, and 10 visits (8 patients) in the second year after BNP. Similar results were obtained when the initial presentation was PD: 41 visits from 14 cases down to 11 and 12 visits from 8 and 12 patients in years 1 and 2 after BNP, respectively. Thus, there was a substantial decrease in the number of repeat alternate diagnosis visits (52 and 76% for PD → HF and 73 and 71% for HF → PD) before and 1 and 2 years after BNP implementation. This decrease cannot be explained by co-morbid HF and PD diseases, as only a minority of the HF (3 of 15) and PD (2 of 14) listed the alternate disease (PD or HF, respectively), as a secondary diagnosis (Table 1).

As shown in Table 1, the mean intervals between repeat visits did not change after BNP was implemented for either group (68 to 88 and 83 days for HF → PD in years 1999, 2001 and 2002,  $P > 0.05$  and 38, 35 and 47 days for PD → HF, for these years, respectively,  $P > 0.05$ ). In contrast, the length-of-stay within the ED for the HF → PD group significantly increased by 65 and 67 min, respectively, after the BNP test was implemented ( $P < 0.05$ ). BNP testing was performed in the ED using a point-of-care testing device with an analysis turnaround time of 15 min. Extra time was needed for ordering the test, collecting the blood, performing the assay, reporting and interpreting the results. There was also an increase of 30 and 54 min in the mean LOS for the PD → HF group, but the difference did not reach statistical significance.

## 4. Discussion

In the current economic climate of reimbursement for medical tests, the justification for including a new

Table 1  
Alternating HF and PD visits within 6 months before and after BNP testing

	Pre-BNP 1999	Post BNP 2001	Post BNP 2002
Total HF cases	189	217	344
HF → PD			
No. cases, alternating diagnoses	15	15	8
% of total HF cases	7.9%	6.9% <sup>a</sup>	2.3% <sup>a</sup>
No. visits	42	20	10
% reduction, before–after BNP		52%	76%
No. of PD as a secondary diagnosis	3	0	0
6-mo recidivism, mean ± S.D., in days	67 ± 60	88 ± 51 <sup>a</sup>	83 ± 69 <sup>a</sup>
LOS, mean ± S.D., median, in min	248 ± 125	313 ± 113 <sup>b</sup>	315 ± 137 <sup>b</sup>
Total PD cases	840	768	1006
PD → HF			
No. cases, alternating diagnoses	14	8	12
% of total PD cases	1.7%	1.0% <sup>a</sup>	1.2% <sup>a</sup>
No. visits	41	11	12
% reduction, before–after BNP		73%	71%
No. of HF as a secondary diagnosis	2	0	1
6-mo recidivism, mean ± S.D., in days	38 ± 38	35 ± 37 <sup>a</sup>	47 ± 52 <sup>a</sup>
LOS, mean ± S.D., median, in min	224 ± 126	254 ± 119 <sup>a</sup>	278 ± 118 <sup>a</sup>

<sup>a</sup> No difference relative to the pre-BNP vs. post BNP testing.

<sup>b</sup>  $P < 0.05$  for pre vs. post BNP testing.

laboratory test can be arduous. The US Centers for Medicare and Medicaid Services and American Medical Association CPT Coding Committee have created a new reimbursement code for the natriuretic peptides that took effect in January, 2003 which adequately covers the expenses for BNP testing. However, for hospitalized patients, no additional reimbursements are available under DRG system of Medicare/Medicaid. Therefore the clinical laboratory must justify BNP testing on the basis of improved clinical care or efficiency of clinical services delivered. Similar, i.e. limited reimbursement programs for laboratory tests are in place in the majority of European countries.

There are several strategies that could be attempted to cost-justify BNP [10]. The utilization of BNP to diagnose and rule out heart failure and the subsequent initiation of proper therapy should improve clinical outcomes. Studies have shown that when BNP is used to guide therapy, there are improvements in heart rate, blood pressure, and number and time to cardiovascular events relative to empiric-driven therapy [11,12]. Justification for this test can be made if it can be shown that there is a reduction in the number of echocardiograms. In 2001, the European Society of Cardiology recommended screening patients with the natriuretic peptides to rule out HF [13]. Adherence to this algorithm would reduce the utilization of these advanced procedures.

In this study, we suggest that use of BNP may have contributed to a reduced number of readmissions for patients with HF or PD. The reduced readmission rate cannot be explained by substantially lower total number of patients seen with these diseases over these time

intervals. There was only a 4% drop in total patients with HF and PD in 1999 (1029 patients) vs. 2001 (985), while in 2002, there was actually a substantial increase of 31% in total patients in 2002 (1350). Among those with HF alone, there was a 15% increase in the number of HF patients in 1999 to 2001, and an 82% increase from 1999 to 2002. This increase in the numbers of HF patients might suggest that BNP testing enabled more patients with appropriate symptoms to be correctly identified, but we have no data to support this. More importantly, there were significant reductions in the readmissions rate for patients who present with one diagnosis and returned with the other. Assuming that these results were directly influenced by the results of BNP testing, substantial savings in unnecessary admissions will occur, which justifies the laboratory test costs. BNP testing did produce longer ED LOS during the first year of implementation at this facility. However, steps can be implemented to improve the efficiency of testing and reduce the time needed to obtain and use BNP results.

The notion that diagnostic ambiguity can exist by ED physicians regarding patients who present with shortness of breath and dyspnea has been previously shown in the Breathing Not Properly Multinational Study [14]. In this study, ED physicians were asked to estimate their preBNP-test result likelihood of HF in 1538 patients who presented with these symptoms. Roughly half of the ED physicians polled indicated diagnostic uncertainties ranging between >20 and <80%. The area-under-the-receiver-operating characteristic (AUC-ROC) curve was 0.86 (95% confidence interval 0.84–0.88) for ED

physician assessment alone. With the addition of BNP testing, the clinical probability of HF significantly increased, with an AUC-ROC of 0.93 (0.92–0.94). The improvement in diagnostic certainty probably had an impact in reducing the rate of readmission.

A limitation is that this study was not a placebo-controlled clinical trial where some randomly assigned patients received results of BNP testing while others did not. This study made use of a historic control, i.e. patients admitted to this facility before the introduction of BNP. Therefore there may be changes in the clinical practice patterns over the duration of the study that might have been responsible for these differences. We have not included a non-HF chronic disease control group, e.g. diabetes or end stage renal failure, to determine if there is a general trend for decreased hospital readmissions. However, even if these data were collected, their relevance to our study could be questioned as the group of attending physicians would be different. Results of this study are directly applicable to testing by NTproBNP, as this marker is used in a similar manner as BNP.

Given the assumption that the overall clinical practice patterns for heart failure and pulmonary disease were largely unchanged at this facility over the two study periods, BNP testing reduced the number of readmissions that occurred for apparently the wrong initial diagnoses of HF and pulmonary disease. This may be helpful in justifying the expense of performing the laboratory test.

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