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# The EuroHeart Failure survey programme— a survey on the quality of care among patients with heart failure in Europe

## Part 1: patient characteristics and diagnosis

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### KEYWORDS

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**Background** The European Society of Cardiology (ESC) has published guidelines for the investigation of patients with suspected heart failure and, if the diagnosis is proven, their subsequent management. Hospitalisation provides a key point of care at which time diagnosis and treatment may be refined to improve outcome for a group of patients with a high morbidity and mortality. However, little international data exists to describe the features and management of such patients. Accordingly, the EuroHeart Failure survey was conducted to ascertain if appropriate tests were being performed with which to confirm or refute a diagnosis of heart failure and how this influenced subsequent management.

**Methods** The survey screened consecutive deaths and discharges during 2000–2001 predominantly from medical wards over a 6-week period in 115 hospitals from 24 countries belonging to the ESC, to identify patients with known or suspected heart failure.

**Results** A total of 46,788 deaths and discharges were screened from which 11,327 (24%) patients were enrolled with suspected or confirmed heart failure. Forty-seven percent of those enrolled were women. Fifty-one percent of women and 30% of men were aged >75 years. Eighty-three percent of patients had a diagnosis of heart failure made on or prior to the index admission. Heart failure was the principal reason for admission in 40%. The great majority of patients (>90%) had had an ECG, chest X-ray, haemoglobin and electrolytes measured as recommended in ESC guidelines, but only 66% had ever had an echocardiogram. Left ventricular ejection fraction had been

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measured in 57% of men and 41% of women, usually by echocardiography (84%) and was <40% in 51% of men but only in 28% of women. Forty-five percent of women and 22% of men were reported to have normal left ventricular systolic function by qualitative echocardiographic assessment. A substantial proportion of patients had alternative explanations for heart failure other than left ventricular systolic or diastolic dysfunction, including valve disease. Within 12 weeks of discharge, 24% of patients had been readmitted. A total of 1408 of 10,434 (13.5%) patients died between admission and 12 weeks follow-up.

**Conclusions** Known or suspected heart failure comprises a large proportion of admissions to medical wards and such patients are at high risk of early readmission and death. Many of the basic investigations recommended by the ESC were usually carried out, although it is not clear whether this was by design or part of a general routine for all patients being admitted regardless of diagnosis. The investigation most specific for patients with suspected heart failure (echocardiography) was performed less frequently, suggesting that the diagnosis of heart failure is still relatively neglected. Most men but a minority of women who underwent investigation of cardiac function had evidence of moderate or severe left ventricular dysfunction, the main target of current advances in the treatment of heart failure. Considerable diagnostic uncertainty remains for many patients with suspected heart failure, even after echocardiography, which must be resolved in order to target existing and new therapies and services effectively.

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## Introduction

Heart failure is a major cause of serious morbidity and death in the population and one of the leading medical causes of hospitalisation among people aged greater than 60 years.<sup>1-4</sup> The burden of disease and the resources required to manage it are likely to escalate over the coming decades for several reasons.<sup>4,5</sup> Probably, the most important reason is the increasing number of older people in the population, a group at high risk of developing heart failure. Paradoxically, improvement in the treatment of hypertension and myocardial infarction, although delaying the onset of heart failure, may increase its incidence and prevalence further. Furthermore, deployment of effective treatments for heart failure will increase its prevalence by extending life.<sup>3</sup> A clear understanding of the health and social challenge set by heart failure is thus of considerable interest for the community and health services. However, there are serious gaps in our knowledge.

Clinical trials provide important, detailed information on the natural history of highly selected groups of patients with heart failure. Although randomised controlled trials frequently recruit patients on an international basis, there is a relative paucity of comparative international epidemiological data. It is important, for the proper interpretation of clinical trials, to have some measure of the population from which the patients were drawn. Epidemiological studies often provide

detailed information, however, on a relatively small number of patients.<sup>6-8</sup> Hospital discharge and health service statistics provide data on large numbers of patients but limited data on the accuracy of the diagnosis of heart failure or on conditions other than the principle diagnosis.<sup>3,9,10</sup> There is also evidence of substantial miscoding of such databases, which underestimates rather than overestimates the true prevalence of heart failure.<sup>9</sup> Clinical trials, epidemiological databases and hospital discharge statistics provide little information on how patients with suspected heart failure present to hospital, how it is investigated or what the outcomes of investigation are.

Guidelines of the European Society of Cardiology (ESC) that provided recommendations for the investigation and treatment of heart failure were published between 1995 and 1997<sup>11,12</sup> and updated recently.<sup>13</sup> However, it is unclear if the guidelines are commonly followed in representative populations of patients with suspected heart failure. The majority of first presentations of heart failure occur in hospital and over 40% of patients in the community with heart failure have been hospitalised within the previous year.<sup>14,15</sup> Hospitalisation is a key event that provides an opportunity to clarify the diagnosis and optimise therapy. Accordingly, the EuroHeart Failure survey was devised and conducted, as part of the EuroHeart Survey programme, in order to determine whether consecutive patients with known or suspected heart failure during a hospital admission were being investigated

and treated in accordance with ESC guidelines.<sup>16</sup> The survey also provided an opportunity to obtain international comparative data on the characteristics and outcome of patients with heart failure, selected mainly by their need for hospitalisation.

## Methods

The design and execution of the survey have been reported in detail previously.<sup>16</sup> The protocol was approved by the multicentre research ethics committee (Northern and Yorkshire) in the UK and at other participating hospitals as required by local rules.

Clusters of hospitals were formed that generally included one University hospital and one or more community hospitals in order to obtain a more representative sample of hospital deaths and discharges. Each hospital recorded consecutive deaths and discharges from general medical, cardiology, cardiac surgery and care of the elderly wards over a period of 6 weeks and indicated any patient who had a discharge diagnosis of acute myocardial infarction, new onset atrial fibrillation or who had diabetes, in order to gain insights into the population screened. Wards solely devoted to other types of surgery and specialities such as gynaecology and ophthalmology were excluded. Renal wards were also excluded since this group of patients often receive loop diuretic therapy for reasons other than heart failure. Large hospitals that had more than 150 deaths and discharges per week from relevant wards were asked to screen wards in rotation each for a shorter period.<sup>16</sup> Screening took place between the third quarter of 2000 and the second quarter of 2001.

The case notes of consecutive deaths and discharges from each patient were reviewed to identify if the patient fulfilled one or more of the following four criteria:

1. A clinical diagnosis of heart failure recorded during the admission (regardless of the primary reason for admission).
2. A diagnosis of heart failure recorded in the hospital notes at any time in the last 3 years.
3. Administration of a loop diuretic for any reason other than renal failure during the 24 h prior to death or discharge.
4. Administration of treatment for heart failure or major ventricular dysfunction within 24 h of death or discharge (investigators were asked, in particular, to review any prescription of ACE inhibitor, beta-blocker, diuretics, digitalis glycosides or spironolactone to determine the reason for their administration).

The diagnosis was that reported routinely by clinicians looking after the patient rather than by the survey investigators. All patients who fulfilled one or more of these criteria had a detailed record of the events precipitating their admission, cardiovascular investigation, cardiovascular and non-cardiovascular disease and therapy completed by an investigator at each site. Surviving patients were contacted and asked to attend an interview at 12 weeks, at which time any further clinical events, investigations and treatment were recorded and a brief examination performed.

The study design attempted to achieve two fundamental goals. First, to achieve precision (lack of random error), and second, to achieve validity (lack of systematic error). Large sample sizes provide substantial protection from random error. In the binomial distribution, a probability of an event or observation of 0.5 is achieved with the greatest measurement error, which decreases in observations that move towards a probability of 0 or 1. Taking a probability of 0.5 as the 'worst case', the 95% confidence intervals around an observation, in a dataset containing 10,000 patients would be  $\pm 1.0\%$ . For individual countries providing 500 observations, the 95% confidence interval would be  $\pm 4.4\%$ . Thus, as designed, the study provides statistically precise answers at every level. Screening of consecutive patients provides some protection from systematic error, especially where countries complied with the request to form geographic clusters. In some countries, only large cardiology centres participated and data from these countries may not be representative of the general population.

Most statistical analyses planned and performed were simply descriptive, many involving subsets of patients defined by specific characteristics. Generalised linear modelling, using a logit link and binomial error, was used to identify any patient characteristics that influenced the use of echocardiography. A non-linear, mixed, hierarchical approach to data modelling was used accounting for hospital clusters. All analyses were conducted using SAS version 8.1 (Cary NC, SAS Institute 2002).

## Results

### Nature of participating hospitals (Table 1)

Altogether, 115 hospitals participated, formed into 60 clusters in 24 countries belonging to the ESC (Table 1). Fifty-eight (50%) hospitals were classified as University hospitals, 42 (36%) as regional cardiothoracic centres and 89 (77%) as community

**Table 1** Patients screened and criteria fulfilled for enrolment into the EuroHeart Failure survey

Region/ country	Clusters	Hospitals	Heart failure service	Screening								Total patients enrolled	Enrolment criteria (more than one may apply)				
				Patients screened	Acute MI (%)		New AF (%)		Diabetes (%)		None <sup>a</sup>		Heart failure diagnosis (%)		Therapy for heart failure or LV dysfunction (%)		
					All	Enrolled	All	Enrolled	All	Enrolled	All		Enrolled	Number and % of screened	Current	Prior or current	Loop diuretic
<i>Northern Europe</i>																	
UK	10	18	10	8581	6	9	7	14	9	16	81	66	1991/23%	54	70	88	55
Ireland	2	4	2	1146	4	9	5	14	7	11	85	70	278/24%	63	74	90	66
Finland	2	4	3	1179	12	18	10	18	16	23	67	51	569/48%	59	80	85	81
Sweden	2	4	3	1758	8	11	7	14	14	19	74	61	560/32%	59	76	93	76
Denmark	1	1	1	945	3	8	7	14	7	14	85	68	203/22%	53	78	86	69
<i>Western Europe</i>																	
Austria	1	3	2	1486	3	8	6	12	14	25	80	64	347/23%	95	96	64	94
Germany	5	7	4	2167	6	8	10	13	17	26	71	58	747/35%	89	93	58	88
Switzerland	2	3	1	980	2	6	1	4	11	17	87	76	172/18%	76	89	61	79
Netherlands	1	2	2	599	7	13	8	17	15	25	72	54	101/17%	64	90	79	80
Belgium	1	1	1	44	9	11	30	36	18	22	50	39	44/100%	92	100	78	94
France	3	6	1	2303	2	9	4	21	8	14	88	63	319/14%	63	87	67	64
<i>Central Europe</i>																	
Czech Republic	3	6	3	2365	7	8	4	7	22	29	70	61	588/25%	66	89	75	90
Slovak Republic	1	4	2	779	3	7	6	13	17	20	75	63	256/33%	83	94	64	91
Hungary	3	5	5	980	3	5	6	13	10	17	82	69	260/26%	78	84	90	66
Slovenia	1	3	1	1349	6	10	12	18	18	21	66	57	459/34%	79	87	72	87
Poland	4	8	4	3451	4	6	7	11	13	20	78	65	943/27%	89	93	55	77
Lithuania	1	2	1	643	9	9	20	34	9	8	65	56	229/36%	~100	~100	61	87
Russia	2	3	3	1695	8	14	5	8	6	11	83	71	466/28%	98	99	49	81
<i>Mediterranean</i>																	
Georgia	1	2	1	1302	6	20	3	18	10	11	84	63	187/14%	100	100	81	91
Israel	2	4	1	2460	4	8	3	9	12	29	84	59	604/25%	65	81	92	82
Greece	2	9	3	3449	8	11	6	12	11	20	78	63	422/12%	59	81	93	87
Italy	4	6	3	3347	7	12	4	8	10	17	83	67	589/18%	65	80	81	59
Spain	4	7	3	2662	5	8	6	19	16	25	75	55	642/24%	72	80	88	68
Portugal	2	3	0	1118	8	8	4	10	17	20	73	67	351/31%	73	74	92	77
Overall	60	115	63	46,788	6	10	6	13	12	20	78	62	11,327/24%	71	83	78	75

MI, myocardial infarction; AF, atrial fibrillation.

Note acute MI, AF and diabetes are *not* mutually exclusive categories.<sup>a</sup> None=no AMI, no AF and no diabetes.

hospitals, admitting unselected patients directly from the community. Many hospitals fulfilled all three functions. Forty-five hospitals served solely as community hospitals. Fifty-five percent of the participating hospitals indicated that they had some form of heart failure service.

### Screening (Table 1)

Over 6 weeks, 46,788 deaths and discharges were recorded; an average of 68 per hospital per week. Of these patients 6% had had an acute myocardial infarction, 6% had new-onset atrial fibrillation and 12% had diabetes. Patients with these diagnoses were about twice as likely to be enrolled with suspected heart failure.

### Enrolment (Table 1)

Overall, 24% of patients were enrolled; an average of 16 per hospital per week. Eighty-three percent of patients had a prior or new diagnosis of heart failure recorded in their notes by the clinician during his routine practice. Fifty-six percent of patients had had a diagnosis of heart failure recorded in their notes at some time in the 3 years prior to their index admission, while an additional 27% had heart failure recorded for the first time during the index admission. Seventy-eight percent of patients were taking a loop diuretic, but this was the sole criterion for enrolment in only 10%. Seventy-five percent of patients were taking some other treatment for heart failure or ventricular dysfunction but this was the sole criterion for enrolment in only 2% of patients.

### Characteristics of enrolled patients (Table 2)

The mean age of patients was 71 years. The mean age of patients was <70 years in most central and eastern European countries and almost a decade younger than were those from northern Europe. A mean age of <70 years in some western European countries (e.g. Germany, Netherlands) may have reflected incomplete screening amongst older patients from general medical wards or the specialised nature of some hospitals.

About half of patients were women, with little international variation. A higher proportion of women (51%) compared to men (30%) were aged >75 years.

Fifty-six percent of patients had been prescribed a diuretic for heart failure prior to admission, with a median duration of treatment of 1.4 years. Forty-

four percent of patients had had a prior hospitalisation with heart failure. There was evidence of heart failure prior to admission (prescription of diuretic for heart failure or a stated diagnosis of heart failure) in 65% of the patients enrolled, slightly more than those who had had a prior diagnosis of heart failure recorded in their notes (56%).

Overall, 50% of patients were admitted to general medical and 43% to cardiology wards. However, there were marked variations between countries. Despite the age of the population few were admitted to units specialising in the care of the elderly, reflecting the lack of development of such services in many countries and possibly some selection in screening.

Heart failure was considered to be the primary reason for admission in 40%, to have complicated or prolonged stay in a further 17% and to be an incidental finding in 4%. In 26% of patients, heart failure (past or current) was reported to be the reason for enrolment but was not assigned to one of the above categories. In 13% of cases this question was not answered and the patients were not enrolled with a diagnosis (past or current) of heart failure.

### Reasons for admission to hospital (Table 3)

The primary and contributory reasons for admission to hospital were diverse but predominantly cardiovascular in nature. Heart failure, cardiac chest pain and arrhythmias accounted for 59% of the primary reasons for admission. There was some international variation partly due to the special interests of some hospitals (e.g. arrhythmias for the hospital centre in Lithuania). Hypertension was reported to be a more common contributor to admission in central Europe, while syncope and stroke appeared more common in those countries where the mean age of patients was highest. Respiratory infection made an important contribution to admissions in some countries but not others, but this may have reflected differences in application of the entry criteria.

### Cardiovascular status at the time of admission to hospital (Fig. 1)

Almost 40% of patients presented with acute breathlessness while an additional 35% presented with some other manifestation of worsening heart failure, such as increasing oedema or exertional breathlessness. Heart failure was considered stable in 23% of patients and so presumably was frequently not the primary reason for admission of these cases.



**Table 2** Patient demographics, speciality at admission and importance of contribution of heart failure to admission

	N <sup>a</sup>	Women (%)	Age (yrs)	Men >75 years (%)	Women >75 years (%)	Evidence for heart failure prior to index admission (%)			Duration of diuretic therapy for HF <sup>b</sup> (years)	Duration of index hospital admission (days)	Speciality at any time during admission (%)			Contribution of heart failure to index admission	
						Diuretics for HF	Prior HF admission	Either			GIM	Geriatrics	Cardiologist	Primary (%)	Secondary (%)
<i>Northern Europe</i>															
UK	1700	52	75	43	60	60	37	64	2.3	12	62	20	21	22	18
Ireland	253	49	71	30	48	58	34	63	1.0	14	52	2	47	25	14
Finland	569	57	75	38	67	50	35	59	1.4	9	48	6	46	31	28
Sweden	553	53	77	52	72	67	46	70	2.6	12	71	9	33	34	8
Denmark	196	53	73	38	51	64	43	67	1.1	8	51	12	36	35	6
<i>Western Europe</i>															
Austria	335	50	73	35	63	58	53	89	1.4	13	52	1	38	65	5
Germany	702	35	67	12	36	59	37	68	0.7	10	21	0	70	50	12
Switzerland	171	57	74	46	61	77	66	87	1.5	10	88	0	16	23	23
Netherlands	101	43	68	28	47	62	53	71	3.1	17	33	0	58	15	44
Belgium	41	37	70	35	47	76	51	83	1.4	18	5	0	88	78	7
France	317	59	72	34	64	62	50	68	0.4	10	7	8	83	55	8
<i>Central Europe</i>															
Czech Republic	562	41	69	26	47	58	52	69	1.1	10	62	0	40	53	18
Slovak Republic	254	43	70	26	53	53	54	69	1.3	14	44	21	35	48	22
Hungary	255	36	63	13	30	60	58	71	0.3	11	8	0	82	54	6
Slovenia	454	49	71	30	51	65	47	69	2.1	10	49	0	53	48	10
Poland	936	50	68	20	37	31	32	42	0.6	14	48	0	51	31	17
Lithuania	226	54	67	19	34	26	78	82	0.6	11	45	0	55	12	24
Russia	370	44	65	13	30	61	69	73	1.2	19	44	0	52	46	41
<i>Mediterranean</i>															
Georgia	187	49	65	8	13	21	26	35	1.7	7	12	2	87	75	23
Israel	584	43	75	48	61	71	42	75	0.4	7	90	1	13	38	14
Greece	410	32	68	22	43	74	45	77	2.1	8	23	0	69	59	17
Italy	545	43	70	22	45	63	56	73	0.8	11	30	<1	52	44	12
Spain	633	47	73	38	53	53	42	61	1.1	11	60	6	26	39	25
Portugal	347	52	71	28	48	47	15	50	0.7	11	78	0	37	46	8
Overall	10,701	47	71	30	51	56	44	65	1.4	11	50	5	43	40	17

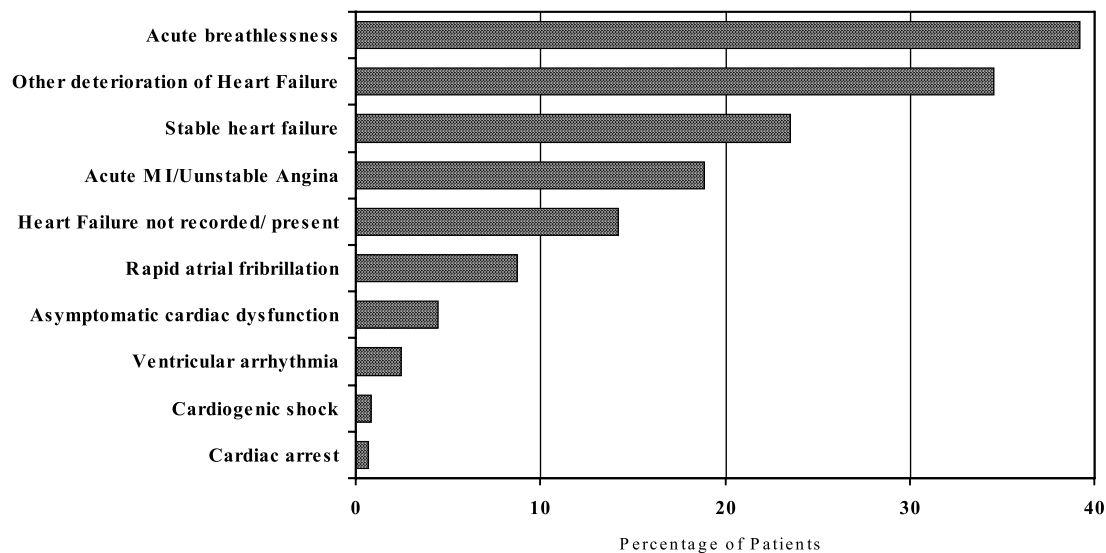
<sup>a</sup>Only patients enrolled and with data returned and entered on the database are included leading to minor differences in numbers enrolled between Tables 1 and 2.

<sup>b</sup>Median excluding patients with no such report prior to index admission.

**Table 3** Reasons for index hospital admission in the population enrolled

1=Primary reason	Heart failure %		Cardiac chest pain %		Arrhythmias %		Hypertension %		Syncope/dizziness %		Stroke/neuro. %		CVS surgery and devices %		Other CVS %		Cancer %		Gastro-intestinal %		Respiratory %		Other %	
	1	Any	1	Any	1	Any	1	Any	1	Any	1	Any	1	Any	1	Any	1	Any	1	Any	1	Any	1	Any
<i>Northern Europe</i>																								
UK	20	48	23	32	7	22	<1	4	3	6	3	5	6	8	2	5	2	4	4	7	15	23	15	30
Ireland	24	61	18	28	7	20	1	12	4	6	4	8	2	8	1	9	2	3	2	6	19	42	13	36
Finland	26	54	24	29	9	21	<1	8	1	4	2	5	4	8	4	14	1	3	4	6	6	14	18	35
Sweden	27	57	23	29	6	25	1	11	2	4	7	9	<1	3	2	10	1	4	2	5	14	26	14	41
Denmark	22	42	22	27	6	8	1	1	3	3	0	1	4	7	3	6	2	4	2	4	16	25	18	27
<i>Western Europe</i>																								
Austria	39	72	19	21	5	13	3	6	5	8	6	7	5	18	4	9	2	4	3	3	3	8	6	12
Germany	22	60	18	30	9	26	2	28	1	2	1	2	27	42	7	20	1	4	3	4	2	7	6	20
Switzerland	21	77	17	35	5	15	1	19	2	2	2	2	11	16	8	22	1	3	8	10	7	12	16	35
Netherlands	33	54	17	27	9	18	0	2	0	0	0	0	13	17	2	5	3	7	3	4	4	14	16	28
Belgium	73	85	7	12	2	27	0	2	7	10	0	2	0	12	2	15	2	2	0	2	2	10	2	17
France	48	68	7	15	6	31	0	3	2	2	1	2	24	27	4	16	0	4	<1	1	4	12	4	14
<i>Central Europe</i>																								
Czech Republic	45	78	12	20	5	24	1	17	2	2	4	7	15	28	2	23	1	2	2	7	2	12	8	30
Slovak Republic	33	77	16	33	7	25	4	24	2	5	4	7	8	28	9	21	2	6	4	9	3	10	7	24
Hungary	25	71	10	25	12	32	7	34	1	3	1	2	10	24	13	37	1	2	<1	2	2	8	9	27
Slovenia	41	69	16	28	7	28	2	26	<1	<1	3	5	8	8	4	19	1	3	6	9	6	21	6	34
Poland	28	79	22	45	7	25	3	30	3	5	4	6	5	17	10	21	2	3	4	7	7	15	7	19
Lithuania	8	98	38	65	21	40	10	42	2	3	0	<1	9	19	8	12	<1	1	<1	2	3	5	<1	7
Russia	49	92	28	50	5	28	9	47	1	3	0	1	1	8	2	14	0	1	0	0	3	4	2	9
<i>Mediterranean</i>																								
Georgia	65	100	27	39	2	32	3	50	0	0	0	3	0	1	3	27	0	1	0	3	0	14	0	11
Israel	33	56	26	37	6	18	1	8	3	4	1	2	3	7	1	5	2	4	2	5	4	9	19	34
Greece	49	76	18	27	6	20	1	9	<1	2	1	1	17	30	2	9	0	2	1	2	1	5	2	11
Italy	36	68	20	30	8	21	1	15	1	2	1	2	14	28	3	15	3	4	2	3	7	16	3	19
Spain	32	62	14	19	3	20	1	17	1	1	3	4	2	4	3	12	1	4	3	6	26	43	9	29
Portugal	38	73	14	32	6	27	1	24	1	2	3	5	17	22	1	13	2	5	3	5	6	28	7	23
Overall	32	66	20	31	7	23	2	17	2	3	3	4	9	16	4	14	1	3	3	5	8	17	10	25

1=heart failure was reported as the most important reason for admission. Any=heart failure was reported either as the most important reason for admission or as a second or third diagnosis. Note that heart failure may not have been present on admission but could be the patients' most important problem during admission. Neuro, neurological; CVS, cardiovascular.



**Fig. 1** Cardiovascular status at the time of admission for patients enrolled in the EuroHeart Failure survey. More than one status may apply at the time of admission. MI, myocardial infarction.

Nineteen percent presented with an acute coronary syndrome, 9% with rapid atrial fibrillation and 2% with a ventricular arrhythmia. Less than 1% presented with a cardiac arrest or cardiogenic shock. In 15% of patients, heart failure was not evident at the time of admission. Within this sub-group, 14% were reported to have developed heart failure during admission and 2% were reported to have asymptomatic cardiac dysfunction.

### Investigations (Tables 4 and 5)

Ninety-five percent of patients were reported to have had an ECG. ECGs are being analysed in a central laboratory and will be the subject of a future report. A preliminary report indicates that only 3% of ECGs appeared normal, although a further 39% exhibited only minor abnormalities.<sup>17</sup> A chest X-ray report was available for 92% of patients and in 71% of these cases cardiomegaly, pulmonary congestion or both were reported (Fig. 2). Other investigations, which guidelines on heart failure suggest should be routine, including haemoglobin, electrolytes and renal function, were measured in >90% of patients.

Sixty-three percent of patients had a left ventricular ejection fraction reported by at least one imaging test, most often echocardiography. When measured, LVEF was <40% in only 45% of cases (Fig. 3). There was substantial international variation in the use of echocardiography, with patients in northern Europe being generally less likely to be investigated. Amongst the 66% of patients who were reported to have had an echocardiogram,

moderate or severe left ventricular systolic dysfunction was reported in only 46% and was more common among men (61%) than among women (35%) (Fig. 4a,b). However, left ventricular diastolic function was seldom reported. Twenty-nine percent of patients were reported to have moderate to severe mitral regurgitation, while 16% of patients were reported to have moderate to severe pulmonary hypertension.

In a multivariate model in patients with a measurement of left ventricular function, the likelihood of a patient having evidence of moderate or severe left ventricular systolic dysfunction was less if they were aged  $\geq 70$  years (odds ratio 0.76, 95% CI 0.68–0.85) or had respiratory disease (odds ratio 0.74, 95% CI 0.66–0.84). Independently, male gender (odds ratio 2.84, 95% CI 2.57–3.18), previous admission for heart failure (odds ratio 1.84, 95% CI 1.62–2.08), diuretic therapy (odds ratio 1.39, 95% CI 1.24–1.55) and ischaemic heart disease (odds ratio 1.27, 95% CI 1.12–1.43) were associated with the presence of moderate to severe left ventricular systolic dysfunction.

Other investigations that may be considered in patients with heart failure but are not recommended as a routine in the guidelines were conducted less frequently than those mentioned earlier in most countries. Coronary arteriography, exercise testing and pulmonary function tests were conducted on a substantial minority of patients. Stress-imaging tests for myocardial ischaemia and viability and exercise testing with metabolic gas exchange were rarely performed. There was



**Table 4** Percentage of patients undergoing investigations in the enrolled population (index=this admission, total=this admission, prior admission or subsequent data)

	ECG		CXR		Echo		Haemoglobin		Electrolytes		Pulmonary function		Exercise test		Peak oxygen uptake		Stress imaging		Coronary angiogram	
	Index	Total	Index	Total	Index	Total	Index	Total	Index	Total	Index	Total	Index	Total	Index	Total	Index	Total	Index	Total
<i>Northern Europe</i>																				
UK	89	91	74	93	12	56	93	96	96	97	3	14	2	13	<1	1	<1	4	4	19
Ireland	91	94	87	96	18	63	97	98	99	100	9	19	7	22	<1	1	1	4	9	34
Finland	91	94	85	98	29	53	95	87	96	98	11	29	6	22	1	2	<1	3	14	29
Sweden	88	91	69	92	26	68	95	99	98	98	3	13	4	20	<1	1	1	3	5	18
Denmark	91	93	61	83	17	41	97	99	97	99	4	10	4	13	0	0	1	3	8	23
<i>Western Europe</i>																				
Austria	96	99	97	100	48	80	98	99	99	100	14	22	3	14	1	2	<1	5	26	41
Germany	99	99	57	83	37	88	97	97	97	98	19	34	17	44	2	5	2	8	60	86
Switzerland	95	97	88	95	20	55	100	100	97	98	7	24	6	23	1	2	3	7	15	29
Netherlands	94	97	85	99	27	94	96	98	96	99	14	53	7	29	0	4	1	21	12	45
Belgium <sup>a</sup>	100	100	90	93	73	90	100	100	100	100	7	27	7	17	7	17	24	39	15	54
France	95	96	91	93	57	93	96	96	97	98	11	20	13	20	5	7	4	8	31	60
<i>Central Europe</i>																				
Czech Republic	96	97	76	92	54	76	95	98	96	98	17	29	9	21	7	12	1	3	12	32
Slovak Republic	99	100	92	98	74	84	98	99	98	99	28	39	7	17	0	0	0	<1	28	33
Hungary	98	98	82	86	35	83	93	93	91	92	7	19	12	22	4	6	5	10	25	40
Slovenia	97	97	87	95	33	62	89	90	99	99	6	11	2	13	<1	1	1	3	14	23
Poland	97	97	67	88	46	63	96	96	97	98	4	7	6	12	<1	1	2	3	20	29
Lithuania <sup>a</sup>	94	100	78	100	66	90	99	99	65	65	<1	30	12	31	<1	<1	<1	6	11	22
Russia	96	97	89	93	54	59	96	98	60	62	7	9	10	14	0	0	4	4	7	15
<i>Mediterranean</i>																				
Georgia	100	100	92	93	68	81	99	100	81	87	1	1	29	31	0	0	1	1	1	1
Israel	85	86	88	91	7	47	97	97	97	98	1	1	1	1	1	1	1	4	5	34
Greece	99	100	89	93	35	80	93	93	92	94	11	25	8	32	7	16	8	23	16	59
Italy	96	98	65	75	49	73	98	98	99	99	4	9	6	17	<1	1	5	15	25	42
Spain	93	95	96	99	29	62	97	99	96	98	8	23	2	7	<1	1	2	4	8	21
Portugal	91	95	79	87	37	48	96	96	97	97	1	1	0	0	0	0	1	1	7	17
Overall	94	95	79	92	34	66	96	97	94	95	8	17	7	17	1	3	2	6	16	32

<sup>a</sup>No follow-up data were received from Belgium and Lithuania. These data are based solely on data acquired during the index admission.

**Table 5** Results of diagnostic imaging

	Left ventricular ejection fraction measured		Method for measuring left ventricular ejection fraction (%) <sup>a</sup>				Moderate or severe on echocardiography (%) <sup>b</sup>									
	Ever	Within 1 year	Echo	RNVG	Angio	Other	Left ventricular			Left atrial dilatation	Valve stenosis		Valve regurgitation		Right ventricular dysfunction	Pulmonary hypertension
							Systolic	Diastolic	Dilatation		Mitral	Aortic	Mitral	Aortic		
<i>Northern Europe</i>																
UK	40	30	86	8	3	3	34	7	14	11	2	4	19	6	3	3
Ireland	51	43	92	1	0	7	36	35	26	28	2	6	27	9	9	4
Finland	56	49	91	3	3	3	33	8	21	26	2	9	29	8	7	13
Sweden	67	48	93	0	0	7	41	6	19	30	2	8	35	8	5	26
Denmark	43	36	82	1	6	11	32	3	30	4	1	4	8	1	4	7
<i>Western Europe</i>																
Austria	80	74	93	2	2	3	52	9	30	51	3	10	42	11	1	23
Germany	87	83	51	19	26	4	60	24	31	42	2	8	25	5	6	23
Switzerland	61	47	80	18	0	2	52	12	13	23	2	10	20	8	5	27
Netherlands	72	53	75	10	4	11	60	8	30	32	11	15	33	11	3	6
Belgium <sup>c</sup>	93	90	79	0	11	11	49	30	43	41	5	8	41	3	14	46
France	91	84	85	<1	13	2	57	6	36	39	<1	10	39	11	10	32
<i>Central Europe</i>																
Czech Republic	79	73	94	1	4	1	60	6	29	26	2	5	38	5	11	18
Slovak Republic	83	80	94	0	3	3	42	15	11	33	4	11	18	6	6	19
Hungary	66	56	80	0	6	14	50	20	48	36	2	9	41	11	2	22
Slovenia	60	52	85	<1	5	10	41	5	27	51	2	10	59	16	1	18
Poland	60	57	89	<1	6	5	47	16	32	32	4	6	27	7	7	6
Lithuania <sup>c</sup>	90	81	98	0	0	2	63	39	19	63	2	4	37	5	16	18
Russia	58	58	91	1	5	3	56	17	44	29	6	4	41	8	16	19
<i>Mediterranean</i>																
Georgia	81	81	92	0	0	8	30	5	31	31	1	0	7	2	1	0
Israel	30	16	52	3	5	40	25	3	7	8	3	8	18	4	3	10
Greece	86	79	69	16	10	5	65	16	51	48	3	8	29	8	12	21
Italy	72	68	93	1	4	2	45	11	23	21	4	3	24	6	4	18
Spain	62	49	85	3	8	4	37	7	19	26	9	10	26	11	4	26
Portugal	52	48	90	3	0	7	Data not completed									
Overall	63	55	84	4	6	5	46	12	26	31	3	7	29	7	6	16

<sup>a</sup>Data shown are the percentages undergoing measurement of left ventricular ejection fraction.

<sup>b</sup>Data shown are the percentages of those who underwent echocardiography (see Table 4).

<sup>c</sup>No follow-up data were received from Belgium and Lithuania. These data are based solely on data acquired during the index admission.

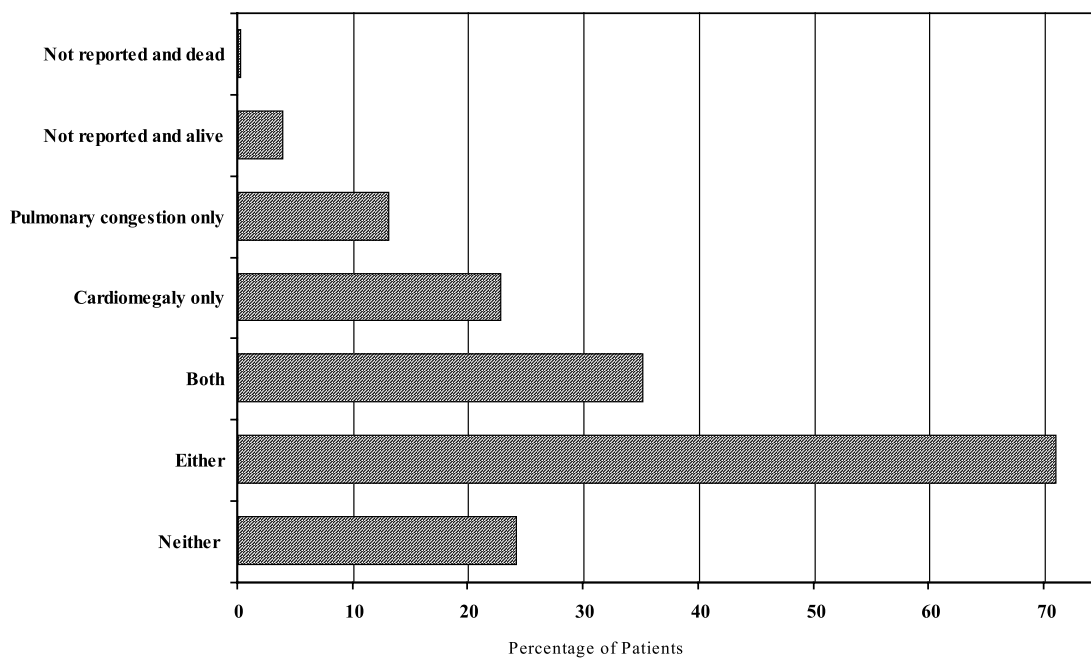


Fig. 2 Radiological evidence for heart failure on or after the index admission for patients enrolled in the EuroHeart Failure survey.

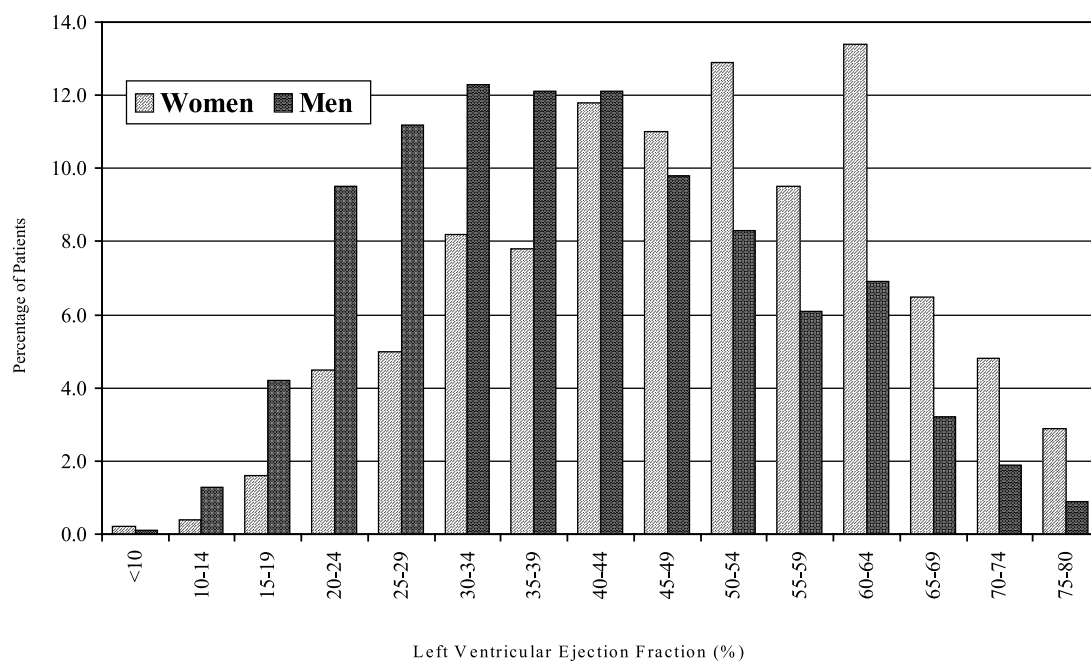
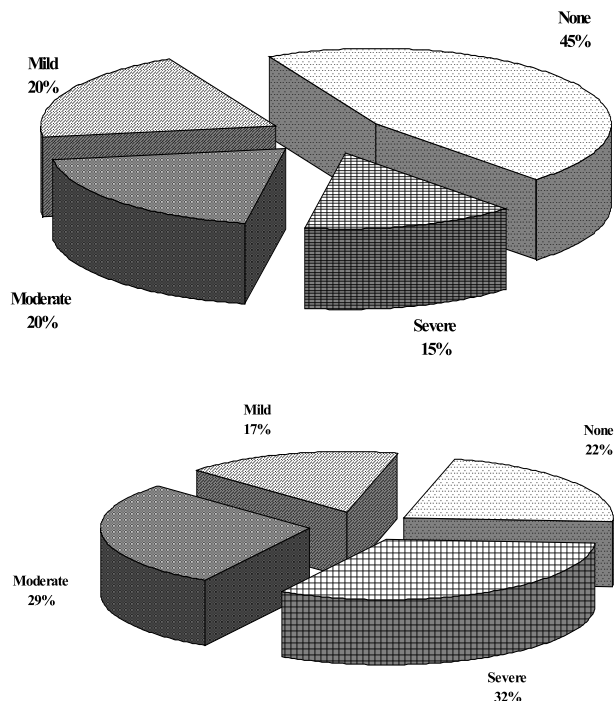


Fig. 3 Distribution of left ventricular ejection fraction measured within 12 months of the survey amongst women ( $n=2048$ ; 41% of total enrolled) and men ( $n=3249$ ; 57% of total enrolled) enrolled in the EuroHeart Failure survey. Where more than one ejection fraction measurement was available, the most recent one was used. Fifty-one percent of men but only 28% of women had a left ventricular ejection fraction <40%.

evidence of considerable international variation in the use of coronary arteriography, with the majority of patients enrolled in Germany, France and Greece undergoing this procedure.

### Aetiology of heart failure (Table 6)

Ischaemic heart disease, identified from the patients' history or by coronary angiography, was



**Fig. 4** Distribution of the severity of left ventricular systolic dysfunction by qualitative assessment in (a) women ( $n=2607$ ; 52% of the total enrolled) and (b) men ( $n=3666$ ; 64% of the total enrolled) enrolled in the EuroHeart Failure survey. Sixty-one percent of men but only 35% of women had left ventricular systolic dysfunction reported as moderate or severe. Forty-five percent of women but only 22% of men had left ventricular function reported as normal.

the commonest potential cause of heart failure in all countries apart from France, Spain, Portugal and Hungary. However, one-third of patients with ischaemic heart disease were not reported to have had a myocardial infarction. Moderate or severe valve disease on echocardiography or prior severe valve disease as evidenced by valve surgery was reported to have contributed to the development of heart failure in 29% of patients, the most common lesion being secondary mitral regurgitation. Dilated cardiomyopathy was a stated diagnosis in 11% of patients but almost half were also reported to have coronary artery disease or hypertension and only 6% had this as the sole diagnosis. Dilated cardiomyopathy appeared more common in France and Hungary.

### Concomitant cardiovascular disease and risk factors (Table 7)

Expected risk factors for cardiovascular disease were prevalent amongst the patients in this survey; 53% had hypertension and 27% had diabetes. Some international variation was observed but without a

consistent regional pattern. A total of 3931 patients (35%) were reported to have had a serum cholesterol measured, which was reported to be  $\geq 5.0$  mmol/l in 50%. Twenty percent of patients were taking lipid lowering therapy. Atrial (43%) and ventricular (8%) arrhythmias were commonly identified in this population. In addition, syncope and blackouts, symptoms that are likely to reflect a combination of hypotension, cerebral vascular disease and a variety of arrhythmias, affected 16% of patients. There was little international variability. Some countries reported high rates of ventricular arrhythmias but this may reflect differences in the frequency with which ambulatory monitoring is used to detect asymptomatic arrhythmias.

Almost 1000 patients (8% of those enrolled) had had a pacemaker implanted. Conventional pacing may cause ventricular dyssynchrony but few, if any, pacemakers would have been for cardiac resynchronisation, given the timing of the survey. Less than 1% of patients had an implantable defibrillator.

Nine percent of patients were reported to have had a stroke and 10% a transient ischaemic attack. Twelve percent of patients were reported to suffer from dementia or mental confusion, reflecting the age of the patients. Although some of the mental confusion may have been due to worsening heart failure or infection and reversible with treatment, it is likely that many of these patients would have major persisting cognitive dysfunction on formal testing.

### Concomitant non-cardiovascular disease (Table 7)

In addition to diabetes, reported earlier, important non-cardiovascular problems known to complicate the management of heart failure were common. A total of 9971 patients had a value for haemoglobin reported, which was less than 11 g/dl in 18% of men and 23% of women (Fig. 5). Renal dysfunction was reported to have complicated the management of patients with known or suspected heart failure in 18% of cases. Serum creatinine was reported in 6598 patients and was  $\geq 150$   $\mu\text{mol/l}$  in 1059 (16%) and  $\geq 200$   $\mu\text{mol/l}$  in 437 (7%) (Fig. 6). Twenty percent of patients had a serum sodium  $\leq 135$  mmol/l. Thirty-two percent of patients were reported to have respiratory disease but this is only likely to be a rough estimate given the lack of respiratory function testing. Gout and arthritis, conditions that may not only limit mobility but may lead to the prescription of non-steroidal anti-inflammatory drugs that may exacerbate renal

**Table 6** Evidence for ischaemic heart disease, valve disease and dilated cardiomyopathy in the population enrolled (index=this admission, total=this admission, prior admission or subsequent data)

	Myocardial infarction			History of stable or unstable angina			Coronary angiography			Angioplasty			CABG			Cumulative evidence for CAD	Valve surgery or moderate/severe valve disease on echo.			Dilated cardiomyopathy <sup>a</sup>		
	Index	Prior	Total	Index	Prior	Total	Index	Prior	Total	Index	Prior	Total	Index	Prior	Total		Total	Index	Prior	Total	Index	Prior
<i>Northern Europe</i>																						
UK	9	40	41	40	52	56	4	15	19	1	3	4	3	8	10	66	5	12	17	1	2	2
Ireland	9	42	42	36	43	48	9	25	34	4	4	8	0	12	12	60	7	14	24	8	7	10
Finland	18	38	44	26	45	49	14	16	29	5	6	10	3	12	15	66	13	10	24	5	3	5
Sweden	12	40	41	35	42	46	5	13	18	1	3	4	<1	9	10	59	13	17	30	2	2	2
Denmark	12	38	40	31	35	37	8	17	23	4	12	13	2	10	12	52	2	5	7	1	1	1
<i>Western Europe</i>																						
Austria	4	31	32	43	43	44	26	24	41	6	7	11	1	10	11	53	23	18	41	9	8	10
Germany	8	50	51	57	64	70	60	53	86	14	24	32	9	22	29	82	17	19	35	7	5	8
Switzerland	6	28	28	33	47	50	15	21	29	5	9	12	0	9	9	58	7	12	20	4	1	4
Netherlands	13	54	56	34	52	59	12	36	45	3	14	15	10	24	33	72	17	34	48	3	3	3
Belgium <sup>b</sup>	10	56	n.a.	24	54	56	15	41	54	7	10	17	0	22	22	76	44	15	51	3	1	3
France	8	27	29	11	32	33	31	41	60	3	8	10	2	6	8	47	34	22	51	17	15	22
<i>Central Europe</i>																						
Czech Republic	8	44	45	21	34	36	12	21	32	3	4	7	0	6	6	57	24	10	36	9	9	10
Slovak Republic	7	43	45	56	59	66	28	11	33	5	2	6	4	3	7	77	22	10	31	2	2	2
Hungary	9	31	32	27	35	38	25	21	40	1	2	2	3	6	8	48	25	25	50	17	15	17
Slovenia	8	23	24	38	38	45	14	9	23	3	4	5	1	4	5	51	23	22	45	9	8	11
Poland	6	33	34	62	63	68	20	11	29	3	3	6	2	5	7	71	21	12	31	2	1	3
Lithuania <sup>b</sup>	8	33	33	82	79	83	40	47	51	5	4	9	0	6	6	84	28	14	41	3	2	3
Russia	14	52	52	62	58	66	7	9	15	1	2	2	1	3	4	77	27	5	29	4	2	5
<i>Mediterranean</i>																						
Georgia	16	33	34	51	49	55	1	0	1	0	0	0	0	1	1	57	6	1	7	3	2	3
Israel	9	48	50	54	61	66	5	30	34	3	14	15	4	16	19	76	3	15	18	1	1	1
Greece	10	36	38	21	36	36	16	44	59	2	6	7	6	15	21	55	15	22	37	12	10	12
Italy	11	37	39	36	34	44	25	21	42	8	9	16	5	8	12	57	19	10	27	11	6	11
Spain	8	21	24	16	22	26	8	13	21	1	2	3	1	4	5	37	14	16	28	5	3	5
Portugal	13	19	25	20	16	27	7	11	17	4	5	9	0	7	7	39	4	12	12	0	0	0
Overall	9	38	39	40	47	51	15	20	32	4	6	9	3	9	11	68	16	14	29	5	4	6

CABG, coronary artery bypass grafting; CAD, coronary artery disease.

<sup>a</sup>Overall, 11% of patients were stated to have dilated cardiomyopathy by the investigators. Numbers shown exclude patients with coronary disease or hypertension.<sup>b</sup>No follow-up data were received from Belgium and Lithuania. These data are solely based on data acquired during index admission.

**Table 7** Concomitant cardiovascular and non-cardiovascular problems in the population enrolled (data shown are percentages)

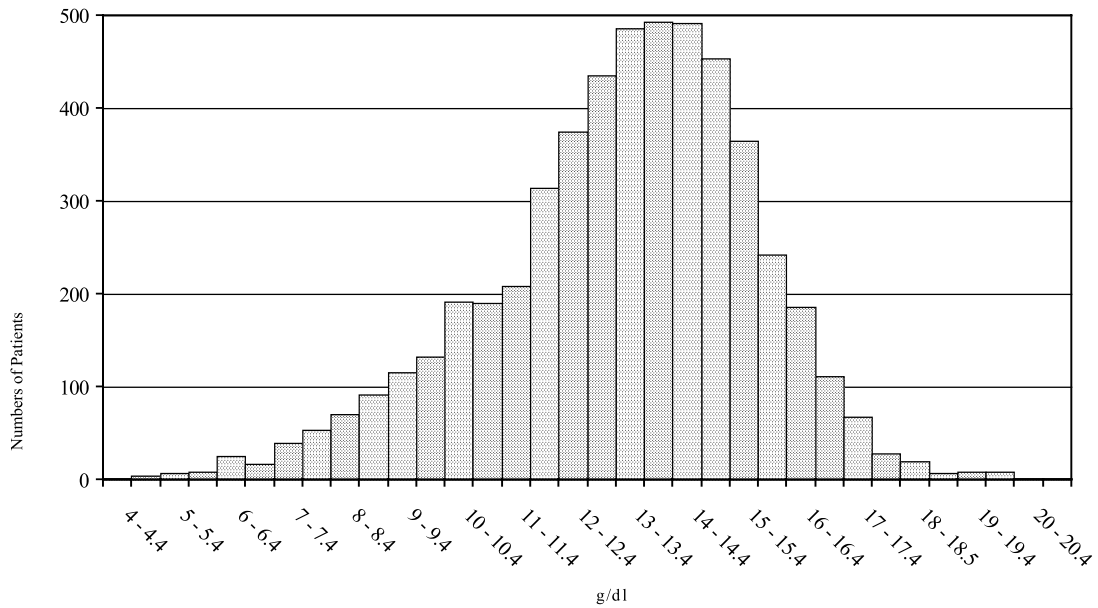
	Hypertension	Diabetes	AF		VT/VF	Syncope	Devices		Stroke	TIA	Dementia <sup>a</sup>	Renal dysfunction	Respiratory disease	PTE	Gout	Arthritis	Infection <sup>b</sup>
			Chronic	Total			Pacing	ICD									
<i>Northern Europe</i>																	
UK	47	21	22	42	7	15	6	<1	10	13	14	13	31	4	6	20	28
Ireland	45	16	23	40	9	19	8	2	7	17	17	9	50	4	8	15	45
Finland	47	26	22	44	12	27	8	1	10	16	18	11	24	4	11	8	31
Sweden	39	23	22	41	6	13	7	0	14	16	13	7	27	3	9	5	29
Denmark	22	18	15	33	7	9	8	0	4	8	9	9	35	2	5	5	23
<i>Western Europe</i>																	
Austria	54	31	21	36	11	8	8	1	13	8	7	29	17	5	3	2	17
Germany	65	35	22	41	12	12	11	1	7	6	6	20	22	2	5	11	19
Switzerland	58	26	22	44	10	23	9	1	6	8	17	36	31	10	5	18	20
Netherlands	35	26	20	50	19	18	14	1	3	8	12	41	33	4	10	4	21
Belgium	59	20	32	66	20	22	22	10	10	2	10	37	27	2	7	2	17
France	51	18	23	56	7	10	14	1	4	10	8	35	26	4	6	3	16
<i>Central Europe</i>																	
Czech Republic	59	46	26	38	7	13	11	<1	13	12	10	18	25	6	5	9	16
Slovak Republic	69	39	24	47	6	24	7	0	15	19	15	30	39	6	23	20	37
Hungary	53	25	22	37	9	11	15	0	5	9	6	6	17	3	4	4	13
Slovenia	50	34	22	51	9	20	5	<1	10	7	17	26	45	4	7	7	28
Poland	58	23	21	40	7	20	8	0	9	7	23	14	32	2	2	17	18
Lithuania	69	12	18	51	4	56	11	0	4	20	4	12	70	4	2	29	11
Russia	67	16	23	43	12	18	3	0	7	5	9	6	24	1	1	6	6
<i>Mediterranean</i>																	
Georgia	70	14	24	38	33	1	1	0	2	4	0	10	24	0	0	9	15
Israel	58	36	28	42	6	8	7	<1	15	4	10	29	23	1	3	2	29
Greece	55	32	24	41	11	13	13	1	5	6	7	19	20	1	7	7	10
Italy	47	23	21	31	5	10	8	0	3	9	4	12	35	2	2	5	13
Spain	56	37	29	49	3	6	6	<1	8	9	12	21	52	2	3	4	42
Portugal	47	29	32	42	4	10	15	1	10	9	10	16	50	5	1	3	36
Overall	53	27	23	42	8	15	8	<1	9	10	12	17	32	3	5	10	24

AF, atrial fibrillation; VT/VF, ventricular tachycardia or ventricular fibrillation; PTE, pulmonary thromboembolism; ICD, implantable cardiac defibrillator.

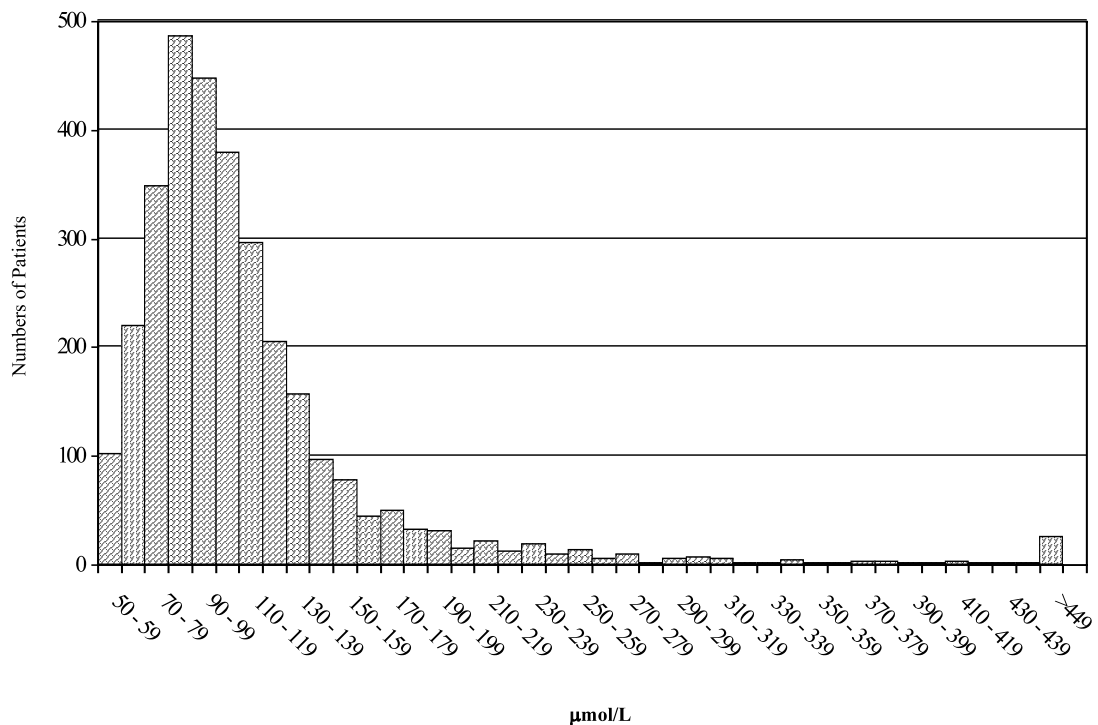
<sup>a</sup>Dementia or mental confusion and therefore may not have been irreversible.

<sup>b</sup>Infection on the index admission only.





**Fig. 5** Distribution of haemoglobin values recorded in 5249 (92% of total enrolled) of the men enrolled in the EuroHeart Failure survey.



**Fig. 6** Distribution of serum creatinine values recorded in 3144 (62% of total enrolled) of the women enrolled in the EuroHeart Failure survey. Renal function was recorded using urea or blood urea nitrogen in a large proportion of the remainder.

dysfunction and cause sodium retention in patients with heart failure, were also common. A total of 2617 patients had uric acid levels measured; plasma concentrations were  $\geq 0.5$  mmol/l in 21%.

### Clinical outcomes (Table 8)

The average duration of the index admission was 11 days. Amongst 8463 patients who survived the

**Table 8** Outcome

	Data available	Readmissions within 12 weeks			Patients readmitted within 12 weeks			Deaths			
		Total	For heart failure <sup>a</sup>	With heart failure <sup>a</sup>	Percentage of patients	Age	Percent who were female	On index admission (%)	Total (%)	Age (years)	Female (% of total)
<i>Northern Europe</i>											
UK	1249	496	84	72	31	75	52	9.1	15.5	79	57
Ireland	203	48	7	11	36	71	53	9.9	14.2	78	49
Finland	458	448	32	40	54	73	59	9.5	17.8	78	59
Sweden	535	328	70	65	41	77	51	2.9	15.0	80	56
Denmark	182	63	6	4	29	73	56	5.6	11.7	79	59
<i>Western Europe</i>											
Austria	296	149	34	12	41	73	46	10.2	18.8	78	54
Germany	532	233	22	64	36	66	28	3.9	6.4	74	45
Switzerland	109	27	4	7	28	74	48	9.9	16.4	75	61
Netherlands	94	54	10	2	36	65	38	6.9	13.9	68	80
Belgium	No data supplied							4.9	n.a.	52	0
France	249	67	14	3	27	72	27	7.6	15.5	76	45
<i>Central Europe</i>											
Czech Republic	517	175	75	26	31	63	32	6.4	14.4	73	46
Slovak Republic	215	103	16	15	39	70	37	9.8	20.5	77	53
Hungary	198	57	12	20	21	61	26	3.9	8.6	69	50
Slovenia	408	122	44	32	26	70	45	9.5	14.5	74	47
Poland	835	101	23	40	12	66	49	7.8	10.7	73	50
Lithuania	No data supplied							1.3	n.a.	75	100
Russia	362	6	2	1	3	60	44	1.6	4.1	71	40
<i>Mediterranean</i>											
Georgia	177	8	4	2	5	64	13	5.4	21.9	66	41
Israel	489	177	37	16	28	74	50	3.8	9.9	80	44
Greece	312	46	24	2	17	65	26	7.3	12.2	74	33
Italy	419	77	23	5	21	69	43	3.5	11.6	72	52
Spain	549	165	48	21	26	72	42	9.6	18.6	79	52
Portugal	75	None reported				n.a.	n.a.	8.4	10.7	75	45
Overall	8463	2950	591	460	24.2% (2046)	71	45	739/10,701 <sup>b</sup> (6.9%)	1408/10,434 <sup>b</sup> (13.5%)	76	717 (51%)

<sup>a</sup>For heart failure means heart failure coded in the first position/with heart failure means heart failure coded in the second or third position.

<sup>b</sup>Number of patients in whom status alive or dead was recorded (98% of enrolled patients for whom baseline data were received.)

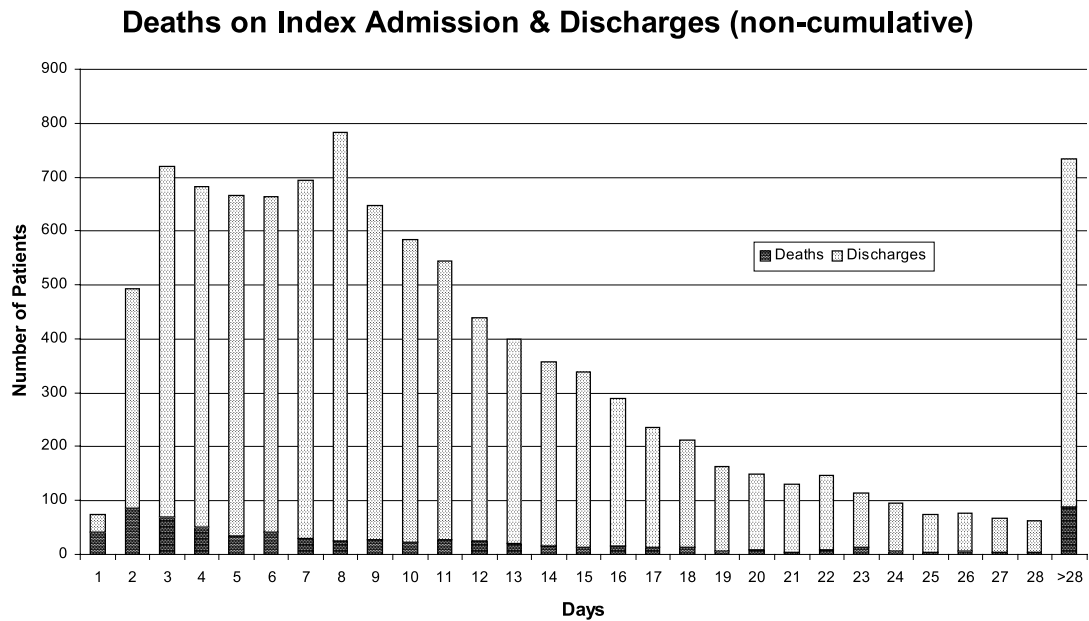


Fig. 7 Deaths on index admission and discharges from the time of admission for 10,701 patients.

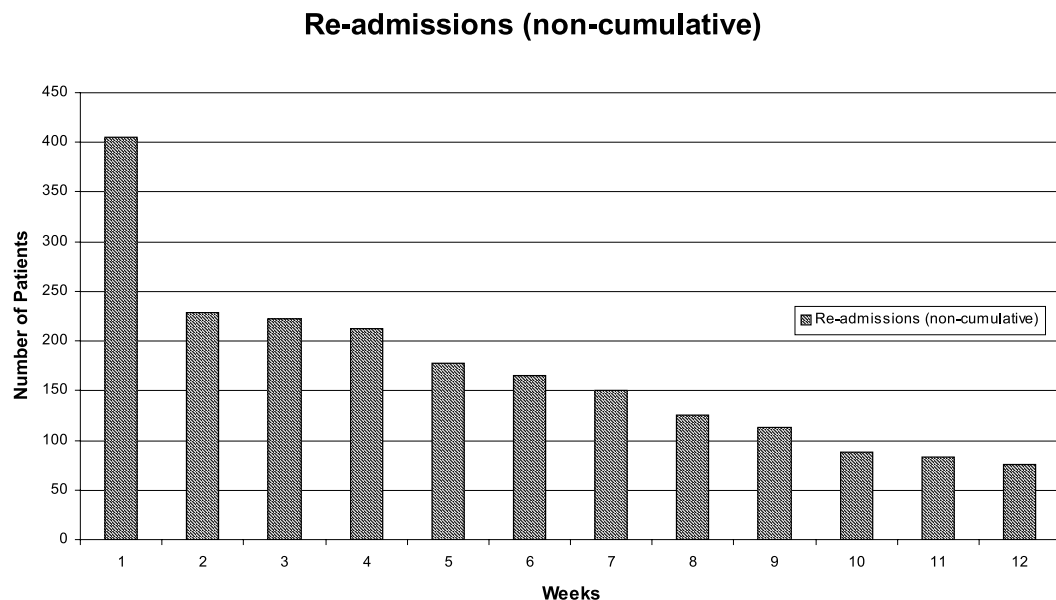


Fig. 8 First admission over 12 weeks for any reason from the time of index admission discharge ( $n=8463$ ).

index admission and had 12-week follow-up data, 2950 re-admissions occurred in 2046 patients during this period (Fig. 7). Heart failure was the principal cause for readmission in 591 (20.0% of admissions) and contributed in a further 460 (15.6%). A total of 1413 patients (13%) died between admission and the 12 week follow-up visit with similar numbers dying during (Fig. 8) and after the index admission. There was some international variation in the index admission mortality and in readmission rates

but 12-week mortality was fairly consistent. Low 12-week mortality in Germany and Hungary may be related to the relatively young age of patients enrolled in these two countries.

#### Patient interview and examination (Table 9)

A total of 3260 surviving patients (38.5% of those with 12-week follow-up data) attended the

**Table 9** Results of patient interview and physical examination

	N	Age	Female (%)	NYHA class %			BMI		Seated				Bilateral pitting oedema	Final diagnosis for patients attending interview					
				I	II	III/IV	<20	>30	Heart rate	SBP	Percent with SBP >140 mmHg	DBP		Definite	Probable	Possible	Doubtful	Absent	
<i>Northern Europe</i>																			
UK	332	71	43	22	37	40	5	30	76	135	34		77	31	23	28	22	16	3
Ireland	107	69	44	26	34	39	6	36	77	128	29		79	14	41	23	15	11	6
Finland	227	72	53	37	26	34	4	20	68	137	31		77	18	25	12	15	19	21
Sweden	136	73	38	31	35	34	4	26	70	139	41		79	26	39	17	14	13	13
Denmark	70	69	43	24	37	38	5	20	72	135	34		78	36	33	23	23	13	3
<i>Western Europe</i>																			
Austria	113	66	32	41	35	25	7	19	73	134	29		73	14	86	7	2	1	4
Germany	342	64	25	25	52	24	3	19	74	135	25		81	19	64	14	15	4	2
Switzerland	68	73	50	60	28	12	10	15	74	124	19		72	37	65	15	3	1	13
Netherlands	37	68	32	51	30	16	0	19	78	129	32		71	27	19	11	24	30	16
Belgium	No data supplied																		
France	26	72	27	54	38	8	4	12	76	137	23		91	8	46	4	4	4	42
<i>Central Europe</i>																			
Czech Republic	242	64	31	36	42	23	3	28	76	130	31		78	14	60	11	7	1	21
Slovak Republic	138	68	41	30	41	30	3	22	76	140	43		82	28					
Hungary	122	60	28	59	21	16	4	34	74	122	18		76	31	56	18	14	8	2
Slovenia	184	70	44	32	45	22	3	32	75	141	48		80	30	54	23	14	5	3
Poland	295	66	50	27	49	24	2	31	80	134	25		79	18	36	26	22	9	6
Lithuania	No data supplied																		
Russia	76	62	29	36	33	31	4	18	76	132	24		79	26	84	7	7	3	0
<i>Mediterranean</i>																			
Georgia	93	65	44	60	27	13	0	3	79	140	40		83	27	22	10	23	24	23
Israel	67	72	34	43	21	31	6	27	74	129	16		74	28	37	25	21	11	6
Greece	153	63	28	48	32	20	3	19	75	121	14		76	18	67	16	9	5	2
Italy	228	68	39	46	30	22	5	14	75	129	16		78	18	24	17	16	15	26
Spain	168	69	54	35	36	28	3	37	77	137	33		77	27	32	26	18	8	10
Portugal	36	70	47	64	17	14	8	19	66	135	36		77	17	14	14	31	31	6
Overall	3260	68	39	36	37	26	4	24	75	133	29		78	23	44	18	15	10	10

interview. These patients tended to be younger and included a higher proportion of men than in the enrolled population. Most patients attending the interview had no or only mild symptoms of heart failure, but a substantial minority had continuing moderate to severe symptoms and pitting oedema remained common. A substantial proportion appeared obese with few patients showing marked cachexia. Heart rate appeared generally well controlled, but systolic blood pressure remained above 140 mmHg in 29% of patients. The investigator was asked to state how sure they were that heart failure was present or absent, in the light of the patient's history and after the interview and examination. The diagnosis was considered definitely present in 44% and definitely absent in 10%, indicating a high level of persisting diagnostic uncertainty in this patient population. Uncertainty about the diagnosis appeared to vary amongst countries. There appeared to be greater diagnostic uncertainty when patients were investigated less intensively.

## Discussion

The EuroHeart Failure is one of the largest surveys of its kind, having screened almost 50,000 consecutive hospital deaths and discharges and collected detailed information on >10,000 patients with a possible diagnosis of heart failure. The survey provides a wealth of information for those who care for patients with heart failure, those who have to design health services for their population and for investigators wishing to conduct trials to improve care.

### Diagnosis 'of' heart failure

There are many definitions of heart failure.<sup>11</sup> The EuroHeart Failure survey attempted to enrol a broad range of patients in order to explore the investigation of patients in whom the diagnosis was uncertain. The survey was successful in enrolling a large number of patients with a high probability of having heart failure. Eighty-three percent of patients had been given a diagnosis of heart failure at some time by those caring for them, 97% of patients had an abnormal ECG,<sup>17</sup> 71% of patients had radiological evidence suggestive of heart failure, 78% were receiving a loop diuretic and 75% were receiving some other therapy targeted at heart failure.

Most investigations recommended by the ESC for the diagnosis of heart failure appear to be followed with, unfortunately, the exception of an objective test of cardiac function. It is likely that

the high adherence to ECG, haematology and biochemistry tests reflects the fact that they are part of the routine clinical practice for all admissions. The failure to assess cardiac function in a third of patients, particularly older patients, reflects a substantial diagnostic deficiency compared to ESC guidelines. The large international variation in the use of echocardiography indicates that differences in the way that care is provided should be explored. The substantial residual uncertainty in the diagnosis of heart failure reported by the investigators at the end of the survey suggests that further efforts are required to lower the threshold for cardiac imaging and/or that further tests, such as for natriuretic peptides, may be required to reach a definitive diagnosis of heart failure.<sup>18,19</sup> Measurement of natriuretic peptides on a large proportion of the participants in this survey is underway.

### Diagnosis 'in' heart failure

The survey shows the diverse and complex pathology underlying heart failure, which not only is part of the problem in understanding and managing it but also provides multiple opportunities for targeted interventions. Most patients had coronary artery disease while dilated cardiomyopathy in the absence of other obvious causes for heart failure appeared uncommon in most countries. However, many patients who had heart failure associated with coronary disease had not had a myocardial infarction. Further analysis will be required to determine to what extent this reflects misdiagnosis, ischaemia masquerading as heart failure, failure to diagnose myocardial infarction (which will be checked by the core laboratory reading of the ECGs) or the presence of myocardial stunning and hibernation.<sup>20</sup> However, cholesterol was often not measured and was often elevated when it was. Whether or not treatment of hyperlipidaemia is safe or effective in patients with heart failure is a matter of controversy<sup>21,22</sup> and the subject of several ongoing randomised controlled trials.

The survey highlights the diversity of cardiac pathophysiology underlying heart failure. Prior to the publication of the SOLVD treatment trial<sup>23</sup> that chose to include only patients with an LVEF  $\leq 35\%$ , trials of heart failure had generally relied on a clinical diagnosis to enrol patients. The use of LVEF helped ensure a correct diagnosis and identified a higher risk sub-sub-set, albeit within a low risk subset, from which older patients and those with concomitant disease, both markers of high risk,

were excluded. The trial showed that the risk in this sub-sub-population was modifiable and consequently future investigators focussed almost exclusively on such patients until recently. This survey, and other epidemiological evidence, suggests that 50% or more of patients with a clinical diagnosis of heart failure have preserved LVSD.<sup>24</sup> Patients with LVSD tend to be younger and male while those with preserved LV function are often women aged >75 years, accounting for much of the difference between heart failure in epidemiological studies and in clinical trials. However, it is not yet clear if and how the natural history of heart failure in the absence of LVSD, probably a heterogeneous group of conditions, can be favourably modified. Future analyses will provide data on the prevalence of cardiac dyssynchrony, another potentially important target for treatment.<sup>17,25</sup>

The survey highlights the utility of echocardiographic investigation of patients with suspected heart failure. Echocardiography proved to be useful in detecting valve disease and pulmonary hypertension, both potential targets for novel drugs, devices and interventions, as well as in identifying LVSD. Unfortunately, LV diastolic function was not reported in the majority of patients. This reflects uncertainty over diagnostic guidelines for diastolic heart failure, especially those that depend upon Doppler assessments in a population with such a high prevalence of atrial arrhythmias.<sup>26,27</sup> Although the accuracy of LVEF measured by echocardiography is controversial, growing expertise and technological refinements are likely to increase the utility of echo in the future.

Heart failure is increasingly recognised as a systemic disease associated with cardiac dysfunction. Anaemia, renal dysfunction and diabetes were once considered only as conditions that caused or exacerbated heart failure, but are now recognised often to be a consequence of heart failure and a potential target for treatment. The survey shows that a large proportion of patients are affected by these conditions, representing a sizeable target for therapy. Other targets, such as hypertension that persists despite the development of and treatment for heart failure may also be an appropriate target for therapy.

### Natural history of heart failure

A high short-term mortality was observed in this study, virtually identical to that observed in epidemiological studies and other hospital discharge surveys, and considerably higher than in most clinical trials. The high rate of early readmission is also

consistent with previous studies in the UK and US.<sup>3,28,29</sup> Unfortunately, the sort of patients identified by simple clinical means in this survey are often excluded from clinical trials, which require patients to be clinically stable at entry. These stability criteria need to be reconsidered.

This survey suggests much more uniformity in the average duration of hospital admission between countries than has been suggested previously although marked variability exists between individual patients. This may reflect progress towards an international standard of care. Nonetheless, the duration and frequency of hospitalisation continue to place a high demand on health care resources, human and financial. Both the length and frequency of admission are likely to increase as the population ages and cognitive function declines.

Despite the high mortality and high rates of readmission, the majority of patients who returned for interview had few or no symptoms of heart failure. This may reflect some patient self-selection, as only about half of surviving patients attended the interview and it is possible that patients with more severe heart failure did not. However, the results suggest that a substantial number of patients with a recent heart failure associated admission do not have persisting, severe symptoms. This could reflect the efficacy of therapy but also suggests that heart failure may follow a much more fluctuating or paroxysmal course than has previously been recognised. This has important implications for the conduct of future clinical trials.

### Provision of services

The survey highlights the fact that most patients with heart failure have several cardiovascular and non-cardiovascular problems in addition to heart failure. Many patients are old and/or frail. Accordingly, the optimal management of patients with suspected heart failure is likely to be complex and requires a multidisciplinary approach. Given the large number of patients who already occupy hospital beds and the opportunity that hospitalisation provides to complete key investigations and institute a long-term management plan, it would seem appropriate for most hospitals to reorientate some existing space and resources to the care of patients with heart failure. Proper discharge planning through such units may greatly reduce readmissions. Given the minimal cost implications of such restructuring of health care delivery, the likelihood of patient benefit and the existing evidence from randomised controlled trials, the widespread



development of such units seems justified. Unfortunately, few hospitals in this survey, and probably less in centres not involved, have units dedicated to the management of heart failure.

### Limitations

One of the main purposes of the survey was to quantify and describe the uncertainty surrounding a diagnosis of heart failure. The lack of a precise, universal definition of heart failure makes the study of its epidemiology difficult and open to many criticisms. It was not the objective of this survey to restrict enrolment to the narrowly defined population of heart failure usually included in clinical trials but rather to include a broad range of patients, including those in whom the diagnosis is uncertain, reflecting the current reality of clinical practice rather than trials.

This survey is likely to reflect better practice than is actually the case and will have underestimated true hospital heart failure-related activity for a variety of reasons. We may have selected hospitals with better than average practice. No infrastructure existed to support the conduct of this survey when it was initiated. Consequently, the survey relied on centres to volunteer their support. This almost certainly biased the study towards larger centres, which could support research staff with a good command of English, the language used for international communication in this study. However, the screening process, enrolment of consecutive patients, the pairing of large centres with smaller community hospitals and the large population recruited over a short period will all have helped ensure that the population included is much more representative of clinical practice in Europe than any other survey conducted so far. More than 70% of hospitals also served as community hospitals. The effect that the type of hospital enrolling patients had on patient characteristics will be the subject of several future analyses.

Unlike myocardial infarction and stroke, heart failure is usually not a discrete, easily identifiable event with patient-care restricted to specialised hospital units. The lack of any proper focus for the care of patients with heart failure in most hospitals led to the need for a screening procedure to try and obtain a representative and comprehensive sample of patients with heart failure. This step is a key element of the survey that bridges the gaps between epidemiological studies, hospital discharge statistics and clinical trials. However, in order to make the study feasible within the avail-

able resources, we excluded general surgical and other specialists wards from this survey. Although heart failure will not be the reason for hospitalisation in the majority of these patients, the prevalence of heart failure as an incidental finding appears to be common among such patients.<sup>30</sup> These patients may be even less likely to have appropriate investigation and treatment. Twenty-three percent of all deaths and discharges were enrolled with suspected heart failure, 83% of whom already carried a diagnosis of heart failure, from the screened population, a higher than expected proportion, suggesting that some pre-selection may have occurred in some countries. This is further supported by the lower than expected average age of patients in some countries based on other data.<sup>31,32</sup>

Undue emphasis should not be placed on occasional differences between countries in terms of mean age, gender and the apparent cause of heart failure, as these may reflect the practice by a particular hospital or physician. Also, all centres will not have applied the protocol in exactly the same way, a problem with all surveys and clinical trials. However, overall, the lack of difference between countries, especially those with larger samples, was more remarkable than any difference observed.

### Conclusions

The EuroHeart Failure survey provides a large and detailed set of data on patients with known or suspected heart failure with a great variety of underlying pathophysiologies and concomitant diagnoses. The patients' profiles and their prognosis are consistent with those in epidemiological studies,<sup>33,34</sup> are similar to those of patients in primary care,<sup>32</sup> and appear representative of heart failure in clinical practice. Patients recruited into the clinical trials reported so far form only a subset of these patients. Further analyses of this dataset should help compare and contrast the nature and diagnosis of heart failure in clinical practice and clinical trials, identify new targets for therapy and help plan services to care for the needs of patients with heart failure.

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