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Demographics and Cardiology, 1950–2050

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Changing demographics, in particular the aging of the North American population, contribute to the understanding of trends in such diverse areas as education, housing, crime, marketing, unemployment, recreation, and health care (1,2). Although annual changes in many of these sectors are influenced by the changing state of the economy and, in some instances, the impact of new legislative or administrative initiatives, longer-term trends are determined to a much greater extent by trends in demographics and technology.

This article examines the impact of changing demographics on the profession of cardiovascular medicine. Although the emphasis here is on the future (2000–2050), the past (1950–2000) provides a context for the findings. Future trends are, therefore, presented as a continuation of the past, albeit with certain appropriate modifications. This inevitable continuity of demographic trends stands in contrast to the discontinuity introduced by major technological innovations, which, by their very nature, can result in comparatively abrupt changes in professional procedures.

The American College of Cardiology (ACC) has seen its share of changes over the past 50 years (3). There has been continuity provided by the leadership of the College, but there have also been new challenges introduced by changes in the discipline; government legislation, especially Medicare and Medicaid; and administrative procedures, including the move of the national headquarters to Bethesda, Maryland, and the building of Heart House.

The past 50 years have also seen many advances in the profession, including, for example, open-heart surgery, pacemakers, defibrillators, coronary artery bypass surgery, heart transplants, and artificial hearts. The future holds equal promise for progress ranging from new techniques in echocardiography and new antithrombolytic agents to genetic engineering and molecular biology (4).

In the U.S., cardiovascular disease is the most important cause of death, with approximately one million people a year dying as a result of diseases of the heart, cerebrovascular diseases, atherosclerosis, hypertension, and other related diseases. This represents approximately 40% of all deaths, and roughly three quarters of these are from diseases of the heart. Cancer is the next most important killer, accounting for approximately one quarter of all deaths in the U.S.

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STRUCTURE OF THE STUDY

The next section of this article is devoted to a review of historical (1950–2000) trends. First, demographic trends, including the growth and aging of the U.S. population, are examined to provide the context for the subsequent future demographic analysis. Second, cardiovascular trends are reviewed to provide relevant parameters and a context for the methodology outlined in the following section. This methodology is designed to isolate the impact of changing demographics on the profession, which is the objective of this article. As such, it is based on status quo assumptions. Changes in parameters based on changes in technology and any other relevant legislative and/or administrative procedures are not considered; however, the methodology adopted in this article allows such inclusions.

The fourth section outlines the future (2000–2050) from a demographic perspective. It examines the near future (2000–2010), the medium future (2010–2030) when the boomers all will reach retirement age, and the distant future (2030–2050). These projections are based on official U.S. Bureau of the Census population projections that include gender and race differences (5). The bureau also provides alternative projections based on different demographic assumptions. Alternative scenarios are a core component of strategic planning and are included in this article to demonstrate the quantitative sensitivity to demographic uncertainties.

Finally, the last section explores some of the policy implications of these results. Of particular importance are the work-force implications of the projections. The cost implications are examined elsewhere (6).

THE PAST (1950–2000)

The review of past trends coincides not only with the latter half of the twentieth century but also with the 50-year existence of the ACC. The most important demographic trends are outlined, followed by the major cardiovascular trends. The choice of variables reflects the requirements of the methodological model outlined in the third section that is used to generate future trends (discussed in the fourth section).

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Table 1. Population, 1950–2000 (July 1 Estimates)

	Number ('000)	Increase	
		Number	Percent
1950	152,271	19,161*	14.5*
1960	180,671	28,400	18.7
1970	250,052	24,381	13.5
1980	227,726	22,674	11.1
1990	249,949	22,223	9.8
2000†	274,634	24,685	9.9

*Decade ending April 1. †Middle projection. Source: U.S. Department of Commerce, Statistical Abstract of the United States, 1998, pp. 8–9.

Table 2. Population by Age, 1950–2000 (Percent)

	Years			Median Age (yrs)
	0–14	15–64	65+	
1950	26.9	65.0	8.1	30.2
1960	26.8	64.0	9.2	29.5
1970	28.3	61.9	9.8	28.0
1980	22.5	66.2	11.3	30.0
1990	21.6	65.9	12.5	32.8
2000*	21.5	65.9	12.6	35.7

*Middle projection. Source: U.S. Bureau of the Census, various publications and Statistical Abstract, 1998, Table No. 13.

Population. Between 1950 and 2000, the U.S. population has grown by more than 120 million people at an average annual growth rate of 1.2% (Table 1). However, the rate of population growth was faster in the earlier part of the period than in the latter part. The 1950s added 28.4 million people to the U.S. population; whereas, subsequent decades have contributed between 22.2 and 24.7 million people. Estimates for the 1990s based on a population projection for the year 2000 may be on the high side; as a result, the continuing slow-down in growth of the U.S. population is unlikely to be reversed in the new millennium. The U.S. is expected to enter the new millennium with approximately 275 million people (see Fig. 1).

Aging. Table 2 summarizes the changing age structure of the U.S. population over the past 50 years. After a dramatic increase in the percentage of young people in the U.S. population associated with the emergence of the post-war baby boom in the 1950s, there has been a continued decline in the percentage of young ever since. Currently, a little over one in five (21.5%) of the population is under age 15. At the same time, there has been a gradual increase in the percentage of senior Americans in the population. Currently, approximately one in eight (12.6%) of the population is age 65 years or older. This declining proportion of young since 1960, and an increasing proportion of seniors in the population, both contribute to the aging of the population. Note that a rising proportion of seniors alone, while indicative of aging, does not guarantee that a population is aging if it is offset by a rising proportion of young. This is not the case in the U.S.

Table 2 also suggests that the speed of aging has slowed at the end of the twentieth century. This slowing is because an individual turning 65 in 2000 was born in 1935, and not many people were born in the Depression years of the

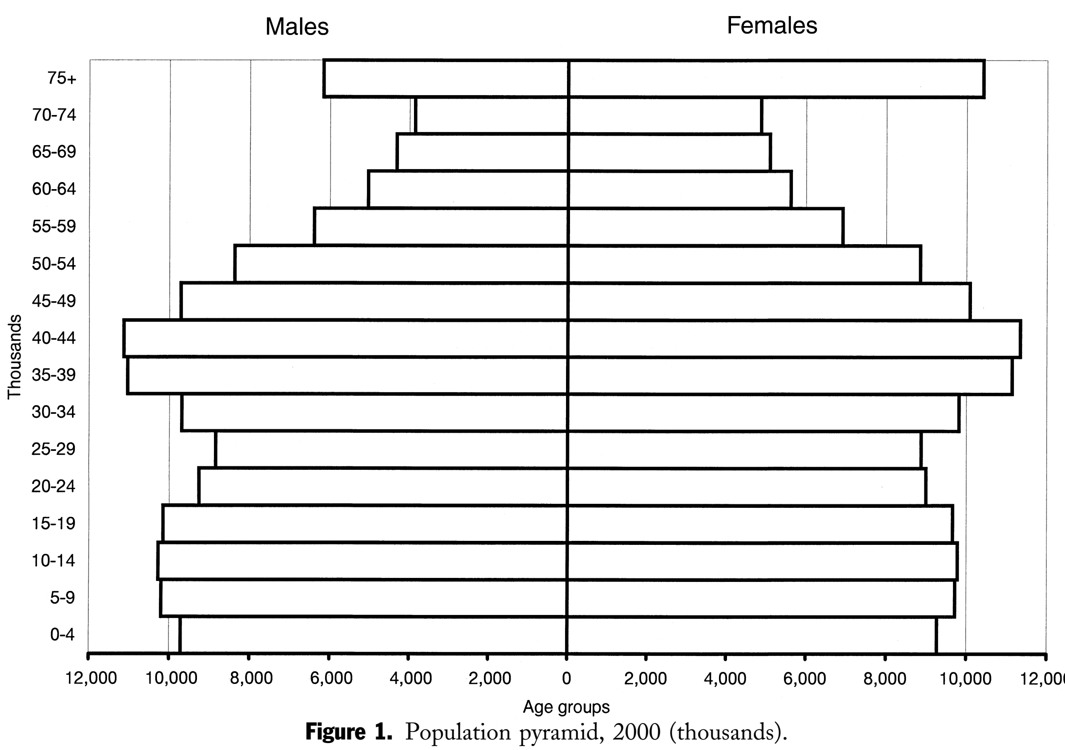

Figure 1. Population pyramid, 2000 (thousands).

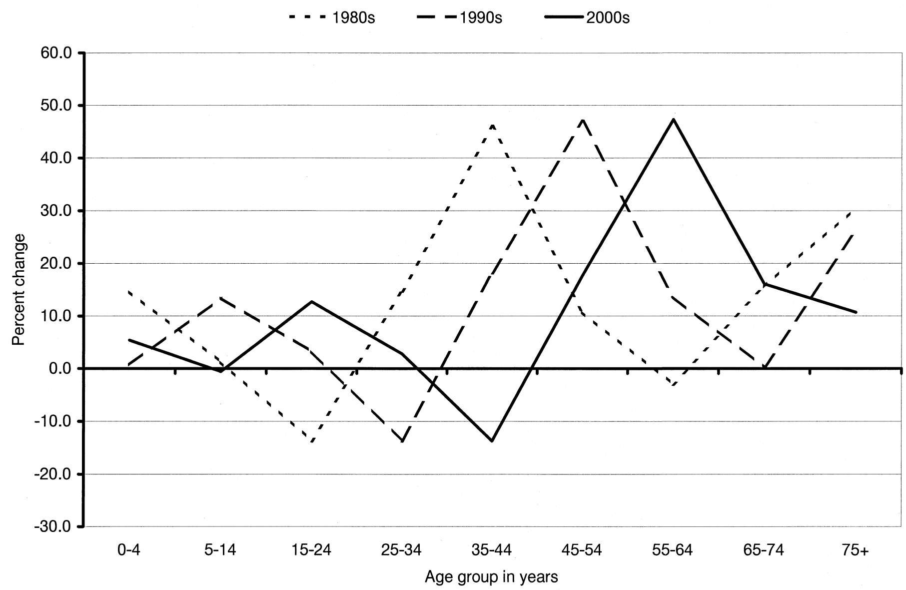

Figure 2. Population growth by age, 1980–2010 (percent).

1930s. For the period 1995–2005, those born between 1930 and 1940 will enter the seniors group, which has slowed the growth of that population at the turn of the millennium.

Figure 2 presents population growth by age for the period 1980–2010. The near future (2000–2010) is included here to facilitate the transition to the future discussed in subsequent sections of the article. The first boomers, born in 1946, were 34 years old in 1980, so they exploded into the 35-to-44 age group during the 1980s and the 45-to-54 age group during the 1990s. During the late 1970s and the 1980s, the boomers had their children, and the younger age groups grew during the 1980s and 1990s. This is known by demographers as the "baby boom echo."

Within the seniors groups, note the very slow growth of the 65-to-74 age group in the 1990s, reflecting the 1930s Depression years noted previously. This is a passing phenomenon, however, as in the first decade of the new millennium, the World War II babies start to enter this group, and there are relatively more of them. Growth rebounds to even exceed that of the 1980s. Perhaps the group of most interest is the senior-seniors, age 75 years and older. Whereas the young seniors show almost no growth in the 1990s, the over-74 group is growing at over 26%, which is still lower than in the 1970s and 1980s. This reflects the robust economy and massive immigration of the 1910s and 1920s in the U.S. Overall, the senior (65 and over) group is at its slowest growth in the 1990s, primarily because of the Depression-born young seniors. Growth increases from 11.1% in the 1990s to 13.5% in the first decade of the new millennium before exploding in the second decade as the boomers reach their senior years.

Race/ethnicity. In 1950, one in 10 Americans were of minority races, predominantly black. By the turn of the millennium, almost one in five are of minority races (Table 3). Over the past 50 years, the black proportion has increased from 9.9% to 12.9%, primarily because of the higher fertility of the black population (19.3 births per thousand projected for 2000) compared with the white population (13.2 births per thousand). The growth in the remaining group, now comprising one in 20 Americans, can be attributed both to higher fertility (American Indian, Eskimo, and Aleut—17.3 births per thousand; Asian and Pacific Islander—16.6 births per thousand) compared with the white (but not black) population and to higher rates of immigration, especially among the Asian and Pacific Islander group (which comprises over 80% of the total).

Americans of Hispanic origin now comprise 11.4% of the population, up from 6.4% in 1980, when these data were first reliably collected in the census. This increasing share reflects the higher fertility of the group (21.8 births per thousand) and some immigration, especially from Mexico, the Dominican Republic, and Cuba (which comprised one quarter of all immigrants in 1996, for example). Because the

Table 3. Population by Race/Ethnicity, 1950–2000 (Percent)

	Race			Ethnicity
	White	Black	Other*	Hispanic†
1950	89.3	9.9	0.8	N/A
1960	88.6	10.5	0.9	N/A
1970	87.6	11.1	1.3	N/A
1980	85.9	11.8	2.3	6.4
1990	83.9	12.3	3.8	9.0
2000	82.1	12.9	5.0	11.4

*American Indian, Eskimo, Aleut, Asian, and Pacific Islanders. †Persons of Hispanic origin may be of any race. Source: Statistical Abstract, 1998, Table No. 13.

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Table 4. Life Expectancy at Birth by Gender and Race, 1950–2000 (Years)

	White		Black		
	Male	Female	Male	Female	Total
1950	66.5	77.2	59.1†	62.9†	68.2
1960	67.4	74.1	61.1†	66.3†	69.7
1970	68.0	75.6	60.0	68.3	70.8
1980	70.7	78.1	63.8	72.5	73.7
1990	72.7	79.4	64.5	73.6	75.4
2000*	74.2	80.5	64.6	74.7	76.4

*Based on middle series mortality assumptions. †Black and other combined. For 1970 the comparable data are 61.3 and 69.4, respectively. Source: Statistical Abstract, 1998, Table No. 128.

white population has the lowest fertility, it is the oldest population of the various racial/ethnic groups. (Or, conversely, because it is the oldest population, it has the lowest birth rate.) At the turn of the century, it is estimated that 13.7% of the white population is age 65 and older, compared with 8.1% of the black population; 7.3% of the Asian and Pacific Islander population; and 6.9% of the American Indian, Eskimo, and Aleut population.

Life expectancy. The percentage of seniors in a population is strongly influenced by life expectancy. Table 4 shows life expectancy at birth for the total population and by gender for the white and black populations. Overall, life expectancy at birth has risen by 8.2 years over the past 50 years, with the most rapid increases in the earlier period primarily from declines in infant mortality. Nonetheless, even over the 1990s, life expectancy is estimated to have risen by one year, with the average American now expected to live until age 76.4, reflecting a lifetime of almost 80 years for females and 73 years for males. White Americans can expect to live on average one year longer, with a gender difference of 6.3 years; whereas, black Americans have a life expectancy 6.7 years shorter than the average, with black females having a 10-year advantage over black males.

Deaths by cause. Rising life expectancy is a better measure of longevity than declining death rates because the death rate (like the birth rate) is influenced by the age structure of the population. A population with a higher proportion in the senior age group is likely to experience relatively more deaths even if that population is healthier compared with some other younger population.

Table 5 presents recent data by gender and race on the five most important causes of death. A number of conclusions emerge from these data. First, heart disease is the most important cause of death in the U.S., now being one third more important than the next most important cause of death, namely cancer. This is true for both males and females, although females are less likely to die from heart disease and cancer and more likely to die from strokes than males. Second, despite an aging population, the death rate for heart disease has been declining, whereas for cancer it has been increasing. The only other discernible trends in these data are increasing pulmonary death rates and declining accident death rates (which does not include homicide). Third, the generally lower death rates for the black population compared with the rates of the white population, with the exception of accidents, reflects its younger age. Nonetheless, the first three most important causes of death are the same for both groups. Fourth, not surprisingly, death rates are much higher (six or seven times above average) for the senior (65 years and over) group; and, in this group, heart disease is an even more important cause of death, being over 60% more important than cancer (40% for males,

Table 5. Death Rates by Leading Causes by Gender and Race, 1980–1995 (Per 100,000)

	Heart Disease	Cancer	Cerebrovascular Diseases	Pulmonary Diseases	Accidents
1980	336.0	183.9	75.1	24.7	46.7
1990	289.5	203.2	57.9	34.9	37.0
1995	280.7	204.9	60.1	39.2	35.5
Total:					
Males	282.7	219.5	48.0	42.0	47.9
Females	278.8	191.0	71.7	36.4	23.7
White	297.6	215.0	62.6	43.6	35.7
Black	237.3	182.9	55.9	20.1	38.5
65 plus:					
Males	2043.6	1463.6	370.4	341.0	105.0
Females	1701.7	909.2	429.0	208.8	72.0
White	1848.9	1126.3	401.3	274.7	85.4
Black	1988.3	1349.2	478.4	167.3	89.0

Source: Statistical Abstract, 1998, Table No. 142.

over 80% for females, and over 70% for blacks). In the senior group, heart disease is more than four times more important than cerebrovascular diseases and over 10 times more important than pulmonary diseases as a cause of death. Finally, for all age groups, ischemic heart disease is the dominant cause of death and is over 20 times more important than hypertensive heart disease (30 times in senior-senior males) and more than 150 times more important than rheumatic heart disease.

The decline in the heart disease death rate has been a major achievement of the cardiovascular profession during the past 35 years. However, there is concern that the tobacco-cholesterol risk model is being replaced by the hypertension-diabetes model as the population becomes more obese and better control of lipids and smoking occurs. This portends more vascular disease in the future. Therefore, continuation of the historically declining heart disease death rate into the new millennium will be one of the challenges facing the discipline, especially in an aging population.

METHODOLOGY

This section presents a methodology that can incorporate the major trends outlined previously and enable the future for cardiovascular medicine in the U.S. to be developed. The objective is to isolate the impact of demographic change, and particularly population aging, on that future. Demographic change is also crucial in determining the potential demand for cardiovascular specialists and related personnel and facility requirements in the future. The methodology provides a consistent framework within which workplace considerations can be incorporated.

Population identity. The foundation for any demographic analysis is the population identity:

$$P(t) = P(t-1) + B(t) - D(t) + I(t) - E(t),$$

where t denotes time and P represents population (at a point in time), B represents births, D represents deaths, I represents immigration, and E represents emigration (all over a time period, usually a year). Births and immigrants add to a population, and deaths and emigrants reduce population size.

Implementation of the identity can be at any level of aggregation. At the global level, there is no immigration or emigration (yet), so global population growth is determined by the difference between births and deaths. At the national level, I(t) and E(t) refer to international migration; whereas, at the regional (or state) level, they include both international and interregional migration.

To capture the impact of population aging, the population identity must be applied to each single year age group in the population. Using the index i to represent an individual age group, the population identity can be written in general as

$$P(i, t) = P(i-1, t-1) + B(i, t) - D(i, t) + I(i, t) - E(i, t).$$

First, note that, for example, 20-year-olds in 2000 (P [20, 2000]) are 19-year-olds in 1999 (P [19, 1999]), so both i and t must be lagged on the right side of the identity. Second, note that births occur at age 0, so the population identity reduces to

$$P(0, t) = B(0, t) - D(0, t) + I(0, t) - E(0, t)$$

because children die and can move before their first birthday, and

$$P(i, t) = P(i-1, t-1) - D(i, t) + I(i, t) - E(i, t)$$

for all age groups above age 0 ($i > 0$). The total population is the sum of the individual ages, or P(t) = SUM(i) P(i, t). Note, finally, that these identities can apply to subpopulations within the national population, such as male and female, white, black, Hispanic, and so forth.

Implementation of the population identity requires assumptions about the four components of change (births, deaths, immigration, and emigration). Historical trends in fertility, mortality (or life expectancy), and migration are traditionally used to determine these parameters. The choice of different parameters will lead to different outcomes or alternative population projections, which provide a foundation for sensitivity analysis and strategic planning. The actual parameter values used in this article are discussed in the discussion of population assumptions.

Although the components of population change are important to any population projection, it is crucial to remember that the quantitatively most important determinant of P(i, t) is P(i − 1, t − 1), the number of people who existed in the previous year. The addition of 25 million people per decade to the U.S. population (see Table 1) averages to 2.5 million a year, which is currently less than 1% of the population (of 275 million). This means that more than 99% of next year's population is already accounted for. Over a decade, the net additions accumulate and become more important, but 25 million people represent less than a 10% addition to a current population of 275 million. This means that for the foreseeable future, population growth and aging are determined mainly by the existing U.S. population. The aging of the boomers is likely to continue to be the biggest story over the next 50 years.

Activity identities. The population identity provides the demographic foundation for the analysis. Applying it to any area of interest can be achieved by introducing a relevant activity identity into the analysis. Defining N as the activity number of interest (usually people or dollars), the identity

$$N = (N/P) \times P$$

can be used to determine N if the population (P) is known along with the activity rate (N/P). If N is the number of deaths, then (N/P) is the death rate (see Table 5); whereas, if N is the number of people, then (N/P) is the prevalence

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or penetration rate. If N is the number of dollars, then (N/P) is a per-capita expenditure measure.

Because activity rates tend to vary noticeably by age (and gender), it is often necessary to incorporate these details into the analysis. This is accomplished simply by specifying

$$N(i, t) = \{N/P\}(i, t) \times P(i, t)$$

with total N(t) = SUM(i) N(i, t). Given the individual activity rates, the populations P(i, t) determine the activity numbers. Because these individual activity rates reflect the melange of behavioral (and technological) effects at a point in time, holding them constant eliminates their time effects and allows the impact of demographics, including aging, to be isolated over some time period. This approach is adopted in this article. Changes in behavior and/or technology (e.g., the declining death rates for heart disease noted in Table 5) can be incorporated to make a forecast of the future that incorporates all changing determinants, including demographics.

The impact of population aging is incorporated into this analysis because

$$N(i, t) = \{N/P\}(i, t) \times \{P(i, t)/P(t)\} \times P(t)$$

where P(t) represents the total population size and P(i, t) /P(t) captures the distribution of the population over the various ages. In this way, the changing growth rates of different age groups (see Fig. 2) are incorporated into the calculation of N(i, t) and hence N(t). In practical implementation, i often refers to five- or 10-year age groups rather than single-year age groups because this is how most activity participation (N/P) data are presented.

This methodology can be extended to incorporate further activity identities of interest. For example, work-force implications can be explored by noting that a patient requires a number of hours of a cardiologist's time (denoted H/N). If this varies by age (perhaps reflecting complexity) or gender, then hours (H) can be projected as

$$H(i, t) = \{H/N\}(i, t) \times N(i, t)$$

with total H(t) = SUM(i) H(i, t). Similarly, costs can be calculated by replacing hours with dollars.

Sensitivity analysis. Two types of sensitivity analysis can be made with this methodology. Demographic sensitivity considers changes in the determinants of P(t) in the population identity. For example, immigration levels primarily affect population size; whereas, increasing life expectancy increases the number and share of seniors in the population, which increases health care needs and costs. Demographic sensitivity is considered in the section on alternative scenarios.

The second type of sensitivity analysis is the health care sensitivity that is captured through the parameters in the activity identities. These embody both behavioral and technological influences. Continued declines in heart disease death rates could be examined, as could alternative technology and cost structures. This type of sensitivity analysis is not considered in detail in this article. Although increasing life expectancy is included in the demographic sensitivity analysis, no explicit link is made with declines in heart disease death rates.

Table 6. Principal Fertility, Life Expectancy, and Net Immigration Assumptions

		2050 LEVEL		
	1995	Low	Middle	High
Fertility*	2.055	1.910	2.245	2.580
Life Expectancy†	75.9	74.8	82.0	89.4
Net Immigration‡	820	300	820	1370

*Children per woman. †Years. ‡Thousands per year. Source: U.S. Bureau of the Census, Population Projections, Table B.

THE FUTURE (2000–2050)

The past 50 years (1950–2000) provide a contextual overview, against which future trends can be assessed—especially future demographic trends and their impact on the cardiovascular medicine profession. The article has also outlined a methodology that allows the effects of changing demographics to be isolated so that their impact on the profession can be assessed independently of changes in practice behavior and technology. This section is devoted to presenting and discussing these effects.

It is useful to look at the future in three components. First, the near future (2000–2010) can be determined with more reliability because it is dominated by the current population. Moreover, in the near future, both the boomers and their children will be in the work force, although a few boomers may be taking early retirement. Second, the medium future (2010s and 2020s) represents the period when the boomers will become seniors. The first boomer born in 1946 will reach age 65 in 2011; and, over the subsequent 18 years (until 2029), the boomers will continue to augment the ranks of the seniors. These changes will lead to considerable dislocation in many sectors of society, including the health care sector. Finally, the distant future (2030s and 2040s) is more speculative. Populations can be projected into this period, but more of this future population is as yet unborn. Trends in migration may change dramatically, and life expectancy trends may reverse (the pollution scare) or accelerate (a cure for cancer). Moreover, changes in technology will surely revolutionize the profession (4). Therefore, the distant-future population projections are included to show the ultimate implications of the near and medium futures.

Population assumptions. The U.S. Bureau of the Census periodically releases official population projections for the U.S. The most recently published projections cover the period from 1995 to 2050. Three different assumptions about the future are used and are summarized in Table 6. In the middle series, all age-specific fertility rates are held constant, but, because Hispanic-origin fertility is higher

Table 7. Projected Residential Population and Growth, 2000–2050 (July 1 Estimates)

	Number ('000)			Growth (%)		
	Low	Middle	High	Low	Middle	High
2000	271,237	274,634	278,129	—	—	—
2010	281,468	297,716	314,571	3.8	8.4	13.1
2020	288,807	322,742	357,702	2.6	8.4	13.7
2030	291,070	346,899	405,089	0.8	7.5	13.3
2040	287,685	369,980	458,444	−1.2	6.7	13.2
2050	282,524	393,931	518,903	−1.8	6.5	13.2

Source: U.S. Bureau of the Census, Population Projections.

than that of the other groups and the Hispanic-origin share of the total population rises, the overall fertility rate rises. The low- and high-fertility series assume a 15% decrease and increase by 2010 for all race/ethnic groups, respectively.

Life expectancy is assumed to continue to increase gradually. Based on the experience of the 1980s, and with some negating effects of AIDS, an increase of almost six years over the period is assumed. This is a smaller increase than in the previous 50 years (see Table 4). The high life expectancy series are based on the experience of the 1970s; whereas, the low life expectancy series holds mortality rates at levels consistent with an increase over the 2000s in deaths from AIDS. Net immigration is assumed to remain constant at 820,000 per year (about 1,042,000 immigrants, minus 222,000 emigrants) in the middle series. The alternative series decrease this number to 300,000 annually in the low series and increase it to 1,370,000 annually in the high series after 2000. These differences are large and are the main reason that the projections differ so much. For example, a difference of 500,000 net immigrants annually results in a total population difference of approximately five million people over a decade and at least 25 million over five decades. Interestingly, no racial/ethnic convergence in either fertility or mortality is assumed in these projections, and immigrants are assigned to age groups in accordance with recent experience.

Population projections. Table 7 summarizes the results of the population projections. In the middle projection, the population increases to 394 million by 2050 (a 119 million, or 43.4%, increase over 50 years). This compares with a 122 million, or 80%, increase over the past 50 years (Table 1). In other words, although the numbers are comparable, the growth rates are not. Note that the middle projection exhibits declining growth over the period and that annual growth averages only 0.7% over the period. With constant immigration, most of the declining growth comes from natural causes (births, minus deaths). Population aging results in increases in the death rate. After about 2025 the U.S. population grows more slowly than ever before in this projection. The low projection shows a population peaking at around 295 million in the 2020s and then declining, whereas the high projection shows almost constant growth into the middle of the next century, with a population almost double current levels, which seems very unlikely.

The aging of the population is projected to continue, with the median age increasing from 35.7 years in 2000 to peak at 38.7 years in 2035 in the middle projection (Table 8). Although this increase is substantial, the pace of aging slows down. The projected three-year increase in median age from 2000 to 2035 comes nowhere near the 7.7-year increase during the past 30 years (see Table 2). Thereafter, it declines slightly to 38.1 years by 2050 as the massive boomer generation passes away.

The proportion of the population in the senior (65 years and over) age group hardly varies among the projections (Table 8). In the middle projection, it peaks at just over 20% in the 2030s and then returns to the one-in-five figure by 2050, the same as in 2030. The low projection is 0.2% higher in 2030, the high projection 0.4% lower (although there are considerably more people because the population is larger). By 2050, the three projections have virtually converged on the one-in-five figure, although the numbers differ greatly because of the life expectancy assumptions. Of special interest is that the period of rapid increase in the

Table 8. Projected Population Aging, 2000–2050

	65 Years and Over			Median Age (Yrs)
	Number ('000)	Growth (%)	Share (%)	
Middle Projection				
2000	34,709	11.7	12.6	35.7
2010	39,408	13.5	13.2	37.2
2020	53,220	35.1	16.5	37.6
2030	69,379	30.4	20.0	38.3
2040	75,233	8.4	20.3	38.5
2050	78,859	4.8	20.0	38.1
Low Projection				
2030	58,869	23.2	20.2	40.2
2050	55,930	−4.3	19.8	41.0
High Projection				
2030	79,329	35.8	19.6	36.8
2050	103,481	12.6	19.9	36.0

Source: U.S. Bureau of the Census, Population Projections and calculations by the authors.

Table 9. Projected Population by Race/Ethnicity, 2000–2050 (Percent)

	White	Black	Asian*	American Indian†	Hispanic
Middle Projection					
2000	82.1	12.9	4.1	0.9	11.4
2010	80.5	13.5	5.1	0.9	13.8
2020	79.0	14.0	6.1	1.0	16.3
2030	77.6	14.4	7.0	1.0	18.9
2040	76.1	14.9	7.9	1.1	21.7
2050	74.8	15.4	8.7	1.1	24.5
Low Projection					
2050	75.7	15.7	7.4	1.2	22.0
High Projection					
2050	73.5	15.8	9.7	1.0	25.7

*Asian and Pacific Islander. †American Indian, Eskimo, and Aleut. Source: U.S. Bureau of the Census, Population Projections.

senior population during the 2010s and 2020s when the boomers reach these ages averages 2.8% annually, which is less than the rate of growth in the elderly population from 1920 to 1960 (3.05% per year). Of course, the numbers are smaller, but it is important not to overstate the growth of the senior population during this period of boomer aging when it is viewed in an historical context.

The projections suggest that the white share of the population will continue to decline to around three in four by 2050, whereas the Hispanic share will continue to increase to around one in four regardless of the assumptions employed (Table 9). The black population share will also increase slightly from just under 13 to over 15% of the population, while the Asian and Pacific Islander group is likely to more than double its share in the population. These trends primarily reflect the cumulative impact of fertility differences, although immigration also plays a role. Nonetheless, despite the increasing share of minority groups, the white population still remains the numerically dominant group, still outnumbering Hispanics three to one by 2050. Moreover, the white population remains the oldest population even after the demise of the boomer generation. In 2050, its median age is 39.9 years, compared with 32.7 for black, 31.6 for American Indian, 34.8 for Asian, and 31.0 for the Hispanic population. Finally, the total number of annual deaths is projected to increase from current levels around 2.4 million to more than 4 million by 2050. The white population accounts for almost four in five of these deaths, regardless of their slightly declining share in the total population, because they remain the oldest group.

Evaluation. The middle projection is a realistic, if perhaps slightly optimistic, view of the future U.S. population. Fertility may well decline, especially in the minority groups, consequently reducing their growth and share in the total population. In addition, it is doubtful that the high net immigration figures assumed in the middle series will be consistently maintained during the next 50 years. A net intake of 820,000 annually assumes a gross annual intake in excess of one million, a level seen only briefly in the 1989–1991 period. Of all the decades in the twentieth century, the biggest annual intake occurred in the last two decades. The 1980s averaged 733,800 annually, and the early 1990s (1991–1996) averaged slightly in excess of one million annually, primarily because of the 1.8 million entrants in 1991. Although these figures can justify the immigration numbers used in the middle projection, history suggests that they are unlikely to be sustained over a 50-year period. Consequently, the high projection appears to be unsustainable.

By contrast, it is very likely that medical advances will result in increasing life expectancy, so the assumption of unchanged mortality in the low series is likely to be unduly pessimistic. Nonetheless, lower fertility is likely as are lower immigration levels (although not as low as 300,000), so the low projection has more credibility as a comparator than the high projection. In retrospect, the Bureau's "low-fertility" alternative projection (not considered here) perhaps offers the most likely outcome, combining a low-fertility assumption with middle (i.e., increasing) life expectancy and middle immigration assumptions. In that projection, the population will reach approximately 345 million by 2050, between the 394 million of the middle projection and the 203 million of the low projection.

Heart disease deaths. Table 10 summarizes deaths and death rates attributable to heart disease by age group for 1995 in the U.S. In 1995, 737,000 Americans died of heart disease. Of these, 615,000, or 84%, were in the senior (65 years and over) age group. It is interesting to note that in the younger age groups heart disease death rates are greater for males than for females, whereas in the senior age group this pattern is reversed.

Applying these death rates to the middle population projection produces the death projections summarized in Figure 3. Deaths attributable to heart disease are projected to increase by 112.7%. Meanwhile, the population is projected to increase by 43.4% over the same period (Table 7). Consequently, deaths from heart disease are projected to

Table 10. Heart Disease Deaths by Age and Gender, 1995

Age (Yrs)	Rank*	Number		Rate†	
		Male	Female	Male	Female
0–4	5	136	115	1.7	1.5
5–14	6	163	131	0.8	0.7
15–24	5	659	380	3.6	2.2
25–44	4	12,268	4,796	29.6	11.5
45–64	2	72,337	30,401	286.8	112.7
65+	1	276,756	338,670	2021.8	1706.7

*Heart disease rank by cause of total deaths. †Per 100,000 population. Source: Statistical Abstract 1998, Table No. 141.

increase at more than 2.5 times that of the rate of the population as a whole over the next 50 years.

The time profile of these differences is interesting. It is estimated that during the 1990s, at constant (1995) age-specific death rates, deaths attributable to myocardial infarction grew faster than the population (by 4.0%). (This is included at the year 2000 in Figure 3.) In the near future (2000s), the pace of growth picks up while population growth slows, thereby accentuating the difference. However, when the boomers reach their senior years in the medium future (2010s and 2020s), the growth in deaths attributable to heart disease really "takes off," averaging 2.9% annually in the 2010s and 2.5% annually in the 2020s—all at a time when population growth is slowing to 0.8% annually. In the distant future (2030s and 2040s), after most of the boomers have died, growth rates slow dramatically and even fall below projected population growth (during the 2040s).

Heart-disease prevalence. Deaths are one measure of the importance of heart disease. A more important measure from a perspective focused on health care resources is the prevalence of the disease. Prevalence is defined as incidence (the probability of having a disease) multiplied by duration (the length of survival with the disease), so either increasing incidence or increasing duration can lead to increasing prevalence. Note that declining incidence can be offset by increasing duration, and vice versa. Return visits from patients who would have died in the past, but now require regular management, result in increasing duration and more visits. These are people who are living with conditions identified as heart disease and who have been or are under treatment for heart disease in one form or another.

Table 11 summarizes the prevalence of chronic heart conditions by age and gender, again for 1995. Once again, the importance of heart disease increases with age, especially for males. Heart disease is the most prevalent of chronic conditions in senior males, whereas for females it is outranked by arthritis and high blood pressure (hypertension), itself an indicator of heart disease. Projections presented in Figure 3, however, focus on the prevalence of chronic "heart conditions" and ignore chronic high blood pressure.

These results are not as dramatic as those for deaths, but they do tell a very similar story. Using the middle population

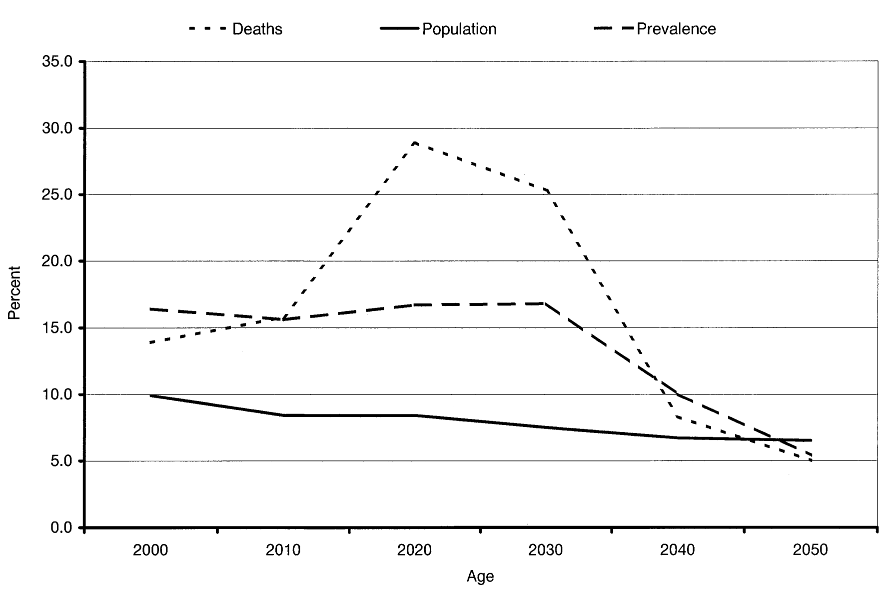

Figure 3. Heart disease growth, 2000–2050 (percent).

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Table 11. Prevalence Of Chronic Heart Conditions by Age and Gender, 1995

Age (Yrs)	Rank*		Rate†	
	Male	Female	Male	Female
Under 45	9	8	24.0	34.0
45–64	5	5	143.1	100.0
65–74	4	3	316.3	229.3
75+	1	3	439.4	318.0

*Rank in 22 chronic conditions. †Per 1,000 people. Source: U.S. National Center for Health Statistics (reported in Statistical Abstract, 1998, Table 231).

projection, prevalence grows approximately 16% a decade (approximately 1.6% per year) during the next three decades, whereas the population grows at approximately half that amount. In other words, over the near (2000s) and medium (2010s and 2020s) futures, the growth of prevalence of chronic heart conditions averages twice that of the general population. Thereafter, in the distant future (2030s and 2040s), the pace of growth slows noticeably and even falls below projected population growth (during the 2040s).

The reasons are essentially the same as for deaths, with perhaps one modification. As the boomers hit their 50s over the late 1990s and 2000s, they enter the ages when the prevalence of chronic heart conditions triples compared with the younger (under 45 years) ages (see Table 11). Some will die (the death rate increases 10-fold) (see Table 10), but many will continue to live with these conditions, which leads to growing prevalence in the population. Although the rate (or individual probability) of prevalence increases with age, it does not increase as dramatically as the death rate, and consequently more of the growth in prevalence occurs in the near future (1990s and 2000s) than in the medium future (2010s and 2020s). (From a methodological viewpoint, it should be noted that the 65–74 age group is broken out separately in Table 10 but not in Table 11. Comparable age data might slightly moderate the differences between the death and prevalence results.) Thereafter, in the distant future (2030s and 2040s) after most of the boomers have died, growth rates slow noticeably and even fall below population growth (during the 2040s) as the median age of the population falls (Table 8).

A final point of interest is the slightly slower growth in projected prevalence in the first decade of the new millennium compared with the 1990s. Recall that to isolate the demographic impact, all numbers are calculated at unchanged (1995) rates (Table 11), so the figure for the 1990s is not the actual prevalence but rather the prevalence associated with demographic change. The 1990s figures, therefore, reflect the population growth figures (Fig. 2), which show a noticeable reduction in the growth in the highly vulnerable senior ages due to the reduced number of births during the Depression years of the 1930s. Although this effect is also embodied in the projection of deaths, it is masked by the effect of the increase in death rates that occurs for the 45–64 age group (Table 10).

Alternative scenarios. As noted previously, the middle population projection, on which the heart disease death and prevalence projections presented in Figure 3 are based, is demographically optimistic because it is based on a relatively high immigration assumption. This assumption results in higher population and, therefore, higher population growth than history might suggest. For this reason, Table 12 presents results comparable with the low (and high) population projections. Recall that because of the assumption of unchanged mortality, the low projection was judged to be demographically "unduly pessimistic," whereas the high projection with its sustained historically high immigration numbers was judged to be "unsustainable."

These alternative scenarios present essentially the same picture, albeit with different numbers of people. In all cases, the growth in heart disease death and prevalence far exceeds population growth until the 2040s. In addition, prevalence growth is more gradual than the growth in deaths, which continue to peak in the 2020s and 2030s as the boomer generation passes on.

However, these alternative scenarios demonstrate an additional conclusion—namely, that the death and prevalence growth projections are not nearly as sensitive to alternative population scenarios as are the population numbers themselves. For example, the growth in deaths from heart disease in the 2020s varies between 22.7% (low) and 33.7% (high) (a ratio of 1.5), whereas comparable population growth

Table 12. Projected Heart Disease Deaths and Prevalence Growth Under Alternative Scenarios, 2000–2050* (Percent)

Year	Low Series			High Series		
	Deaths	Prevalence	Population	Deaths	Prevalence	Population
2000	12.5	15.1	8.5	15.2	17.7	11.3
2010	11.0	11.1	3.8	20.4	20.1	13.1
2020	22.7	10.8	2.6	33.7	21.6	13.7
2030	18.1	9.6	0.8	30.7	22.3	13.3
2040	−0.4	1.8	−1.2	15.3	16.5	13.2
2050	−4.0	−3.4	−1.8	12.4	12.6	13.2

*Growth over previous decade. Source: Heart disease projections by the authors and Table 7.

varies between 2.6% and 13.7% (a ratio of 5.3). Another way of looking at the same numbers is that a difference of 11% seems more significant on a lower base (2.6) than on a higher base (22.7).

This relative insensitivity of the heart-disease projections reflects the fact that heart disease is an older person's disease. Alternative population scenarios are based on alternative assumptions about fertility, life expectancy, and net immigration (Table 6). Variations in fertility will have very little impact on heart disease over a 50-year projection horizon because a newborn in 2000 is only age 50 in 2050 and all other subsequent newborns are younger. Variations in net immigration are likely to have a somewhat greater impact, although it still takes years (because many migrants are in their 20s) before they enter their high-incidence heart disease ages. For example, a new 25-year-old immigrant in 2000 becomes a senior in 2040. This means that variation in life expectancy is the most significant demographic determinant of heart disease projections because it directly affects the number of people in the senior ages. Although variations in all three assumptions directly influence population size, only variations in life expectancy have substantial impact on the population most at risk for heart disease. This conclusion means that strategic planning for both the private and the public sectors is somewhat easier in areas related to heart disease than in many other sectors (e.g., work-force and recreation).

The most likely projection for the population and, therefore, for heart disease deaths and prevalence probably lies between the low and middle projections. The middle series is more likely to happen than the low series, while the high series seems unobtainable. The scenarios presented in this section provide the alternatives around which strategy can be assessed.

IMPLICATIONS AND CONCLUSIONS

The heart disease projections presented in this article have important implications for both work-force requirements and the costs associated with the provision of services both inside and outside of the health care sector. In addition, the past 50 years have demonstrated the impact that research and development and technology can have on the delivery of services to patients afflicted with heart disease. Not only have age-adjusted death rates been reduced since the 1960s, but the introduction of new techniques has necessitated ongoing work-force recruiting and training and new facility and equipment purchases.

This concluding section explores some of the work-force and cost implications of changing demographics and then outlines how technological changes can be incorporated into the analysis. It provides a bridge to complementary research on costs and technology not considered in detail in this article (4,6).

Work-force implications. The increase in the number of heart disease cases in the future will lead to an increase in the number of qualified physicians and other related health care personnel required to manage the increased patient load within the health care system. There are also increased work-force requirements outside of the health care system from those who develop, supply, and build the facilities and equipment to those who bury the dead. From an ACC perspective, the primary concern is with the physician requirements, so this subject will be the focus of this section. However, the same analytical approach can be applied to other related occupations.

The ratio of total patients to total physicians can be defined as the average patient load. If this ratio remains unchanged, then an increased number of patients (as projected above) will lead to increased physician requirements. In the very near future, this can be accomplished by a heavier physician workload; but, over a longer period (as considered in this article), this increase will be accommodated by a need for more qualified physicians, in this case cardiovascular specialists.

If the average patient load does not change, then the increased requirement for cardiovascular specialists will be directly proportional to the growth in the number of patients (Fig. 3). Deaths from heart disease are projected to increase by 128.5% between 2000 and 2050, which suggests a need to more than double the number of cardiovascular specialists over this period. However, because most of the growth will occur before 2030, the needs are concentrated in the early part of the new millennium. In particular, heart disease deaths are projected to increase by 95.8% between 2000 and 2030, or 2.3% per year.

Although heart disease deaths indicate a need for cardiologists, patients that do not die continue to make demands on the profession. Consequently, prevalence is more important than death in determining work-force requirements. The prevalence results indicate similar but not identical needs—a 66% increase by 2030 and a 93% increase by 2050. Although they are smaller, they are still substantial increases (1.7% and 1.3% annually, respectively), especially for a general work force that is unlikely to grow more than 1% annually over the period and a population growing at an even slower pace.

However, the assumption of an unchanged patient load requires investigation. Table 13 includes American Medical Association data on the number of self-identified, active, nonfederal physicians involved with office-based patient care in cardiovascular disease. In 1996, of the 664,000 professionally active physicians in the U.S., 446,000 (or 67.2%) were involved in office-based patient care (of whom 14,000 [or 3.2%] were classified as being involved with cardiovascular diseases). Because hospital-based practice, medical research and teaching, and federal physicians may also be involved with cardiovascular diseases, 3.2% of all 664,000 physicians would result in an estimated total of 21,400 physicians involved with cardiovascular diseases in 1996. This estimate of cardiovascular physicians is developed for selected years in Table 13. Age-adjusted heart

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Table 13. Heart Disease Patient Load Estimates, 1980–1996 ('000)

	Year			
	1980	1990	1995	1996
PHYSICIANS:				
Professionally Active	435.5	560.0	646.0	663.9
Office based	271.3	359.9	427.3	445.8
Cardiovascular	6.7	10.7	13.7	14.3
% Cardiovascular*	2.5	3.0	3.2	3.2
Total Cardiovascular†	10.8	16.6	20.7	21.4
Deaths‡	473.2	681.8	729.0	738.5
Deaths/CV Physician	53.3	41.0	35.2	34.5
Prevalence‡	17,736.9	20,144.3	21,793.4	22,072.5
Prevalence/CV Physician	1,649.2	1,209.9	1,052.2	1,032.6

*Cardiovascular disease share of office-based practice. †Percent cardiovascular multiplied by total professionally active. ‡Age adjusted (at 1995 rates). Source: Statistical Abstract, 1998, Table No. 190 and calculations by the authors.

disease deaths and prevalence estimates consistent with the projections are then divided by this estimate of cardiovascular physicians to produce crude measures of average physician patient load (Table 13 and Fig. 4). (These estimates are biased upward to the extent that not all heart disease patients have a cardiologist as the primary care physician, and they are biased downward to the extent that cardiologists are the primary care physician for non–heart disease [including cerebrovascular disease, hypertension, and atherosclerosis] patients. If the proportion of heart disease patients treated by a cardiologist remains unchanged, then the average patient load estimates can be used to determine work-force requirements. American College of Cardiology data confirm these patient load trend estimates.)

Regardless of the accuracy of the individual numbers, these crude measures indicate that average physician patient load in cardiovascular medicine has declined by more than one third over the 1980–1995 period. This downward trend, which continued into 1996 (Table 13), reflects the fact that the growth in the number of cardiovascular physicians outpaced the growth in age-adjusted patients over the period (Fig. 4).

There may be many reasons for these trends. First, physician contacts per patient have risen 25% over the period. For all physicians, the average American male visited a physician 4.9 times a year in 1995, up from 4.0 in 1980, while the average American female's annual visits increased from 5.4 in 1980 to 6.9 in 1995. This increasing trend might be expected in an aging population because the average senior (11.1 visits per year) is more than twice as likely to visit a physician as an average 25- to 44-year-old (5.2 visits per year) and almost three times as likely as the average school-age student (3.4 visits per year). But even average seniors' visits have increased 73%, from 6.4 in 1980

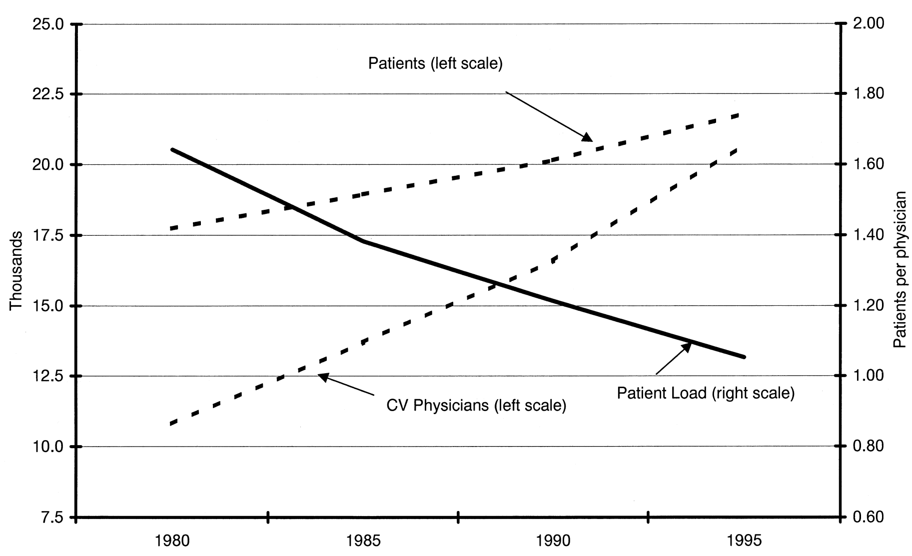

Figure 4. Heart disease patient loads, 1980 to 1995.

Table 14. Physicians by Age and Gender, 1997

	Age (Yrs)					
Physician Specialty	**Under 35**	**35–44**	**45–54**	**55–64**	**65 and over**	**Total**
			('000)			
All Physicians	133.8	213.4	175.5	104.3	129.7	756.7
Cardiovascular	1.7	6.8	6.0	3.1	1.6	19.3
Pediatric Cardiology	0.2	0.5	0.3	0.2	0.1	1.4
Thoracic Surgery	0.1	0.2	0*	0*	0	0.3
			(%)			
All Physicians	17.7	28.2	23.2	13.8	17.1	100.0
Cardiovascular	8.9	35.4	31.1	16.1	8.5	100.0
Pediatric Cardiology	13.4	37.6	24.5	15.7	8.7	100.0
Thoracic Surgery	34.9	63.9	0.7	0.4	0	100.0

*Less than 100. Source: American Medical Association, Physician Characteristics and Distribution in the U.S., 1999, Tables B.3 and B.4.

to 11.1 in 1995, so aging is only part of the explanation. Another part of the explanation, especially in cardiovascular medicine, is that the average number of operations and procedures per patient has increased. The American Heart Association reports that over a similar time period (1979–1996), the number of cardiovascular operations and procedures increased by 355%, whereas the number of patients increased by 227.7%. Specific procedures, such as cardiac catheterization and coronary artery bypass surgery, increased by 315% and 425%, respectively, over the same period (7).

These numbers are indicators of an increasingly demanding and complex patient base. Not only is the average physician seeing the same patient more often in a year, but there also appears to be more likelihood that the patient will require an operation or a procedure. This trend can reflect an increase in incidence of heart disease, patient demands (perhaps resulting from better education and incomes), and availability of operations and procedures.

Whatever the reason, if this trend of decreasing patient load continues, then the need for new cardiovascular physicians will be even greater than indicated by the prevalence (and death) estimates presented above. For every 10% decrease in average patient load, 20% more physicians are required. At 2% a year, this trend doubles the need for physicians within 50 years.

Note that these patient-load estimates do not consider average hours worked per week (or per year). Obviously, one solution to the reduced patient-load challenge would be a proportionate increase in hours worked. However, even without the benefit of appropriate data, it is unlikely that such a recommendation would be a realistic solution to the work-force requirement challenge outlined previously.

Finally, the above work-force requirements are net estimates—that is, in addition to the projected retirements over the period. Because there is no rule that physicians retire at a certain age, such as 65, it is always difficult to project retirements. Table 14 presents the 1997 age distribution of physicians, including cardiovascular specialists. Not surprisingly, this distribution reflects the population at large, with the highest percentages being in the boomer ages. More than one half of all physicians were age 35–54 in 1997 (when the boomers were age 33–51). For cardiovascular disease, the figure is even greater at 66.5%. Moreover, these figures are biased downward because they include both active and inactive physicians, as evidenced by the relatively high percentage in the 65-and-older age group.

These data suggest that cardiologists are generally younger than the total physician population. Less than one quarter (24.6%) are 55 years and older compared with over 30% (30.9) for the general physician population. The maximum numbers, like the boomers, are in the 35–44 age group in both groups, but the share is bigger for cardiovascular medicine. However, the share under 35 years is smaller in cardiovascular medicine compared with the general physician population, which could reflect the increased training and practice style of cardiovascular specialists.

Although there is some consolation in the fact that the majority of cardiovascular specialists are still 20 or more years from retirement, there will still be significant numbers departing from the profession during the next decade. Over 3,000 cardiovascular specialists are 55–64 years old, representing 16.1% of the total number of cardiovascular specialists, or 17.5% of the number under 65 years of age. With increasing demand for their services, some may be induced to keep practicing, but the retirement of the remainder will add to the demand for physicians in the future.

If only 10% retire during the next decade, this adds another 1% (on average) to the annual growth in the demand for physicians. However, the real challenge will occur in the second decade of the new millennium when the boomers reach the prime heart disease ages and the boomer physicians are retiring.

Now is the time to confront this challenge. The children of the boomers, the large "echo" generation, are now leaving

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Table 15. Selected Consumer Price Indexes, 1980–1997 (1982–1984 = 100)

Item	Year			
	1980	1990	1995	1997
All items	82.4	130.7	152.4	160.5
Medical care	74.9	162.8	220.5	234.6
Medical commodities	75.4	163.4	204.5	215.3
Prescription drugs	72.5	181.7	235.0	249.3
Medical services	74.8	162.7	224.2	239.1
Physician	76.5	160.8	208.8	222.9
Hospital	69.2	178.0	257.8	278.4
		(1980 = 100)		
All items	100.0	158.6	185.0	194.8
Medical care	100.0	217.4	294.4	313.2
Medical commodities	100.0	216.7	271.2	285.5
Prescription drugs	100.0	250.6	324.1	343.9
Medical services	100.0	217.5	299.7	319.7
Physician	100.0	210.2	272.9	291.4
Hospital	100.0	257.2	372.5	402.3

Source: Statistical Abstract, 1998, Table 773, and calculations by the authors.

high school and entering college. College enrollments are rising, and this trend will continue for at least another decade. The peak of the echo boom, those born in 1991, turn nine in the year 2000. They are approximately 13 years away from making a decision about whether or not to enter medical school and perhaps 20 years away from choosing a specialty.

There will be a window of opportunity during the early 2000s to develop a strategy to attract and retain the children of the boomers into the profession. High-profile college and medical school scholarships and internships could be an important ingredient in the strategy, as could mentoring programs in high-profile institutions or with key practitioners and research cardiovascular physicians. Although the echo generation is not quite as large as the boomer generation, its members will be crucial in filling the future need for physicians—that of looking after their aging parents and their parents' friends. The opportunity to attract them into the cardiovascular medicine profession should not be missed.

Cost and technology implications. The general results presented in this report indicate that at unchanged per-capita cost levels and disregarding inflation, costs associated with heart disease will grow approximately twice as fast as the general population. Productivity growth, perhaps facilitated by technological advances, could help ameliorate this increased cost, but the average patient-load trends suggest that technological advances may be resulting in greater longevity (and complexity) of patients, rather than in increasing the average physician patient load.

Table 15 presents limited data on the costs of medical care in general. Over the 15-year period from 1980 to 1995, the general price index increased 85%, whereas the medical care price index increased 194%, the drug component rose by 224%, the physician component increased 173%, and the hospital component rose by 273%. Therefore, while the cost of physicians grew by over twice the general cost of items in the economy, the cost of drugs and hospitals increased by much more. Over the same period, the population grew 15.5%, and age-adjusted heart disease deaths and prevalence increased by 27% and 23%, respectively (derived from Table 13). Consequently, demographic change as measured by heart disease indicators accounted for no more than 14% of the increase in the medical care price index. Clearly, the causes of rapidly increasing medical costs over the past 15 years (1980–1995) lie elsewhere. Demographic changes should not be blamed for these increases.

By affecting death rates and, hence, life expectancy, technological change can have a direct impact on population size and composition. It can also affect death prevalence rates by keeping patients with known chronic heart conditions alive longer. Increases in life expectancy are included in this article; however, to isolate demographic influences, changes in heart disease death and prevalence rates are not considered in this article, although the methodology can easily incorporate such changes.

Technological change will also change medical practices (4). These types of changes can affect physician patient loads and, hence, future physician requirements. It can also affect the use of facilities, including equipment and pharmaceuticals, which will have a direct effect on future costs (6). Although neither of these impacts is explored in this report, the methodology can be extended to incorporate these changes by varying appropriate parameters (e.g., physician patient loads).

Conclusions. This article isolates the effects of demographic changes on the cardiovascular medicine profession over the next 50 years (2000–2050). The past 50 years (1950–2000), during which the ACC has been in existence, provide the historical context for the projections. The research findings show that changing demographics alone, especially the aging of the boomer generation into their senior years during the 2010s and 2020s, will have a major impact on the profession. Both the prevalence of chronic heart disease and the number of deaths attributable to heart disease can be expected to grow much faster than the population until the 2040s, when many of the boomers will have died. The implications for physician requirements are substantial. Moreover, these projected work-force requirements are compounded by increasing patient complexity and increased potential retirements. Now is the time to develop a strategy to recruit the children of the boomers, the large echo generation, into the discipline during the next 15 years. They will be much needed, especially in the 2010s and 2020s when their parents' generation reaches the senior years.

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