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REVIEW ARTICLE

Hypertension — still an important cause of heart failure?

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Hypertension has been the single most important risk factor for heart failure until the last few decades. Now, it is frequently claimed that atherosclerotic coronary artery disease dominates as the major underlying cause, and hypertension is of lesser importance. We here review evidence regarding the contribution of hypertension to heart failure in the recent decades. It is not possible, in our view, to be confident of the relative importance of hypertension and coronary artery disease since there are significant limitations in the available data. The often-questionable diagnostic criteria used in defining heart failure is one such limitation. The absence or inadequacy of blood pressure recordings over the years prior to a diagnosis of heart failure seriously hinders the reaching of firm conclusions in many reports. Extrapolations from aetiological observations in one racial group to those in other racial groups, and from highly selected study groups in tertiary referral centres to patients with heart failure in primary and secondary care, may not be justified. Finally, the situation of heart failure primarily due to impaired left ventricular diastolic function, where hypertension is a frequent precursor, is often ignored in discussions of aetiology. Our view is that hypertension remains and probably is the single most, important modifiable risk factor for cardiac failure in some races and countries, where the dominant cardiac abnormality is left ventricular diastolic dysfunction. The situation is less clear for patients with heart failure primarily due to left ventricular systolic dysfunction.
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Background

Heart failure was a common, and perhaps the most common, cause of death in hypertensive patients prior to the widespread availability of antihypertensive drug therapy. The dose–response relationship between severity of hypertension and the likelihood of heart failure[1–3] together with later evidence that antihypertensive drug treatment, even of short duration, was protective against heart failure, indeed more so than against stroke or myocardial infarction,[4–6] left no doubt regarding the causal relationship between the two conditions.

There is every indication that, at least in Western countries, hypertension was the commonest identifiable cause of heart failure until the middle – late twentieth century. This evidence came from postmortem studies in the early decades of the last century[7,8] and later from epidemiological data, the Framingham Heart Study in particular.[2,3,9] This study in a general community in Massachussetts, initiated in 1948 and for the offspring of the original cohort in 1971 (the Framingham Offspring Study), documented that hypertension antedated the development of heart failure in 91% (357 of 392) of patients.[3] The population attributable risk was 39 and 59% for males and females, respectively, which was considerably higher than for myocardial infarction and angina pectoris combined for females, but was similar for males.[3] The Framingham authors concluded that for a period of 14.1 years from January 1970 'hypertension was the most common risk factor for congestive heart failure'. A subsequent analysis for the years 1971–1996 revealed that the lifetime risk of developing congestive heart failure in both men and women doubled for a blood pressure of 160/100 mmHg or more compared to those with readings of less than 140/90 mmHg.[10] In 2003, the Framingham workers again stated: 'hypertension is the most common risk factor for congestive heart failure'.[11] In that 2003 update, only 25% of 234 patients developing congestive heart failure up to 1994 had suffered a myocardial infarction[11] and the authors noted, as have others,[12,13] the particularly robust association between systolic and/or pulse pressure and the subsequent development of cardiac failure

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(Figure 1). The primacy of hypertension as the dominant risk factor for heart failure, even in recent decades, is accepted by many observers.[14,15] Based on their epidemiological findings, the Framingham authors have, over many years, championed the early detection and treatment of hypertension as the chief means of preventing heart failure.

A contrary view is that coronary atherosclerotic disease has become, over recent decades, the most common cause of heart failure. For example, Teerlink *et al*[16] in 1991 concluded that in 50.3% of 1861 patients enrolled in 52 studies of heart failure, the aetiology was myocardial ischaemia and in only 10% was hypertension the cause. A similar style of analysis by Gheorghiade and Bonow in 1998 led the authors to state: 'In 13 multicentre heart failure treatment trials reported in the New England Journal of Medicine over the past 10 years, involving >20 000 patients, coronary artery disease was the underlying aetiology of heart failure in nearly 70% of patients. This is probably an underestimation'.[17] The Canadian Cardiovascular Society's Consensus Conference stated in 1994 that 60–70% of adult patients with heart failure have severe left ventricular dysfunction secondary to ischaemic heart disease.[18] In a review paper 3 years ago, Petrie *et al*[19] were of the opinion that 'coronary heart disease is the most common reported cause of chronic heart failure in all age groups', a claim echoed by He *et al* from NHANES data.[20]

These contrary claims for the primacy of hypertension and for coronary macrovascular disease as the most important single cause of heart failure in recent decades (Table 1) need reconciling. In this

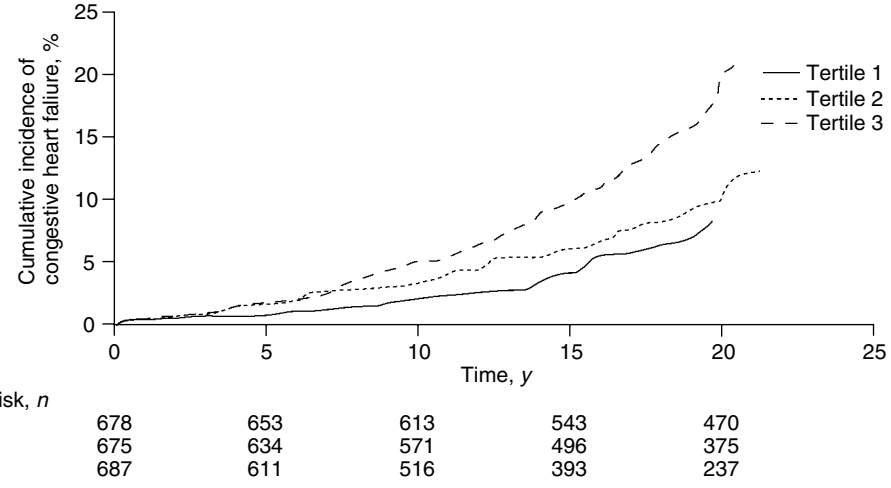

Figure 1 Cumulative incidence of congestive heart failure according to pulse pressure tertiles at the baseline examination in the Framingham Heart Study. Tertile 1 was defined as a pulse pressure of 26–48 mmHg, tertile 2 was defined as a pulse pressure of 49–60 mmHg, and tertile 3 was defined as a pulse pressure of 61–150 mmHg. From Haider *et al*[11] with permission.

Table 1 Aetiology of heart failure as reported in selected published studies

		Percentage of patients with prior disorder[b]*, or heart failure attributed to*[c]	
Study	*Reference*	*Hypertension*	*Ischaemic heart disease*
Framingham (1971)	[a]	75%[b]	39%[b]
Framingham (1996)	3	91%[b]	?
		39% male, 59% female[d]	39% male, 18% female[d]
Review 52 Articles (1991)	16	3.8%[c]	50.3%[c]
Western Sweden (1993)	34	17%[c]	40%[c]
SOLVD (1993)	37	7%[c]	~70%
Hong Kong (1995)	45	37%[b]	31%[b]
African Americans (1996)	40	61%[c]	23%[c]
Finland (1997)	31	54%[b]	54%[b]
Thirteen treatment trials (1998)	17	?	68%[c]
South London (2001)	29	4.4%[c]	52%[c]
NHANES I (2001)	20	~44%[b]	~84%[b]
		10.1%[d]	61.6%[d]
IMPROVEMENT (2002)	35	48%[c]	57%[c]

[a]McKee PA *et al*, *N Engl J Med* 1971; **285**: 1441–1446; [b]percentage of patients with prior hypertension or ischaemic heart disease; [c]heart failure attributed to hypertension or ischaemic heart disease; [d]population attributable risk. SOLVD: studies of left ventricular dysfunction. NHANESI: The First National Health and Nutrition Examination Survey.

review, we discuss issues that we consider germane to determining the role of hypertension in the development of heart failure.

The diagnosis of heart failure

How heart failure should be defined has been a long-standing challenge to the medical profession.[21] However, if the diagnosis is ill-defined or suspect,[22,23] discussion of its aetiology must be of limited use. It is a fact that the diagnostic criteria for heart failure, whether in epidemiological, prevention or treatment studies, have rarely been well-defined. Marantz *et al*,[24] in a 1988 review of clinical trials in heart failure, noted that many were carried out without explicit diagnostic criteria. This basic omission, they stated, might account for conflicting results regarding responses to treatment.[24] Such a fundamental deficiency could also give misleading information as to the underlying aetiology.

One might hope that problems in this regard would have been rectified in recent years but this is not always so despite the publication and widespread dissemination of various guidelines for the diagnosis of heart failure. For example, the NHANES I Epidemiological Follow-up Study, reporting on the risk factors for congestive heart failure in the USA in the 1980s and early 1990s, defined heart failure from hospital discharge ICD codes (or death certificates).[20] Yet data collected according to ICD codes may seriously underestimate the incidence of heart failure in some settings.[25] On the other hand, dependence on ICD coding when pecuniary interests intrude can lead to equally serious overenumeration of the diagnosis.[26] Who can tell whether the approach used in NHANES would favour one aetiological factor (hypertension, the population attributable risk being reported as 10.1%) over the other (coronary heart disease, the population attributable risk apparently being 61.6%) in the causation of such 'heart failure'?

O'Conner *et al*,[27] in their study of 2498 patients in the year 2000, claimed that 65% of their subjects with heart failure had ischaemic heart disease. One might accept a diagnosis of ischaemic heart disease since all patients underwent coronary angiography. By contrast a diagnosis of heart failure is far from certain since this required the patients to have New York Heart Association functional class II–IV symptoms and chest discomfort. In the absence of clinical or radiological signs and with the inclusion of 'chest discomfort', the diagnosis is tilted away from heart failure and towards angina.

In regard to epidemiological studies, the Framingham Heart Study took account of symptoms, signs and radiology, and their diagnostic criteria were prospectively and clearly defined. Accordingly, findings from Framingham are especially valuable. However, the study population in Framingham was, as discussed below, predominantly Caucasian and extrapolation to other races might not be applicable. Furthermore, use of cardiomegaly as one major criterion for the diagnosis of heart failure could, as noted by the Framingham researchers,[2] lead to overestimation of hypertension (which may induce cardiomegaly in the absence of overt heart failure) as a cause of cardiac failure. Indeed, it is questionable whether some cases of heart failure in the Framingham study would meet modern diagnostic criteria.

Measurements of arterial pressure

The Framingham Heart Study not only predetermined its definition of heart failure but it also defined how blood pressure was to be measured and how frequently in its study population over the years leading up to the development of heart failure. The absence of this, the most basic information from most other studies, particularly where patients with established heart failure resulting from systolic dysfunction of the left ventricle were assessed in tertiary referral centres, makes interpretation of published data difficult or impossible with regard to the aetiological role of hypertension. Arterial pressure falls with the onset of heart failure and most drugs used in its treatment lower blood pressure further—thereby tending to obscure antecedent hypertension. Accordingly, the conclusions reached from such individual or combined analyses, notwithstanding the often impressive patient numbers,[16,17] are likely to underestimate the prevalence of prior hypertension. There are other reasons, beyond inadequacies in blood pressure recordings, as to why the role of hypertension in causing or precipitating heart failure might be underestimated, as discussed elsewhere.[28]

The study by Fox *et al*[29] of 332 patients with heart failure presenting to hospital or a rapid access heart failure clinic in South London considered hypertension to be an aetiological factor 'if there was a documented history of hypertension and evidence of hypertensive cardiac disease'. No level of blood pressure as a cutoff between normotension and hypertension was given and what percentage of patients ever had their blood pressure recorded prior to the development of heart failure is unclear. The aetiological role of hypertension in this study, and many others, is impossible to gauge.

In relation to the distinction between normotension and hypertension in cohorts, which subsequently develop or have developed heart failure, some studies have used very high cutoff levels of blood pressure. For example, the Swedish study of Wilhelmsen *et al*[30] used 175/115 mmHg from recordings made in the afternoon, as the cutoff. Even a cutoff of 160/95[31] will, by current definitions,[32,33] underestimate the prevalence of hypertension and its possible contribution to the later development of heart failure. Another Swedish study, by Andersson and Waagstein,[34] suggested that hypertension

'caused' heart failure in 17% of 2711 patients aged 16–65 years, hospitalized with heart failure in the late 1980s and early 1990s. However, the importance of hypertension will have been seriously underestimated since it was defined as at least three measurements of blood pressure with diastolic readings exceeding 105 mmHg, from the hospital records, possibly in the presence of heart failure. This ignores the relevance of systolic (and pulse) pressure, suggests that diastolic readings of below 105 mmHg might be taken as 'normotensive', and as in most other studies, had no systematic recordings of arterial pressure prior to the onset of heart failure and its treatment.

An additional point of note is, in some studies, the high recorded level of arterial pressure in patients with established heart failure who are receiving antiheart failure drug treatment. An average blood pressure of 140/81 mmHg in the 6337 patients in primary care with heart failure in the IMPROVEMENT of Heart Failure study points to a considerably higher mean pressure before the onset of heart failure and administration of drug therapy, and quite possibly a higher prevalence of predisposing hypertension than the 48% quoted.[35] In the report by Kitzman *et al*,[36] patients aged 60 years and greater with systolic or diastolic heart failure had, despite anti-heart failure treatment, higher levels of systolic arterial pressure than age-matched healthy controls (136, 147 and 128 mmHg respectively). Perhaps, in this particular case, the prevalence of hypertension prior to heart failure was in the order of 62–85%, as quoted.

Aetiology of heart failure according to ethnicity

Ethnicity is said to be one important aetiological determinant of heart failure. Dissecting this factor from others of potential relevance (diet, socioeconomic status, urban/rural living, access to medical care, study criteria, accuracy of diagnosis, etc) is, of course, not easy.

In the Studies of Left Ventricular Dysfunction (SOLVD) trial carried out in North America and Belgium, blacks and whites were said to have exhibited striking differences in the aetiology of impaired left ventricular systolic function.[37] In whites, hypertension was said to account for only 4% of cases but in blacks it was present in 32% of cases. Although one can legitimately criticize the lack of systematic recording of blood pressure in the cohort over the years prior to this study, and hence the prevalence of predisposing hypertension might have been underestimated, this limitation is unlikely to account for the racial difference reported.[37] Alexander *et al*,[38] in a retrospective cohort study in a large health maintenance organization in USA, reported a higher risk of hospitalization with heart failure for African Americans than whites, and this was largely explained by the greater prevalence of hypertension and diabetes mellitus in the former racial group. A similar conclusion was reached by Aronow *et al*[39] in a study of elderly African Americans, Hispanics and whites in the USA. Hypertension was considered to be the aetiological factor in 61% of 301 African Americans with congestive heart failure in Cook County Hospital, Chicago in the mid 1990s, compared with ischaemic heart disease in 23% of patients.[40] As with so many studies, the prevalence of hypertension might have been underestimated since there were no systematic recordings of blood pressure prior to the onset of heart failure, and the cutoff pressure in defining hypertension was set high at 160/90 mmHg (or the taking of antihypertensive medication). This cohort was dominated by males (60%) and the mean age was only 56 years.[40] The aetiological importance of hypertension may be considerably greater in a black population that is older and dominated by female patients. Again emphasizing racial differences, Vaccarino *et al*[41] reported that African Americans admitted to hospital with decompensated heart failure more often had a history of hypertension (91.5% of 82 patients) than did whites (66.1% of 316 patients).

As noted already, the Framingham Heart Study is particularly helpful in clarifying the role of hypertension in the development of heart failure. However, this study involved an overwhelmingly white population. Accordingly, the authors have been at pains to point out that their findings might not be applicable to other races and ethnic groups.[3] Indeed, this seems to be the case, especially, as discussed above, for African Americans in whom hypertension more commonly precedes heart failure than in Caucasians in the USA.

Hypertension is said to be the major cause of heart failure in some areas in Africa.[42–44] Sanderson *et al*[45] reported that hypertension (37%) and ischaemic heart disease (31%) were the main identifiable risk factors for heart failure in Chinese patients admitted to a single hospital in Hong Kong in 1992 with diabetes mellitus being an important cofactor. Many of their patients harboured two or even three of these risk factors. Yet again, the presence of hypertension in this cohort might have been underestimated in the absence of systematic prehospitalisation measurements of blood pressure.

In an Arab population, Agarwal *et al*[46] considered ischaemic heart disease to be a commoner aetiological factor (51.7%) than hypertension (24.9%) in 1164 patients with heart failure referred to a single hospital in Oman between 1992 and 1994. How hypertension was defined, however, was not mentioned and again, blood pressure recordings were not made systematically prior to the development of heart failure.

The situation in Latin America is even less clear. The recent article by Cubillos-Garzon *et al*[47] suggests that coronary macrovascular disease is an increasing

problem and will be, if it is not already, the dominant aetiological factor in cardiac failure in the region. The need of objective data is obvious.

Aetiology of heart failure in clinical trials and in the community

As mentioned already, some authors reviewing the aetiology of heart failure from reported clinical trials[16,17] have concluded that ischaemic heart disease is dominant. This presumes that patients included in those clinical trials reflect accurately the 'average' patient presenting with heart failure. Clearly, this is not so. As mentioned by Ghali[48] in 1999, almost 80% of patients in heart failure clinical trials, largely from North America and Europe and reported between 1987 and 1997, were men and the mean age was approximately 62 years whereas community patients with heart failure are substantially older on average[49] and approximately half are women. Masoudi *et al*[50] conducted a cross-sectional study of 20 388 Medicare beneficiaries in USA aged over 64 years with a principal diagnosis of heart failure who were discharged from acute-care hospitals in the USA in 1998/9. They noted that only a minority of these patients, even those in whom left ventricular systolic function was demonstrably reduced, fitted the profile of populations selected for clinical trials.[50] Heart failure with preserved left ventricular systolic function, for which hypertension is of particular aetiological importance, was an exclusion criterion in these treatment trials and yet accounted for half of the cases in Masoudi's study of Medicare beneficiaries.[50]

Aetiology of heart failure associated with systolic *vs* diastolic left ventricular dysfunction

As noted already, a review of treatment trials for heart failure associated with a reduced left ventricular ejection fraction points to the aetiological primacy of ischaemic heart disease and an apparently lesser role for hypertension.[16,17,19] As emphasized repeatedly throughout this paper, however, few if any of these trials included systematic recordings of arterial pressure prior to the onset of heart failure, and hence the prevalence of hypertension is likely to have been underestimated. Furthermore, as discussed below, a diagnosis of coronary macrovascular disease in patients with heart failure might be called into question in the absence of visualization of the major coronary vessels.

How 'diastolic heart failure' should be defined has been the topic of considerable discussion and uncertainty.[51,52] Without entering into a debate on current diagnostic criteria, which are likely to evolve over time, a consensus appears to be that heart failure primarily due to impaired diastolic function of the left ventricle (or heart failure with a normal left ventricular ejection fraction) accounts for close to 50% of all cases of heart failure, is more common in women than men, afflicts the elderly in particular, and the aetiology is dominated by prior hypertension and left ventricular hypertrophy,[53–58] although coronary artery disease, diabetes mellitus and obesity may also contribute. In regard to the aetiological contribution of coronary artery disease, this could be through atherosclerotic involvement of the epicardial coronary vessels, via impaired coronary reserve secondary to hypertension-related alterations in the structure and function of coronary resistance vessels,[59–61] or to a combination.

The diagnosis of atherosclerotic coronary artery disease as a cause of heart failure

We have argued that the aetiological role of hypertension in heart failure is likely to have been underestimated in most reports. One might equally surmise that, in the absence of coronary arteriography or other definitive testing, the impact of coronary atherosclerotic disease might be more prevalent than has been claimed. On the other hand, it is theoretically possible that coronary ischaemic symptoms, presumed to reflect underlying coronary atherosclerotic disease, might in some patients be a manifestation of hypertensive coronary microvascular disease.[59–61] The suggestion by McDonagh *et al*[62] that ischaemic heart disease has overtaken hypertension as the dominant aetiological factor for left ventricular dysfunction is difficult to evaluate, in part because the broad definition of ischaemic heart disease might include patients with hypertensive coronary microvascular disease, epicardial atherosclerotic coronary artery disease, or both. There are no studies, to our knowledge, that have systematically and definitively set out to determine what percentage of unselected patients with heart failure have underlying pathophysiologically significant epicardial coronary artery disease. The study that comes closest to this ideal is that by Fox and colleagues who carried out coronary angiography, not in unselected patients, but in those aged less than 75 years presenting with heart failure from the general population to hospital or a rapid access heart failure clinic.[29] They reported in 2001 that 71 of 136 (52%) patients exhibited significant coronary artery disease (defined as a luminal stenosis of 50% or more in one or more epicardial arteries) and concluded that coronary artery disease was the single most important aetiology in heart failure in this age group.[29] Cardiological bias might intrude here since a patient with longstanding hypertension and single vessel coronary stenosis of 55% might have his heart failure attributed to coronary disease whereas, in fact, hypertension may be the more important contributing factor. As mentioned earlier, the role of hypertension in the aetiology of heart failure in the study by Fox *et al* is likely to have been underestimated.

In contrast to the study by Fox *et al*, Zugck *et al*[63] considered that only 30% of 408 consecutive patients with heart failure associated with a left ventricular ejection fraction of less than 45%, referred to a specialist cardiology department, had ischaemic cardiomyopathy based on coronary angiography although details of their definition of ischaemic cardiomyopathy were not given.

Hypertension, myocardial infarction and heart failure

Hypertension is well accepted as a risk factor for atherosclerotic coronary artery disease which, in turn, is a risk factor for heart failure. However, hypertension predisposes patients to heart failure via numerous mechanisms other than coronary macrovascular disease including coronary microvascular disease with impaired coronary reserve, and increased cardiac fibrosis.[64–67] It is not surprising, therefore, that myocardial infarction associated with epicardial atherosclerotic disease in a previously hypertensive patient is associated with more serious consequences, including heart failure, than in previously normotensive patients. In this regard, the Survival and Ventricular Enlargement Trial (SAVE) investigators reported that ventricular dilatation after acute myocardial infarction was greater in hypertensive than normotensive patients[68] and Richards *et al*[69] found that antecedent hypertension, interacting with age, neurohormonal activation and early ventricular remodelling, conferred an increased risk of heart failure after acute myocardial infarction. Accordingly, heart failure after myocardial infarction in a patient with previously undiagnosed hypertension might be attributed solely to epicardial atherosclerotic coronary artery disease whereas in reality hypertension may have contributed through its effects on the heart and coronary microvasculature[64–69] in addition to its role as a risk factor for the development of coronary atherosclerosis.[70,71]

Implications for the prevention of heart failure

The Framingham authors made note in 1996 that 'hypertension plays a key role in the evolution of the syndrome of heart failure….The changes associated with hypertension evolve over decades, emphasizing the importance of early diagnosis and effective treatment to prevent cardiac complications.'[9] This advice, based on the best-available epidemiological data in a predominantly Caucasian population, seems even more pertinent for some other ethnic groups, notably African Americans in whom, as discussed already, the aetiological role of hypertension is especially prominent. Add to these epidemiological data the fact that short-term antihypertensive drug treatment reduces by more than 50% the incidence of heart failure in hypertensive patients[6] including those with type II diabetes[72] and the case for the early detection and treatment of hypertension as proposed by Framingham workers is undeniable. Yet, control of hypertension within the community in many affluent countries, let alone in poorer countries, is notably poor. For example, two annual cross-sectional surveys in England in 2000 and 2001 observed that among hypertensives aged 65 years and older, treatment and control rates were 56 and 19%, respectively.[73] Of the untreated hypertensives, 76% had isolated systolic hypertension,[73] which, as mentioned earlier, has a robust association with the subsequent development of heart failure.[11–13] In the USA, lack of control of systolic pressure was noted in both Framingham (1990–1995) and NHANES (1991–1994).[74] In Olmsted County, Minnesota, a socioeconomically prosperous community with ready access to primary and tertiary medical care, a decline in awareness, treatment and control rates for hypertension was reported in the late 1990s compared with a decade earlier,[75] although the opposite trend has been recorded in Finland.[76] Overall, the modern era has witnessed a disappointing uptake of trial evidence as to the protective benefits of antihypertensive drug therapy and the majority of hypertensive patients, even in well-to-do countries, have inadequate control of their blood pressure, systolic readings in particular. Logic, and the evidence quoted in this article, dictates that improved control of hypertension, will inevitably result in fewer cases of heart failure in affluent countries, and even more so in third-world countries.

Regarding the vexed question of costs of antihypertensive drug treatment *vs* benefits gained, it should be obvious that prevention of heart failure—which once established accounts for 1–2% of total health-care budgets in Western countries—should be taken into account along with prevention of stroke and coronary heart disease. Yet, some authors have ignored the hypertension–heart failure link in their cost–benefit analyses[77] perhaps because often-quoted articles, and meta-analyses have concentrated their attention on stroke and coronary heart disease as the major complications of hypertension[78–80] sometimes to the exclusion of heart failure. A statement in 2004 from the World Heart and Stroke Forum regarding prevention of cardiovascular disease begins the section on Blood Pressure as follows: 'Hypertension is a major cause of stroke and contributes to an increased risk of recurrent myocardial infarction in patients with coronary heart disease. Treatment of hypertension is therefore important as a primary and secondary prevention strategy'.[81] These statements might be taken to imply that heart failure, as a consequence of hypertension, is of lesser importance than stroke and recurrent myocardial infarction. At the very least, this is debatable in regard to the relative numbers of

patients affected, quality of life, longevity and costs associated with each of these three complications of hypertension.

The sage advise from Framingham regarding the necessity for early detection and treatment of hypertension is at variance with some official guidelines, which recommend antihypertensive drug therapy only for patients in whom the 5- or 10-year risk of a cardiovascular event exceeds an arbitrary level, usually 20%. Such guidelines that, with few exceptions, equate a cardiovascular event in a 45 year old with a similar event in an 85 year old and pay little heed to health over the long term would keep many young and middle-aged patients with substantial hypertension off antihypertensive drug treatment for years, even decades. This approach to the prevention of serious, life-threatening disorders would be viewed with justifiable concern for patients with, for example, precancerous lesions.

Overview

Hypertension was the most important single identifiable risk factor for heart failure until the last few decades. The issue has become less clear over recent years, in part, because of uncertainties in the documentation of heart failure, the lack of systematic recordings of arterial pressure prior to the onset of, and treatment for, heart failure, and the absence of systematic visualization of epicardial coronary arteries. The Framingham Heart Study, in a largely Caucasian population, attributes a dominant role for hypertension with 'no significant change in the frequency of hypertension as the attributable cause of heart failure during four decades (1948–1988) of observation'.[82] Nevertheless, Framingham workers note that coronary heart disease 'has been increasing in prevalence among new cases of heart failure.'[83] The caveat here is, again, that coronary heart disease as defined might well include a percentage of patients with hypertensive coronary microvascular disease with or without epicardial coronary artery disease.

It appears that for cardiac failure primarily due to diastolic left ventricular dysfunction, and in some racial groups, hypertension is the single most important identifiable cause. For patients with systolic dysfunction of the left ventricle the situation is less clear, but hypertension along with epicardial coronary artery disease, is still clearly important. In our view, the importance of the early detection and treatment of hypertension as a means of preventing or delaying the onset of cardiac failure has been underemphasized in recent years.

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