Value of Clinician Assessment of Hemodynamics in Advanced Heart Failure

The ESCAPE Trial

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Background—We determined whether estimated hemodynamics from history and physical examination (H&P) reflect invasive measurements and predict outcomes in advanced heart failure. The role of the H&P in medical decision making has declined in favor of diagnostic tests, perhaps because of the lack of evidence for utility.

Methods and Results—We compared H&P estimates of filling pressures and cardiac index with invasive measurements in 194 patients in the Evaluation Study of Congestive Heart Failure and Pulmonary Artery Catheterization Effectiveness (ESCAPE) trial. H&P estimates were compared with 6-month outcomes in 388 patients enrolled in ESCAPE. Measured right atrial pressure was <8 mm Hg in 82% of patients with right atrial pressure estimated from jugular veins as <8 mm Hg, and was >12 mm Hg in 70% of patients when estimated as >12 mm Hg. From the H&P, only estimated right atrial pressure ≥12 mm Hg (odds ratio, 4.6; $P<0.001$) and orthopnea ≥2 pillows (odds ratio, 3.6; $P<0.05$) were associated with pulmonary capillary wedge pressure ≥30 mm Hg. Estimated cardiac index did not reliably reflect the measured cardiac index ($P=0.09$), but "cold" versus "warm" profile was associated with lower median measured cardiac index (1.75 versus 2.0 L/(min·m^2); $P=0.004$). In Cox regression analysis, discharge "cold" or "wet" profile conveyed a 50% increased risk of death or rehospitalization.

Conclusions—In advanced heart failure, the presence of orthopnea and increased jugular venous pressure is useful to detect increased pulmonary capillary wedge pressure, and a global assessment of inadequate perfusion ("cold" profile) is useful to detect reduced cardiac index. Hemodynamic profiles estimated from the discharge H&P identify patients at increased risk of early events. **(*Circ Heart Fail*. 2008;1:170-177.)**

Key Words: diagnosis ■ heart failure ■ hemodynamics ■ history and physical examination

The role of the history and physical (H&P) examination, traditionally the cornerstone of patient care, has been threatened by the declining emphasis on H&P examination training and performance[1,2] and an increasing reliance on ordered tests such as biomarkers and imaging. This shift away from the H&P examination may reflect in part a perception that it does not provide useful information,[3] especially when compared with "modern" diagnostic approaches for which there are some bases of evidence. Demonstration of the utility of the H&P examination[4,5] may reinvigorate the teaching and practice of careful bedside assessment.

The role of the H&P examination has been highlighted in the management of patients with heart failure (HF).[4–8] Controversy surrounds the accuracy with which the jugular venous pressure (JVP) can be assessed in patients with HF. Some data suggest that examination of the JVP leads to an inaccurate estimation of the right atrial pressure (RAP),[9–11] whereas other reports indicate the accuracy and utility of assessing the JVP to guide HF management.[12,13]

Clinical Perspective see p 177

The Evaluation Study of Congestive Heart Failure and Pulmonary Artery Catheterization Effectiveness (ESCAPE) was a National Heart, Lung, and Blood Institute–sponsored multicenter trial designed to test whether therapy guided by invasive hemodynamic monitoring by a pulmonary artery catheter (PAC) and clinical assessment improves clinical outcomes over therapy guided by expert clinical assessment alone.[14,15] A prespecified secondary objective of ESCAPE was to assess the utility of skilled clinician assessment of

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hemodynamic status from the H&P examination in advanced HF.

Methods

ESCAPE Trial

The ESCAPE trial was conducted in the United States and Canada at 26 sites between 2000 and 2003. The trial was designed to study the effectiveness of right heart catheterization in hospitalized patients with NYHA 4 symptomatic HF. Patients had to have left ventricular ejection fraction ≤30%, 3 months of symptoms despite ACE inhibitor therapy, a systolic blood pressure <125 mm Hg, and at least 1 sign and 1 symptom of congestion. Of the 433 patients randomly assigned, 215 were assigned to the PAC arm. The primary results of the trial have been published,[14] demonstrating that PAC did not improve or worsen outcome as assessed by the primary end point (number of days alive outside of the hospital 6 months after randomization). The protocols were approved at each site and written informed consent was obtained from all patients before randomization.

Right Heart Catheterization

Sites were selected for known expertise in invasive monitoring and clinical management of patients with HF. Training was provided in standard methods for collection and interpretation of hemodynamics. Paper printouts were used. We averaged 3 measurements: 1 at PAC insertion and 2 subsequent baseline readings. The mean of the A wave was used preferentially as the pulmonary capillary wedge pressure (PCWP). If the A wave was not recorded, then we used the overall mean of all waves in its place to minimize missing data. The A wave was available in 94% of subjects, recorded at either 3 (n=130), 2 (n=21), or 1 (n=11) of the PAC measurements. Cardiac output was measured by thermodilution in triplicate.

Clinical Assessment for Estimation of Hemodynamics

Physicians performed an H&P examination and recorded their findings on a standardized case report form at randomization. Signs and symptoms were categorized as follows: rales (none, <1/3, 1/3 to 2/3); hepatomegaly (absent, 2 to 4 finger breadths, >4 finger breadths); ascites (none, trace, moderate, massive); peripheral edema (0, 1+, 2+, 3+, 4+); orthopnea (needs only 1 pillow, occasional orthopnea with 1 pillow, needs 2 pillows most of time, needs 3 pillows most of time, needs 4 pillows most of time); gastrointestinal distress (none, occasional, constant); fatigue (at rest, any activity, routine daily activity); and dyspnea (at rest, walking in room, walking <1 block). Supine blood pressure was measured. Hepatojugular reflux and S3 were recorded as present or absent. Elevated filling pressures were assessed by symptoms (dyspnea, abdominal discomfort, nausea, or vomiting attributable to hepatosplanchnic congestion) or signs (RAP ≥8 cm above right atrium, rales, peripheral edema, ascites, or hepatomegaly). Clinicians assessed adequacy of peripheral perfusion with emphasis on warmth of extremities and proportional pulse pressure ≥25%. Estimated hemodynamics were categorized: RAP <8, 8 to 12, 13 to 16, >16 mm Hg; PCWP <12, 12 to 22, 23 to 30, >30 mm Hg; and cardiac index: <1.8, 1.8 to 2.2, 2.3 to 2.5, >2.5 L/(min·m^2). These categorizations were at the investigator's discretion based on the totality of data from the H&P. Investigators also classified subjects into 1 of 4 previously described profiles[7] based on adequacy of cardiac output ("warm" or "cold") and increase in left-sided filling pressures ("wet" or "dry"). Specific criteria for when to classify the patient as "wet" or "cold" (ie, at what estimated PCWP or cardiac output) were left to the investigator's discretion.

B-Type Natriuretic Peptide Assay

B-type natriuretic peptide (BNP) was measured in Dr John Burnett's laboratory at the Mayo Clinic using the Shinogi assay as previously described.[16] Blood samples were obtained shortly after randomization, before or immediately after PAC placement, and were available in 351 patients (167 PAC arm; 184 clinical arm).

Table 1. Baseline Characteristics Including Invasively Measured Hemodynamics in PAC Arm (N=194)

Characteristics	
Age, median (25th, 75th), y	57 (47, 66)
Male	73
White	61
Ischemic etiology	49
Diabetes mellitus	34
Measured RAP, mm Hg	
<8	21
8–12	27
13–16	20
>16	32
Measured PCWP, mm Hg	
<12	5
12–22	32
23–30	38
>30	26
Measured cardiac index, L/(min·m^2)	
<1.8	33
1.8–2.2	40
2.3–2.5	15
>2.5	12

Values are expressed as percentages unless otherwise indicated.

Statistics

Measured cardiac index was compared between estimated cardiac index groups and between clinical profile groups, and measured PCWP was compared between estimated PCWP groups, using Wilcoxon rank sum tests because of the skewed distribution of the response variables. Standard calculations were used for measures of diagnostic utility. Receiver operating characteristic curves were plotted, and area under curve (AUC) was determined. Multivariable logistic regression models were developed for the outcome of increased PCWP (>22 mm Hg). Multivariable Cox proportional hazards models for the primary outcome of ESCAPE (number of days alive outside the hospital at 6 months) were adjusted for 6-minute walk distance, systolic blood pressure, blood urea nitrogen, and PAC. SAS version 8.2 (SAS Institute Inc, Cary, NC) was used for analyses.

Results

Baseline Characteristics

Of the 194 subjects who underwent PAC placement, 73% were male, 61% were white, and half had ischemic cardiomyopathy (Table 1). Most patients had PCWP >22 mm Hg (64%) and cardiac index <2.3 L/(min·m^2) (73%). Atrial fibrillation or flutter was present in 14% of subjects, whereas a paced rhythm was present in 21% of subjects on the baseline ECG.

Time From Randomization to PAC Placement

The median time from randomization to PAC placement was 5.60 (3.53, 8.43) hours. When comparing those with a shorter (< 6 hours) versus longer (≥6 hours) time from randomiza-

		Measured RAP		
		<8	8-12	>12
H&P Estimated RAP	<8	9	1	1
	8-12	20	29	18
	>12	12	22	80

Figure 1. Number of patients stratified by their estimated RAP by H&P examination (vertically) and their measured RAP by right heart catheterization (horizontally).

tion to PAC placement, there was no difference in baseline measured RAP [12 (8, 17) versus 13 (8, 20), $P=0.3$], or in baseline measured PCWP [24 (19, 30) versus 24 (19, 32), $P=0.6$].

Association of H&P Examination and BNP With Ventricular Filling Pressures

Estimates of RAP were related to invasively measured RAP in millimeters mercury (Figure 1). Of 11 subjects with estimated low RAP (<8 mm Hg), 9 (82%) had a measured RAP <8 mm Hg; 149 of 181 (82%) with estimated RAP ≥8 mm Hg had a measured RAP ≥8 mm Hg, and 80 of 114 (70%) with estimated RAP >12 mm Hg had a measured RAP >12 mm Hg. The positive and negative likelihood ratios of an estimated RAP <8 mm Hg for measured RAP <8 mm Hg were 16.6 and 1.3. The positive and negative likelihood ratios of an estimated RAP >12 mm Hg for measured RAP >12 mm Hg were 2.2 and 3.3. H&P examination also had utility for estimation of PCWP. When comparing those with an estimated PCWP >22 mm Hg to those with PCWP ≤22 mm Hg, the median (25th, 75th percentile) measured PCWP was 26 (21, 32) versus 20 (16, 25), respectively, $P<0.001$. In receiver operator characteristic curves (Figure 2), performance of H&P examination estimates was good for RAP >12 mm Hg (AUC=0.74) and fair for PCWP >22 mm Hg (AUC=0.63). Nevertheless, the H&P examination compared favorably with BNP for detecting increased PCWP (AUC=0.55).

We next assessed which components of the H&P examination were associated with an increased PCWP defined as >22 mm Hg. The number of subjects who exhibited the various signs and symptoms of HF, and the percentage of those who had a measured PCWP >22 mm Hg, is shown in Table 2. When assessing the operating characteristics of components of the H&P examination as a diagnostic tool for assessing PCWP >22 mm Hg (Table 3), estimated JVP ≥12 mm Hg had nearly equal sensitivity and specificity and yielded likelihood ratios (positive and negative) of 1.8. The majority of other H&P examination components, including symptoms (orthopnea, gastrointestinal distress, fatigue, and dyspnea) and signs (rales, ascites, edema, and hepatomegaly) were insensitive markers of PCWP >22 mm Hg, limiting their use in this setting. Once JVP ≥12 mm Hg was entered in a multivariable model with PCWP >22 mm Hg as the dependent variable, no other component of the H&P examination remained associated with PCWP >22 mm Hg (JVP odds ratio, 3.3; 95% CI, 1.8, 6.1). In a sensitivity analysis, we determined if other H&P findings were associated with higher threshold values of PCWP. In addition to JVP ≥12 mm Hg, only orthopnea was associated with increased

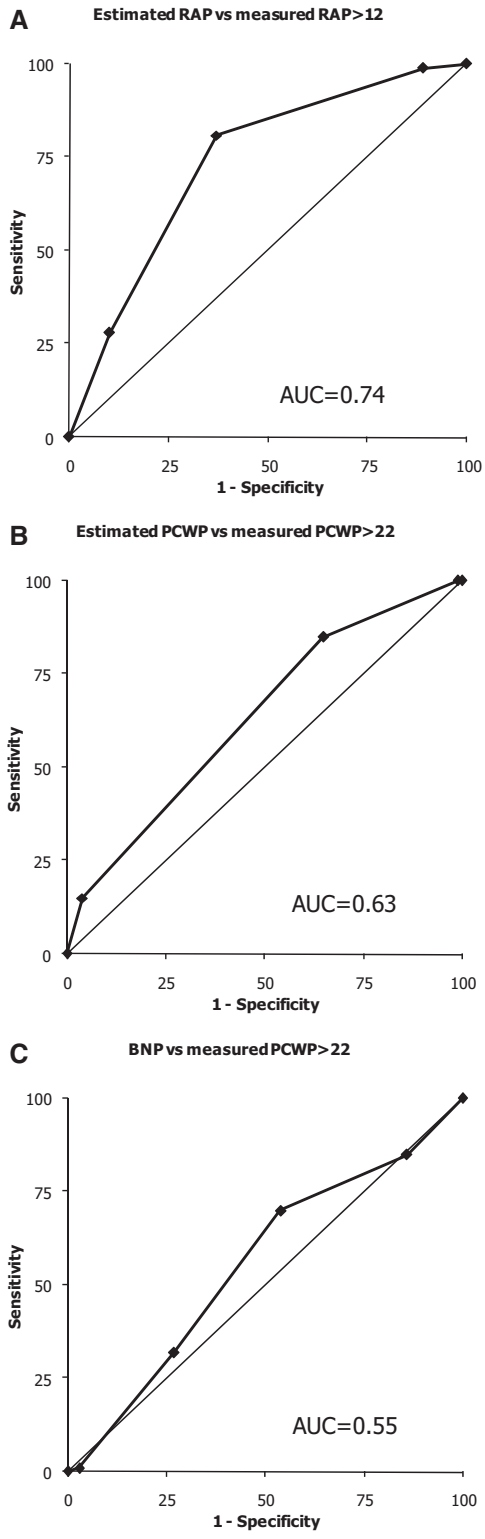

Figure 2. Receiver operating characteristic curves for hemodynamic parameters estimated by the H&P examination or BNP as compared with invasively measured values. Depicted curves are for estimated vs measured RAP (A), estimated vs measured PCWP (B), and BNP vs measured PCWP (C). H&P examination estimates were in categories of: RAP <8, 8 to 12, 13 to 16, >16 mm Hg; PCWP <12, 12 to 22, 23 to 30, >30 mm Hg. BNP, measured by the Shinogi assay, was in categories of 100, 400, 1000, and 5000 pg/mL.

Table 2. Number of Subjects With Designated H&P Examination Findings and the Percentage of Those With Measured PCWP >22 mm Hg

Finding on H&P Examination	N	PCWP>22 mm Hg, %
JVP		
<8	18	28
8–12	67	54
13–16	62	71
>16	39	82
Rales		
None	96	63
<1/3	70	61
1/3–2/3	26	69
S3		
No	69	67
Yes	123	61
Hepatomegaly		
Absent	86	61
2–4 finger breadths	82	61
>4 finger breadths	23	78
Hepatojugular reflux		
No	39	51
Yes	147	65
Ascites		
None	128	56
Trace	33	73
Moderate	29	86
Massive	2	0
Peripheral edema		
0	64	55
1+	55	67
2+	47	66
3+	20	75
4+	6	50
Orthopnea		
Needs only 1 pillow	18	50
Occasional orthopnea with 1 pillow	17	47
Needs 2 pillows most of the time	82	71
Needs 3 pillows most of the time	48	56
Needs 4 pillows most of the time	27	70
GI distress		
None	78	64
Occasional	82	63
Constant	32	59
Fatigue		
At rest	125	60
Any activity	176	63
Routine daily activity	185	64
All 3 of the above	121	61
Dyspnea		
At rest	113	60
Walking in room	167	62
Walking<1 block	185	63
All 3 of the above	109	60

Values expressed as percentages unless otherwise indicated.
N indicates No. subjects; GI, gastrointestinal.

PCWP when defined as ≥28 mm Hg (P=0.02), ≥30 mm Hg (P=0.01), or ≥32 mm Hg (P=0.05). Both orthopnea (odds ratio, 3.6; 95% CI, 1.02, 12.8; P<0.05) and JVP≥12 mm Hg (odds ratio, 4.6; 95% CI, 2.02, 10.2; P<0.001) remained associated with PCWP>30 mm Hg independently of each other in multivariable models.

Association of the H&P Examination With Reduced Cardiac Index

In contrast to the relationship of estimated and measured PCWP (above), there was not a strong relationship between estimated and measured cardiac index (Table 4). Using a threshold of estimated cardiac index <2.3 versus ≥2.3 L/(min·m^2), the invasively measured cardiac index was 1.9 (1.6, 2.2) versus 2.0 (1.7, 2.4) L/(min·m^2) (P=0.09). When the threshold value was an H&P examination estimated cardiac index <1.8 or ≥1.8 L/(min·m^2), the median measured values were 1.9 (1.5, 2.3) versus 1.9 (1.6, 2.3) L/(min·m^2) (P=0.4).

Although estimated cardiac index was not associated with invasively measured cardiac index <2.3 L/(min·m^2) (above), we assessed whether any component of H&P examination would be a marker of a low cardiac index (Table 5). A proportional pulse pressure <25% and cool extremities had good positive predictive value but were relatively infrequent findings and were not significantly associated with reduced cardiac index. In contrast, the integrated assessment of a "cold" profile was significantly associated with CI <2.3 L/(min·m^2) (P=0.015). A "cold" profile was also significantly associated with measured cardiac index <1.8 L/(min·m^2) (odds ratio, 2.7; 95% CI, 1.4, 5.2; P=0.004). The median invasively measured CI in those classified as "cold" versus "warm" was 1.75 (1.5, 2.05) versus 2.0 (1.7, 2.3) L/(min·m^2), respectively (P=0.004).

The finding that a "cold" versus "warm" designation was associated with a significantly lower invasively measured CI, whereas estimated cardiac index was not, suggests that there is utility in a binary classification of adequacy of perfusion. This hypothesis is supported by the finding that among those with an estimated cardiac index <2.3 L/(min·m^2), the invasively measured cardiac index in those who were classified as "cold" [1.7 (1.5, 2.0) L/(min·m^2)] was lower than in those classified as "warm" [1.9 (1.7, 2.3) L/(min·m^2), P=0.006]. There were no differences between the comparator groups in blood pressure, heart rate, ejection fraction, sodium, creatinine, and BNP (data not shown), suggesting that underlying differences in perfusion were indeed the basis for the "cold" classification.

Prognostic Information From the Baseline and Discharge H&P Examination

RAP and PCWP estimated from the baseline H&P examination (Table 6) were each independently associated with the primary outcome (days alive outside the hospital 6 months post randomization) after adjustment for randomization and those other variables found to contain prognostic value in ESCAPE (6-minute walk distance, systolic blood pressure, and blood urea nitrogen). These associations persisted despite addition of BNP to the models. When both estimated PCWP

Table 3. Utility of Components of the H&P Examination in Detecting PCWP >22 mm Hg

				Predictive Value		LR		
H&P Finding	Frequency	Sensitivity	Specificity	Positive	Negative	Positive	Negative	OR (95% CI)
Rales (≥1/3 lung fields)	26/192	15	89	69	38	1.32	1.04	1.4 (0.6, 3.4)
S3	123/192	62	32	61	33	0.92	0.85	0.8 (0.4, 1.5)
Ascites (moderate/massive)	31/192	21	92	81	40	2.44	1.15	2.8 (1.1, 7.3)
Edema (≥2+)	73/192	41	66	67	40	1.20	1.11	1.3 (0.7, 2.5)
Orthopnea (≥2 pillows)	157/192	86	25	66	51	1.15	1.80	2.1 (1, 4.4)
Hepatomegaly (>4 finger breadths)	23/191	15	93	78	39	2.13	1.09	2.3 (0.8, 6.6)
Hepatojugular reflux	147/186	83	27	65	49	1.13	1.54	1.7 (0.9, 3.5)
JVP ≥12 mm Hg	101/186	65	64	75	52	1.79	1.82	3.3 (1.8, 6.1)
JVP <8 mm Hg	18/186	4.3	81	28	33	0.23	0.85	0.2 (0.07, 0.6)

Values expressed as percentages unless otherwise indicated. LR indicates likelihood ratio; OR, odds ratio.

and RAP were entered into the model, PCWP remained significantly associated with the primary outcome but RAP did not. In contrast to estimates of ventricular filling pressures, the baseline H&P examination estimated cardiac index was not associated with the primary outcome ($P=0.5$). The H&P examination estimated discharge hemodynamic profile also was associated with the primary outcome (Table 7). In particular, subjects who were assessed as being volume overloaded ("wet") or poorly perfused ("cold") had higher event rates than those subjects who were "dry and warm" at discharge. The event rates were more closely related to the discharge profile than the baseline profile. Individuals who were "wet" or "cold" at baseline but were discharged "warm and dry" had the same event rates as those "warm and dry" at baseline.

Discussion

Our study provides important clarification of the role of the focused H&P examination in assessment of patients with advanced HF. First, physicians were able to estimate the RAP and PCWP by the H&P examination. In particular, the estimates of RAP from JVP were relatively useful as compared with measured values (AUC=0.74). Because the RAP is usually concordant with the PCWP in patients with advanced HF,[17] the JVP is a useful surrogate of left-sided filling pressures in many patients. In fact, once estimated RAP was considered, no other H&P examination parameter provided additional information to detect a PCWP >22 mm Hg, thus endorsing assessment of JVP as a critical component of the H&P in patients with HF. In addition to estimated RAP, orthopnea was also a marker of increased PCWP, albeit only for higher levels of PCWP. The second important finding was that a simple classification as to whether a patient was poorly perfused ("cold") or well-perfused ("warm") had utility in stratifying patients based on their true cardiac index (1.75 versus 2 L/(min·m^2); $P=0.004$). This finding may prove useful given that the ESCAPE investigators, selected for their experience in HF management, were unable to accurately estimate an absolute value of cardiac index. In contrast, had the "warm/cold" classification been used exclusively, a reasonable dichotomous assessment of cardiac index (adequate or inadequate) would have been achieved. Additionally, the H&P examination yielded information that was independently associated with increased risk of adverse outcomes within 6 months.

Table 4. Comparison of the Estimated Cardiac Index From H&P to the Invasively Measured Cardiac Index

Estimated Cardiac Index	N	Measured Cardiac Index, L/(min·m^2)
<1.8	32	1.85 (1.50, 2.25)
1.8–2.2	102	1.90 (1.60, 2.20)
>2.3	55	2.00 (1.70, 2.40)

Values are expressed as medians (25th, 75th).

Estimation of RAP and PCWP by the H&P Examination

Previous data have questioned the ability of the H&P examination to yield accurate estimates of RAP.[9–11] In a study of 25 patients, H&P examination estimates were accurate when RAP was normal but systematically underestimated RAP when increased.[11] In an earlier study of critically ill patients, H&P examination estimates of RAP overall were inaccurate, though were said to be more frequently correct in those with low cardiac index with or without increased PCWP (>18 mm Hg).[9] In contrast, others have reported that assessment of low central venous pressure had a likelihood ratio of 3.4 for a low central venous pressure and an assessment of high central venous pressure had a likelihood ratio of 4.1 for a high central venous pressure.[18] Recent evidence suggests that using the external jugular veins allows accurate estimation of the central venous pressure.[12] Nevertheless, the inconsistent ability to demonstrate accurate assessments of RAP has led to the suggestion that clinicians should decide only whether the venous pressure is increased or not and forsake attempts to determine actual RAP values.[10] In the present study, investigators categorized the JVP and RAP into 3 categories, and these H&P examination guided estimates were associated with measured RAP (Figure 1).

The role of the H&P examination in detecting increased left-sided filling pressures has also been assessed previously. A recent study suggested echocardiography was more accurate than the H&P examination,[19] though the H&P examina-

Table 5. Utility of History and Physical Examination in Detecting an Invasively Measured Cardiac Index <2.3 L/(min·m^2)

				Predictive Value		LR			
H&P Finding	Frequency	Sensitivity	Specificity	Positive	Negative	Positive	Negative	OR (95% CI)	*P*
PPP<25%	16/188	10	96	87.5	28	2.54	1.07	2.71 (0.59, 12.4)	0.2
SBP<100	75/188	42	66	77	29	1.24	1.14	1.41 (0.72, 2.77)	0.3
SBP<90	25/188	12	84	68	26	0.77	0.96	0.74 (0.30, 1.83)	0.5
Fatigue (at rest/any activity)	177/189	94	8	74	33	1.02	1.39	1.42 (0.41, 4.95)	0.6
Cool extremities	34/189	20	88	82	28	1.68	1.1	1.85 (0.72, 4.78)	0.2
"Cold" profile	52/188	33	86	86.5	32	2.33	1.28	2.97 (1.24, 7.13)	0.02

Values expressed as percentages unless otherwise indicated.
LR indicates likelihood ratio; OR, odds ratio; PPP, proportional pulse pressure; SBP, systolic blood pressure.

tion parameters may have been suboptimal as JVP was not used to estimate the PCWP. A systematic review of 12 studies suggested that increased JVP was a "very helpful" finding for detecting increased filling pressure.[6] Our study is consistent with and extends this conclusion by demonstrating that increased JVP and orthopnea ≥2 pillows were the only H&P examination parameters that provided incremental value in detecting an increased PCWP in patients with advanced HF. These data should translate into increased interest in assessing the JVP and inquiring about orthopnea by the medical community.

Estimation of Cardiac Index by H&P Examination

There are few data regarding the reliability of the H&P examination to detect a low cardiac index.[3] A decreased proportional pulse pressure was associated with low cardiac index in a study of 50 patients with advanced HF.[8] The toe temperature measured by a thermistor placed on the digital pad of the first toe has been correlated with cardiac output.[20] In ESCAPE, both a low proportional pulse pressure and cool extremities had no significant association with measured CI <2.3 L/(min·m^2) in univariable analysis (Table 5). In contrast, a global assessment of inadequate perfusion ("cold" profile) was associated with a reduced cardiac index, whether defined as <2.3 or <1.8 L/(min·m^2). Even when the cardiac index was estimated to be <2.3 L/(min·m^2), a "cold" profile detected by the same assessor was associated with a significantly lower cardiac index. In total, these data suggest that physicians should focus on a global assessment leading to a dichotomous classification ("warm" or "cold") to stratify patients into those with adequate or inadequate perfusion.

Table 6. Association of Baseline Estimates of RAP and PCWP With Survival Time (in Days) Outside Hospital 6 Months After Randomization

Baseline Estimated Variable	Hazard Ratio* (95% CI)	*P*
RAP, mm Hg		
<13 (referent)	. . .	. . .
13–16	1.2 (0.96, 1.5)	0.1
>16	1.6 (1.2, 2.11)	0.001
PCWP, mm Hg		
<23 (referent)	. . .	. . .
23–30	1.4 (1.1, 1.7)	0.008
>30	1.9 (1.4, 2.7)	0.001

*Cox proportional hazard models are adjusted for randomization, 6-minute walk distance, baseline systolic blood pressure, and baseline blood urea nitrogen.

H&P Examination and Prognosis

A number of H&P examination findings have been shown to be risk markers for poor prognosis in patients with systolic HF including increased JVP.[5] Previously, in a single-center observational study, the admission H&P-based hemodynamic profile of "wet" with either "warm" or "cold" was shown to be an independent risk factor for the composite end point of mortality or urgent transplant at one year.[7] However, similar hemodynamic profiles ascertained by right heart catheterization were not associated with outcomes in the Flolan International Randomized Survival Trial.[21] We now demonstrate that the H&P-based hemodynamic profile at discharge appears more important than on admission (Table 7) and that subjects assessed as being "wet" or "cold" at discharge were at 50% increased risk of rehospitalization or death independently of other markers of disease severity. In addition to suggesting potential targets for therapy, these data may prove useful in the management of patients with advanced HF in guiding intensity of follow-up in the outpatient setting.

Limitations

ESCAPE investigators had particular interest in hemodynamic assessment and the accuracy of the H&P examination may differ in other practice settings. Further, the ESCAPE patients had known HF in which increased filling pressures were likely; accuracy of increased RAP in other patient populations may be lower. Additionally, the patient population was younger (median age 57 years) and with more advanced systolic HF than many patients in the general community, and this too may limit the generalizability of our findings. Severity of tricuspid regurgitation was not routinely assessed and thus we cannot assess its impact on RAP and thermodilution cardiac index. Likewise, the relationship between RAP and PCWP would be expected to be different in patients with primary right ventricular failure and may be affected in the presence of severe TR or MR. We cannot be certain that investigator estimates of hemodynamics were not influenced by other parameters such as the BNP level or chest x-ray examination. However, if such bias existed, one might expect the H&P examination estimates of the PCWP to be more accurate than the RAP (eg, because the chest radiograph or

Table 7. Association of H&P Baseline and Discharge Profiles and Survival Time (in Days) Outside Hospital 6 Months After Randomization in Cox Regression Analysis

N	Baseline Profile*	Discharge Profile*	Event Rate (%)	Hazard Ratio	*P*
51	warm and dry	warm and dry	61	1 (referent)	. . .
268	wet or cold	warm and dry	59	0.9 (0.7, 1.2)	0.5
69	wet or cold	wet or cold	81	1.5 (1.1, 2.1)	0.017

*Patients were classified based on whether volume overloaded ("wet") or not ("dry") and whether their cardiac perfusion was inadequate ("cold") or adequate ("warm"). One subject had a baseline warm and dry profile and had a discharge warm and wet profile. No subject had a baseline warm and dry profile with a discharge cold profile. Model is adjusted for 6-minute walk distance, baseline systolic blood pressure, and baseline blood urea nitrogen.

BNP would reflect left-sided filling pressures better than the RAP), which was not the case. It is not known whether accurate estimation of the hemodynamics improves clinical outcomes. Indeed, detection of a low output state by a "cold" assessment could lead to initiation of intravenous inotropic agents[22] which can worsen outcomes. The discharge profile might influence subsequent clinical decisions for rehospitalization, thus magnifying the predictive power of the wet and cold profile. It is less likely that there would be bias leading to the end point of death. A large number of statistical comparisons were conducted, and this may have led to false-positive associations.

Conclusions

The H&P examination allowed accurate estimation of the RAP and reasonable discrimination as to whether left-sided filling pressures were increased or not, principally based on estimation of the JVP or presence of orthopnea. Assessment of the adequacy or inadequacy of perfusion correlated significantly with measured cardiac index. Estimates of hemodynamic status from the H&P examination are associated with prognosis in patients with advanced HF. These data provide a basis of evidence for the use of the H&P examination in the evaluation and management of HF and should spur renewed emphasis on learning and teaching the increasingly neglected H&P examination.

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Disclosures

None.

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CLINICAL PERSPECTIVE

The role of the history and physical (H&P) examination in patient care has diminished, perhaps due to a paucity of evidence demonstrating its value. In the present study we assessed whether clinicians could estimate accurately the hemodynamic status in patients with advanced heart failure enrolled in the Evaluation Study of Congestive Heart Failure and Pulmonary Artery Catheterization Effectiveness (ESCAPE) trial, and whether such estimates were associated with subsequent outcomes. We found that estimates of jugular venous pressure were reasonably accurate when compared to the invasively measured right atrial pressure. From the H&P examination, only estimated elevated jugular venous pressure and the presence of orthopnea $\geq$2 pillows were associated with elevated left ventricular filling pressures. Additionally, an overall assessment of inadequate perfusion (a "cold" profile) was associated with a reduced cardiac index. The H&P assessment of hemodynamic status at discharge (either "cold" or "wet") was associated with a 50% increased risk of death or rehospitalization at 6 months. These data emphasize that clinicians should focus on estimating the jugular venous pressure and inquiring about orthopnea when assessing the volume status of patients with heart failure, and on an overall assessment of adequacy of perfusion when assessing the cardiac index. Further, these data support the contention that the H&P examination continues to provide useful information in the modern era, and may renew interest in the teaching and learning of this increasingly neglected skill.

Value of Clinician Assessment of Hemodynamics in Advanced Heart Failure: The ESCAPE Trial

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