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16.5 Cardiac failure CONTENTS 16.5.1 Epidemiology and general pathophysiological classification of heart failure 3390 Theresa A. McDonagh and Kaushik Guha 16.5.2 Acute cardiac failure: Definitions, investigation, and management 3397 Andrew L. Clark and John G.F. Cleland 16.5.3 Chronic heart failure: Definitions, investigation, and management 3407 John G.F. Cleland and Andrew L. Clark 16.5.4 Cardiorenal syndrome 3421 Darren Green and Philip A. Kalra 16.5.5 Cardiac transplantation and mechanical circulatory support 3428 Jayan Parameshwar and Steven Tsui 16.5.1 Epidemiology and general pathophysiological classification of heart failure Theresa A. McDonagh and Kaushik Guha ESSENTIALS Definition and classification Heart failure is a clinical syndrome caused by cardiac dysfunction, most commonly left ventricular systolic dysfunction. Patients with heart failure symptoms or signs and normal or near normal left ven- tricular function are often classified as having heart failure with pre- served ejection fraction (HF-PEF), but there is no clear and generally accepted definition of this condition. Epidemiology Estimates of incidence and prevalence are heavily influenced by definition. An

echocardiographic study of a random sample of the general population estimated a prevalence of heart failure of 1.5%, with a further 1.4% having asymptomatic left ventricular systolic dysfunction. Prevalence rises significantly with age, with a median age of first presentation in the mid-seventies. Longitudinal data suggests that the incidence of heart failure has remained fairly stable over the last few decades, but prevalence is increasing as more people survive cardiovascular disease earlier in life. Aetiology Determining the aetiology of heart failure in epidemiological studies is difficult: the commonest cause in the developed world is coronary artery disease, followed by hypertension, which predominates in those with a diagnosis of HF-PEF. Prognosis and morbidity Data from the United States of America and the United Kingdom show that those admitted to hospital with a diagnosis of heart failure have a mortality of over 30% at one year. The outcome has improved in recent years, perhaps linked to the increased usage of angiotensin inhibitors and β-blockers. Heart failure accounts for around 5% of all adult general medical admissions, and in developed countries the condition consumes 1–2% of healthcare budgets. Introduction Over the last 30 years we have gone from famine to feast for heart failure epidemiological data. The first seminal publication on the natural history of heart failure was from the Framingham Heart Study in 1971, showing a prevalence of heart failure of 0.8% in those aged between 50 and 59, rising to 9.1% in those over 80 years, with incidence rates of 0.2% at age 54 and 0.4% at age 85 (Fig. 16.5.1.1). This was followed by a large European study, ‘The Men Born in 1913’, which gave similar figures of a prevalence of 2.1% at age 50 and 13% at age 67 and incidence rates of 0.15% and 1%, respectively, at ages 50 and 67. These landmark studies relied on a clinical diagnosis of heart failure, based on symptoms, signs and scoring systems to identify cases. More modern epidemiological studies have used definitions of heart failure which include objective measures of -cardiac function, and in keeping with the ever-changing definitions of heart failure we have developed more insight into its pathophysi- ology and treatment. Initially studies focused on systolic dysfunction as they reported at much the same time as the heart failure treat- ment trials which also enrolled patients with systolic heart failure.

16.5.1 Epidemiology and classification of heart failure 3391 More recently attention has turned to describing the epidemiology of heart failure with preserved systolic function. This chapter out- lines the contemporary epidemiology of heart failure by describing its prevalence, incidence, aetiology, mortality, and trends. Pathophysiological description of heart failure Most clinical practice guidelines produced by the major inter- national cardiology and heart failure societies have very similar definitions of heart failure. All agree that it is not a diagnosis, per se, but a clinical syndrome: a constellation of symptoms and signs that are ultimately due to cardiac dysfunction. That car- diac dysfunction can be epicardial, myocardial, or endocardial in origin. Most commonly heart failure is attributable to myo- cardial dysfunction. Of particular importance, due to its main causes being coronary artery disease and hypertension, is the occurrence of left ventricular systolic dysfunction (LVSD). This has added significance because the main heart failure treatment trials, which sealed the place of the neurohormonal antagon- ists in the therapeutics of heart failure, were conducted in those with left ventricular ejection fractions (LVEF) of less than 40%. 35 30 25 20 15 10 5 45–54 n = 1 n = 2 n = 3 n = 5 n = 6 n = 9 n = 13 Average annual incidence/1000 people Females Males n = 17 n = 28 n = 31 55–64 65–74 Age (years) 75–84 85–94 0 Fig. 16.5.1.1 Incidence of heart failure within the Framingham cohort. From McKee PA, Castelli WP, McNamara PM, Kannel WB (1971). The natural history of congestive heart failure: the Framingham study. N Engl J Med, 285, 1441–6. Copyright © 1971, Massachusetts Medical Society. Table 16.5.1.1 Prevalence of symptomatic and asymptomatic LVSD in populations with a calculated prevalence

of manifest heart failure, where applicable Authors Name of study Number of patients (no. of cases of heart failure) Location Age range Percentage of symptomatic left ventricular systolic dysfunction (LVSD) Percentage of asymptomatic left ventricular systolic dysfunction (ASLVD) Prevalence of heart failure <65 yrs of age Prevalence of heart failure

> 65 yrs of age Parameshwar et al., 1992 Prevalence of heart failure in 3 GP practices 30 204 (117) Northwest London, UK 5–99 28% had echoes 0.6 per 1000 27.7 per 1000 Murphy et al., 2004 National survey of heart failure 307 741 (2186) Scotland, UK 0–>85 — 7.1 per 1000 (though not <65) 85–90.1 per 1000 Rutten et al., 2003 A questionnaire- based survey of heart failure (202) Utrecht, Netherlands 40–95 53% had echoes 97%-LVSD McDonagh et al., 1997 MONICA 1640 (43) North Glasgow, UK 25–74 2.9% LVSD 1.4% ALVSD 15 per 1000 Davies et al., 2001 ECHOES 3960 (72) West Midlands, UK 1.8% LVSD 3.5% Preserved EF 0.9% ALVSD 31 per 1000 (>45 yrs of age) Kupari et al., 1997 Helsinki Ageing Study 501 (41) Helsinki, Finland 75–86 4.1 % HEFPEF 3.9 % LVSD 9% ASLVD (75–86) –82 per 1000 Mosterd et al., 1999 Rotterdam Heart Study 2267 (88) Rotterdam, Netherlands 55–94 3.7% LSVD 1.4% ASLVD Men 7 per 1000 (55–64) Women 6 per 1000 (55–64) Men 37 per 1000 (65–74) 144 per 1000 (75–84) 59 per 1000 (85–94) Women 16 per 1000 (65–74) 121 per 1000 (75–84) 140 per 1000 (85–94) Morgan et al., 1999 Poole Heart Study 817 (61) Poole, Dorset, UK 70–84 7.5 % LVSD 3.9 % ASLVD

section 16 Cardiovascular disorders 3392 Many epidemiology studies therefore focused on character- izing the incidence and prevalence of LVSD, using varying cut points of the normally distributed variable, LVEF, ranging from less than 30% to 50%. This difference in the cut points chosen affects the incidence and prevalence rates which are quoted (see Tables 16.5.1.1 and 16.5.1.2). Often studies have classified those with heart failure symptoms and signs with a normal or only mildly reduced left ventricular function to have heart failure with preserved ejec- tion fraction (HF-PEF). In the absence of any convincingly posi- tive drugs trials for this end of the spectrum of heart failure, no unifying definition of HF-PEF has emerged and been applied to community-based studies. The latest definitions of HF-PEF, in addition to symptoms and or signs of heart failure and a relatively preserved ejection fraction, also require evidence of structural heart disease (usually left ventricular hypertrophy, increased left atrial size/volume and Doppler or tissue Doppler evidence of dia- stolic dysfunction). Rigorous population-based studies with these more modern definitions have yet to appear. Prevalence studies Community-based studies Many studies have been conducted in primary care or across geo- graphical healthcare communities. One of the first was in northwest London where 30 204 case records were reviewed, yielding a crude prevalence of 3.8/100 cases in the general population with a marked rise from those under 65 to those above 65 years of age, where the rate rose from 0.6 per 1000 to 28.0 per 1000. More recent data is available from the Scottish Continuous Morbidity scheme, which covers 57 general practices in Scotland and uses GP Read codes for heart failure in 307 741 patients. This results in a calculated prevalence of heart failure within the general population in Scotland of 7.1 per 1000, increasing to 90.1 per 1000 in the population above 85 years old. The population identified in the

primary care setting were more elderly and had more comorbidities than in population-based studies or clinical trial populations. These findings have been corroborated in a European study based in Utrecht, Netherlands, where patients with heart failure who were under the supervision of a cardiologist were more likely to be male, in their sixties, and have an ischaemic aetiology. When considering such data, it should be remembered that the signs and symptoms of heart failure are neither sensitive nor specific. Studies evaluating referrals from primary care, when compared to expert cardiology assessment, have revealed only approximately 30% of such patients actually have heart failure. Population-based studies using echocardiography Systolic dysfunction The North Glasgow MONICA study was the first to report on the prevalence of left ventricular dysfunction in a random sample of the general population of 2000 men and women aged 25–74 years. In
Table 16.5.1.2 Studies demonstrating incident rates of heart failure within different populations
Study Name of study Number of patients Location Age range Mean/ Median age of diagnosis Incidence of heart failure <65 yrs of age Incidence of heart failure

> 65 yrs of age McKee et al., 1971 Framingham Framingham, US 45–94 2 per 1000 (45–54 years) 40 per 1000 (85–94 years) Erikkson et al., 1989 The men born in 1913 973 Gothenburg, Sweden 67 10 per 1000 Cowie et al., 1999 Hillingdon Heart Study 151 000 Hillingdon, northwest London, UK 29–95 76 years 0.02 per 1000 (25–34 years) 0.2 per 1000 (35–44 years) 0.2 per 1000 (45–54 years) 1.2 per 1000 (55–64 years) 3 per 1000 (65–74 years) 7.4 per 1000 (75–84 years) 11.6 per 1000 (85–94 years) Murphy et al., 2004 GP database, Continuous morbidity recording scheme 307 741
> (2186 cases) Scotland, UK 45–85 — 1.3 per 1000 (45–64 years) 6.1 per 1000 (65–74) 16 per 1000 (75–84 years) De Giuli et al., 2005 GP research database 696 884
> (6478 cases) United Kingdom 45–101 77 years 3.4 per 1000 (55–64 years) 25.5 per 1000 (75–84 years) Kalogeropoulos et al., 2009 ABC study 2934 (258) Pittsburgh, and Memphis, Tennessee US 70–79 73.6 years 13.6 per 1000 Bibbins- Domingo et al. CARDIA study 5115 (27) Birmingham, Alabama, Chicago, Illinois, Minneapolis, Oakland, California, US 18–30 39.1 years African-American male (cumulative incidence)—0.9% African-American Female (cumulative incidence)—1.1% White male (cumulative incidence)—0% White female (cumulative incidence)—0.08% —

16.5.1 Epidemiology and classification of heart failure 3393 this cohort 2.9% had significant systolic dysfunction, and of these just over half had symptoms of breathlessness or were taking a loop diuretic. The estimated prevalence of heart failure in this population was therefore 1.5%, with 1.4% having the important precursor of heart failure, asymptomatic LVSD. The prevalence rose with age and was higher in men than in women (Fig. 16.5.1.2). Many studies have reported since, both in Europe and in the United States of America. Data from these cohorts is fairly consistent for the general population. Prevalence rates for LVSD were 1.8– 3.5% in the Echocardiographic Heart of England Screening Study (ECHOES) study from the English Midlands, with 50% of the left ventricular dysfunction being asymptomatic, and in the US Olmsted county study 2.2% had heart failure validated using the Framingham criteria, and of these 56% had systolic dysfunction. When

we look at population-based studies which have included much older subjects, the prevalence rates increase markedly. In the Helsinki Ageing Study of 501 subjects aged 75–86 years, the overall prevalence of clinical heart failure was found to be 8.2%, with 2.3% having systolic dysfunction, and 9% with asymptomatic LVSD. In the Rotterdam Study of 2267 men and women aged 55– 95, 3.7% had fractional shortening of 25% or less (5.5% men and 2.2% women) and 2.2% had asymptomatic left ventricular dysfunc- tion (Fig. 16.5.1.3). Similar findings were reported in a UK study of 817 subjects aged 70–84 years from Poole (southern England) which demonstrated that 7.5% had LVSD (12.2% of men and 2.9% of women) and 52% were undiagnosed. Analysis of a cohort of 585 participants within a Dutch primary care system corroborated the lack of diagnosis within elderly patients. Using panel of history, examination, brain natriuretic peptide (BNP), electrocardiograms (ECG), and echocardiography (in those with a raised BNP or ab- normal ECG), 92 further cases of heart failure were identified. Most of these had HF-PEF, with only 17 individuals suffering from LVSD using a LVEF cut point of 45%. Heart failure with preserved systolic function Many of the population-based studies have also—by default or design—been able to comment on the prevalence of HF-PEF. Hogg et al. reviewed the epidemiological data for HF-PEF and found that the prevalence ranged from 1.5% to 4.8% depending on the study. There was a definite increase in the proportion of heart failure due to this in cohorts which studied more elderly subjects. In the ECHOES study of the general population, 1.1% had definite heart failure and a LVEF greater than 50%, whereas in the Helsinki Ageing Study, 72% of all the heart failure identified occurred with a normal LVEF. In the United States of America, the Rochester Epidemiology Project in a random sample of 2042 subjects over 45 years of age reported similar findings, with 44% of subjects having heart failure with a LVEF greater than 50%. Even higher prevalence rates have been found in a recent large cross-sectional study from Portugal: 16.1% in the population above 80 years old had heart failure. The prevalence was split roughly equally between preserved and reduced ejection fraction. These studies all confirm one thing, namely that heart failure is common and in- creases exponentially with age (Fig. 16.5.1.3). It is unsurprising, therefore, that heart failure affects 25 million Europeans and more than 10 million Americans. Incidence Contemporary studies of incidence are far fewer than those for prevalence. In the west London district of Hillingdon, all incident cases of heart failure were identified via either a specialist referral clinic or emergency hospital admission (Fig. 16.5.1.4). The popu- lation served was 151 000, and 220 new cases were identified. Participants had a full clinical assessment, standard investigations including a chest radiograph, electrocardiogram, and echocardi- ography; 99% of the study population had an echocardiogram. The gold standard diagnosis was made by a panel of three cardiologists. The incidence rose from 0.02/1000 per year in the 25–34 age group to 11.6/1000 in those aged over 85. Most had LVSD. This study con- firmed that heart failure is predominantly a disease of older people with a median age of first presentation of 76 years. Incidence data for the United States of America are also reported from the Cardiovascular Health Study, showing a rate of 19.3/1000 person-years in 5.5 years of follow-up. In the United Kingdom data are also available for incidence from general practice from the General Practice Research Database (GPRD): 696 884 potential patients aged above 45 years old were identified. The records were interrogated and categorized on the basis of clinical data and medi- cation prescription patterns. Using this approach, 6478 patients had 15 25–34 35–44 45–54 55–64 65–74 Age (years) Glasgow 10 Prevalence (%) 5 0 Fig. 16.5.1.2 Prevalence of left ventricular systolic dysfunction in the North Glasgow MONICA cohort. Reprinted from The Lancet, Vol. 350, McDonagh TA et al., Symptomatic and asymptomatic left ventricular systolic dysfunction in an urban population, pp. 829– 33, Copyright 1997, with permission from Elsevier. 15 10 5 0 55–64 65–74 75–84 Age (years) Rotterdam Prevalence (%) 85–94 Fig. 16.5.1.3

Prevalence of left ventricular systolic dysfunction within the Rotterdam Study. From Mosterd A, et al. (1999). Prevalence of heart failure and left ventricular dysfunction in the general population; the Rotterdam study. Eur Heart J, 20(6),
447–55, by permission of Oxford University Press.

section 16 Cardiovascular disorders 3394 definite heart failure, 14 050 possible heart failure, and 6076 were treated with diuretics but a nonheart-failure diagnosis was assigned. The overall incidence of definite heart failure was 9.3/1000 per year, but when possible heart failure was included the figure increased to 20.2/1000 per year. The mean age of the definite heart failure popu- lation was 77 years. More recently data from the Scottish Continuous Morbidity Recording data set showed an overall incidence of 2/1000 popula- tion per year; it was 25/1000 per year in men over the age of 85 years. Trends in incidence and prevalence Data from the Framingham Heart Study have not shown any in- crease in incidence since the 1970s, dispelling the theory that we are experiencing an epidemic of heart failure. Similarly, data from Medicare records show a slight reduction in incidence from 57.5/ 1000 to 48.4/1000 person-years in the 80–84-year age group in the period 1994–2003. However, despite the slight reduction in inci- dence, the prevalence rate rose markedly from 90/1000 to 120/1000. The latest data from the Olmsted county gives similar findings: the annualized incidence rate of heart failure within the cohort declined by 4.6%, despite an ongoing raised level of mortality. These trends will continue with the changing demography of most Western popu- lations, with more elderly people and a greater number of survivors from cardiovascular disease earlier in life. Aetiology Determining the exact aetiology of patients with heart failure in epi- demiological studies is difficult. The commonest cause within the Western world is coronary artery disease. This represents a change in aetiology over time. When the Framingham study first reported, the main factor was hypertension. Over time in this study the in- fluence of coronary heart disease has increased by 40% in men and 20% in women. In the North Glasgow MONICA study over 95% of patients with symptomatic LVSD had some evidence of prior ischaemic heart disease (IHD), although hypertension was also prevalent in this group, occurring in 68%. Other data from prevalence studies show similar results. In the ECHOES study, 53% of those with systolic dysfunction had evidence of IHD and 42% had hypertension, and in the Helsinki Ageing Study it was 54% for hypertension and for IHD. In the United States of America data from the Cardiovascular Health Study confirm similar results, with the population attribut- able risk for heart failure for coronary heart disease being 13.1% and for hypertension 12.8%. Both are clearly important aetio- logical factors. In the original Hillingdon study of incident heart failure, 41% of the heart failure cohort was due to coronary artery disease and a much smaller number, 6%, had hypertension. A subsequent study carried out in Bromley (south London) looked into putative is- chaemic aetiologies in more depth. All incident cases of heart failure were identified and referred to a specialist dedicated clinic or iden- tified by tracking the patient during their hospitalization. Using the diagnostic criteria, 332 patients had been identified and 99 of the 136 cases under 75 years of age also underwent coronary angiog- raphy. An ischaemic aetiology was eventually attributed to 52% of the 136 cases. Hypertension as a cause of heart failure still seems to predominate in those HF-PEF patients in whom ischaemic heart disease seems less prominent. These patients tend to be older and there is a higher proportion of women than men. Both diseases are still common: a recent study by Zile showed a prevalence rate of 82% for hyperten- sion and 45% for coronary heart disease in patients with HF-PEF. 18 16 14 12 10 8 6 4 2 0 25–34 0.00 0.04 0.16 0.18 0.26 0.07 1.70 0.67 3.88 2.31 9.82 5.92 9.62 16.76 Incidence (cases per 1000 population per year) 35–44 45–54 55–64 65–74 75–84 85+ Age (years) Fig. 16.5.1.4 Incidence of heart failure by sex

and age group in Hillingdon Heart Failure Study. From Cowie MR, et al. (1999). Incidence and aetiology of heart failure; a population-based study. Eur Heart J, 20(6), 421–8, by permission of Oxford University Press.

16.5.1 Epidemiology and classification of heart failure 3395 Comorbidities Heart failure is predominantly a disease of elderly people and is therefore associated with multiple comorbidities, which include renal impairment, anaemia, diabetes mellitus, obstructive sleep ap- noea, and chronic obstructive pulmonary disease. These all have an adverse impact on survival when associated with heart failure. Anaemia was present in 51% of patients with heart failure in the Rochester Epidemiology Project. Severely impaired renal function was present in 10%. These rates are increased in patients presenting with acute heart failure syndromes: renal dysfunction occurred in 20% of those admitted with decompensated heart failure in the EuroHeart Failure Survey II. Prognosis Mortality The 32-year follow-up of the Framingham study highlighted the substantial mortality rate of heart failure: 62% for men and 42% for women at 5 years of follow-up from incident diagnosis. However, data from the Framingham study have shown consistent improvements in survival over time for both men and women. In Europe, the mor- tality of incident heart failure also seems to be falling. In the initial Hillingdon study, 25% of patients were dead at 6 months, but in the more recent cohort of this study from 2004 to 2005 this figure had dropped to 14%. This was independent of confounding variables and linked to the increased usage of angiotensin inhibitors and β-blockers. Although mortality is higher in studies of incident heart failure, it is also poor in prevalent cases (Fig. 16.5.1.5). In the ECHOES study, the 5-year survival rate was 53% for those with heart failure due to systolic dysfunction. Survival for those with HF-PEF was a little better, at 62%. This is in contrast to the Mayo Clinic data which showed that survival in the community with heart failure was similar for those with LVSD or HF-PEF. However, more recently the Mayo Clinic group reported on 4596 patients, of whom 47% had preserved left ventricular function between 1987 and 2001. The survival rate was slightly better within the population with preserved systolic function. However, rates of mortality declined in the population with systolic dysfunction over the study period, whereas patients with normal ventricular function had no change in mortality rates throughout the study period. This was supported further by the MAGGIC group (Meta- Analysis Global Group in Chronic Heart Failure) who reviewed the data on 50 000 previous trial participants. Patients with LVSD had higher rates of mortality, but the absolute level of mortality within patients with HF-PEF remained high. The mortality rates for left ventricular dysfunction in the popu- lation are also high—21% dead at 4 years in the North Glasgow MONICA cohort—with no significant difference between those with symptoms of heart failure and those with asymptomatic left ventricular dysfunction. This underscores the need for early detec- tion and treatment of this precursor phase of heart failure. Data from hospitalized patients in Scotland also show a trend to- wards improved survival (Fig. 16.5.1.6). Between 1986 and 2003 median survival after a first admission to hospital with heart failure improved in men from 1.3 to 2.3 years and in women from 1.3 to 1.8 years. Overall survival remains poor, with 50% of men dead at 2.3 years and 50% of women dead at 1.7 years after a first admission for heart failure. This poorer survival between those with acute heart failure syn- dromes requiring admission, compared to population-based sur- veys of prevalence, is now well described. Data from large European and US registries show consistent findings. Initial European data from the EUROHEART II study demonstrated an in-hospital mor- tality rate of 6.6%, but this has declined to 3.8% by the time of the ESC-HF Pilot. American data from the OPTIMISE registry suggests an in-hospital mortality of 4%. However, the picture is probably bleaker when we look to data sources that try to capture consecutive

admissions to hospital with heart failure. One of the world’s largest single-country audits of acute hospital admissions is the national heart failure audit from England and Wales. Inpatient case fatality rates for those admitted to hospital with a primary diagnosis of heart failure remain high, with a mortality of 9.6% (2015–2016), and the 1-year mortality following a solitary admis- sion is 30%. Indeed, the mortality of the heart failure syndrome remains unfavourable compared to patients with commonly en- countered solid organ malignancies, despite the recent thera- peutic and technological advances in management for systolic dysfunction. Morbidity and hospitalizations Part of the enormous morbidity incurred by heart failure patients relates to frequent hospitalizations. In advanced heart failure, pa- tients who have been hospitalized experience rehospitalization rates at 6 months of 36–45%. In the 1990s studies in the Netherlands, Scotland, the United States of America, and Sweden documented increasing trends of admissions relating to heart failure. The rise in hospital admissions was accompanied with increasing expenditure. In Scotland, 0.2% of the population were hospitalized per annum and heart-failure-related admissions accounted for more than 5% of all adult general medical admissions. Some evidence has now emerged that heart failure admissions may have peaked in some European countries during the mid-1990s. Data from Scotland on 116 556 100 75 50 25 0 0 2 4 6 8 10 HF, LVSD HF, no LVSD No HF, LVSD No HF, no LVSD Years since screening % Surviving Fig. 16.5.1.5 Mortality after screening in the Echocardiographic Heart of England Screening Study (ECHOES). HF, heart failure; LVSD, left ventricular systolic dysfunction. Reproduced from Hobbs FD, et al. (2007). Prognosis of all-cause heart failure and borderline left ventricular systolic dysfunction: 5 year mortality follow-up of the Echocardiographic Heart of England Screening Study (ECHOES). Eur Heart J, 28(9), 1128–34. With permission from Oxford University Press.

section 16 Cardiovascular disorders 3396 patients identified from hospital discharge records during the period 1986–2003 showed that rates of admission rose and peaked in the mid-1990s and subsequently fell by 2003. This is also the case in the Netherlands (Fig. 16.5.1.7). The latest data from the United States now concurs with the picture described in Europe. Using the national inpatient sample, covering the period between 2001 and 2009, there was a decrease in the number of primary heart failure admissions with an as- sociated rise of secondary heart failure hospitalizations, most commonly due to intercurrent illness, renal dysfunction, and pul- monary disease. Health economics The high prevalence and frequent and recurrent hospitalizations place a large economic burden on healthcare budgets. In the United States of America, total expenditure on heart failure in 2007 was more than $33 billion (£21 billion, €24 billion). The statistics are mirrored in European settings. Within the United Kingdom heart failure consumes 1–2% of the National Health Service budget, which is approximately £1.2 billion (€1.3 billion, $1.8 million). It is the leading cause of hospitalization within the elderly population in the United Kingdom. Approximately 60% of the total expenditure on heart failure in the United Kingdom is spent on hospital admis- sions. Figures are similar in continental Europe, with heart failure consuming approximately 1% of healthcare budgets. The length of stay also contributes to the expense, with median stay in Europe of 9 days. These estimates of cost are likely to be underestimates as the true costs should include all primary care consultations, secondary care referrals, diagnostics, prescribing further ther- apies including devices and care networks, and surgical intervention including transplantation. Conclusions Despite the advances which have been made in its treatment over the course of the last 20 years, which have seen mortality rates for those in clinical trials of heart failure therapies fall to less than 10% per annum, epidemiological studies still indicate that heart failure remains a common, lethal, disabling, and expensive condition. This is hardly surprising as most of the reduction in mortality is due to advances in treatment for a subset

of heart failure patients, those with chronic heart failure due to LVSD. We still have much to do. The increasing prevalence of heart failure, and the lack of 3 2.5 1.5 1 0.5 0 1986 1987 1988 Median survival (years) 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 Year 2 Men Women Fig. 16.5.1.6 Trends in median survival in Scotland from 1986 until 2003. Reprinted from Jhund PS, et al. (2009). Long term trends in first hospitalization for heart failure and subsequent survival between 1986 and 2003: A study of 5.1 million people. Circulation, 119, 515–23. 190 170 150 Men Women 130 110 90 70 81 84 87 90 93 96 99 Year Per 100 000 per year Fig. 16.5.1.7 Heart failure hospitalization rate in the Netherlands from 1980 to 1999. Reproduced from Heart, Mosterd A and Hoes AW, vol. 93, pp. 1137–46, copyright © 2007 with permission from BMJ Publishing Group Ltd.

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