Women and Coronary Heart Disease

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- Read the enclosed course.
- Complete the questions at the end of the course.
- Return your completed Evaluation to NetCE by mail or fax, or complete online at www.NetCE.com. (If you are a Florida nurse, please return the included Answer Sheet/Evaluation.) Your postmark or facsimile date will be used as your completion date.
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Faculty Disclosure

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The division planner and director have disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

Audience

This course is designed for all nurses in family practice or medical/surgical areas, especially critical care or cardiac units.

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Course Objective

The purpose of this course is to identify the unique challenges that face women with heart disease, including prevention, diagnosis, and treatment.

Learning Objectives

Upon completion of this course, you should be able to:

1. Describe the morbidity and mortality associated with CHD, especially in women.
2. Describe how female cardiac anatomy and physiology differs from men's.
3. Discuss the role that traditional and nontraditional risk factors play in the development of CHD in women.
4. List sex- and gender-specific risk factors for CHD in women.
5. Discuss primary CHD prevention strategies for women.
6. Identify reasons CHD is more complex to diagnose in women.
7. Compare and contrast the efficacy of noninvasive and invasive cardiac diagnostic tests in women.
8. Describe the basic types and variations of angina and their prevalence in women.
9. Compare and contrast the usual clinical course of women with angina versus myocardial infarction (MI).
10. Discuss common complications seen in women post-MI.
11. Discuss clinical outcomes of medical treatment options in women with CHD.
12. Discuss the preoperative status of women undergoing coronary artery bypass (CABG) surgery and implications for postoperative outcomes.
13. Describe clinical outcomes associated with female participation in formal cardiac rehabilitation programs.
14. Identify nursing diagnoses and appropriate nursing interventions applicable to women with CHD during the acute phase.
15. Identify reasons women have historically been excluded from clinical trials related to the diagnosis and treatment of CHD.
16. Identify areas where further research is needed in relation to CHD and women.

Sections marked with this symbol include evidence-based practice recommendations. The level of evidence and/or strength of recommendation, as provided by the evidence-based source, are also included so you may determine the validity or relevance of the information. These sections may be used in conjunction with the course material for better application to your daily practice.

INTRODUCTION

More than one in three women in the United States has coronary heart disease (CHD) [1]. This fact has stimulated the lay and scientific communities, and CHD has gained recognition as a significant health issue for women. The purpose of this course is to discuss the realities and uncertainties about CHD in women. Progress has been made in defining both the incidence of CHD in women and how women and men differ in regard to cardiac anatomy and physiology. In addition, both traditional and sex- and gender-specific cardiovascular risk factors have been studied, along with the reliability of conventional cardiac diagnostic tests in women. However, many uncertainties remain because, for many years, women have largely been excluded from CHD research. In particular, cardiac symptomatology of women may differ from the classic textbook cases seen in men. Clinical outcomes of women receiving standard medical and surgical treatments remain another area of difference. Healthcare professionals who participate in this course will be able to identify the unique challenges women face—from prevention and diagnosis to treatment issues. Patients will benefit from this advanced knowledge base as healthcare providers strengthen their roles as patient advocates and health educators. This knowledge and skill will help women to receive appropriate and timely treatment, as well as preventive and follow-up care.

The American heart Association asserts that, to optimize prevention and clinical care, interdisciplinary collaboration between cardiologists, vascular neurologists, primary care clinicians, obstetricians-gynecologists, and other relevant health professionals is necessary to improve recognition of women's risk for cardiovascular disease lifelong and improve implementation of holistic risk-reducing strategies. Clinical education must emphasize the importance of risk factors specific or predominant in women. Risk calculators must integrate quantitative measures of risk in women for life course use (childhood and adolescent well visits, preconception, gestational and postpartum visits, and primary care and gynecologic visits).

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Level of Evidence: Expert Opinion/Consensus Statement

OVERVIEW OF WOMEN AND CHD

CHD remains a major health problem in the United States, but only in the last few decades has there been an increased focus on the incidence of CHD in women. This section will discuss the morbidity and mortality associated with CHD in women compared to that seen in men. Factors that influence these differences will be discussed, including the unique cardiovascular system features seen in women and the significance of cardiovascular risk factors in women, including traditional, nontraditional, and gender- and sex-specific risk factors. Techniques to help women determine their level of risk for CHD will be discussed based on assessing certain cardiovascular parameters, risk factors, and lifestyle choices.

MORBIDITY

Statistics have shown that women are at considerable risk for CHD, contrary to previous belief. An estimated 44.4% of women 20 years of age and older in the United States are affected by some form of cardiovascular disease [1]. The prevalence is 42.1% in non-Hispanic White women, 58.8% in non-Hispanic Black women, and 42.7% in Hispanic women [1]. In 2010, CHD was the first-listed diagnosis of 2.2 million women discharged from short-stay hospitals [1].

Overall, the incidence of CHD in women increases with age [2]. In women younger than 65 years of age, CHD usually manifests itself about 10 years later than it does in men. By about 65 years of age, however, a woman's risk is approximately equal to a man's and the outcomes are frequently worse [1]. In women 75 to 84 years of age, the morbidity from CHD increases 40-fold compared to women 35 to 44 years of age [3].

CHD can be obstructive or nonobstuctive in nature. Obstructive CHD is an acute condition whereas nonobstructive CHD (defined as less than 50% stenosis in epicardial coronary arteries) is a chronic condition [347]. CHD most commonly presents in the form of angina in women, compared to myocardial infarction (MI) and sudden death in men. However, women tend to report chest pain less frequently than men, which may result in either a delayed diagnosis or a misdiagnosis. Women are also frequently further along the disease trajectory than men when presenting with cardiac symptoms [1; 4]. Even women who are at risk for CHD may not be referred for diagnostic tests that are considered routine in men [1]. Therefore, screening is the key, with early detection focused on improving clinical outcomes and reducing the costs associated with hospitalization. Furthermore, symptomatic women should be advised to interact with her physician and persist until a correct diagnosis is obtained.

The older adult population is changing the demography of CHD in the United States. In 2018, 16% of the U.S. population was 65 years of age and older [5]. This number is projected to grow to 20% of the U.S. population (approximately 72 million people) by 2030 [6]. Individuals who are 85 years of age and older are the most rapidly growing subgroup of older adults. Approximately 6.3 million Americans are 85 years of age and older, with a projected increase to more than 19 million expected by 2060 [7; 8]. These trends will clearly influence the diagnosis and treatment of CHD in women. For the year 2015, the total economic cost of this health problem in the United States was estimated to be $351.2 billion [3]. Given the fact that the incidence of CHD in women increases with age, coupled with the projected increase in the older population, this economic burden will continue to grow.

MORTALITY

CHD is the leading cause of death in American women [9]. Although the risk of breast cancer has been the focus of intense media coverage for several years, CHD is responsible for more deaths among women in the United States each year than all forms of cancer, including breast cancer [9]. However, CHD mortality has been declining for men and women since 1979. In a 1979–2011 analysis, mortality rates declined consistently for adults older than 65 years of age, with steep declines observed between 2000 and 2011. While adults younger than 55 years of age showed initial declines in mortality, these improvements eventually plateaued, with younger women experiencing the least improvement [345]. The rate of CHD death increased 6% from 2011 to 2017 [10]. In 2019, CHD was the cause of death in 420,812 women, representing 48.1% of all CHD deaths [1].

FRAMINGHAM HEART STUDY CARDIAC OUTCOMES		
Outcomes	**Percent of Women**	**Percent of Men**
Suffered a more serious coronary event	17%	44%
Remained survival free of MI for eight years	80%	71%
Had an uncomplicated course post-MI	86%	66%

Source: [11] *Table 1*

In terms of race, CHD mortality declined 14% for non-Hispanic White women and 20% for non-Hispanic Black women from 1999 to 2009 but then increased 12% from 2009 to 2017. Unlike the trends for non-Hispanic White and Black women, the CHD death rates for Hispanic women declined by 37% from 1999 to 2017 [10]. This decline is most likely due to improved medical care and increased emphasis on prevention via reduction of cardiovascular risk factors [11; 12; 13].

THE FRAMINGHAM HEART STUDY

The Framingham Heart Study was one of the first longitudinal studies conducted to investigate sex differences in the prevalence and manifestations of CHD. The study enrolled equal numbers of men and women with a total sample size of 5,127 subjects. After 26 years, the findings demonstrated that 40% of all documented cardiac events occurred in women. In addition, the study suggested that women with angina have a better prognosis than men [11]. The clinical outcomes documented in this study are shown in ***Table 1***.

It is important to note that these early findings suggested that, for women, a diagnosis of CHD was not a serious health matter. In the Framingham Study, the symptom of chest pain was used to define the presence of CHD. As a result, many women who suffered chest pain attributable to a noncardiac cause were still enrolled in the study, thus explaining their significantly longer survival when compared to men. These findings, which suggested that CHD in women was not serious, led to an under-recognition of the significance of cardiovascular risk factors and manifestations in women. This trend has been referred to as a treatment, referral, and research bias [14]. For instance, women remain on medical management longer than men before undergoing invasive diagnostic testing and revascularization by either percutaneous coronary intervention (PCI) (also referred to as percutaneous transluminal coronary angioplasty or coronary artery bypass graft (CABG) procedures. This delay may be due to the physician's reluctance to refer women to a procedure that may be associated with complications (e.g., age and other risk factors), as well as the patient's desire to forgo these types of procedures [15; 16].

CARDIOVASCULAR RISK PROFILE IN WOMEN

THE FEMALE CARDIAC ANATOMIC PROFILE

Several anatomic and physiologic differences exist in the cardiovascular system of women compared to men. Because women's bodies are generally smaller in stature, the female heart and thoracic cavity are smaller and lighter. A woman's heart weighs approximately 229 grams, whereas a man's heart weighs 285 grams. The female heart also has smaller coronary arteries than a man's heart. The right coronary artery appears to be more dominant in women [1; 17; 18; 19; 20].

In addition to anatomic differences in male and female cardiovascular systems, research indicates that women may deposit plaque differently than men. The Women's Ischemia Syndrome Evaluation (WISE) Study, supported by the National Heart, Lung, and Blood Institute, evaluated sex differences in the presentation and treatment of obstructive CHD [21; 22]. Researchers found that women's atherosclerotic plaque deposition was more diffuse than men's. This physiologic difference results in scalloping or artery irregularities, rather than the large, obstructive blockages that are commonly associated with CHD and MI. A 2019 study also analyzed plaque characteristics in male and female patients with suspected CHD. A total of 1,050 patients were matched for sex, age, and known coronary risk factors. All patients underwent CT angiography analysis to assess for stenosis, plaque types (i.e., noncalcified, mixed, or calcified), and high-risk plaque features [23]. The men had significantly more plaques and a larger proportion of calcified plaques, whereas women had more mixed and noncalcified plaques. These findings support the need for a differentiated plaque analysis to improve the accuracy of risk stratification for both sexes [23].

Microvessels and vasodilator response also appear to be impaired more frequently in the female population. These less obvious changes are more difficult to detect from a traditional angiogram and may result in different symptoms. These characteristics may partially account for the differences in presentation and subsequent treatment of CHD in women.

On the electrocardiogram (ECG), women's resting heart rate is higher, PR and QRS intervals tend to be shorter, and the amplitude of the R, S, and T waves across the precordium are smaller. Left ventricular end-diastolic pressure and volume are also lower in women, yet stroke volume and resting ejection fractions (EF) tend to be higher in women than in men [24]. Up to 30% of women with normal coronary arteries do not have an increase in EF with exercise, a finding that has important implications for exercise testing [1; 17; 19; 25; 26; 27].

Hematologic differences also exist. Women's hematocrit and blood volumes tend to be lower, along with their oxygen-carrying capacity. Cholesterol levels tend to rise in women around 55 years of age; however, the natural estrogens of perimenopause are believed to provide protection against CHD by conferring beneficial effects to the lipid profile. It has also been suggested that estrogen receptors located within the walls of blood vessels may affect the proliferation of smooth muscle cells, reduce platelet aggregation, and alter the degradation of collagen and elastin [22; 28; 29].

The last anatomic and physiologic difference between men and women is body fat percentage. The percentage of body fat is higher in women and may be distributed differently. Women who have a large waist, also referred to as abdominal obesity or central adiposity, tend to have an increased risk of an MI at an earlier age [19; 20; 28]. Studies have suggested that, in particular, waist-to-hip ratio measures of abdominal adiposity may be strong indicators of mortality in women [30; 31; 32]. Other studies have indicated that waist-to-height ratio may be an accurate predictor of CHD in women [33; 34]. Patterns of fat distribution and associated cardiovascular health risks will be discussed in further detail in the following section on traditional coronary risk factors. ***Table 2*** summarizes how women's physiologic profile differs from men's.

TRADITIONAL RISK FACTORS

Traditional cardiovascular risk factors increase the likelihood of the development of CHD in both men and women. However, the weight given to these risk factors may not be the same between the sexes. Furthermore, the traditional diagnostic tests, which generally focus on obstructive disease, are not as effective in women as compared to men [21]. At comparable levels of cardiovascular risk factors, the risk of a cardiac event in a premenopausal woman is 50% the risk level for a man the same age. The relative protection of women from CHD may be due to better tolerance of cardiovascular risk factors, as well as hormonal and metabolic differences [21; 35].

PHYSIOLOGIC PROFILE OF WOMEN COMPARED TO MEN	
Physiologic Characteristic	**Female Tendencies**
Body size	Smaller in size
Heart and thoracic cavity size	Smaller and lighter in size Smaller cardiac muscle fibers
Coronary arteries	Smaller in diameter Right coronary artery dominance
ECG	Higher resting heart rates Shorter PR and QRS intervals Smaller amplitude of R, S, and T waves
Stroke volume	Higher
Resting EF	Higher
Left ventricular end-diastolic pressure and volume	Lower
Hematology	Lower hematocrit and blood volumes Lower oxygen-carrying capacity Natural estrogens in premenopausal women that protect from effects of obstructive coronary heart disease Higher cholesterol levels beginning at 55 years of age
Body fat percentage and distribution	Increased body fat percentage and different fat distribution
Source: [17; 19; 20; 26; 27; 28]	*Table 2*

Traditional risk factors may be further categorized as nonalterable and alterable factors. While recognition of both sets of risk factors is important, patient care should include an emphasis on those factors that can be altered or changed.

Nonalterable Factors

Age

As men and women age, they become progressively more likely to develop CHD. Men's heart problems tend to peak earlier than women's; however, the incidence in women tends to catch up to that in men around 65 years of age. Until that time, estrogen produced during the premenopausal years provides some protection. As a result, CHD usually manifests itself 10 years later in women compared to men. Women are also more likely to have other age-related health problems, such as diabetes, hypertension, or arthritis [36; 37].

Family History

Family history is a significant traditional CHD risk factor. Premature family history of CHD (before 55 years of age in fathers and before 65 years of age in mothers) is a risk-enhancing factor for both men and women. [28; 38; 39; 340].

Ethnic Background

Like family history and age, ethnic background is a factor that cannot be modified. For example, non-Hispanic Black women are at higher risk of developing and dying from CHD compared with non-Hispanic White and Hispanic women [40; 41]. Women of south Asian descent are also at increased risk, which has been attributed to a higher incidence of uncontrolled hypertension, obesity, and sedentary lifestyle in this population [340]. Differences in access to and utilization of healthcare services, as well as the need for risk reduction interventions targeted at specific socioeconomic status, may also be contributing factors [40; 42; 43].

Alterable Factors

Again, alterable cardiovascular risk factors require the most attention when counseling female patients. These factors include smoking, hypertension, hyperlipidemia, diabetes, obesity, metabolic syndrome, sedentary lifestyle, obstructive sleep apnea, and psychosocial wellness.

Smoking

Although there has been a consistent decline in cigarette smoking in the United States over the past several decades, an estimated 14.1% of men and 11.0% of women continue to smoke [45; 344]. Cigarette smoking remains the most dominant independent cardiovascular risk factor for women, especially for those younger than 55 years of age, increasing their risk sevenfold [338; 344].

As a risk factor, smoking accounts for more than one-half of all cardiac events [47]. Results of the Nurses' Health Study (NHS) and NHS II have indicated that the mortality rate of women who smoke is higher than that of former smokers (i.e., those who have quit smoking) and is twice that of women who have never smoked. The NHS results have also indicated that women who smoke are more likely to have comorbid conditions than women who do not smoke [48]. Smoking also increases the risk of sudden death in both men and women [49].

According to the Centers for Disease Control and Prevention (CDC), cigarette smoking causes an estimated 201,773 deaths among women each year and increases a woman's risk of dying threefold [50]. The risk increases with the number of cigarettes smoked per day and the duration smoking history [51]. Women who smoke more than 24 cigarettes per day have a 10-fold increase in MI risk compared with nonsmokers. However, the risk of a first MI decreases soon after a person stops smoking. The risk of having a nonfatal MI declines within three to four years to the same level as that of women who have never smoked [19; 26; 36].

Smoking produces harmful physiologic effects by decreasing high-density lipoprotein (HDL) levels and increasing platelet aggregation and fibrinogen levels [42]. Smoking is also associated with early menopause and may exert an antiestrogenic effect [44]. The widespread use of cigarettes, and the significance of smoking as a risk factor, led the Surgeon General to state that it is the leading preventable cause of disease and deaths in the United States [46]. Women are less likely to quit smoking than are men due to a desire for slimness. And, when women do quit smoking, they tend to experience greater weight gain than do men [20; 36].

Cigarette smoking also works synergistically with other cardiovascular risk factors in influencing the development of CHD. For instance, women who smoke and also use oral contraceptives increase their risk for CHD compared to those women who neither smoke nor use the pill [52; 53]. Coronary-related mortality rates are also higher in women smokers who have high cholesterol levels [54].

Hypertension

Like smoking, hypertension is a powerful independent risk factor for the development of CHD in men and women. Compared with men, hypertension is twice as prevalent in women with CHD. Additionally, women with hypertension have three to four times the risk of developing CHD than women with normal blood pressure [56]. Among non-Hispanic Black women, hypertension tends to occur at an earlier age, be more severe and treated less adequately, and result in more significant morbidity and mortality rates. More than 57.6% of non-Hispanic Black women in the United States have hypertension, compared with 40.5% of White women [1]. In addition to Black women, pregnant women and postmenopausal women older than 65 years of age are also at high risk for developing hypertension [57].

Hypertension damages the lining of blood vessels and promotes the deposition of plaque, thereby predisposing people to CHD. Hypertensive women are also more likely to have other significant cardiovascular risk factors, including diabetes, obesity, or high cholesterol levels. If accompanied by obesity and oral contraceptive use, a woman's risk of CHD increases two- to fourfold.

Hypertension is one of the most modifiable cardiovascular risk factors [55]. Patients with prehypertension (defined as blood pressure 120–139/80–89 mm Hg) may be at risk for progression to hypertension and in need of lifestyle modifications [55]. Hypertension has been defined as a blood pressure of 140/90 mm Hg or greater. Even among individuals with no evidence of hypertension by 55 to 65 years of age, an estimated 90% will eventually develop hypertension [59]. CHD risk increases approximately twofold in men and threefold in women with hypertension [60]. Even modest increases in blood pressure have been shown to be dangerous. As little as a 10 mm Hg rise in systolic blood pressure may increase a woman's risk for CHD and stroke by 20% to 30% [26; 36; 61]. Tight control (<130 mm Hg systolic) has been associated with a 42% lower incidence of stroke [344].

The measurement of the ankle-brachial index (ABI) may play a role in assessing a person's level of CHD risk for CHD. Normally, blood pressure values are equal to or higher in the ankles compared to those in the arm. While a lower blood pressure in the ankle has been recognized as a sign of peripheral vascular disease, the ABI is a marker for overall CHD risk. A low ABI (i.e., less than 0.9) has been associated with an increased risk of CHD and stroke [61; 63; 64]. However, a systematic review conducted by the U.S. Preventive Services Task Force found insufficient evidence to support ABI as a useful screen to identify asymptomatic patients at risk of cardiovascular events [61].

Hyperlipidemia

Hyperlipidemia is a strong traditional cardiovascular risk factor [355]. From 2015 to 2018, hyperlipidemia was present in 38.1% of U.S. adults [344]. In 2015–2018, 40.4% of women 20 years of age and older had total blood cholesterol levels of 200 mg/dL or greater [1]. Of these, 14.8% of non-Hispanic White, 10.3% of non-Hispanic Black, and 9.0% of Mexican Americans have total blood cholesterol levels of 240 mg/dL or greater [66].

CHD risk is low if total cholesterol levels are less than 200 mg/dL. Cholesterol levels are considered borderline-high risk between 200 and 239 mg/dL and high risk when total cholesterol climbs to greater than 240 mg/dL. These high levels are also the point at which a woman's risk of CHD doubles [65]. In general, younger women tend to have more favorable lipid profiles (e.g., high HDL, lower low-density lipoprotein [LDL]/very low-density lipoprotein [VLDL] and triglycerides).

While total cholesterol plays an important role in global risk assessment, individual components have a more integral role in the development and progression from fatty streak to atherosclerotic plaque formation [343; 355]. Elevated total cholesterol (sum of HDL, LDL, and VLDL) and LDL predict cardiac death in both middle-aged and older women. LDL transports cholesterol to organs and blood vessels. Thus, LDL is associated with the development of atherosclerotic plaque and has been referred to as "bad cholesterol." CHD risk increases when LDL reaches 160–189 mg/dL [340]. VLDL consists of small particles with very high triglyceride and cholesterol content.

Triglyceride levels are considered normal if they are less than 150 mg/dL when cholesterol levels are also normal. Borderline-high blood triglyceride levels fall in the 150–199 mg/dL range. Levels increase following a meal and are also affected by time of day, diet, hormones, medications, recent exercise, and alcohol intake. Very few individuals have levels greater than 500 mg/dL which is considered very high [67; 68; 338]. These extremely high levels are rarely caused by diet alone and usually involve other cardiovascular risk factors [67].

In contrast, HDL is responsible for transporting cholesterol away from blood vessels and back to the liver. Because HDL helps remove cholesterol from the blood, it has been coined the "good cholesterol." Low HDL is another powerful CHD risk factor in women [338].

Diabetes

Of the estimated 26.8 million persons in the United States with diagnosed diabetes, about 12.8 million are female, a number that has more than tripled since 1980 [70]. From 2015 to 2018, another 9.8 million adults were estimated to have undiagnosed diabetes and 113.6 million adults with undiagnosed prediabetes [344]. In 2017, diabetes was the cause of death of 37,262 women, which represented 44.5% of the total number of deaths from diabetes [71].

Next to smoking, diabetes has the most significant negative effect on cardiovascular-related mortality in women [44]. Women with diabetes have twice the risk of developing CHD compared with nondiabetic women and experience more serious outcomes. For instance, women with diabetes are 25% more likely to experience stroke and are twice as likely to die after an MI compared with men with diabetes [72; 349]. Diabetes also doubles the risk of a second heart attack in women but not in men [56].

High glucose levels irritate the endothelial layer of blood vessels, leading to the development of atherosclerosis. Moreover, diabetes leads to abnormalities in the lipid profile, increasing total cholesterol, LDL, and triglyceride levels and decreasing HDL. In addition, the protective effects of estrogen may be negated in women with diabetes. As a result, diabetic women may be placed in the same cardiovascular risk level as men of the same age who do not have diabetes [56; 72]. For these reasons, diabetes appears to be a more significant risk factor for CHD in women [19; 36; 44; 73]. Although secondary cardiovascular prevention has become more equitable between the sexes, women with diabetes still experience greater coronary hazard than their male counterparts. Sex differences may explain these outcomes in that men develop diabetes at a lower BMI than women. In women with prediabetes, impaired glucose tolerance elevates cardiovascular risk. This finding points to the need for greater screening for prediabetes and clinical follow-up [349].

Obesity

Obesity is another traditional risk factor. In 2016, 39.8% of U.S. adults were obese, an incidence that has greatly increased in the last 20 years [74; 75]. As of 2018, every state had a prevalence of obesity greater than 20%. Twenty-two states reported an obesity prevalence of 30% to 35%, and nine states reported rates greater than 35% prevalence [75].

One-third of U.S. women are obese, and 7% are extremely obese [338]. From 2017 to 2018, the prevalence of obesity among women increased from 33.4% to 41.9% and severe obesity from 6.2% to 11.5% [344]. Women 20 to 34 years of age have the fastest increase in being overweight or obese. Minority women as well as low socioeconomic status individuals are disproportionately affected across all age groups, with 50% at risk of being obese. Approximately 54.8% of non-Hispanic Black women and 50.6% of Hispanic women in the United States are overweight or obese [76].

If a woman is 30% overweight, she is at increased risk for developing an MI, heart failure, stroke, and even death. Mild-to-moderate obesity (i.e., 5% to 15% overweight) may also be detrimental. Women who are overweight have a two to three times greater risk of an MI compared to lean women [77]. Fluctuations in weight may also impact a women's overall risk for metabolic syndrome and CHD [78]. Like the other cardiovascular risk factors, CHD risk increases with certain risk factor combinations, such as obesity and smoking [20; 36; 42; 48; 79]. Obesity unfavorably influences other metabolic processes, including elevation of blood pressure, triglyceride, and uric acid levels; reduction of HDL cholesterol; and alteration of glucose tolerance and insulin sensitivity [20].

Metabolic Syndrome

A clustering of symptoms has been recognized as playing an important role in the development of CHD. This symptom cluster, referred to as metabolic syndrome, is defined as central obesity (i.e., waist circumference ≥ 80 cm in women and ≥ 90 – 94 cm in men), plus any two or more of the following factors [80]:

- Serum triglyceride level of 150 mg/dL or greater
- HDL cholesterol level less than 50 mg/dL (women) or 40 mg/dL (men)
- Blood pressure of 130/85 mm Hg or greater
- Fasting blood glucose level of 100 mg/dL or greater

The age-adjusted prevalence of the metabolic syndrome for adult women in the United States is 35.5% among non-Hispanic Black women, 38.6% among Hispanic women, and 37.4% among non-Hispanic White women [81]. All individuals diagnosed with metabolic syndrome are at greater risk for the development of type 2 diabetes and CHD [82]. However, younger women with metabolic syndrome have a five-fold increase in CHD risk [338].

Physical Inactivity

Inactivity or the lack of consistent aerobic exercise is another traditional cardiovascular risk factor. Among women 18 years of age and older, only 20.8% met the 2018 Federal Physical Activity Guidelines for both aerobic and strengthening physical activity [1]. Research studies have shown that women report lower levels of physical activity compared to men, which may place women in a higher CHD risk category [83]. However, these results should be interpreted cautiously because the measurement tools used may not have been accurate in measuring activities specific to women [36].

Obstructive Sleep Apnea

Growing evidence from large population and clinical cohort studies suggests untreated obstructive sleep apnea is associated with an increased incidence of serious cardiovascular events such as stroke, especially in women younger than 65 years of age. Approximately 50% the general population have apnea with an apnea-hypopnea index (AHI) score of at least 5 events perhour. One study found a nearly three-fold increased risk of first time stroke or cardiovascular events in individuals with obstructive sleep apnea relative to controls [352]. Adequate CPAP treatment (over four hours per day) reduces cardiovascular risk, with greater adherence (over seven hours per day) reducing the incidence of cardiovascular outcomes.

Psychosocial Factors

Psychosocial CHD risk factors include stress/anxiety, anger/hostility, cynicism, depression, and social isolation While single psychosocial risk factors are generally unrelated to level of CHD or its progression, depression is predictive of CHD [358]. Two times more prevalent in women than men, depression increases women's CHD risk by at least 50%. As a powerful risk factor, depression has been associated with early-onset MI, especially in younger and middle-aged women [338; 358]. Additionally, social isolation increases with age. New evidence demonstrates such isolation is a risk factor for heart failure independent of traditional cardiovascular risk factors. Social isolation may influence heart failure risk by inducing a negative psychological state that reduces protective hormones, leading to adverse effects on the heart, blood pressure, and blood vessel wall repair, as well as immune function. As socially isolated individuals lack social support, they may also experience more stress and depression, influencing their engagement in health-promotion activities [357].

SEX- AND GENDER-SPECIFIC RISK FACTORS

Women also face sex- and gender-specific risk CHD factors. Sex differences result from biological factors, including anatomy and physiology, genetics, and sex hormones. Gender differences reflect psychological, behavioral, social, and cultural influences [338]. These risk factors include oral contraceptive use, menopause, rotating shift work, and employment conflict [17; 35; 91; 340].

Sex-Specific Risks

Oral Contraceptive Use

Women who use combination hormonal contraceptives have an increased risk of MI. Women who take hormonal contraceptives and smokes experience a risk 20 greater than that of a woman who neither smokes nor uses oral contraceptives. However, the risk of CHD diminishes after the contraceptives are stopped [19].

Research has indicated that third-generation contraceptives are the first to have been associated with no excess risk of MI [101]. However, other studies have found that women taking third-generation oral contraceptives have an estimated two-fold increased risk of venous thrombosis compared with those taking second-generation oral contraceptives [102; 103; 104]. Additionally, the risk appears to depend upon the class of estrogen, the dose, and the duration of use [105]. A retrospective cohort study used Medicaid data from 2000 to 2013 to assess the relationship between types of oral contraceptives and incidence of CHD in women in South Carolina [106]. Compared with combined oral contraceptives, progestin-only oral contraceptives were associated with decreased CHD and stroke incidence. However, a positive association was found between progestin-only contraceptive plus combined oral contraceptive and incidence of both CHD and stroke. The debate over which contraceptives have the least possibility of harmful side effects continues; more research is needed for a definitive answer.

Menopause

At the time of menopause, serum estrogen levels decrease. The absence of estrogen increases a postmenopausal woman's vulnerability to CHD due to the effects on lipoprotein metabolism. These changes include a decrease in HDL levels and an increase in LDL levels. In addition, blood vessels become less flexible due to the reduction in circulating estrogen after menopause [107]. Premature menopause enhances this risk for women [340].

Research has demonstrated that elevated iron levels increase men's risk of CHD. However, additional studies are needed to determine if the iron retention that occurs in nonmenstruating women is a significant cardiovascular risk factor [108; 109].

Gender-Specific Risks

Rotating Shift Work

Evidence suggests longer durations of rotating shift work can impact cardiovascular health. In one study, female nurses working rotating night shifts had a small but absolute increased risk of CHD [354]. CHD risk waned after the cessation of shift work, with risk decreasing over time. More research is needed to examine the risk associated with specific work hours and individual characteristics, such as sleep duration and quality, hypertension, hyperlipidemia, diabetes, and social support.

Employment Role Conflict

In 2016, women comprised 51.7% of the total U.S. work force and are projected to account for 51.9% of the total labor force by 2024 [92]. It was once believed that with more women entering the work force, they would begin to have the same cardiac disease profile as men. While studies have established job strain (a particular form of job stress) to be predictive of CHD in men, studies in women have been few and have produced inconsistent results [93].

For example, one study of 35,038 women, which was conducted within the NHS, found no relationship between job demands, job control, or social support and CHD [93]. The study examined four types of work experience based on the level of job demands (i.e., low or high) and the level of job control (i.e., low or high). Examples of job demands examined included excessive work, conflicting demands, insufficient time to work, fast work pace, and working hard. Examples of job control examined included skill discretion (e.g., learning new things, task variety) and decision authority (e.g., freedom to make decisions, having a voice in the workplace). The level of support received from coworkers and managers was also included in the assessment. The Framingham Offspring Study found that women with active job strain (i.e., high job demand, high job control) had a 2.8-fold increased risk of CHD when compared to women with high job strain (i.e., high job demand, low job control) [94]. Other studies have indicated that women in male-dominated jobs, women who perform caregiving outside work, and women experiencing marital stress may be at increased risk for CHD [93; 95; 96; 97; 98; 99]. One review of evidence from more than 600,000 women and men in 27 cohort studies in Europe, the United States, and Japan found that work stressors (e.g., job strain, long working hours) were associated with a moderately elevated risk of CHD and stroke but that the risk was similar for men and women [100]. Most researchers agree that additional research is needed that specifically includes women.

NONTRADITIONAL RISK FACTORS

Research has uncovered other nontraditional risk factors that may be implicated in the development of CHD. These nontraditional risk factors include homocysteine, lipoprotein(a), C-reactive protein (CRP), leukocyte count, periodontal disease, and subclinical hypothyroidism.

Homocysteine

Homocysteine, an amino acid by-product of foods rich in protein, occurs naturally in blood and tissues. The prevalence of elevated homocysteine, or hyperhomocysteinemia, increases with age in both sexes and has been linked to atherosclerosis, premature CHD, stroke, and blood clots, even among those with normal cholesterol levels. Research has demonstrated that elevated homocysteine (>12 mmol/L) is relatively common, with hereditary and high dietary consumption of animal protein playing a role [111]. Homocystinuria (>15 mmol/L) elevates the risk for atherosclerosis by increasing oxidative stress and secretion of pro-inflammatory factors that damage the interior lining of arteries. A direct relationship between homocysteine and severity of artery blockages has been established. Researchers have additionally found a 20% increase in risk of coronary events among men and women for every 5 mmol/L increase in homocysteine level [90; 112; 343]. Thus, homocysteine may become as important as other risk factors for CHD in the future.

Lipoprotein(a)

Lipoproteins are molecules that transport fats throughout the body. While LDL has been well documented to be deleterious to the heart, lipoprotein(a) may also wreak havoc. Lipoprotein(a) accelerates the transformation of LDL into plaque and slows the dissolution of blood clots. Any lipoprotein(a) level greater than 30 mg/dL is considered elevated for adults [116]. CHD risk increases with lipoprotein(a) levels greater than 50 mg/dL [340].

C-Reactive Protein

C-reactive protein (CRP) is a specialized protein released when an injury must be repaired or a microbe warded off. CRP is circulated in the body at low concentrations in healthy people. Levels are increased, however, when infection and injury stimulate the body's repair mechanisms. Measuring serum levels of CRP has been shown to be a good predictor of outcome in cardiac patients (***Table 3***).

C-REACTIVE PROTEIN LEVELS AND ASSOCIATED RISKS[a]	
Level	**Risk**
<1 mg/L	Low risk
1–3 mg/L	Average risk
>3 mg/L	High risk
>10 mg/L	May indicate increased cardiac risk or recent inflammatory reaction
[a]Specific target levels for men and women, as well as various ethnic groups, are being studied.	
Source: Compiled by Author	*Table 3*

If a patient with angina has large amounts of the protein in the blood, the likelihood of MI increases. Risk of subsequent infarctions increases in patients who have suffered a MI when CRP levels remain elevated [120].

C-reactive protein may also signal whether a healthy person is at risk. Although a direct correlation between elevated CRP levels and new coronary events has not been established, prospective studies of men, women, and older adults have found that those in the upper third of CRP levels have twice the risk of MI as those with CRP levels in the lower third [120]. Another study found that C-reactive levels are a stronger predictor of cardiovascular events than LDL cholesterol levels [121]. In one study of healthy women, those with metabolic syndrome and a baseline high-sensitivity C-reactive protein (hs-CRP) of 3.0 mg/L had almost twice the risk of future cardiovascular events than those with the syndrome and hs-CRP <3.0 mg/L [122].

The Reynolds risk score (a risk assessment tool) incorporates hs-CRP and has been shown to improve risk prediction in women [121; 122; 123; 124]. Studies have suggested that measuring CRP may increase the predictive value of other cardiovascular risk factors in women. In a study of 122 women, those who experienced a fatal or nonfatal MI, stroke, or underwent a coronary revascularization procedure had significantly higher baseline levels than the control group of four markers of inflammation: hs-CRP, serum amyloid A, soluble intercellular adhesion molecule-1 [sICAM-1], interleukin-6), total and LDL cholesterol, homocysteine, and total cholesterol to HDL cholesterol ratio [124]. Researchers concluded atherosclerosis must be recognized as an inflammatory disease. While high cholesterol levels foster the development of atherosclerosis, plaque instability and adverse cardiovascular outcomes result from inflammation. As a result, monitoring CRP levels may assist in identifying women who might benefit from statin therapy to reduce inflammation beyond the anti-inflammatory effects provided by aspirin [124; 125]. The ability of statins to lower CRP levels has also been shown to be significantly associated with its LDL-lowering ability [126].

Leukocyte Count

Given the increasing evidence supporting the role for inflammation in atherosclerotic process, the role of the leukocyte count in predicting CHD has been receiving increased research attention. White blood cell (WBC) count is an independent predictor of cardiovascular events and all-cause mortality in postmenopausal women [131]. Specifically, a WBC count of greater than $6.7x10^9$ cells/L may identify high-risk women who may not be currently identified by traditional cardiovascular risk factors. A high leukocyte count also appears to be a risk factor independent of the atherosclerotic disease status [132].

Periodontal Disease

Periodontal disease may also increase the risk of CHD in adults by exacerbating several cardiovascular risk factors [136]. A significant association has been found between poor periodontal status and increased levels of CRP and fibrinogen.

Periodontal status has been weakly associated with an increased total cholesterol level, but not an increased HDL level. Explanations for this association include the repeated systematic exposure of individuals with periodontal disease to bacteria, endotoxin, lipopolysaccharide, and other bacterial products that influence lipid metabolism and homeostasis. Total cholesterol, CRP, and fibrinogen may be possible intermediary factors linking periodontal disease to elevated CHD risk [137]. While plasma fibrinogen levels have been associated with the risk of CHD and stroke, a direct causal relationship has not yet been established [118; 119].

Subclinical Hypothyroidism

While subclinical hypothyroidism has also been associated with increased risk of aortic atherosclerosis and MI in postmenopausal women, this association has not been confirmed [133]. Subclinical hypothyroidism has been defined as an elevated thyroid-stimulating hormone level greater than 4.0 mU/L and a normal serum free thyroxine level (11–25 mmol/L) [134]. It occurs in 5% to 20% of women older than 60 years of age [111]. Subclinical hypothyroidism in patients younger than 60 years of age is associated with an increased risk of CHD, heart failure, and cerebrovascular disease. The risk increases with increasing levels of thyroid-stimulating hormone and is highest in patients with levels 10.0 mU/L and greater [135].

SUMMARY

Like men, women are at increased risk for CHD due to several traditional cardiovascular risk factors, including both nonalterable factors (i.e., age, family history) and alterable factors (i.e., smoking, hypertension, hyperlipidemia, diabetes). Women additionally have sex- and gender-specific risks, such as use of hormonal contraceptives and menopause. When assessing cardiovascular risk factors in both women and men it is important to remember many of these factors are synergistic, or work together, in significantly increasing CHD risk.

PRIMARY CHD PREVENTION

Primary prevention of CHD is targeted to healthy populations. While risk factor modification is the mainstay of primary prevention, these strategies are not without their challenges. Because women present with CHD an average of 5 to 10 years later than men, convincing women of the need to make lifestyle changes in the absence of symptoms may be difficult. Furthermore, the benefits of risk factor modification may not be apparent for many years due to the slow progression or later manifestation of CHD in women [122; 276]. These realities underscore the importance of increasing awareness and providing education to the larger public about primary prevention of CHD in women.

AWARENESS

Despite the statistics, many women do not have an accurate picture of the threat CHD holds. Surveys show women are far more afraid of breast cancer than CHD, despite the fact that breast cancer is responsible for only 1 of 31 female deaths, whereas CHD claims the lives of 1 in 3 women [122; 277]. In 2012, only 56% of women identified CHD as the leading cause of death in women [278]. Not only do women not recognize CHD as a significant health problem, but many women are also not aware that major cardiovascular risk factors (e.g., smoking, hypertension, hyperlipidemia) and CHD signs and symptoms in women may differ from those of men [2; McConnell et al., 2014].

More strategies need to be identified to educate the public about women's risk for CHD. This education should include recognition of signs and symptoms of CHD and reducing the time between onset of signs and symptoms of MI and seeking medical care [271]. In 2000, the AHA launched the public awareness campaign Go Red for Women, whereby advertisements were distributed nationally to encourage women to obtain informational materials about CHD and to take action to improve or protect their own heart health [323]. Twenty years later, Go Red for Women remains a strong voice, with events held nationally each year during American Heart Month (February).

Additionally, it is important to understand what motivates women to seek health care and what barriers they may face when seeking care. A report prepared for the Office on Women's Health has suggested a woman's decision to seek health care is influenced by whether she believes she has a health problem, which is based upon her perceptions and knowledge of illness. Concerns about resources (e.g., financial, personal) will then influence whether she feels she can seek care. Finally, her perceptions about ease of access to care and her attitude toward healthcare providers will influence whether she actually makes the decision to seek care [324].

EDUCATION AND COUNSELING

More energy needs to be directed to breaking down the barrier of beliefs that CHD primarily occurs in the male population. Indeed, CHD occurs and is fatal equally between the sexes [279]. To that end, risk factor teaching to women should emphasize the positive impact lifestyle changes make on overall health. With modification of one or more cardiovascular risk factors, other areas may also be affected favorably [2; 280]. For instance, women who successfully quit smoking will experience improvement in lipid profiles, specifically an increase in HDL levels.

Primary prevention begins in youth and early adulthood with general screening of family history of CHD and cardiovascular risk factors. This is also an opportunity to reinforce lifelong heart healthy habits. With regard to total cholesterol, the initial screen in adults should be done at 20 years of age and followed up thereafter every five years. With female patients, obstetrician/gynecologists play a key role in this screening process. If cholesterol levels are greater than 200 mg/dL, additional testing of lipoproteins, specifically HDL and LDL, and annual checks are warranted [73].

Cardiovascular risk screening should be performed at all routine visits for women starting at 40 years of age, around the time of perimenopause, as risk factors increase with age. Age of menopause onset and associated cardiometabolic changes have been found to influence cardiovascular outcomes in women. In older women, the prevalence of subclinical and clinical CHD increases substantially. Thus, heart healthy screening, counseling, and education is critical along the trajectory of women's lives. Detailed histories, assessment of general health, review of cardiovascular risk factors, and measurement of weight, blood pressure, and cholesterol are paramount, as is management of diabetes [340].

Over the last several years, women-geared clinics that are focused on the prevention of CHD have emerged within hospital centers across the country [276; 282]. These clinics typically include personalized cardiovascular assessment, goal setting, and individualized education to help women meet their goals for achieving a heart-healthy lifestyle. A number of cardiovascular risk assessment tools are available to provide women with a relative risk for the development of CHD [2; 280]. These tools assess factors such as:

- Age
- Family history of CHD and other medical conditions

- Personal history of cardiac symptoms, diagnosed conditions, treatments, and procedures
- Smoking history, blood pressure, cholesterol (total, LDL, HDL, total cholesterol:HDL ratio, triglycerides)
- Weight, body mass index (BMI), waist-hip ratio (WHR)
- Presence of diabetes
- Exercise patterns
- Stress levels

The American College of Cardiology Foundation/ American Heart Association (ACCF/AHA) recommend obtaining a Framingham-like (global) risk score for all asymptomatic adults without a history of CHD. They additionally recommend risk-stratifying women based on their risk scores into one of three categories: 1) high risk (e.g., women with known CHD); 2) at risk (e.g., one or more risk factors, such as smoking); and 3) optimal risk [122; 281; 283].

Following data collection, many cardiac centers will provide women with an individual computerized or hand-scored summary assessment of their cardiovascular risk profile. This summary profile details each cardiovascular risk factor according to the history provided by the woman, along with specific recommendations for lifestyle modification to reduce her risk level and develop a prevention-based program focused on heart-healthy living. An overall risk rating scale for CHD is also often provided, ranging from low to moderate to high. The summary may conclude with a health risk summary, which briefly emphasizes key areas in need of attention, such as smoking cessation or development of a regular exercise program. Risk assessments of this nature are intended for education purposes, not to be a substitute for medical attention by a woman's personal physician. Furthermore, women who receive cardiac risk assessment profiles should be informed to consult their physicians before making any major lifestyle changes, especially those who have existing heart or serious cardiovascular conditions [2; 280].

LIFESTYLE MODIFICATION

The Stages of Change model was developed by psychologists to describe the phases that an individual making significant behavioral changes experiences. Because changes to lifestyle are so important in preventing and managing CHD, knowledge of the model is helpful for all healthcare professionals. The Stages of Change model may be applied to both primary and secondary prevention programs. In this model, women are helped through the stages of change with behavior-modification strategies aimed at enhancing long-term maintenance of new healthy behaviors. The first stage, precontemplation, is generally defined as avoidance (i.e., not seeing a problem behavior or not considering a change) [284]. In the second stage, contemplation, a problem is acknowledged, but the woman may struggle with feelings of ambivalence, weighing the pros and cons and benefits and barriers to change.

In stage three, the preparation/determination stage, the woman is ready to begin to change behavior by initiating a step-by-step plan. In stage four, the action/will power stage, the woman makes the change and begins living with the new behavior. Stage five is the maintenance stage, in which the woman continues with her plan on a regular basis, making changes in goals as needed, based on what has worked well and what has not. The change is then integrated into her life [284]. The Stages of Change model may be used to help guide women as they make plan to meet their heart health goals.

Table 4 outlines primary prevention recommendations for women, jointly developed by several organizations including the AHA, the CDC, and the NIH's Office of Research on Women's Health.

CLINICAL RECOMMENDATIONS FOR PRIMARY CHD PREVENTION IN WOMEN	
Lifestyle Interventions	
Cigarette smoking	Women should not smoke and should avoid environmental tobacco smoke. Provide counseling, nicotine replacement, and other pharmacotherapy as indicated in conjunction with a behavioral program or formal smoking cessation program (Class I, Level B).
Dietary intake	Women should consume a diet rich in fruits and vegetables (5 servings/day), whole-grain, high-fiber foods, nuts and legumes, low-fat dairy products and omega-3 fatty acids (in the form of oily fish at least twice a week); limit sweets, sugar-sweetened beverages, red meats, saturated fat (<7% of total energy intake), cholesterol <150 mg/d, alcohol intake no more than 1 drink per day, sodium intake <1,500 mg/d (approximately 1 tsp salt); and avoid consumption of trans fatty acids (Class I, Level B).
Weight maintenance/ reduction	Women should maintain or lose weight through an appropriate balance of caloric intake, physical activity, and formal behavioral programs when indicated to maintain/achieve a body mass index (BMI) between 18.5 and 24.9 kg/m^2 and a waist circumference ≤35 in (Class I, Level B).
Physical activity	Women should accumulate at least 150 minutes/week of moderate exercise, 75 minutes/week of vigorous exercise, or an equivalent combination of moderate- and vigorous-intensity aerobic physical activity. Aerobic activity should be performed in episodes of at least 10 minutes, preferably spread throughout the week (Class I, Level B). Women should be advised of additional cardiovascular benefits by increasing moderate-intensity aerobic physical activity to 5 hours/week, 2.5 hours/week of vigorous-intensity physical activity, or an equivalent combination of both (Class I; Level of Evidence B). Women should engage in muscle-strengthening activities involving all major muscle groups on ≥2 days/week (Class I; Level of Evidence B). Women who need to lose weight or sustain weight loss should accumulate a minimum of 60 to 90 minutes of at least moderate-intensity physical activity (e.g., brisk walking) on most (and preferably all) days of the week (Class I, Level B).
Major Risk Factor Interventions	
Blood pressure—optimal level and lifestyle	Encourage an optimal blood pressure of <120/80 mm Hg through lifestyle approaches such as weight control, increased consumption of fresh fruits, vegetables and low-fat dairy products, sodium restriction, increased physical activity, and alcohol moderation (Class I, Level B).
Lipid and lipoprotein levels—optimal levels and lifestyle	Lifestyle approaches should be encouraged to achieve the following levels of lipids and lipoproteins: LDL <100 mg/dL, HDL >50 mg/dL, triglycerides <150 mg/dL, and non-HDL (total cholesterol minus HDL cholesterol) <130 mg/dL (Class I, Level B).
Diabetes	Lifestyle and pharmacotherapy should be used in women with diabetes to achieve a HbA1c <7% without significant hypoglycemia (Class IIa, Level B).
Preventive Drug Interventions	
Omega 3 fatty acid supplementation	Capsule form (e.g., eicosapentaenoic acid [EPA] 1,800 mg/d) may be considered with hypercholesterolemia and/or hypertriglyceridemia. Note: Fish oil dietary supplements may have widely variable amounts of EPA and DHA (likely the only active ingredients) (Class IIb, Level B).
Blood pressure—pharmacotherapy	Pharmacotherapy is indicated when blood pressure is ≥140/90 mm Hg or ≥130/80 mm Hg) in women with diabetes or chronic kidney disease. Thiazide diuretics should be part of the drug regimen for most women (unless contraindicated) or if there are compelling indications for other agents in specific vascular diseases.

Table 4 continues on next page.

CLINICAL RECOMMENDATIONS FOR PRIMARY CHD PREVENTION IN WOMEN *(Continued)*	
Preventive Drug Interventions *(Continued)*	
Aspirin or clopidogrel	*High-risk women*: Aspirin therapy (75–325 mg/d) should be used (unless contraindicated) (Class I, Level A). If a high-risk woman is intolerant of aspirin therapy, clopidogrel should be substituted (Class I, Level B). *Women with diabetes*: Aspirin therapy (75–325 mg/d) is reasonable (unless contraindicated) (Class IIa, Level B). *Women 40 to 59 years of age with an estimated 10-year cardiovascular risk of at least 10% per ACC/AHA equations*: The net benefit is small and should be considered through shared decision-making. *Women 60 to 69 years of age with at least 20% 10-year cardiovascular risk or with diabetes and an estimated risk of at least 10%*: Aspirin therapy should be considered in the context of no excess risk of bleeding and shared decision-making (USPSTF Grade C).
Class III Interventions (Not Useful/Effective and May Be Harmful)	
Antioxidant supplements	Antioxidant vitamin supplements (e.g., vitamin E, C, and beta carotene) should not be used for primary CHD prevention (Class III, Level A).
Folic acid	Folic acid, with or without B6 and B12 supplementation, should not be used for primary CHD prevention (Class III, Level A).
Aspirin for MI in women <65 years of age	Routine use of aspirin therapy in healthy women is not advised (Class III, Level B; USPSTF Grade D).
Hormone replacement therapy	Hormone therapy and selective estrogen-receptor modulators should not be used for primary CHD prevention (Class III, Level A).

Source: [281] Reprinted from Mosca L, et al. Effectiveness-based guidelines for the prevention of CHD prevention in women–2011 update: a guideline from the American Heart Association. Circulation. 2011;123(11):1243-1262. With permission from Lippincott Williams & Wilkins. (c) American Heart Association. *Table 4*

STRENGTH OF RECOMMENDATIONS	
Classification	
Class I	Intervention is useful and effective.
Class IIa	Weight of evidence/opinion is in favor usefulness/efficacy.
Class IIb	Usefulness/efficacy is less well established by evidence/opinion.
Class III	Intervention is not useful/effective and may be harmful.
Level of Evidence	
A	Sufficient evidence from multiple randomized trials
B	Limited evidence from single randomized trial or other nonrandomized studies
C	Based on expert opinion, case studies, or standard of care

U.S. Preventive Services Task Force Recommendations	
Classification	
Grade A	Therapy recommended – High certainty net benefit is substantial.
Grade B	Therapy recommended – High certainty net benefit is moderate to substantial.
Grade C	Therapy selectively recommended to individual patients based on professional judgment and patient preferences. At least moderate certainty exists that the net benefit is small.
Grade D	Therapy not recommended due to moderate or high certainty the therapy has no net benefit or harms outweigh benefits.

Smoking Prevention and Cessation

Approximately 12.2% of women in the United States are cigarette smokers [285]. Smoking cessation is considered vital to decreasing several negative public health effects, including CHD. For teenage female smokers, emphasizing social undesirability, rather than long-term health implications, may be more successful in reducing tobacco use. For older patients, the 60% reduction in MI risk that has been associated with smoking cessation may be more persuasive as a reason to quit [286].

The use of nicotine gum or patches, varenicline, bupropion, counseling, and/or smoking cessation programs (alone or in combination) may be very helpful for smoking cessation, especially for those who smoke more than 25 cigarettes per day. While the overall cost-effectiveness of smoking cessation counseling may not seem impressive, its success is considerable when compared with the ability to influence other cardiovascular risk factors [287].

The fear of weight gain may be a major obstacle or concern for women contemplating quitting smoking. Diet and exercise strategies should be incorporated into the overall cessation plan because women have been reported to gain more weight after quitting than men [46]. One study found that cognitive-behavioral therapy reduced weight concerns and was more effective than weight control counseling in ensuring smoking cessation after one year [288].

Diet

Dietary factors play a significant role in the prevention of CHD. Major dietary goals include achieving and maintaining healthy weight for height and body size and decreasing intake of sodium, cholesterol, and fat [2; 280]. Maintaining a healthy weight is essential due to the negative health consequences associated with obesity and weight fluctuation [289]. National guidelines define a BMI of 25 or greater as overweight and a BMI of 30 or greater as obese [290].

One drawback to the use of BMI is that it does not distinguish between individuals with high percentages of body fat versus those who are muscular. A measurement of waist circumference and/or WHR may be useful in identifying abdominal adiposity and determining the distribution of weight and total body fat [290]. One study demonstrated women with a waist circumference of 76.2 cm or greater and/or a WHR of 0.76 or greater had a more than twofold increase in risk of CHD [291]. Significant health improvements may be achieved by a 5% to 10% reduction in body weight [292].

In terms of diet composition, the intake of saturated fatty acids significantly increases risk of CHD in both men and women [350]. In a large prospective cohort of more than 100,000 postmenopausal women, plant protein intake was inversely associated with all-cause, cardiovascular, and dementia-related mortality [339]. Unprocessed red meat, eggs, and dairy products were associated with a higher risk of CHD mortality. Thus heart-smart eating includes choosing from a wide variety of foods and concentrating more on whole foods, such as fruits, vegetables, and nuts/legumes, than on processed or refined foods.

In 2005, the traditional Food Pyramid was replaced as the national dietary guideline with the U.S. Department of Agriculture's ChooseMyPlate (later renamed MyPlate). This model individualizes dietary recommendations based on age, sex, and activity level [293]. These guidelines continue to emphasize the importance of whole grains, fruits, and vegetables, and in addition, provide an upper limit of calories that may be derived from extra fats and sugars. The ACCF/AHA also recommend adoption of dietary approaches to stop hypertension (DASH) to improve heart health [85]. The DASH diet plan was developed by the U.S. National Institutes of Health to help lower blood pressure without medication. The DASH diet emphasizes vegetables, fruits, and low-fat dairy foods and moderate amounts of whole grains, fish, poultry, and nuts. It also recommends limiting sodium intake [294].

Teaching how to read nutrition labels is vital. Such health literacy can impact a woman's ability to choose low-fat, low-sodium, and low-calorie food items that support heart health [293]. For instance, folate, an essential B vitamin found in fruits, vegetables, beans, and fortified grain products, has been shown to improve endothelial function and decrease homocysteine levels, and thus, may significantly lower CHD risk [322].

A moderate alcohol intake is associated with beneficial changes in serum lipids and lipoproteins. One glass of red wine per day has been shown to increase HDL levels and may reduce the risk of MI. However, regular exercise has the same benefit, and the AHA does not recommend consuming alcohol to derive any potential gains. Thus, women who do not drink should not be encouraged to start [295]. Other health risks, such as obesity, hypertension, and cancer, may be associated with alcohol use [295]. A University of Wisconsin study found that drinking red grape juice may also render beneficial heart effects without the other risks associated with alcohol. Red grape juice may delay the oxidation of LDL among people with CHD [295; 296].

Laboratory Tests

Cholesterol screening is an essential component of primary prevention. Women with high cholesterol have been found to be 23% less likely than men to have their cholesterol medically managed [69]. Thus, if total cholesterol level is elevated, a lipid profile should be done to examine lipoproteins, specifically HDL and LDL. Recommended lipoprotein levels for women include HDL levels greater than 50 mg/dL and LDL levels less than 100 mg/dL [62; 68]. Additionally, lipoprotein(a) tests are available but generally are reserved for young patients who suffer an MI without an apparent cardiovascular risk profile, those with family histories of very high cholesterol, or those who are not responding to cholesterol-lowering treatment [116].

Homocysteine assays are available; however, screening of asymptomatic women with no history of CHD is not recommended [113]. Plasma homocysteine levels are inversely related to vitamin intake, especially vitamins B6, B12, and folate. As a result, high levels of homocysteine may usually be remedied by increasing folic acid intake through diet or supplements (400 mcg/day) [114]. Dietary sources of folate include orange juice, green leafy vegetables, and fortified cold breakfast cereals [114; 115].

A CRP test (i.e., the hs-CRP assay) is widely available and may be completed at the same time as cholesterol screening. There is a general consensus that the hs-CRP assay should be reserved for individuals with a 10% to 20% (i.e., intermediate) 10-year risk of CHD after screening for traditional risk factors (e.g., family history, age, hypertension) has been performed [113; 127]. Increased CRP may predict future cardiovascular events in both women and men with CHD; therefore, using both cholesterol and CRP to determine heart attack risk is more accurate than either test alone. When both values are elevated, there is a significantly increased risk for CHD [121; 124]. It is important to recognize that CRP is only a good predictor of cardiac risk if the test is done when there is no current infection (e.g., sinus infection) or other chronic underlying inflammatory process (e.g., rheumatoid arthritis, lupus, Crohn disease). Additionally, there is a general consensus that CRP levels are most effectively used to determine risk classification and to reclassify risk of coronary events in some individuals [128]. Reducing CRP levels has not been shown to reduce coronary events [127; 129; 130].

Exercise

Reports on physical activity and CHD in women have been conflicting. While some studies have found no reduction in CHD risk, many other studies have demonstrated lower all-cause mortality in women and men with higher levels of fitness. A study published in 2001 reported that even light-to-moderate amounts of exercise (i.e., at least one hour of walking a week) were associated with a lowered risk of CHD in women [297]. This correlation extended to women with heightened risk for CHD, including those who were overweight, had high cholesterol, or smoked.

Exercise may favorably modify other cardiovascular risk factors by increasing HDL, decreasing total cholesterol levels, augmenting fibrinolytic activity decreasing the risk of thromboembolism, and improving insulin resistance, especially in obese women. Additional benefits associated with exercise include weight and blood pressure control, as well as promoting a general sense of well-being [298].

Female patients should be instructed on the importance of aerobic exercise for cardiovascular fitness. Aerobic exercise lowers blood pressure and resting heart rate, as well as counteracts the detrimental effects of other cardiovascular risk factors, such as obesity and stress [36; 83; 85]. Like men, women should engage in aerobic exercise for at least 30 minutes, five times per week [84; 85]. Women who have previously been sedentary should begin with short intervals of activity (e.g., 5 to 10 minutes) and gradually increase the intervals. Moderate- to vigorous-intensity exercise for 30 minutes on most days of the week is ideal [299]. Cardiovascular fitness is reached when the patient's heart rate decreases 30 beats per minute within the first minute after stopping maximum exercise [73]. However, women with chronic health problems as well as those 50 years of age and older who are just beginning a physical activity program should first consult with a physician [83].

EVIDENCE-BASED PRACTICE RECOMMENDATION

According to the American Heart Association, women should be advised to accumulate at least 150 minutes per week of moderate exercise, 75 minutes per week of vigorous exercise, or an equivalent combination of moderate- and vigorous-intensity aerobic physical activity. Aerobic activity should be performed in episodes of at least 10 minutes, preferably spread throughout the week.

(https://ahajournals.org/doi/10.1161/cir.0b013e31820faaf8. Last accessed December 12, 2022.)

Level of Evidence: IB (Intervention is deemed useful and effective based on limited evidence from single randomized trial or other nonrandomized studies.)

Psychosocial Well-Being

New evidence points to the impact of psychosocial well-being on heart health. Findings from the Study of Women's Health Across the Nation (SWAN) study of 312 women found well-being was associated with less progression of CHD even after adjustment for health behaviors, depression, and other potential confounding factors. Well-being was measured through a composite score of optimism, life engagement, life satisfaction, rewards from multiple roles, positive affect, and vitality [358]. These results demonstrate the importance of the mind-heart-body connection in CHD prevention across the lifespan.

Psychosocial well-being in women can be encouraged in multiple ways. First, women can be encouraged to assess the stressors in their lives and incorporate methods to lessen them, thereby promoting well-being and a healthy outlook on life. Stress management techniques that are effective vary from person to person but may include exercise, hobbies, daily periods of solitude, looking for ways to better organize and simplify their lives, and spending time with friends and loved ones. Building and maintaining supportive social networks are critical as well.

Alternative Birth Control Methods

As discussed, contraceptives containing both estrogen and progestin have been associated with an increased risk of CHD. The risk is highest in women who are older than 35 years of age, smoke, and have other cardiovascular risk factors. While estrogen has been linked to some favorable effects on lipids and serum lipoproteins—namely increased HDL and decreased LDL—it also is associated with increased triglyceride levels. Progestins are believed to produce unfavorable effects by decreasing HDL and increasing LDL levels. In addition to changes in lipid metabolism, hormonal contraceptives have an effect on blood pressure for some patients [300].

As a result of these lipid changes, birth control counseling is a mainstay of primary prevention in high-risk women. These women should be advised to explore safer birth control methods, such as the diaphragm, contraceptive sponge, or condoms. While the birth control pill poses increased risk, the oral contraceptives available today are safer and contain less estrogen than those seen during the 1960s [301].

Blood Pressure Control

Appropriate management of systolic and diastolic hypertension is critical to reduce adverse cardiac effects. Lifestyle changes that may assist in achieving healthy blood pressure include weight control, physical activity, as well as moderation of alcohol intake and sodium restriction. If blood pressure readings remain ≥140/90 mm Hg (≥130/80 mm Hg in the setting of chronic kidney disease and diabetes) after three months of lifestyle modification, or if initial readings are greater than 160 mm Hg systolic or 100 mm Hg diastolic, pharmacologic intervention should be initiated and individualized for each woman [59;62; 281].

EVIDENCE-BASED PRACTICE RECOMMENDATION

The American Heart Association asserts that pharmacotherapy is indicated when blood pressure is ≥140/90 mm Hg (≥130/80 mm Hg in the setting of chronic kidney disease and diabetes). Initial treatment of high-risk women with acute coronary syndrome or myocardial infarction should be with beta blockers and/or angiotensin-converting enzyme (ACE) inhibitors/angiotensin receptor blockers (ARBs), with addition of other drugs such as thiazides as needed to achieve goal blood pressure. However, ACE inhibitors are contraindicated in pregnancy and ought to be used with caution in women who may become pregnant.

(https://ahajournals.org/doi/10.1161/cir.0b013e31820faaf8. Last accessed December 12, 2022.)

Level of Evidence: IA (Intervention is deemed useful and effective based on Sufficient evidence from multiple randomized trials.)

Hyperlipidemia Management

Primary prevention is aimed at lowering elevated serum cholesterol and triglyceride levels. Controlling diet, weight management, smoking avoidance, and exercise are positive lifestyle choices that should be promoted in all women, and especially those with elevated lipid profiles. Lifestyle interventions that may help lower high cholesterol and triglyceride levels include [281]:

- Avoiding smoking
- Achieving and maintaining normal blood glucose levels
- Achieving and maintaining a healthy body weight
- Limiting intake of sugar, refined carbohydrates, and trans-fatty acids
- Eating complex carbohydrates and high-fiber foods (e.g., whole-grain products, dried beans and peas, fruits, and vegetables)
- Limiting fat intake to 25% to 35% of total calories

- Eating sources of omega-3 fatty acids (e.g., salmon, mackerel, herring, lake trout, flaxseed and flaxseed oil, canola oil, soybean oil, nuts)
- Engaging in regular physical activity

Despite positive lifestyle changes, some women may require a lipid-lowering agent (***Table 4***) [281].

Diabetes Control

The effects of glycemic control in reducing cardiovascular risk in patients with diabetes are unclear. A diet with less than 30% of calories from fat, less than 7% of calories from saturated fat, 0% from trans-fatty acids, and cholesterol intake less than 150 mg/day should be encouraged [281]. When indicated, the use of insulin and hypoglycemic agents may be used to control blood glucose levels based on the type of diabetes and patient response. Regular physical activity should also be encouraged in women with diabetes [281]. In addition, for metabolic syndrome, lifestyle changes such as weight loss, exercise, and smoking cessation are the main treatment strategies [302].

Antioxidant Vitamins

Antioxidants such as vitamin C, vitamin E, and beta-carotene have been found to be effective in inhibiting either the oxidation of LDL cholesterol or its uptake into the endothelium of coronary arteries. Although more research is needed, some preliminary studies have demonstrated a significant inverse relationship between the use of antioxidant vitamins and a reduction in CHD [20; 79]. On the other hand, the Alpha-Tocopherol Beta Carotene Cancer Prevention Study Group reported no significant reduction in the incidence of CHD in middle-aged male smokers who took beta-carotene and/or vitamin E daily supplements. Rather, in this study there was a concern for an increased risk of hemorrhagic stroke among those subjects who took vitamin E supplements. Therefore, the findings of these and other studies are inconclusive regarding the benefits of antioxidant vitamins in reducing CHD risk and also point out some of the potential associated health risks [311; 312; 313]. In 2004, after reviewing all available studies regarding antioxidant supplementation and CHD, the AHA concluded the evidence indicated antioxidant supplements had little to no definitive effect on preventing or treating CHD. Due to this analysis, the AHA does not recommend the use of antioxidant vitamins as part of prevention or treatment of CHD [314]. Rather, AHA continues to stress the importance of diet but does not rule out the possible beneficial role of antioxidants derived from food sources for patients with CHD [281; 314].

Calcium Supplementation

Calcium supplementation, especially with vitamin D, has been a recommended public health intervention for older postmenopausal women to reduce fracture risk. Meta-analyses suggest calcium with or without vitamin D increases MI risk. With concerns over the quality of these meta-analyses, a more recent meta-analysis of randomized controlled trials found calcium supplementation with or without vitamin D did not increase CHD or all-cause mortality risk in older women [351].

PHARMACOTHERAPY

Aspirin

As with men, low-dose aspirin therapy may play a role in the primary prevention of CHD in women. Aspirin works as a thromboxane inhibitor keep blood platelets from sticking together and forming clots [281]. The NHS demonstrated a 32% reduction in risk of first MI in women who took low-dose aspirin (i.e., one to six aspirin per week) [303]. While low-dose aspirin may be associated with a somewhat lower cardiovascular and total mortality rate in women, its cardioprotective role is not without limitations. The benefit of such therapy should be weighed against the risk of hemorrhagic stroke and gastrointestinal bleeding [304]. In 2022, the U.S. Preventive Services Task Force issued updated guidance regarding the use of aspirin for cardioprotection [304]. They recommend against initiating low-dose aspirin use for the primary prevention of

cardiovascular disease in adults 60 years or older. The decision to initiate low-dose aspirin use for the primary prevention of cardiovascular disease in adults 40 to 59 years of age who have a 10% or greater 10-year risk should be an individual one. Evidence indicates that the net benefit of aspirin use in this group is small. Persons who are not at increased risk for bleeding and are willing to take low-dose aspirin daily are more likely to benefit [304].

Clopidogrel Therapy

Like aspirin, clopidogrel inhibits platelet aggregation but through the adenosine diphosphate pathway. It is recommended as a preventive intervention in high-risk women who are intolerant of aspirin therapy [281].

Additional research has evaluated clopidogrel versus aspirin. The Clopidogrel versus Aspirin in Patients at Risk of Ischemic Events (CAPRIE) study was one of the largest studies conducted on a medication in development. This three-year, international study enrolled 19,185 patients who had previously suffered an ischemic stroke, MI, or symptomatic peripheral arterial disease. Patients received either 75 mg of clopidogrel or 325 mg of aspirin daily. Clopidogrel was shown to be more effective than aspirin in reducing the number of MIs, strokes, and vascular deaths in at-risk patients. Researchers found aspirin prevented about 25% of these events, whereas clopidogrel prevented about 33% of them [306]. All of the patients in CAPRIE had been diagnosed with atherosclerosis. Atherosclerotic plaques can cause cracks or fissures in the vessel wall. Blood platelets aggregate around these fissures and cause the formation of thrombi that can completely block or occlude arteries. This process, atherothrombosis, is the common link that results in ischemic strokes, MIs, and vascular death. Importantly, CAPRIE showed that patients treated with clopidogrel were significantly less likely to suffer from severe gastrointestinal bleeding than those treated with aspirin. This finding is particularly striking because the entire study population had been rigorously selected to exclude those patients with a history of ulcers or gastrointestinal bleeding. The study showed no other relevant differences in clinical or biologic effects between the groups. In CAPRIE, the most common clinically important side effects were pruritus, purpura, diarrhea, and rash. Infrequent events included intracranial hemorrhage (0.4%) and severe neutropenia (0.04%). Suspected cases of thrombotic thrombocytopenic purpura have been reported at a rate of about four cases per million patients exposed [306].

Hormone Replacement Therapy

Estrogen was once thought to have a relative protective value against CHD in premenopausal women. In the past, hormone replacement therapy was shown to decrease this risk by as much as 50% [17; 44; 73]. It was believed to confer protection not only by decreasing triglyceride and LDL levels, but also by increasing HDL levels. While further evidence suggests estrogen provides protection by improving lipid and carbohydrate metabolism, lowering blood pressure, and producing beneficial coagulation patterns, newer studies indicate that hormone replacement therapy does not provide protection against CHD in women as once believed [17; 315; 316; 317; 318]. The AHA, the U.S. Preventive Services Task Force, and the Institute for Clinical Systems Improvement agree that hormone replacement therapy should neither be initiated nor continued to prevent CHD [235; 319; 320; 321].

The U.S. Preventive Services Task Force recommends against the use of combined estrogen and progestin for the primary prevention of chronic conditions in postmenopausal persons.

(https://jamanetwork.com/journals/jama/fullarticle/2797867. Last accessed December 12, 2022.)

Strength of Recommendation: D (USPSTF recommends against routinely providing the service based on at least fair evidence that it is ineffective or that harms outweigh benefits.)

DIFFERENTIAL DIAGNOSIS OF CHEST PAIN	
System	**Potential Health Problem**
Cardiovascular	Ischemia vs. infarction Pericarditis Dissecting aortic aneurysm
Pulmonary	Spontaneous pneumothorax Pneumonia Pulmonary embolism
Gastrointestinal	Esophageal reflux/spasm Cholecystitis Peptic ulcer disease/perforation Pancreatitis
Musculoskeletal	Costochondritis Cervical/thoracic spine injuries
Psychogenic	Anxiety/panic disorder (psychosomatic)
Source: [142; 143; 144]	*Table 5*

SUMMARY

Primary prevention strategies should be targeted to each woman's specific risk factors. Many risk factor assessment tools are available to help women gain awareness of their cardiovascular risk profile and the areas of focus for positive lifestyle changes. For instance, if a woman is a smoker, motivating her to quit smoking is of paramount importance. Other areas of primary prevention focus on controlling blood pressure, cholesterol, and diabetes; managing diet and stress; and incorporating regular exercise. Developments have also occurred with respect to measurement of CRP, homocysteine levels, and diagnosis of subclinical hypothyroidism.

CARDIAC DIAGNOSTIC TESTS

COMPLEXITY OF DIAGNOSIS IN WOMEN

The diagnosis of CHD is a more complex process in women for two primary reasons: age at presentation and differences in presenting symptoms. As noted, women are typically 5 to 10 years older than men when presenting with CHD, which may be due either to delays in diagnosis or presentation. When women do present, other conditions, such as osteoporosis, diabetes, or hypertension, as well as the provider's interpretation of the woman's chest pain, may obscure the indications of disease. Noncoronary causes of chest pain are also more prevalent in the female population. Chest pain in women is frequently accompanied by abdominal pain, dyspnea, nausea, fatigue, and greater functional disability [138; 139; 140]. Additionally, a variety of intrathoracic and extrathoracic structures may cause symptoms localizing to the chest, such as mitral valve prolapse, pericarditis, or gallbladder disease. Therefore, the differential diagnosis of chest pain must include a number of conditions to prevent a false-positive diagnosis of CHD in women [140; 141]. ***Table 5*** outlines the differential diagnosis to first rule out the most critical problems.

To further complicate the picture, the clinical history and physical exam have limited value in women older than 65 years of age with definite angina [139]. The history and physical exam do provide information on the occurrence of prior events and risk factors and also uncover symptoms of more advanced disease. However, these diagnostic clues often only partially indicate disease likelihood, which makes further diagnostic tests important and necessary

[139; 145; 146]. The presence of new physical assessment findings, such as dysrhythmias, mitral regurgitation, a fourth heart sound (atrial gallop), or bibasilar crackles, increases the chances of a positive diagnosis of CHD [147]. The diagnosis is also favored by the presence of other cardiovascular risk factors or by ECG changes at rest or during anginal episodes [147].

The Coronary Artery Surgery Study correlated women's clinical symptoms with angiographically documented CHD. CHD was identified in 72% of women presenting with typical angina and in 36% of women with probable angina [141]. In those women with nonspecific chest pain, angiography rarely documented CHD. Because women with convincing symptoms of CHD lack angiographic evidence almost 30% of the time, diagnosis based on clinical symptoms alone is not adequate [21; 141]. Both noninvasive and invasive cardiac tests may be helpful in diagnosis. The following sections highlight the difficulties or nuances of diagnosing CHD in women compared to men.

NONINVASIVE DIAGNOSTIC TESTS

Several noninvasive tests are used to diagnose CHD. These include the resting ECG, exercise ECG, exercise or stress echocardiogram, nuclear medicine stress tests, cardiac magnetic resonance imaging, and coronary computed tomographic angiography (***Table 6***).

Resting ECG

The resting ECG is the first-line screening test used in men. It is also an important test in women due to the increased proportion of unrecognized or "silent" infarctions. The presence or absence of abnormal Q waves on the resting ECG may be affected by the use of HRT in women older than 50 years of age. Study results have shown that HRT, specifically estrogen therapy, lengthens the QT interval in postmenopausal women [148; 149].

Exercise ECG

Exercise ECG (also referred to as the stress test or exercise treadmill test) may not be as accurate in the diagnosis of CHD in women as in men [347]. However, the ACCF and the AHA recommend the routine use of the exercise ECG (when combined with traditional analysis of ST-segment and heart rate changes) for evaluating suspected CHD in women who have a normal resting ECG and good exercise tolerance [150]. Women with nonobstructive disease and stress test abnormalities are no longer defined as having a false-positive test. Instead, their test is classified as abnormal, and they are noted as being at an elevated risk of obstructive CHD [150]. A test result that is clearly negative has been found to be equally reliable in both women and men [141]. Better diagnostic results are seen in women with multivessel involvement versus single vessel or no disease. With multivessel disease, an overall accuracy of 84% has been reported [150].

Even in women with CHD, the accuracy of using exercise ECG for diagnosis alone is not recommended. When test results are clearly positive or not clearly positive or negative, additional risk stratification with cardiac imaging is recommended [150]. The ACCF/AHA have recommended cardiac imaging for symptomatic women with established CHD, women who have an indeterminate or intermediate-risk exercise ECG test, and women with an intermediate-risk Duke treadmill score. Cardiac imaging has also been recommended for women with diabetes, metabolic syndrome, and polycystic ovary syndrome because of their increased risk of cardiovascular death [122; 150].

A second difficulty associated with the exercise ECG is women must be able to raise their heart rate up to 85% of maximum capacity by exercising for about 15 minutes. Women have a lower maximal aerobic capacity, which limits their ability to exercise to adequate intensity levels. As a result, the test is too strenuous for many women who are older, sedentary, or have other medical conditions limiting their ability to exercise (e.g., arthritis) [150].

NONINVASIVE DIAGNOSTIC TESTS FOR WOMEN WITH KNOWN OR SUSPECTED CHD	
Noninvasive Test	**Recommendations**
Exercise ECG	*For symptomatic women at intermediate risk with a normal resting EKG and capable of exercising at >5 metabolic equivalents (METs)*: Exercise ECG is recommended initial test of choice; imaging is reserved for women with resting ST-abnormalities or who are unable to exercise adequately (Class I, Level B). Interpretation should include ST-segment response and risk score measurements, exercise capacity, chronotropic response, heart rate recovery, and blood pressure response to exercise (Class I, Level B). If results indeterminable or abnormal, stress imaging should be undertaken. Individualized decision-making and targeted anti-ischemic therapies should consider the patient's ongoing symptom burden and degree of abnormalities during exercise ECG (Class I, Level C).
Exercise and stress echocardiography	*For symptomatic women at intermediate-high risk or those with resting ST-segment abnormalities, functional disability, indeterminate or intermediate-risk stress ECG*: Recommended for identification of obstructive CHD and estimation of prognosis (Class I, Level B). *Women with dyspnea*: Assessment of diastolic function and pulmonary artery pressure may be reasonable in echocardiographic evaluation of (Class IIb, Level C). *Premenopausal women with functional disability*: Pharmacologic stress echocardiography is recommended for identification of obstructive CHD and prognosis estimation (Class I, Level C).
Stress myocardial perfusion imaging (MPI)	*Symptomatic women at intermediate-high CHD risk and those with resting ST-segment abnormalities, functional disabilities or indeterminate or intermediate-risk ECG*: Stress MPI with single-photon emission computed tomography (SPECT) or positron emission tomography (PET) is recommended (Class I, Level B). *Premenopausal women with functional disability*: Alternative tests like stress echocardiography or CMR are encouraged; MPI may be considered when radiation exposure levels are <3 mSv (Class IIb, Level C). *Younger women*: Choice of test should be based on concerns about radiation exposure and increased projected cancer risk (and not higher reported test accuracy) (Class IIb, Level C). Radiation-dose reduction techniques should be used in all women undergoing clinically necessary or appropriate stress MPI whenever possible (Class I, Level C)
Cardiac magnetic resonance imaging (CMR)	*Symptomatic women with intermediate-high CHD risk and those with resting ST-segment abnormalities, functional disability, or indeterminate or intermediate risk*: Stress CMR (especially vasodilator stress perfusion CMR) may be reasonable as index procedure within diagnostic evaluation (Class IIb, Level B). *Premenopausal women with functional disability*: Stress CMR may be reasonable for identification of obstructive CHD and estimation of prognosis (Class IIb, Level B).
Coronary computed tomographic angiography (CCTA)	*Symptomatic women at intermediate CHD risk and with resting ST-segment abnormalities, functional disability, or indeterminate or intermediate-risk stress ECG*: It may be reasonable to use CCTA as index procedure within diagnostic evaluation (Class IIb, Level C). *Premenopausal women with functional disability*: Alternative tests such as stress echocardiography or CMR are encouraged; CCTA may be considered when radiation levels can be <3 mSv (Class IIb, Level C). *Younger women*: Choice of test should be based on concerns about radiation exposure and increased projected cancer risk (and not higher reported test accuracy) (Class I, Level C). Radiation dose-reduction techniques should be used in all women undergoing CCTA whenever possible (Class I, Level C).
Source: [347; 348]	*Table 6*

Exercise and Stress Echocardiogram

The exercise echocardiogram is a two-dimensional exam used to assess synergy of myocardial contraction. This test is more specific and reliable than the exercise ECG and a strong, independent prognostic indicator [156; 157; 158]. The exercise echocardiogram is a useful diagnostic test in women because of its sensitivity to single-vessel disease (greater than 50% stenosis), which occurs more frequently in women than men (18% versus 9%) [159]. When properly performed (i.e., not stopped too quickly), the exercise echocardiogram has been found to have high sensitivity and specificity (86%) for the detection of CHD in women [25].

Due to the difficulty of diagnosing changes with exercise, drugs such as dipyridamole, adenosine, or regadenoson may be used to stress the heart [159]. Dipyridamole is a potent coronary artery vasodilator. Side effects from its use include dizziness, gastrointestinal upset, nausea and vomiting, headache, and rash. Adenosine has a more rapid onset but wears off more quickly. Adverse reactions include transient new arrhythmias and heart block [160]. Regadenoson increases coronary blood flow and mimics the increase in coronary blood flow caused by exercise. Adverse reactions include tachycardia, flushing, chest discomfort, and headache [160]. In 2013, the FDA issued a warning of a rare but serious risk of MI and death associated with both adenosine and regadenoson [161]. The FDA has approved changes to the drug labels to reflect these events and updated its recommendations for their use [162]. These agents should be avoided in patients with evidence of unstable angina or cardiovascular instability.

The American Society of Nuclear Cardiology has stated that dobutamine infusion may be an effective alternative agent for stress echocardiography [163]. Dobutamine stimulates beta-adrenergic receptors, resulting in increased contractility and heart rate. It may cause premature ventricular contractions, chest pain, and hypotension. Adverse reactions include nausea, dyspnea, and fever. It is important to note that dobutamine infusion for stress echocardiography is an off-label use [160].

Myocardial Perfusion Scan

The nuclear medicine myocardial perfusion scan is another noninvasive test that may be used in women. At peak exercise, a small amount of radioactive tracer is injected and a series of images of myocardial blood flow are then evaluated. Normal myocardial blood flow is indicated by a homogeneous distribution of thallium throughout the myocardium, while myocardial ischemia and/or infarction is suggested by either a transient or persistent defect in tracer uptake. Compared with exercise ECG, nuclear medicine perfusion tests have better accuracy with fewer false-positive results in women, especially in patients with multivessel disease [141; 151; 152; 153].

Stress myocardial perfusion imaging (MPI) is recommended to diagnose CHD in women with intermediate-to-high risk who have resting ECG abnormalities. Stress MPI may be performed with single photon emission computed tomography (SPECT) or positron emission tomography (PET) imaging. Widely available, SPECT has robust evidence of utility in women; however, false-positive results from breast attenuation and obesity-related artifacts are its main limitation [347].

PET is another tool in the assessment of functional ischemia replacing the need for invasive angiography. PET imaging is well suited in the diagnosis of women, with its built-in attenuation correction and lowered radiation exposure compared with SPECT. In addition to assessing relative perfusion, PET assesses absolute quantitative coronary flow and flow reserve from the coronary macro- to microvasulature. Thus, this test can aid the diagnosis of microvascular dysfunction (nonobstructive CHD), which is defined as a functionally reduced coronary flow reserve in the absence of flow-limiting CHD. More prevalent among women and those at high cardiovascular risk, microvascular dysfunction is associated with adverse outcomes [347].

Cardiac Magnetic Resonance Imaging

Cardiac magnetic resonance imaging (CMR) has grown considerably in the last decade and is a recommended test in the evaluation of suspected ischemia in symptomatic women at intermediate-to-high CHD risk [347; 348]. CMR is a comprehensive imaging modality that can provide detailed evaluation including myocardial structure, function, viability, ischemia and valvular heart disease and, thus, is useful in detecting coronary microvascular dysfunction. It avoids the risks of ionizing radiation exposure with high resolution and diagnostic accuracy [347].

Electron Beam Computerized Tomography (EBCT)

Electron beam computerized tomography (EBCT), also called an ultrafast CT scan, is a rapid form of non-contrast imaging technology that results in a clear image of the heart and surface of the coronary arteries. EBCT has been studied as a tool to identify individuals at risk for CHD by measuring calcium deposits in the coronary arteries which correlate to the amount of atherosclerosis. Experts have indicated, however, that the amount of coronary calcification does not necessarily indicate that an individual will suffer an MI, and the absence of calcification does not rule out CHD. Still, calcium scoring has been shown to improve risk prediction in women and assist therapeutic guidance, especially for intermediate-risk women [164; 347]. The Multi-Ethnic Study of Atherosclerosis (MESA) trial included 3,601 women, 90% of whom were classified as low risk [165]. The prevalence of any coronary calcium was associated with a six-fold increased risk of CHD, adjusted for age, ethnicity, body mass index, LDL, hypertension, smoking, estrogen, and statin therapy. The results showed that the presence of coronary calcium redefined the women who had been improperly labeled as low-risk, based on Framingham criteria.

Coronary Computed Tomographic Angiography (CCTA)

Rapid development has also occurred in coronary computed tomographic angiography (CCTA) in recent years. CCTA can assess many causes of CHD in one test. It has high sensitivity as well as diagnostic and prognostic accuracy for detecting and excluding CHD and coronary anomalies in both men and women [347; 348].

INVASIVE DIAGNOSTIC TESTS

Angiography

Coronary angiogram is the definitive diagnostic test to detect CHD despite major drawbacks, such as its invasive nature, cost, and potential complications [11]. While the number of catheterizations performed on women has increased, men are more likely to be referred for catheterization than women, possibly because women may be at greater risk of adverse events after angiogram, including death [167; 168; 169; 170]. One study found that men were 40% more likely to undergo angiography than women, despite angiography data indicating women have more functional impairment and unstable symptoms than men [171; 172].

A number of factors may affect the decision to perform invasive testing. Patient factors may include symptom severity, response to treatment, lifestyle modification, comorbidities, age, social circumstances, and personal preferences. A Canadian study found that, after detection of acute coronary syndrome, neighborhood socioeconomic status negatively affected the receipt of cardiac catheterization and mortality for women but not men. Every incremental decrease in income quintile for women was associated with 6% lower odds of receiving cardiac catheterization within 30 days and 14% higher odds of 30-day mortality [173]. Women may also be

more likely to defer invasive testing until a cardiac crisis occurs because they tend to underestimate the impact of CHD on their lives [174; 175; 176]. Provider factors may include interpretation of symptoms and their severity and noninvasive test results, as well as perceptions of the probability of CHD and the risk/benefit of potential revascularization strategies. Thus, bias can influence provider perceptions and interpretations. Social factors center on the availability of noninvasive testing and cardiac catheterization facilities [177].

Compared with men, when angiography is performed in women the test usually reveals less extensive disease [172]. Single-vessel disease occurs in 50% of women, with the left anterior descending artery the most common site of lesions (i.e., in 43% to 54% of cases). In the remaining 50% of women, 25% have two-vessel disease and 25% have three-vessel disease. In addition, left main disease is less common in female cardiac patients compared to men [11; 19; 35]. Despite these findings, women continue to experience persistent symptoms, poor functional status, and recurrent hospitalizations and repeat angiograms [347].

SUMMARY

CHD is more complex to diagnose in women because of the lower overall prevalence and also more frequent noncoronary causes of chest pain. When CHD is diagnosed, certain diagnostic tests are more reliable in women. These tests include the resting ECG (which is especially reliable in identifying unrecognized or asymptomatic infarctions seen more commonly in women), nuclear myocardial perfusion scans, and the resting or exercise echocardiogram. While coronary angiogram is the criterion standard for diagnosis in both men and women, the procedure tends to show more extensive disease in men. Women tend to suffer from more single vessel and two-vessel disease as opposed to the three-vessel disease seen more often in men.

Differences in the use of diagnostic cardiovascular tests have been documented. Although the overall use of tests is high, men with unstable angina are more likely to undergo stress tests or angiography compared with women experiencing the same symptoms. Healthcare professionals have a significant role to serve as patient advocates to ensure women receive the appropriate diagnostic workup when presenting with potential cardiac symptomatology

CLINICAL MANIFESTATIONS OF CHD IN WOMEN

ANGINA

After menopause, the clinical manifestations of CHD increase in women. The most common CHD manifestation in both men and women is angina [178]. Approximately 9.1 million women in the United States are currently living with CHD; 35,000 are younger than 65 years of age, and 4 million suffer from angina [1; 56]. The basic forms of angina include stable angina, unstable angina, and variations of angina. In terms of incidence, stable angina occurs more frequently in women in the United States than in men, with an estimated female-to-male ratio of 1.7:1 [178; 179].

Stable anginal episodes often worsen and become more severe, leading to unstable angina. Unstable angina is a type of chest pain that radiates more widely, may occur at rest, and is difficult to relieve. Women who suffer from unstable angina have the greatest likelihood of significant coronary artery stenosis and three-vessel or left main CHD. Consequently, these women are at greatest risk to experience more serious cardiac events, such as an MI or sudden cardiac death [180].

There are also several variations of angina. Variant or Prinzmetal angina is a form of unstable angina usually associated with a coronary artery spasm. It is characterized by episodes of severe ischemic-type chest pain that occur at unpredictable intervals, usually when the patient is at rest. There is a tendency for the anginal episodes to occur at night or in the early morning. Transient ECG changes that may accompany the anginal episodes include ST-segment elevations. Variant angina occurring in the presence of angiographically normal coronary arteries is more common in women than in men. It may also occur in the presence of high-grade coronary artery lesions [181].

Another variation is microvascular angina manifested by complaints of atypical or vague chest pain. This variant occurs more frequently in perimenopausal and postmenopausal women [182]. While the pain is comparable to the characteristics of angina, several atypical features are present, including rest pain, prolonged pain, and a less favorable response to nitroglycerin [182]. ECG changes often include ST-segment and T-wave abnormalities at rest, as well as exercise-induced ischemia [182].

By definition, microvascular angina is characterized by the presence of angiographically normal coronary arteries. In women with this syndrome, plaque accumulates in very small arteries of the heart, causing arterial narrowing, reduced oxygen flow to the heart, and pain that may be similar to that experienced by patients with blocked major coronary arteries. As noted, the difficulty with microvascular angina is that plaque does not appear when using standard tests. Rather, PET scan or magnetic resonance imaging are the primary diagnostic tools, as discussed [347]. The exact etiologic mechanism of microvascular angina is not known. It has been speculated that up to 80% of cases may be due to hypersensitivity in the nerves that lead to the heart, esophagus, and chest, making women acutely aware of sensations in their heart. Another possibility is that the syndrome is caused by a disorder of the small blood vessels that feed the heart, wherein the vessels fail to dilate in response to physical and/or emotional stress. The syndrome could also be due to a hormonal imbalance induced by a deficiency of estrogen. Women with this type of angina have less of a likelihood of significant CHD, and therefore a better prognosis, compared to other forms of angina. However, these women are still at risk of suffering an MI or, at a minimum, of experiencing a reduced quality of life [183; 184; 185; 186]. Many women respond to risk factor modification through cardiac rehabilitation and to pharmacotherapy with beta blockers, calcium channel blockers, and nitrates.

Differences in Chest Pain Syndromes

The sexes differ in still other ways when it comes to cardiac symptomatology. Men often experience textbook cases of angina and other CHD symptoms, perhaps because the texts were written to describe men's symptoms. However, the classic picture of CHD in women is just not known. For example, the hallmark symptoms of an MI (i.e., chest discomfort, pain that spreads, cold sweats, nausea) are experienced more frequently by men than women. Additionally, while chest pain is the most common symptom reported among both women and men, women more frequently report "vague" chest discomfort that comes and goes with no particular precursor [139; 187; 188].

Women may complain of classic substernal pain or have variations in their chest pain syndromes for reasons that are not completely understood. Women frequently report pain centered in the chest, pain in one or both arms, pain in the neck and/or jaw, or pain centered in the back and/or shoulders. Women also frequently report nausea, back pain, dizziness, generalized fatigue, shortness of breath, and palpitations [139; 145; 187; 189; 190]. Recognition of these sex differences in symptom reporting may result in more prompt and accurate diagnosis and treatment, as well as preventable deaths.

PSYCHOSOCIAL RESPONSES TO CARDIAC EVENTS

In addition to variations in presentation, women may experience different psychosocial responses to cardiac-related signs/symptoms than men [192; 193]. For instance, women, especially those 65 years of age and older, tend to delay seeking treatment for many hours [194; 195; 196; 338]. In one study, the median was 4.25 hours; other studies have reported delays of up to 15 or more hours [193; 197]. A woman may not suspect that her symptoms are related to CHD, so it may be difficult to convince her she needs medical help. Other reasons women delay seeking treatment include perceptions about the severity of their symptoms or their vulnerability to MI, and the presence of other chronic illness that create confusion about cardiac symptoms [193; 194; 198]. Maintaining control and not wanting to trouble others have also been found to influence a woman's decision about when to seek treatment for cardiac symptoms [199; 200].

Women should be taught the importance of seeking early medical attention and the subsequent clinical benefits [178; 198; 199]. One study found women tend to call for emergency services more often than men, but rates are low for both sexes, pointing to the need for increased education [338]. For instance, in the face of an acute MI, delays in seeking treatment reduce a woman's chance of successful myocardial salvage with medications, such as thrombolytic agents. Another delay may occur once in the emergency department, especially if a female patient presents with nonspecific symptomatology and/or an initial normal ECG and cardiac enzymes [56]. Furthermore, women are also less likely to be transferred from a small hospital to a large university hospital for aggressive care. Generally speaking, men tend to be transferred to larger centers twice as fast as women.

MYOCARDIAL INFARCTION

Men and women also differ in their incidence of MI. Thirty-four percent of women with CHD experience an MI, compared to 50% of men [11; 44]. Of the 9.1 million women with CHD, about 3 million have a history of MI [1]. Each year, new and recurrent MI will impact an estimated 445,000 women [1]. Plaque rupture is the most common cause of MI in both men (76% of cases) and women (55% of cases) [338].

CHD is the single leading cause of death of American women, accounting for nearly 22% of all deaths in 2018 [9]. Approximately two-thirds of women who died suddenly of CHD had no previous symptoms [56]. Both typical and atypical symptoms may be experienced by women presenting with an acute MI. Women typically report chest pain/discomfort (pressure, tightness, squeezing), along with additional symptoms including radiation of pain to jaw, neck, shoulders, arm, back, or epigastrium; nausea/vomiting; loss of appetite; dyspnea; lightheadedness; and diaphoresis [338]. Atypical symptoms may include sharp, pleuritic, burning, aching pain or soreness, upper back/chest pain, neck/jaw/arm/shoulder/back/epigastric pain, palpitations, unusual fatigue or shortness of breath, flu-like symptoms, dizziness, generalized anxiety or weakness, and indigestion [338].

Unrecognized or silent MIs are more frequent in women (54%) than men (33%), accounting for more than 50% of all infarctions in women 55 years of age and older [201]. Factors that place women at increased risk include older age, hypertension, and diabetes [201]. As mentioned previously, sudden cardiac death generally occurs about 5 to 10 years later in women compared to men.

Accurate diagnosis of myocardial injury and/or infarction is aided by measurement of serial cardiac enzymes [166]. Due to smaller body size, enzyme elevations may not be as high in women as those seen in men. This information is important to know when analyzing and interpreting enzyme rises in female patients presenting with cardiac symptoms. Further research is needed to explore sex-specific cardiac enzyme activity patterns [19].

Despite the overall lower incidence, if women suffer an MI they have a much poorer prognosis than men [1]. Morbidity and mortality may be higher in women due to their advanced age at the time of the infarction and the increased number of other comorbidities or chronic health problems. In addition, women may have more extensive damage with inferior MIs due to their greater tendency to have dominant right coronary artery systems [140].

In terms of mortality, women are twice as likely to die within the first few weeks post-MI compared to men [56]. Women are also more likely to die within the first year post-MI (38% versus 25% men) [56]. Again, the higher mortality figures may be due to the older age of women at the time of the MI. In further research, Yale investigators examined the records of 229,313 men and 155,565 women who were hospitalized for MI and enrolled in the National Registry of Myocardial Infarction II (NRMI-2) from 1994 to 1998. The findings revealed that for every five-year decrease in age, the odds of women dying during hospitalization increased 11.1% compared with men [202]. Subsequent analysis revealed a marked decrease in in-hospital mortality rates in women between 1994 and 2006, with the largest relative decrease in women younger than 55 years of age [203].

Women also have higher post-MI complication rates compared with men, despite similar treatment outcomes. These complications include bleeding from pharmacologic therapies or invasive procedures; cardiogenic shock from pump failure; mechanical problems such as mitral regurgitation, ventricular septal rupture, and left ventricular free wall rupture and tamponade; reinfarction; heart failure; and ventricular dysrhythmias. As noted, psychosocial factors have been implicated in the development of post-MI adverse outcomes [338].

Cardiogenic shock is more prevalent among women despite less extensive coronary disease and smaller infarct size. Factors that increase this risk include older age and higher rates of smoking, diabetes, hypertension, and underlying heart failure. In the early hospitalization period, women also have slightly higher reinfarction rates (25% versus 22% in men). Women with symptomatic infarctions are at greater risk for reinfarction than those with silent or unrecognized MIs. These rates are higher even up to five years post-MI [11; 19; 35]. Within six years after a recognized heart attack, 46% of women will be disabled with heart failure [56]. In another study, data from the Global Use of Strategies to Open Occluded Coronary Arteries in Acute Coronary Syndromes IIb study (GUSTO-IIb) were examined to evaluate sex-based differences in MI presentation and outcome [204]. Women were found to have more complications than men during hospitalization and a higher mortality rate at 30 days. However, in this analysis, women were found to have similar rates of reinfarction at 30 days post-MI. Researchers concluded that these differences may be due to anatomic or pathophysiologic differences between men and women or differences in rates of referral for diagnostic work-up or revascularization. Subsequent studies have indicated that when women receive timely, appropriate cardiac intervention, their 30-day mortality rate is similar to that of men [205; 206].

Heart failure tends to be more severe in women despite their higher left-ventricular EF and less severe ventricular dysfunction, perhaps due to the adverse effects of diabetes and hypertension on left ventricular diastolic function [11; 19; 35; 338]. Furthermore, the incidence of supraventricular and ventricular dysrhythmias, as well as heart block, appears to be similar in women and men [56; 338]. However, more ventricular dysrhythmias have been reported in young women with MI who use hormonal contraceptives. Women also have a much higher risk of stroke post-MI and death from stroke compared with men [56].

SUMMARY

The clinical presentations of CHD in men and women are different. Women are more likely to suffer from angina, while more men tend to suffer MI as an initial indication of their disease. Women's cardiac symptoms may also be quite different than the "typical" presentation seen in men. In addition, if women suffer an MI, they have a much poorer prognosis than men and have higher complication rates, such as heart failure, dysrhythmias, and even stroke. These findings may be due to the fact that the women are typically older, sicker, and have more comorbidities at the time of their MI in comparison to their usually younger male counterparts.

THERAPEUTIC INTERVENTIONS

In response to the increasing recognition of CHD in women, heart centers for women began to open in the late 1990s to provide personalized cardiac care for women. These programs continue to increase in numbers and provide services ranging from primary prevention, acute treatment, and cardiac rehabilitation to secondary prevention in primary and specialty care. Multidisciplinary care is essential to ensure best possible health outcomes for women. Thus, teams include nurses, physicians, psychologists, nutritionists, and exercise physiologists [347].

Various forms of treatment are available for CHD. Medical management may include pharmacotherapy with thrombolytic agents such as streptokinase and tissue plasminogen activator (tPA) and revascularization. Surgical intervention may be indicated in patients who have extensive coronary artery lesions. Revascularization via PCI or CABG surgery improves mortality risk and quality of life [347]. However, a large clinical trial that enrolled 1,689 women found the risk of death, MI, or cerebrovascular accidents was significantly lower in women who underwent CABG surgery for left main disease in comparison to PCI. This difference was not observed in men [356]. Regardless of whether a medical or surgical approach is taken, women who have documented CHD should be encouraged to enroll in a formal outpatient cardiac rehabilitation program.

MEDICAL THERAPIES

Clopidogrel Therapy

Clopidogrel is an antiplatelet agent approved since 1997 for use in the reduction of atherosclerotic events in patients with recent MI [305]. The Clopidogrel in Unstable Angina to Prevent Recurrent Ischemic Events (CURE) trial enrolled 12,562 patients with unstable angina or non-Q-wave MI. The study found that the addition of clopidogrel to aspirin for patients with acute coronary syndrome reduced the risk of death, reinfarction, or stroke by 20% in people who had survived a mild heart attack. These patients were at serious risk of further complications in the days and months following their attack. The drug showed equal benefits for those with unstable angina. The effects were evident within two hours and were sustained [305]. A major side effect was serious bleeding, such as stomach ulcers, which occurred in about 1% of patients (a similar rate to the effects of aspirin) [305].

Studies have revealed responsiveness to clopidogrel is not uniform, and a low response is linked to a higher incidence of thrombotic events. As a result, newer P2Y12 receptor antagonists (e.g., prasugrel, ticagrelor) and a combination of clopidogrel with newer oral anticoagulants (e.g., dabigatran, apixaban, rivaroxaban) are being studied for their use in patients with stable and unstable CHD [307; 308; 309; 310].

Thrombolytic Therapy

Thrombolytic therapy is frequently given to patients within the first six hours of presenting with possible cardiac symptoms. It has proved beneficial in restoring vessel patency and improving clinical outcomes in both men and women (i.e., 25% to 30% reduction in short-term mortality) [209; 216]. However, women are less likely to receive thrombolysis to restore vessel patency in the management of acute MI for several

reasons, including advanced age, delayed arrival at the hospital, and medical contraindications [216]. Even in those eligible, women are less likely to receive thrombolytic therapy [217]. The *Gruppo Italiano per lo Studio della Streptochinasi nell'infarto Miocardico* (GISSI-1) first validated streptokinase as an effective therapy and reported a significant reduction in the 21-day mortality in women who received IV streptokinase within six hours post-MI. Despite these promising outcomes, treated women's mortality rates remain higher than men's [217; 218; 338]. The AHA recommends thrombolytic therapy be used at non-PCI centers when a significant delay to performing a primary PCI within 120 minutes of first medical contact is anticipated [338].

Women who are treated with thrombolytic therapy tend to experience more complications, such as major bleeding and stroke. Increased bleeding, especially severe intracranial bleeding, has been reported in some women, particularly with advanced age [216; 338]. These adverse reactions may be due to the administration of fixed dosages as women may require lower doses to be consistent with their smaller body mass. Indeed, differences may exist between the sexes in how drugs are absorbed, distributed, metabolized and excreted. Historically excluded from clinical trials related to cardiac medications, women continue to be under-represented in drug studies. Inclusion of women in these trials is imperative in order to understand differences that may exist so clinical care can be individualized accordingly to enhance best possible cardiovascular outcomes for women. [217; 342; 346; 353].

Angioplasty

PCI is the treatment of choice for patients with single-vessel disease [207]. It offers patients a lower 30-day mortality rate compared with thrombolytic therapy [338]. An estimated 35% of PCIs in the United States are performed in women [208]. At the time this procedure was first performed, women tended to be on average nine years older than men, with more cardiovascular risk factors and severe unstable angina [208]. However, angiographically documented CHD has not been found to be more extensive in women compared to men [209]. On a per-lesion basis, angiographic success rates have been found to be similar between men (88%) and women (89%), as were clinical success rates [209; 210]. Determinants of PCI success include lesion-specific angiographic features, such as the severity of stenosis, coronary calcification, and intralesional thrombosis-factors that are not influenced by either age or sex [211]. In treating left anterior descending disease, CABG surgery is an attractive option due to the high rate of post-PCI restenosis [208].

Women undergoing PCI with stenting have a greater incidence of initial post-procedure complications. These short-term complications include bradycardia, hypotension, MI, bleeding, and vascular complications [210; 347]. Radial versus femoral access sites has significantly decreased these complications in women [347]. A higher rate of unsuccessful PCIs, or inability to cannulate the vessel and pass the lesion with the balloon catheter, has also been reported in female patients. [210]. These women are more likely to have elective CABG surgery after PCI than men. Advances in new techniques and equipment, such as angioplasty catheters, as well as the clinical expertise of the physician performing the procedure, are helping to bring these rates into comparable levels between men and women [210; 212; 213].

Historically, women had a significantly higher in-hospital mortality rate compared with men [212; 214]. However, according to the results of one meta-analysis, reported increases in both all-cause and in-hospital mortality in women is confounded by baseline cardiovascular risk factors and differences in the clinical profile of male and female patients, suggesting that intensive risk modification efforts in women may help reduce the sex disparities [215]. Long-term follow-up at 20 months post-procedure shows women tend to have decreased mortality after stenting compared with men [347].

Additionally, survival rates post-PCI are similar for men and women with regard to long-term outcomes [215]. While women have slightly fewer coronary events and a lower incidence of restenosis and need for additional revascularization (i.e., repeat PCI or CABG), symptomatic improvement is similar for men and women [210].

SURGICAL INTERVENTION

Preoperative Status and Referral

The Coronary Artery Surgery Study (CASS) investigated 2,800 women and 5,300 men who were experiencing severe enough chest pain to warrant a coronary angiogram. This study revealed a number of differences in the preoperative status of men and women. As discussed earlier, women were found to be at increased surgical risk because they tend to be older, have more unstable angina, frequent cardiac enlargement on chest x-ray, severe mitral regurgitation, and more symptoms and comorbidities, such as hypertension, diabetes, and heart failure. Factors that place women at lower risk include they tend to have fewer diseased arteries and less myocardial damage. In other words, women generally have better EFs and ventricular wall motion, as well as less left main stenosis and three-vessel disease [11; 19; 26; 27; 35]. It has been suggested these differences in preoperative status may be less related to sex than to delays in the initial diagnosis and treatment of symptomatic CHD in women. This delay translates into an older age and more frequent comorbidity in women at surgical presentation [219; 220].

CABG surgery continues to be the criterion standard in the treatment of multi-vessel CHD in both men and women. However, women tend to be referred for surgery much later in relation to men. In one study, fewer women with symptoms were referred for angiogram, and men underwent CABG four times as often as women. Women were referred more for symptoms of unstable angina, heart failure, and post-MI angina, while men were referred on the basis of a positive exercise ECG [19; 26]. As a result, women are more likely to have surgery on an emergency basis, with potentially fewer techniques available to the surgeon, rather than on an elective basis, as is common in men. For example, the use of left internal mammary artery (LIMA) grafts is accepted as the criterion standard for surgical revascularization. Many studies have demonstrated better long-term patency rates and survival in patients undergoing CABG with LIMA [223; 224]. The benefit of LIMA grafts has been observed consistently regardless of age, sex, stenosis severity, or LV function. Although a number of risk factors have been identified to result in LIMA graft failure, they are less common than for other grafts [224]. Nevertheless, the risk-to-benefit question is of increasing importance as the proportion of high-risk subgroups continues to rise [223; 225].

Perioperative Outcomes

In terms of operative success, the perioperative mortality rate has been documented to be higher in women than in men despite less preoperative coronary plaque burden [347]. These outcomes are particularly true for women younger than 60 years of age; however, advanced age is still considered a significant risk factor for women [226]. The higher mortality in women may be attributed to pre-operative clinical status, other cardiovascular risk factors, and smaller body size and coronary artery diameter, which make anastomosing grafts more difficult. As surgical techniques become more refined, the latter issue may be less of a problem. For both men and women, operative mortality decreases as height and vessel diameter increases. Therefore, vessel diameter, and perhaps not sex, is most indicative of operative success [19; 26; 35; 36].

Improved surgical techniques, such as off-pump coronary artery bypass, appear to be safe, effective surgical alternatives for high-risk patients, including women [228]. However, evidence is conflicting on the long-term outcomes [228]. A Canadian study reported the five-year survival rates to be similar between on- and off-pump CABG, while a study funded by the Department of Veterans Affairs found that off-pump CABG led to lower rates of five-year and event-free survival compared with on-pump CABG [229; 230]. Factors that may contribute to long-term survival include the completeness of revascularization and surgeon experience [231; 232].

Postoperative Outcomes

Postoperative outcomes of women after CABG surgery have also been studied. The findings indicate that women experience increased hospital stays, higher complication rates, and greater postoperative morbidity, leading to more hospital readmissions compared with men [26; 227; 228]. Women report less relief of angina, more symptoms, and poorer overall health than men [35; 225].

An interesting study compared the symptoms experienced by men and women during the first four weeks of recovery post-CABG surgery. Women reported numbness and discomfort in their breasts, while men reported more fatigue, incisional pain, and negative emotions. Both men and women felt their recovery emotions were related to their social roles and circumstances [225]. For instance, women were concerned and anxious about who would care for them during their home recovery, as they tended to be older and live alone. In contrast, men were more concerned first with their immediate physical recovery symptoms and secondly with return to work issues [233]. Researchers have noted that women tend to find strength for the postoperative recovery phase from their own spirituality and relationships with others, especially their families, friends, and social networks [234]. One study found that women's primary concerns shifted over the course of one year after CABG surgery [235]. In the first postoperative month, women were most concerned with issues related to future plans, such as progress in recovery and resuming their lifestyle. By one year after surgery, women were most concerned about diet, and more than half of the women were exercising more.

Additional studies offer more encouraging news for women. A study conducted by several leading New England hospitals compared patients and outcomes from 1987–1989 with those from 1993–1997. Researchers found that although women having CABG in the latter date range were older and sicker than those in the earlier range, the mortality rate had decreased [221]. Another study of 2,200 patients who underwent CABG at Cleveland Clinic between 1993 and 2003 found no sex difference for in-hospital mortality but did find that women have a longer length of stay after surgery, as well as higher postoperative complications rates, factors that may affect a woman's postdischarge recovery.

The Surgical Treatment for Ischemic Heart Failure (STICH) trial randomized 148 women and 1,064 men with heart failure to either CABG plus medical therapy or medical therapy alone [222]. Ten-year outcomes with each treatment were compared according to sex. At baseline, women were older with higher BMI, more cardiovascular risk factors (e.g., diabetes, hypertension, hyperlipidemia), and lower rates of prior CABG than the men. Women also had higher NYHA class and lower six-minute walk capacity. However, over 10 years of follow-up, all-cause mortality and cardiovascular mortality were significantly lower in women compared with men. Additionally, there was no significant association between sex and treatment groups in all-cause mortality, cardiovascular mortality, or the composite of all-cause mortality or hospitalization [222].

CARDIAC REHABILITATION

Cardiac rehabilitation is a comprehensive, multidisciplinary chronic disease management program that includes patient assessment, nutritional counseling, cardiovascular risk factor management, psychosocial management and counseling, exercise training, and physical activity counseling/prescription. The Centers for Medicare and Medicaid Services provides coverage for cardiac rehabilitation for patients with stable angina and heart failure with reduced EF, as well as after acute MI, PCI or coronary stenting, CABG surgery, heart value repair or replacement, and heart or heart-lung transplant. Both inpatient and outpatient cardiac rehabilitation programs are an essential component of CHD treatment in women. Participation in cardiac rehabilitation is associated with improved cardiovascular risk factor management, exercise capacity, and quality of life, as well as reduced hospital admissions and mortality. More current evidence, however, demonstrates

women have poorer outcomes related to patient assessment, exercise training and physical activity counseling, and management of weight, lipids, diabetes, and psychosocial concerns compared with men [341].

Challenges abound in providing phase I inpatient rehabilitation due to decreasing lengths of stay. Therefore, there is a need to emphasize survival skills to the female cardiac patient, as well as to enroll her in an outpatient phase II program. Despite these needs, reported compliance rates for formal cardiac rehabilitation programs, for both men and women, range anywhere from 21% to 75% [236]. This range in compliance rates may be a reflection of the referring physician. For example, researchers have found that as few as 7% of eligible cardiac patients are referred to a cardiac rehabilitation program and an even smaller percentage are referred for outpatient rehabilitation following discharge. Lack of adherence to or awareness about referral guidelines or disagreement with guidelines may be contributing factors in low referral rates. This is important because the strength of the physician's recommendation is strongly associated with patient compliance [237]. Factors affecting physician referral include limited general knowledge about cardiac rehabilitation programs (e.g., attributes, benefits), perceived barriers to uptake of rehabilitation, lack of insurance coverage, low physicians' fees, and positive perceptions of a short distance to the rehabilitation site [238; 239].

Furthermore, sex disparities remain in referral, enrollment, and completion of outpatient cardiac rehabilitation. Women tend to be referred for cardiac rehabilitation post-MI or CABG surgery less often than men and, thus, have lower overall participation rates. This is true even though an estimated 40% of cardiac events occur in women [19; 234; 237; 240; 341]. In one study of the 91% of female patients that were eligible for outpatient cardiac rehabilitation, only 48% were referred by their physician, in comparison to 67% of men [241]. Of those women who participated in outpatient rehabilitation, 75% completed the program versus 88% of the men. Thus, it appears women have higher dropout rates compared with male cardiac patients, despite their higher risk of decreased quality of life and functional ability following an MI [237; 242]. Referral to and completion of a cardiac rehabilitation program is associated with a significant mortality reduction in women that is comparatively better than that found with men [242].

A number of factors account for the lower program completion rates among women. These factors include family commitments, financial concerns such as insurance barriers, and lack of spousal support. Other reasons for decreased program attendance in both men and women include transportation problems, distance, cost, work conflicts, medical reasons, and having a sense of personal control over their condition [238; 243]. Societal barriers, such as low education, may also impede enrollment in a rehabilitation program [244]. However, women's attendance at cardiac rehabilitation programs is more often affected by medical reasons compared to men, with complaints of increased angina and other associated symptoms, comorbidities such as arthritis and peripheral vascular disease, and/or a need for admission to transitional care postdischarge. This trend may be due to the presence of more cardiovascular risk factors and increasing cardiac symptoms in women [26; 241; 245]. On the other hand, men usually receive more family support and are accompanied by their spouse to cardiac rehabilitation programs more often than women, a finding that may partially explain women's higher dropout rates.

Nurse-led coordination of care after hospital discharge may have a role in improving rehabilitation uptake [248]. Some experts advocate giving nurses more responsibility to educate and motivate women to complete their recovery by participating in outpatient cardiac rehabilitation [249]. By assessing each woman prior to discharge, those women who are at increased risk for not participating may be identified and targeted for follow-up. This assessment should include a woman's psychological state, namely anxiety and depression, as well as other factors like functional status; education, employment and socioeconomic status; and availability of social support.

Combined systematic and liaison-facilitated referral has been found to result in significantly greater enrollment in cardiac rehabilitation programs among women. One prospective study included 2,635 inpatients that utilized one of four referral strategies [250]. All participants completed a sociodemographic survey, and one year later, 1,809 participants (452 [25%] women) completed a mailed survey that assessed their utilization of cardiac rehabilitation. Overall, more men than women were referred to (67.2% and 57.8%, respectively) and enrolled in (58.6% men and 49.3% women, respectively) a cardiac rehabilitation program. Among the women, combined systematic and liaison-facilitated referral resulted in significantly greater referral to and enrollment in a cardiac rehabilitation program when compared with usual referral strategies.

Other novel strategies to mitigate sex differences in cardiac rehabilitation patterns have been recommended. These strategies include implementing automated electronic health record referral systems to eliminate sex differences in referral patters, as well as designing female-specific cardiac rehab programs that incorporate not only a behavioral change intervention, but also exercise sessions where women would only be exercising with other women. Other innovative models could provide hybrid cardiac rehab allowing participants to engage in traditional rehab centers coupled with rehab at home using mobile technology such as telehealth, peer support, health coaches and community health workers [338; 341]. Home-based cardiac rehabilitation programs are another attractive option for older women and those who are homebound [19; 240; 247]. Clearly, cardiac rehabilitation programs should be structured to the unique needs of women [237; 246].

Activity and Exercise

While women have a lower aerobic capacity at baseline and after exercise training, the magnitude of their improvement is similar to or greater than that of men after a 12-week program. In other words, cardiac rehabilitation may actually have greater benefit for women because they begin with a lower functional capacity. Women develop increased physical work capacity and lower their myocardial oxygen demand through exercise training and achieve the same training effects as men [245; 251]. In addition to exercise, cardiac rehabilitation favorably alters other cardiovascular risk factors [252; 253]. In one study, both men and women showed a trend in decreasing mean weight and quitting smoking. Yet, no changes in their lipid profiles were found before or after the program [245].

Women have a tendency to begin household activities early in the postdischarge period, often immediately upon discharge, then increase progression of their activities by the third or fourth week. In studying psychosocial responses, women tend to experience guilt feelings if they are not able to assume their usual household activities after their cardiac illness and often resist help from their family members because they do not perceive chores as a strenuous activity [225]. In contrast, men tend to rest for a period prior to progressing activity levels and begin to walk at approximately three to four weeks after discharge from the hospital [26]. As a result, women tend to be active at higher metabolic equivalent levels compared to men, most likely due to the earlier resumption of household activities. This is an area of major concern in the treatment of female patients due to their higher mortality rate post-MI. Women also experience more depression in association with their cardiac illness compared to men, which may be associated with activity limitations due to recurring symptoms and poorer health [19; 237].

Return to Work

According to research presented at the Acute Cardiac Care Congress 2013, a delay in treating patients with MI postpones their return to work and increases early retirement [254]. Researchers conducted a population-based cohort study that included 4,061 patients younger than 67 years of age admitted with STEMI who were treated with PCI during a 13-year period (1999–2011). Only patients who were employed either full-time or part-time before their admission were included in the study. After four years of follow-up, 91% of the study population had returned to work. After eight years of follow-up, 29% had retired. After adjusting for confounding factors, the researchers found that a delay in treatment of more than 120 minutes was associated with a postponed return to work. Researchers also discovered that after eight years, a long delay in treatment of MI resulted in a 21% increase in retirement rate. Researchers found no differences between men and women in the effect of treatment delay but did find that men returned to work later than women [254].

Psychosocial Support

Another component of cardiac rehabilitation involves psychosocial support. This support may be provided either individually or in group settings [237]. Support groups may be offered as an intervention to meet the unique needs and concerns of women with CHD. Because women tend to be more process- and relationship-oriented, they may have a need to talk about their experience with other women, family, friends, and healthcare providers after the cardiac event. Asking female cardiac patients what they believe caused their cardiac illness and what fears they have, as well as what the experience means to them or what they have learned as a result of their heart condition, may be helpful [19; 192].

Cardiac support groups may also be designed to include family members in addition to the female cardiac patient. Many different kinds of groups may be offered to provide support during the acute and convalescent phases. For instance, a support group could be offered to the families of women who have undergone CABG surgery. Family members could be asked how they perceive their relative is responding to the cardiac event and how the event is affecting their lives [192]. Other groups may be offered for only the patient, for example after recovering from an MI, or the group may be structured to also include the patient's spouse or significant other. Regardless of the approach used, the group sessions should be scheduled at times that are convenient for women and their families.

Several experts have described the common themes discussed in either patient, spouse, or couple support group settings. The common themes often discussed in patient-only groups include [255]:

- Reliving the coronary event and searching for a reason or cause for the event
- Hiding anger and depression from the family
- Uncertainty about the future
- Separation anxiety related to discharge from the hospital
- Change in family roles
- Ambivalence about medical care
- Change in sex life and fear of sex
- Dependence-independence conflict in marital relationships
- Need for control
- Conflictual relationships with young children
- Feelings of anger, hostility, helplessness, and dependency

While these themes have been reported in numerous group settings with cardiac patients and families, more research is needed to determine whether the themes are equally common when the patient is a female [255]. Perhaps some of these themes are more prevalent or are only reported in cases of men with CHD. In addition, some themes would undoubtedly only be present when a woman in the family has CHD.

In contrast, couple groups were concerned with issues such as expressing anger, imparting information, instilling hope, redefining wellness, identifying with others, and an altruistic concern for others. Themes in spouse groups have centered on the following areas [255]:

- Concern for the patient's medical condition, discharge from the hospital, and emotional ability
- Emotions such as anger, frustration, insecurity, guilt, loss, and uncertainty
- Anxiety about the future
- Sexual-related fears
- Conflict between self-expression and a need to protect spouse
- Catharsis
- Fear of upsetting patient
- Change in interpersonal relationships
- Sense of responsibility for patient's recovery
- Death
- Depression and psychosomatic symptoms

As with patient-only group themes, further investigation is needed to determine if the themes of couple and spouse groups are similar when the cardiac patient is a woman. These relationships will most likely be affected in unique ways when a woman in the family is struck with CHD.

Regardless of whether a medical or surgical approach is taken in the treatment of women with CHD, patients should be encouraged to enroll in an outpatient cardiac rehabilitation program. These programs have shown that women can favorably impact their cardiovascular risk profile and obtain physiologic benefits of aerobic exercise. Furthermore, addressing psychosocial aspects of care through support groups or individual therapy may be helpful.

IMPLICATIONS FOR NURSING PRACTICE

ACUTE PHASE

Women with heart problems are in special need of patient advocates. Nurses have a crucial role in supporting female patients to ensure they receive appropriate diagnostic and therapeutic care. In addition to briefly exploring this patient advocate role, this section will present common nursing diagnoses for women with CHD during the acute care phase.

Implications for Assessment

The main implication for assessment in women is recognition that chest pain may not be their presenting symptom. Women have more complaints of vague chest pain that warrant further workup. It is important to anticipate nonspecific signs and symptoms, such as back pain and loss of appetite. It is important to be aware of the possibility of occult CHD in women older than 65 years of age. Unrecognized CHD may complicate the recovery course of women who are hospitalized for noncardiac problems, as women have more episodes of silent ischemia and infarction. Nurses have a critical role in the thorough assessment of patients and in providing education on reduction of cardiovascular risk factors and recognition of signs and symptoms of CHD [256].

Evaluation of Medical Therapy

Historically, it has been believed that women will respond to the same cardiovascular interventions as men. However, the clinical outcomes may be quite different. Therefore, it is important not to assume that what has been learned about men through practice or research may be equally applied to women [257; 258]. The unique physiologic aspects of women's cardiovascular systems should be considered when implementing medical therapy [257; 258].

Nurses have a special role to play as patient advocates when caring for women with cardiac problems. Nurses should encourage symptomatic women to interact with their physician to obtain a correct diagnosis and suggest appropriate cardiac diagnostic tests, such as exercise echocardiograms. If female patients are not responding to medical or nursing interventions, nurses should question if these are the right therapies. By detecting subtle changes in a woman's response to treatment, nurses can provide input and suggestions for the plan of care. For instance, if anginal episodes post-MI are not resolving, changing to a cardioselective beta blocker and adding nitrates to the medication regime may be suggested. In addition, nurses can request researchers to gather data on women or replicate studies with women. With increased understanding of female responses to CHD, nurses will be able to identify and test more appropriate interventions. If women and men respond differently to cardiac events, nursing care standards should then be modified and integrated into clinical practice accordingly [257; 258].

Nursing Management

Several sequelae may occur in women with CHD during the acute hospitalization phase, including decreased cardiac output, alteration in comfort level or pain, knowledge deficit, activity intolerance, body image disturbance, and sexual dysfunction [258; 338]. Each of these will be further explored, with special consideration given to implications for treatment in female patients.

Decreased Cardiac Output

Decreased cardiac output is one of the most significant sequelae in women with CHD. This diagnosis exists whether the woman is experiencing angina or MI or is recovering from CABG surgery, although the nursing implications may vary with each clinical scenario.

It is important to recognize female cardiac patients experiencing angina have a more favorable prognosis than men. However, prevention of an acute MI is paramount in this group, because when a woman does have an MI, she has an unfavorable prognosis. A comprehensive cardiovascular risk assessment should be performed, focusing on both traditional and sex- and gender-specific risk factors (e.g., myocardial dysfunction, blood loss, increase in intrapericardial pressure, changes in cardiac rhythm and/or electrical conduction) [259]. When these risk factors have been identified, female patients may be educated and counseled about strategies to reduce their cardiovascular risks through various lifestyle modifications [145; 259].

During the post-MI phase, female patients have significant morbidity and mortality. Assess for the presence of other diseases that may impact the patient's recovery, such as diabetes or hypertension, as well as early manifestations of heart failure [145]. Several pharmacologic considerations in relation to cardiac output status apply in these patients. Cardiac medications, such as antidysrhythmics, may be less indicated in women because complex ventricular ectopy or ventricular dysrhythmias are not associated with as severe adverse prognoses as in men. It is also important to recognize that thiazide diuretics used in conjunction with antihypertensives to treat hypertension may have hyperlipidemic effects. Estrogen protects women against hyperlipidemia, so cholesterol levels should be closely monitored, especially in menopausal women [19].

Beta-blockers have been extensively evaluated in placebo-controlled clinical trials including many types of patients, including women and older adults [260]. Three beta-blockers (i.e., carvedilol, bisoprolol, and sustained-release metoprolol [succinate]) have been found to be beneficial in women with heart failure when added to an ACEI [261; 262; 263]. Carvedilol is a nonselective agent that improved survival in the 256 women who participated in the U.S. Carvedilol Heart Failure Study; it also reduced the combined end point of death or hospital stay in the 469 women

who participated in the Carvedilol Prospective Randomized Cumulative Survival Study (COPERNICUS) trial. Bisoprolol and metoprolol succinate are beta-selective agents. Bisoprolol improved survival in the 515 women who participated in the European CIBIS II (Cardiac Insufficiency Bisoprolol Study); its use in heart failure is unlabeled. Metoprolol succinate had no survival benefit in the 898 women who participated in the Metoprolol Extended-Release Randomized Intervention Trial in Heart Failure but did reduce heart failure hospital stay by 42% [261]. Because reinfarction rates tend to be higher in women, beta blockers are an important part of treatment [11]. However, women tend to experience more medication side effects and suffer from more peripheral vascular disease, such as Raynaud's phenomenon, than men. Cardioselective beta blockers, such as atenolol or metoprolol, are a better choice for therapy in women, as nonselective agents have adverse effects on the peripheral circulation, magnifying vasospasm and vasoconstriction [260]. Additionally, beta blockers may not be the optimal first-line medication choice in diabetic women and should be used cautiously due to their hyperglycemic effects [160].

After PCI or CABG surgery, female cardiac patients are also at increased risk for mortality, primarily those who are older and have more comorbid disease [264]. At the time of these procedures, assess the patient's status to determine the presence of other factors or comorbidities that may impact recovery. Anticipating potential complications during the acute phase may help reduce morbidity and mortality [264]. Management during the acute phase should be directed toward early detection and prevention of possible complications and prompt intervention when adverse events occur [264]. Unless contraindicated, angiotensin receptor blockers (ARBs) are recommended for women with heart failure with current or prior symptoms who are intolerant of ACEIs to reduce morbidity and mortality [262; 263].

Pain

Pain is another nursing diagnosis that applies to women with CHD. Nitrates and calcium channel blockers are the drugs of choice for the management of angina in women [265; 266; 267]. These medications dilate coronary arteries and are used to treat coronary artery spasms. Sublingual nitroglycerin can be used for acute relief of angina and prophylactically before activities that may precipitate angina. Long-acting, heart rate-slowing calcium channel blockers can be used to control anginal symptoms in patients with a contraindication to beta-blockers [266]. Because few women have been included in clinical trials of cardiac medications, sex-specific differences in the efficacy of these medications are not known. Therefore, women may not require the same drug dosage as men. Fluctuations in vasomotor tone may be significant because women have smaller coronary arteries. Consequently, women may require lower doses of medications such as nitrates and calcium channel blockers. However, because angina tends to be more severe in women than in men, anti-anginal treatment may need to be more intensive [11; 35].

Special considerations exist in relation to assessing chest pain in premenopausal women who may have cyclic hormonal variation to their cardiac symptoms. For instance, angina tends to occur during the second half of the menstrual cycle, when estrogen levels are low. Therefore, current menstrual cycle information is an essential part of assessment [268; 269; 270].

Knowledge Deficit

Patient education for women with CHD should incorporate several components, including the disease process, diagnostic tests, medications, the recovery process, and risk-factor modification. In relation to the disease process, female patients should be taught symptom recognition and early treatment of complications. The positive long-term outcomes of women with angina and post-PCI and CABG surgery should be stressed when counseling patients regarding the recovery process. Medication

teaching should include a description of the action and effects of the cardiac medication, along with the dosage, frequency, and possible side effects. The nurse may also act as a patient advocate with regard to diagnostic testing. Attempt to ensure that the appropriate diagnostic tests and treatment procedures are provided to the patient. Finally, risk factor modification enhances the patient's progress and quality of life [271].

Other considerations related to patient teaching focus on providing women-centered education. Much of the teaching and audio-visual materials available to women with CHD were developed primarily with men in mind. Therefore, patient teaching materials should be modified so that patients can see other women and learn about their own unique needs [271]. The National Institutes of Health (NIH) offers booklets that cover heart healthy topics such as prevention, awareness, diet, exercise, and smoking cessation [271; 272]. Additionally, a woman's level of health literacy can affect the course of CHD, including readmissions and early death. According to a research summary compiled by the CDC, patients with limited health literacy face difficulties performing self-care activities (e.g., monitoring weight, salt, fluid intake) [273]. The findings support training healthcare staff to deliver tailored education that matches a patient's health literacy skills. Family members should also be included in cardiac teaching, with emphasis on how they can support the female family member with CHD. For instance, family members can be taught to encourage the patient to follow activity recommendations after discharge from the hospital. Family involvement to recognize signs and symptoms of complications postdischarge has become more important than ever with the trend towards shortened hospital stays. Other strategies to detect early complications after discharge include follow-up telephone programs and the use of home health nursing when appropriate [249; 272].

Activity Intolerance

Due to complications, women may be slow to mobilize in the acute care setting. Comorbidities such as arthritis and diabetes may also affect activity levels. As a result, activity progression should be modified as needed. However, cardiac rehabilitation should begin as soon as possible during the inpatient phase as well as in the outpatient phase. Ensuring that female patients are connected with cardiac rehabilitation programs in their community may facilitate this intervention [274].

Body Image Disturbance

A qualitative study with female CABG patients has examined experiences related to body image. The most frequently occurring themes were concern over lack of privacy in the hospital setting, difficulty adjusting to short-term memory loss, extreme breast discomfort, and visibility of chest and leg scars [35]. Therefore, female cardiac patients may need assistance in exploring concerns and attitudes related to the impact of their cardiac illness on their body image.

Sexual Dysfunction

Researchers interviewed 17 women with monogamous sexual partners in the Translational Research Investigating Underlying Disparities in Acute Myocardial Infarction Patients' Health Status (TRIUMPH) registry to understand the recovery of sexual function and improve sexual outcomes in women post-MI [208]. Although the women universally expressed a desire to receive direct advice from their physician (particularly their cardiologist) about when they could safely resume sexual activity and how much exertion would be safe for their heart, the study findings indicated that the few women who had discussed sexual activity with their physician found the counseling to be vague or confusing. Lack of counseling by a physician has been found to be one of the predictors of loss of sexual activity following MI, despite recommendations for such counseling by the ACCF/AHA and the European Society of Cardiology [208]. Guidelines for safe return to sexual activities are available to guide individualized and culturally appropriate sexual counseling with female patients [338].

Nursing Diagnoses and Interventions

Several nursing diagnoses are relevant to the female cardiac patient during both the preventive and acute care stages. This section will summarize these nursing diagnoses along with appropriate nursing interventions and measurable expected outcomes for both the patient and the family [254].

- **Altered health maintenance** related to lack of education, readiness, or motivation to modify cardiovascular risk factors

  Expected Outcomes

  1. The patient will describe lifestyles that promote cardiovascular health.
  2. The patient will describe and demonstrate health behaviors that are needed to manage the cardiac condition.

  Nursing Interventions

  1. Assess patient's knowledge level of primary prevention strategies:
     - Avoidance of smoking
     - Low-fat and low-cholesterol diet
     - Zero to moderate alcohol consumption
     - Regular exercise program
     - Stress management techniques
  2. Teach patient the importance of secondary prevention:
     - Control of hypertension
     - Dietary or pharmacologic management of abnormal blood lipids
     - Management and control of diabetes
  3. Determine knowledge the patient and family require to implement primary and secondary prevention strategies.
  4. Assess the need for other resources or referrals to assist the patient and/or family.

- **Decreased cardiac output** related to electrophysiologic, mechanical, or structural problems of the heart

  Expected Outcomes

  1. The patient will maintain an adequate cardiac output to meet the needs of body tissue demands, as evidenced by:
     - Vital signs within normal range
     - Optimal skin color, temperature, and peripheral pulses
     - Optimal respiratory and neurologic status
     - Optimal renal perfusion evidenced by intake and output and/or daily weight within normal limits

  Nursing Interventions

  1. Assess skin color and temperature and peripheral pulses. Examine for the presence of edema.
  2. Assess respiratory rate, breath sounds, and heart sounds.
  3. Assess intake/output and weight every day.
  4. Assess neurologic status (e.g., mental status, level of consciousness).
  5. Assess patient's tolerance of activity each day and modify activity progression as needed.
  6. Administer cardiac medications and/or treatments as ordered.

- **Alteration in tissue perfusion**, cardiopulmonary, related to myocardial ischemia or infarction or electromechanical problems of the heart

  Expected Outcomes

  1. The patient will demonstrate adequate or improved cardiopulmonary tissue perfusion as evidenced by:
     - Systolic blood pressure greater than or equal to 90 mm Hg
     - Absence of dysrhythmias
     - Respiration sounds normal
     - Balanced intake/output
     - Lab values within normal limits
     - Improved comfort level

  Nursing Interventions

  1. Monitor hemodynamic parameters and EKG rhythm.
  2. Instruct patient to report level of pain on 0 to 10 scale.
  3. Assess heart sounds and breath sounds.
  4. Instruct patient to avoid activity and exercise if symptoms occur and to promptly report any symptoms experienced.
  5. Administer medications and/or treatments as ordered.

- **Pain** related to myocardial ischemia or infarction, cardiac procedure, and/or CABG surgery

  Expected Outcomes

  1. The patient will describe level of chest discomfort.
  2. The patient will communicate relief of pain to a tolerable level.
  3. The patient will be able to perform expected activities for recovery.
  4. The patient will verbalize understanding of the pain management plan.

  Nursing Interventions

  1. Assess comfort level on a 0 to 10 scale every 2 hours for 24 hours and then at least every 4 hours.
  2. Assess patient's physiologic and behavioral responses to pain.
  3. Assess relationship of patient's activities to pain and discomfort.
  4. Instruct patient to report pain promptly so pain relief measures may be instituted before the level of pain gets out of control.
  5. Reassure patient and family on expected pain relief measures every 12 hours.
  6. Collaborate with patient and family to develop a plan for pain control.
  7. Administer analgesics or treatments as ordered for daily pain management.
  8. Instruct patient and family on alternative comfort measures, such as relaxation and diversion or other integrative therapies (e.g., music, meditation, massage) as appropriate every day.

- **Activity intolerance** related to alterations in oxygen transport system associated with cardiac problems

  Expected Outcomes

  1. The patient will identify factors that aggravate activity intolerance and verbalize understanding of need to increase activity level after undergoing cardiac procedure or surgery.
  2. The patient will demonstrate desire and ability to progress with activity and exercise patterns on a daily basis.
  3. The patient will demonstrate a decrease in physiologic signs and symptoms of activity intolerance.

  Nursing Interventions

  1. Monitor patient's vital signs in lying, sitting, and standing positions prior to ambulation and/or exercise.
  2. Notify physician if patient's heart rate increases more than 20 beats per minute from baseline or if blood pressure drops more than 10–15 mm Hg from baseline values.
  3. Ambulate patient with assistance, monitoring vital signs and oxygen saturation if indicated; stop activity if vital signs change according to guidelines above or if oxygen saturation drops below 90%.
  4. Teach patient and family about activity and exercise pattern, especially emphasizing importance of increasing activity level by adding minutes each day to the exercise program, as opposed to emphasizing the distance walked.
  5. Instruct patient and family on signs and symptoms of activity intolerance and alternative methods of completing daily living activities, including use of assistive devices if needed.

- **Knowledge deficit** related to lack of knowledge regarding cardiovascular risk factors, symptomatology, diagnostic tests, treatments and procedures, and/or surgical interventions

  Expected Outcomes

  1. The patient will verbalize understanding of risk factors for CHD, including both traditional and gender- and sex-specific factors, about her cardiac illness or event as well as medical therapies, cardiac procedures, and/or surgical intervention.
  2. The patient will demonstrate behaviors to modify alterable risk factors, including smoking history, hypertension, hyperlipidemia, diet, exercise, and birth control methods.

  Nursing Interventions

  1. Assess patient's and family's current knowledge base and readiness/ability to learn.
  2. Develop realistic teaching/learning objectives with patient and family as appropriate.
  3. Provide individualized instructions to patient and family on specific aspects of care every day; reinforce information as needed.
  4. Allow patient and family to verbalize concerns and questions about care as needed.
  5. Encourage family to participate in care as desired.
  6. Assess patient's and family's current knowledge base related to the cardiac event and evaluate if patient/family can verbalize/demonstrate information learned as needed.

- **Anxiety** related to impact of acute or chronic cardiac illness and/or surgical procedure

  Expected Outcomes

  1. The patient will verbalize thoughts, feelings, and fears about current cardiac illness and/or surgery and support systems/other resources to cope with the current illness stressors.
  2. The patient will verbalize understanding of hospital environment and routine as well as medical therapies, cardiac procedures, and treatments.
  3. The patient will verbalize decreased feelings of anxiety as well as demonstrate decreased physical symptoms of anxiety.

  Nursing Interventions

  1. Assess patient's level of anxiety and knowledge of the condition and the treatment.
  2. Encourage patient to verbalize feelings and causes of anxiety.
  3. Provide information on the condition and treatment to patient and family.
  4. Support patient and family involvement in decisions regarding care and treatment.
  5. Instruct patient on measures to decrease anxiety; consider integrative modalities (e.g., music, meditation, massage).

- **Body image disturbance** related to acute cardiac event and/or surgical procedure

  Expected Outcomes

  1. The patient will verbalize thoughts, feelings, and fears about recent cardiac illness and/or surgery.
  2. The patient will assume role-related responsibilities and develop confidence in ability to accomplish whatever activity is desired.

  Nursing Interventions

  1. Encourage patient to express feelings about how she views herself after the cardiac event; clarify any misconcep-tions expressed.
  2. Assess the meaning of the cardiac illness/event to the patient; support her in responding to the loss through the stages of denial, shock, anger, and depression.
  3. Encourage patient to ask questions about cardiac problem, prognosis, treatments, and progress; provide information requested and reinforce to patient and family as necessary.
  4. With surgical patients, assist women in resolving altered body image by encouraging them to view and touch the surgical site and incisions.
  5. Encourage visits from family, significant others, and peers to provide support.
  6. Encourage contact with other women who have experienced cardiac health problems to show the patient how they have successfully adapted.
  7. Provide family members and significant others opportunity to express feelings and fears related to patient's cardiac illness and/or surgery.
  8. Inform patient and family of community resources available, such as Mended Hearts, sponsored by the AHA.

- **Sexual dysfunction** related to serious cardiac illness or surgical procedure

  Expected Outcomes

  1. The patient will verbalize concerns about sexual functioning and a desire to resume sexual activity.
  2. The patient will identify current life stressors.
  3. The patient will express increased satisfaction with her sexuality pattern.

  Nursing Interventions

  1. Assess patient's sexual history, including usual sexual pattern, problems, and expectations.
  2. Assist patient in developing a plan to modify lifestyle to reduce stress if negatively impacting sexual functioning (e.g., exercise program).
  3. Encourage patient to express concerns and fears related to resuming sexual activities after acute cardiac event; stress the importance of patient sharing these concerns with her partner.
  4. Encourage patient to resume sexual patterns as close to prior to cardiac event as possible.
  5. Teach patient techniques to reduce cardiac workload, such as resting before engaging in sexual activity and avoiding sexual relations directly after eating and when tired. Sexual activity should also be terminated if chest discomfort or dyspnea occurs.

Caring for women with CHD requires knowledge of several nursing considerations, which may be broken down into the primary prevention, acute, and secondary prevention phases. Common nursing diagnoses and interventions focus on maintaining an adequate cardiac output, controlling pain, progressing activity and exercise, teaching the patient and family about the disease process and treatment, as well as attending to psychosocial concerns, such as body image alterations and sexual difficulties. Of course, women who suffer an acute cardiac event will benefit from secondary prevention strategies during the recovery phase to reduce continued risk and improve quality-of-life outcomes.

POST-ACUTE PHASE

In the post-acute phase, ongoing medical therapy is provided to improve symptoms, delay disease progression, and prevent recurrent events and complications [340]. Secondary prevention interventions during this phase of care provide women with aggressive individualized management of cardiovascular risk factors such as blood pressure, lipids, and diabetes. ***Table 7*** summarizes current recommendations for management of cardiovascular risk factors in the transition from the acute to ongoing ambulatory care.

CASE STUDIES

The following case studies offer an opportunity for healthcare professionals to test or improve their skills in observation and diagnosis. While the outcome in each has already been determined, the information and scenarios may be used to help in day-to-day patient interaction. Analyses of all of the case studies are presented following this section.

CLINICAL RECOMMENDATIONS FOR SECONDARY CHD PREVENTION IN WOMEN	
Blood Pressure	
Beta blockers	*All women after MI or acute coronary syndrome with normal left ventricular function*: Beta blockers should be used for up to 12 months (unless contraindicated): (Class I, Level A). *Women with left ventricular failure*: Long-term beta-blocker therapy should be used indefinitely (unless contraindicated) (Class I, Level A) and may be considered in other women with coronary or vascular disease and normal left ventricular function (Class IIb, Level C).
ACE inhibitors	*Women after MI and in those with clinical evidence of heart failure or an LVEF ≤40% or with diabetes*: ACE inhibitors should be used (unless contraindicated) (Class I, Level A).
ARBs	*Women after MI and in those with clinical evidence of heart failure or an LVEF ≤40% or with diabetes who are intolerant of ACE inhibitors*: ARBs should be used (Class I, Level B).
Aldosterone blockade	*After MI in women without significant hypotension, renal dysfunction or hyperkalemia who are already receiving therapeutic doses of an ACE inhibitor and beta blocker and have LVEF ≤40% with symptomatic heart failure*: Use aldosterone blockade (Class I, Level B).
Lipids	
Pharmacotherapy for high-risk women	*Very-high-risk women with CHD plus multiple major risk factors, severe and poorly controlled risk factors or diabetes to achieve an LDL <100 mg/dL (Class I, Level A), and women with other atherosclerotic CHD or diabetes or 10-year absolute risk >20%*: Utilize LDL-lowering drug therapy simultaneously with lifestyle therapy (Class I, Level B).
Pharmacotherapy for low HDL, or elevated non-HDL, high-risk women	*Very-high-risk women with CHD who may require an LDL-lowering drug combination*: Utilize niacin or fibrate therapy when HDL is low or non-HDL is elevated in high-risk women after LDL goal is reached (reduction to <70 mg/dL is reasonable) (Class IIa, Level B).
Pharmacotherapy for low HDL or elevated non-HDL, other at-risk women	*Women with multiple risk factors and a 10-year absolute risk 10% to 20%*: Consider niacin or fibrate therapy when HDL is low (<50 mg/dL) or non-HDL is elevated (>130 mg/dL) after LDL goal is reached (Class IIb, Level B).
Pharmacotherapy for other at-risk women	*Women with or without CHD risk factors on lifestyle therapy*: Utilize LDL-lowering therapy if LDL ≥190 mg/dL (Class I, Level B). *Women with multiple risk factors even if 10-year absolute risk is <10%*: Utilize LDL-lowering therapy if LDL level is>160 mg/dL with lifestyle therapy (Class I, Level B). *Women older than 60 years of age with an estimated CHD risk 10%*: Statins could be considered if hs-CRP is >2 mg/dL after lifestyle modification and no acute inflammatory process is present (Class IIb, Level B). *Women with multiple risk factors and 10-year absolute risk* 10% to 20%: Utilize LDL-lowering therapy if LDL is ≥130 mg/dL with lifestyle therapy (Class I, Level B).
Antiplatelet Therapy	
Aspirin or clopidogrel	*High risk women*: Aspirin therapy (75–325 mg/d)[a] should be used (unless contraindicated) (Class I, Level A). If intolerant of aspirin therapy, clopidogrel should be substituted (Class I, Level B). *Women with diabetes*: Aspirin therapy (75–325 mg/d) is reasonable (unless contraindicated) (Class IIa, Level B).
Class III Interventions (Not Useful/Effective and May Be Harmful)	
Menopausal therapy	Hormone therapy and selective estrogen-receptor modulators should not be used for secondary CHD prevention (Class III, Level A).
Antioxidant supplements	Antioxidant vitamin supplements (e.g., vitamin E, C, and beta carotene) should not be used for secondary CHD prevention (Class III, Level A).
Folic acid	Folic acid, with or without B6 and B12 supplementation, should not be used for secondary CHD prevention (Class III, Level A).

Table 7 continues on next page.

CLINICAL RECOMMENDATIONS FOR SECONDARY CHD PREVENTION IN WOMEN *(Continued)*	
Lifestyle Interventions	
Cardiac rehabilitation	*Women with a recent acute coronary syndrome or coronary intervention, new-onset or chronic angina, recent cerebrovascular event, or peripheral arterial disease (Class I, Level A), or current/prior symptoms of heart failure and a left ventricular EF (LVEF) <35%.* Comprehensive risk-reduction regimen, such as cardiovascular or stroke rehabilitation or a physician-guided home- or community-based exercise training program should be recommended (Class I, Level B).
[a]After PCI with stent placement or CABG surgery within previous year and in women with noncoronary forms of CHD, use current guidelines for aspirin and clopidogrel.	
Source: [281] Reprinted from Mosca L, et al. Effectiveness-based guidelines for the prevention of CHD prevention in women–2011 update: a guideline from the American Heart Association. Circulation. 2011;123(11):1243-1262. With permission from Lippincott Williams & Wilkins. (c) American Heart Association. *Table 7*	

CASE STUDY 1

Read through the following clinical vignettes and take time to review each woman's cardiovascular risk factor profile. Then, refer to the questions at the end of the case study to analyze each female patient's current health status.

- Patient S is a White woman, 43 years of age, and mother of three small children. She has a long-standing history of significant obesity with little success in dieting over the years. At 5'3", she is obese, weighing 220 pounds. Her fat distribution is "apple-shaped" and consequently, her waist-hip ratio is more than the 0.8 normal range. In addition, Patient S lives a fairly sedentary lifestyle and does not have a regular exercise program. Her dietary habits do not take into account basic recommendations for cardiac nutrition.
- Patient J is 55 years of age and teaches high school English. Her cardiovascular risk factor profile includes a 30-pack-year history of cigarette smoking and altered lipid levels. Her HDL is only 35 mg/dL and her LDL is 145 mg/dL. Patient J has tried with little success to control her cholesterol with diet. Recently, she began taking gemfibrozil as prescribed by her family physician, but has not followed his recommendation to quit smoking and enroll in a smoking cessation program at a local hospital. Rather, she continues to smoke one pack of cigarettes per day.
- Patient V is a woman, 47 years of age, who has a family history of CHD. Although she denies ever experiencing cardiac symptoms, her brother suffered a nonfatal MI at 46 years of age and her father had an MI at 53 years of age. Both of these cardiac events were medically managed. However, her father's disease did progress to the point that he underwent CABG surgery five years ago. He had three coronary artery lesions bypassed. In addition to her family history, Patient V is approximately 30 pounds overweight and does not exercise on a regular basis. She drinks approximately two to three glasses of red wine per day and has never smoked.
- Patient D is 67 years of age and lives in an assisted living retirement community. An insulin-dependent diabetic since adolescence, Patient D is unable to care for herself due to the effects of the diabetes on her eyesight, as well as the development of peripheral neuropathies. In addition to the diabetes, Patient D continues to smoke. By now, she has a 40-pack-year history of smoking.

- Patient F is an African American woman, 36 years of age, with a history of mild hypertension. Her blood pressure has been fairly well controlled on an ACE inhibitor over the past two years. Patient F eats a well-balanced, nutritious diet, exercises three to five times a week, and does not have a history of smoking or alcohol use. However, she does exhibit excessive competitiveness, being harried, and rushing to complete more and more tasks in an ever-shrinking period of time. In addition to these characteristics, she exhibits a somewhat cynical or negative outlook with occasional expression of hostile or angry thoughts and feelings.

In analyzing these clinical vignettes, consider the following questions:

1. Which of these women is at greatest risk for CHD?
2. Who is at least risk?
3. What recommendations would you make in counseling each patient regarding her cardiovascular health?

CASE STUDY 2

Patient M is a White woman, 75 years of age, who presented to her local emergency department with sudden complaints of chest pain. She described the pain as a severe substernal burning sensation that radiated across the chest to her shoulders bilaterally and then to the neck and jaw region. Although not brought on by exertion, the chest pain was associated with dyspnea, pallor, diaphoresis, nausea, and epigastric discomfort. Patient M had taken one nitroglycerin tablet with partial relief. When the chest pain recurred 10 to 15 minutes later, her family dialed 911 and the local emergency medical service responded. Once transported to the emergency department, her pain persisted. She received two additional doses of nitroglycerin and was placed on 2 L of oxygen per nasal cannula. Following stabilization, she was admitted to a telemetry floor for further observation and medical management. Nursing assessment revealed the following cardiovascular risk factors: 50-pack-year history of smoking, hypertension, and mild-to-moderate obesity. As part of the medical workup, Patient M was scheduled for a coronary angiogram the following day. The angiogram revealed an 80% blockage of the right coronary artery and the cardiologist recommended Patient M consider a PCI to open the coronary artery blockage.

The following day, Patient M underwent a PCI to the right coronary artery. The procedure was progressing uneventfully until she had an episode of bradycardia as her heart rate dropped to 38 beats per minute. The patient received a 0.5 mg dose of IV atropine, which was repeated in 10 minutes. Other than this episode, Patient M did not experience any other postprocedure complications, such as hypotension, or other technical-related problems.

The day after the PCI, Patient M was receiving her discharge instructions from her nurse when she began noticing a return of the dull epigastric pain. The pain did not appear to be related to her food intake because she was progressing on her diet. Later that day, as the pain persisted, Patient M had an ultrasound of her abdomen, which showed multiple walnut-sized gallstones. The gastroenterologist referred her to a general surgeon who recommended that she undergo a cholecystectomy for further relief of her gastrointestinal symptoms. The surgeon advised her of the risks and benefits of laparoscopic versus traditional surgery, and Patient M opted for the laparoscopic procedure. Four small incisions were made in her abdomen, and the cholecystectomy was performed without any complications. Three days postoperatively, she complained again of moderate-to-severe epigastric pain and became jaundiced. An endoscopic retrograde cholangiopancreatography revealed retained stones in the common bile duct, which were removed. Patient M subsequently recovered and was discharged home after a total of nine days in the hospital.

In analyzing this case study, consider the following questions:

1. What cardiovascular risk factors are present? What risk factors are negative?
2. Is the patient's chest pain syndrome typical or atypical for women? Why or why not?
3. What tests would you anticipate in the diagnostic workup of women experiencing angina?
4. What nursing diagnoses would be appropriate for this patient during hospitalization? What special implications do these diagnoses have in women?

CASE STUDY 3

Patient Y, a woman 76 years of age, was seen in the Women's Cardiac Center for a personalized health and risk factor assessment. Assessment findings included a heart rate of 84 beats per minute, blood pressure 172/68 mm Hg, height 5'5", and weight 171 pounds. Waist-hip ratio was 0.75, and skin fold calipers measured 42% body fat. Lipid profile included total cholesterol of 239 mg/dL, HDL 40 mg/dL, LDL 159 mg/dL, ratio 5.9 mg/dL, and triglycerides 248 mg/dL. Fasting glucose was 79 mg/dL. Past medical history included hiatal hernia, cholecystectomy, hypothyroidism, arthritis, insomnia, and a long-standing history of ankle edema. The patient also reported symptoms suspicious of sleep apnea.

Based on this assessment, cardiovascular risk factors were identified and the patient was instructed on risk factor modification. Four months later, she phoned the Women's Cardiac Center with complaints of anterior chest discomfort that radiated to her neck, jaw, and back, accompanied by shortness of breath. She was referred to Cardiology and seen three days later.

The diagnostic workup included a 12-lead ECG and nuclear myocardial perfusion scan, followed by an angiogram. She was not considered a candidate for the exercise EKG due to her advanced age and other comorbidities, specifically arthritis, which would limit her ability to exercise at adequate intensity levels. The 12-lead ECG revealed nonspecific T-wave changes in the inferior leads, and the nuclear scan was positive, suggestive of single-vessel disease of the left circumflex artery. An angiogram was then performed and showed triple vessel disease with significant left main disease. Her occlusions were 50% to 60% of the left main, 90% of the circumflex, and 60% of the right coronary artery. EF was estimated at 60%, indicating preserved left ventricular function. Based on these diagnostic findings, the patient was referred for CABG surgery.

Two weeks later, Patient Y underwent CABG surgery with internal mammary grafting. During surgery, she required inotropic support with dobutamine and epinephrine and atrioventricular sequential pacing. An intra-aortic balloon pump (IABP) was also placed via the right femoral artery due to right heart failure. On the first postoperative day, the patient remained in the intensive care unit on the IABP and ventilator. Lab values showed a creatine phosphokinase of 3113 IU/L and creatine kinase isoenzyme MB of 169.4 IU/L. A bedside echocardiogram confirmed an inferior-posterior and right ventricular infarct.

The patient was transferred to the cardiac surgical stepdown unit on the third postoperative day where she developed atrial fibrillation and was digitalized. Oxygen was administered at 5 L per nasal cannula and her ambulation was significantly limited. In addition, a bruit was noted in her right groin. An echo-Doppler revealed a two-chamber pseudoaneurysm which was unsuccessfully compressed. On the sixth postoperative day, the patient went in and out of atrial fibrillation/flutter and converted to sinus rhythm on postoperative day 7. As a result, she was weaned from oxygen and progressed with independent ambulation. However, she remained hospitalized until postoperative day 12 for observation of her heart rhythm and right groin pseudoaneurysm.

Two days after discharge, the patient received a follow-up telephone call from the Cardiac Liaison Nurse to assess her condition. Patient Y stated she was "feeling pretty good," yet indicated some difficulty with incisional pain, anorexia, fluid loss, insomnia, and confusion about her medications. After recuperating at home, the patient enrolled in a phase II cardiac rehabilitation program. At this time, the patient reports no angina or chest discomfort. She is progressing in her exercise program and tolerating activity. Problems experienced since discharge include a urinary tract infection, depression, and increasing heart failure. Her furosemide dosage has been increased, and she has obtained good relief of her symptoms.

In analyzing this case study, consider the following questions:

1. What cardiovascular risk factors are present? What risk factors are negative?
2. Is the patient's chest pain syndrome typical or atypical for women? Why or why not?
3. What is the common picture of a woman's general health and cardiac status when referred for CABG surgery?
4. What significance does this patient's perioperative MI have for her long-term prognosis?
5. What nursing diagnoses would be appropriate for this patient during hospitalization? What special implications do these diagnoses have in women?
6. Identify ways to assess both short- and long-term outcomes of women post-CABG surgery.

CASE STUDY 4

Patient A was a woman, 88 years of age, who lived in an assisted living retirement home. She had been a widow for 20 years, after losing her husband to long-term complications associated with diabetes. Until approximately seven years ago, Patient A had been in relatively good health with no major health problems, but she suffered a mild stroke at 81 years of age. At that time, she decided to quit her 50- to 60-year smoking habit. Other than her smoking history, she did not have any other significant cardiovascular risk factors.

After recuperating from her stroke, Patient A decided to leave her apartment and move into the assisted living facility where she would not only have some companionship but also receive assistance with meals and transportation to doctor's appointments and other activities. About six years after suffering the cerebrovascular accident, she had a bout of heart failure. She was admitted to the local hospital and received oxygen per nasal cannula, IV furosemide, and digoxin. After two weeks in the hospital, the patient was discharged home in apparently better condition. However, two days after returning home Patient A suffered a sudden cardiac death event at the breakfast table. Efforts at resuscitation were unsuccessful.

In analyzing this case study, consider the following questions:

1. What cardiovascular risk factors are present? What risk factors are negative?
2. Is the patient's chest pain syndrome typical or atypical for women? Why or why not?

CASE STUDY 5

Patient H, a White woman 60 years of age, suddenly began complaining of chest pain one evening. The pain was substernal, spread down both arms bilaterally, and radiated to her neck and jaw region. Patient H also complained of shortness of breath, nausea, and diaphoresis. Never having witnessed these symptoms before, Patient H's husband and daughter transported her to the local emergency department.

When she arrived in the emergency department, immediate priorities focused on obtaining a brief yet comprehensive history of symptomatology and past medical problems, as well as instituting appropriate treatments. The health assessment revealed numerous cardiovascular risk factors. Patient H's increasing age is one nonalterable risk factor present. In addition, she has a significant family history of CHD. Her mother and grandmother both suffered fatal heart attacks in their late 50s or early 60s. While Patient H does not have a history of smoking, she does have hypertension, hyperlipidemia, and diabetes. She is also obese, with a height of 5'2" and weight of 240 pounds and does not report engaging in a regular exercise program.

In terms of supportive treatment, Patient H was placed on 3 L of supplemental oxygen per nasal cannula and given sublingual nitroglycerin. She rated her pain an 8 on a 0 to 10 scale and did not report an appreciable decrease in her pain level after the first nitroglycerin dose. A second sublingual dose was given, after which she obtained relief. In the diagnostic workup phase, Patient H had a 12-lead ECG that revealed signs of ischemia in leads II and III and a ventricular dysrhythmia. Serial cardiac enzymes were drawn to rule out MI. Patient H was admitted to the coronary care unit (CCU) for treatment of an inferior MI.

Once transferred to the CCU, the patient was placed on the bedside monitor and a left radial arterial line and left subclavian Swan Ganz catheter were inserted for hemodynamic monitoring purposes. A bedside echocardiogram was performed to assess left ventricular EF and overall function of the chambers of the heart. The exam revealed that left ventricular EF was not preserved, estimated at only about 40% pumping function. Positive inotropes were started to increase the contractility of the heart and improve cardiac output. Intravenous nitroglycerin that was started in the emergency department was continued to improve coronary perfusion and for afterload reduction. After two days, Patient H was transferred out of the CCU to the cardiology stepdown unit. Telemetry showed slight sinus bradycardia at a rate of 56 beats per minute without ectopy. Other vital signs included blood pressure 102/56 mm Hg and a respiratory rate of 26 breaths per minute. Patient H remained on supplemental oxygen at 2 L per nasal cannula.

Cardiac rehabilitation was initiated when Patient H was in the stepdown unit. Rehabilitation activities first focused on identifying her risk stratification level, from low to high on a continuum, to guide initial activity and further exercise prescriptions. Because the patient's left ventricular EF was approximately 40%, her risk stratification level was identified as moderate and she was instructed that her cardiac rehabilitation activity would entail ambulating three times a day, first with monitored assistance in the hallway, working eventually toward the goal of independent ambulation. Prior to her first ambulation, Patient H's nurse took orthostatic blood pressure readings with the following results: lying 120/68 mm Hg; sitting 116/64 mm Hg; and standing 112/62 mm Hg. Heart rate pre-exercise was 58 beats per minute. As a result of these data, Patient H was assisted into the hallway for monitored ambulation. After walking for approximately two minutes, her heart rhythm converted from sinus bradycardia

into a fast atrial fibrillation, with a ventricular rate of 180 beats per minute. Her blood pressure was 102/56 mm Hg. The patient was assisted back to bed, and a cardiology consult was requested.

The consulting cardiologist ordered a diltiazem drip. After her ventricular rate was under control, the patient was digitalized with 1 mg of digoxin followed by a maintenance dose of 0.125 mg IV. Other cardiac medications added to the regime included a beta blocker, furosemide, and potassium.

On the day of discharge, Patient H's family was present for discharge teaching. Her nurse explained the list of medications, including the dose and frequency, as well as her activity limitations. Patient H was instructed not to drive a car for two weeks and to increase her walking each day by one minute until she arrived at the goal of approximately 30 to 45 minutes at least three times a week. In addition, Patient H was informed about the nearest outpatient cardiac rehabilitation program. It was explained to her that the primary benefits of attending an outpatient program would be that the staff would assist her in developing an activity and exercise program individualized to her needs and physical capabilities. In addition, they would teach her and her family other components of heart healthy living, such as cardiac nutrition, managing diabetes, and stress.

After discharge, the patient did enroll in an outpatient cardiac rehabilitation program and had attended three sessions when she began developing symptoms of heart failure, including orthopnea, shortness of breath, and weight gain. On physical examination, crackles were auscultated bibasilarly and dependent pitting edema was present in her ankles bilaterally. On being seen in the heart failure clinic, she was restarted on a diuretic, furosemide, and an ACE inhibitor and her digoxin was kept at the same dosage.

In analyzing this case study, consider the following questions:

1. What cardiovascular risk factors are present? What risk factors are negative?
2. Is the patient's chest pain syndrome typical or atypical for women? Why or why not?
3. What nursing diagnoses would be appropriate for this patient during hospitalization? What special implications do these diagnoses have in women?
4. What special implications exist with regard to dosing cardiac medications in women?
5. Describe the common response of women with CHD to activity.
6. What factors influence women's involvement in cardiac rehabilitation programs?

CASE STUDY 6

The following vignettes describe women with cardiac symptomatology who received either medical or surgical treatment. Read through these vignettes and analyze them using the questions that are presented at the end of the case studies.

- Patient R, an African American woman 52 years of age, recently underwent a CABG procedure. An angiogram revealed three-vessel disease. As a result, she had bypasses to her right coronary artery, left circumflex artery, and obtuse marginal artery.
- Patient B is a White woman, 65 years of age, with a long-standing history of stable angina. She has been medically managed for the past several months on nitrates (sublingual nitroglycerin) and an ACE inhibitor.

- Patient L is 45 years of age. She experienced a sudden onset of chest and arm pain while driving to a family affair with her husband. Because the pain did not subside, her husband drove her directly to the local emergency department, where she was evaluated and underwent several diagnostic tests, including a 12-lead ECG, serial cardiac enzymes, and a dipyridamole echocardiogram. The 12-lead ECG and cardiac enzyme elevations suggested an evolving MI. As a result, Patient L was treated with thrombolytic therapy in the emergency department, then admitted to the CCU for further treatment and observation.
- Patient E, an Asian American woman 52 years of age, had been experiencing episodes of pain that spread across her chest and occasionally radiated down one or both arms and/or to her jaw region. Over the last week or so, the chest pain episodes increased in frequency to the point she thought she should have a medical evaluation. Patient E saw a cardiologist, who suggested the patient undergo an angiogram. The procedure revealed a 60% lesion of the right coronary artery that the cardiologist believed could be treated successfully with angioplasty.

In analyzing this case study, consider the following questions:

1. Based on the information, which woman has the best prognosis? The worst prognosis? Why?
2. What are some of the complications associated with each of these medical and surgical therapies?

CASE STUDY ANALYSES

CASE STUDY 1

Case Study 1 Analyses

1. *Which of these women is at greatest risk for CHD?*

All five of these women have risk factors for CHD. However, Patients J and D possess three of the most significant cardiovascular risk factors: cigarette smoking, diabetes, and hyperlipidemia. Therefore, based on the data available in the vignettes, Patients J and D are at greatest risk for CHD. If further information was available about each woman's cardiac risk factor profiles, we might be able to differentiate even further to determine which of these two women is at greater risk.

2. *Who is at least risk?*

Patient F appears be in the best cardiovascular state among the group. Her mild hypertension is well controlled; she is not overweight, eats a sensible diet, and sees that she gets some form of aerobic exercise at least three times a week.

3. *What specific recommendations would you make in counseling each woman about her cardiovascular health?*

Patient S

Counseling recommendations for Patient S would primarily focus on cardiac nutrition aspects and developing an exercise program for cardiovascular fitness. Because she is more than 30% overweight, she is at a tremendously increased risk of CHD due to the added stress on her heart and the changes that occur in lipid metabolism when fat is distributed in the abdominal versus gluteal region. Therefore, patient teaching should emphasize good nutrition and reading nutrition labels to manage caloric

intake, as well as limiting intake of fat and cholesterol. In addition to changes in diet, Patient S should be counseled on incorporating some form of aerobic exercise, such as walking, three to five times a week to achieve cardiovascular fitness. The exercise will also have the added benefit of helping her modify her weight level.

Patient J

Two major concerns become evident in assessing Patient J's health status—her smoking history and her hyperlipidemia. Recommendations would focus on encouraging and motivating the patient to quit smoking, through the use of the nicotine patch or gum with the additional support of bupropion and/or a smoking cessation program to increase her chances of successfully quitting. These programs are essential because they teach the patient behavioral and psychologic techniques to utilize at various stages of the quitting process and help the person identify specific problem situations and how these can be realistically managed. Patient J's lipid profile should be closely monitored to determine the effectiveness of gemfibrozil in lowering her LDL levels. In addition, patient teaching should focus on the deleterious effects of smoking on lipid profiles, specifically HDL levels. Smoking tends to decrease levels of HDL, which could be used as another health information tidbit to motivate Patient J to quit smoking.

Patient V

Recommendations for cardiac health for Patient V would primarily focus on the alterable factors rather than her significant family history, which cannot be changed. As a result, patient teaching and counseling would be geared toward getting her weight into a more desirable range by paying attention to nutrition and getting some form of regular aerobic exercise. Patient V would also benefit from more health teaching regarding alcohol consumption. While a moderate intake of alcohol may be associated with positive antioxidant effects that can impart some protection against the development of CHD, the key is moderation. One drink per day is the recommendation for alcohol consumption in women.

Patient D

In assessing Patient D's health history, her diabetes and smoking habit are big concerns. In terms of her diabetes, she is in need of strict control to prevent further progression and significant complications associated with the disease, such as CHD. Another major factor that would help prevent a major cardiac event is for her to quit smoking. Remember that many cardiovascular risk factors are synergistic. In other words, risk factors work together in increasing an individual's risk of developing CHD. Cigarette smoking and diabetes are both powerful independent risk factors for CHD, and together, they significantly elevate the chances of developing the disease.

Patient F

Patient counseling recommendations for Patient F are twofold: continued control of her hypertension and stress management. Patient F and all of the women should be applauded regarding the positive habits they have incorporated into their lifestyle. In this patient's case, these positive aspects include attention to nutrition, aerobic exercise, and staying away from smoking or alcohol use. She does, however, need assistance with stress management. While her regular exercise program is most likely one avenue for her to deal with this stress, it obviously is not singly effective. In other words, additional stress management strategies could be added to her repertoire.

CASE STUDY 2

Case Study 2 Analyses

1. *What coronary risk factors are present? What risk factors are negative?*

The cardiovascular risk factors known for Patient M include her age, postmenopausal status, smoking history, and hypertension.

2. *Is the patient's chest pain syndrome typical or atypical for women? Why or why not?*

The chest pain syndrome experienced by Patient M is typical for women. She described the chest pain as a substernal burning sensation that radiated across her precordium to her shoulder region bilaterally and then to her neck and jaw. In addition, her chest pain was accompanied by dyspnea, diaphoresis, nausea, and epigastric distress, all of which may or may not be associated with anginal episodes in women. In contrast, chest pain in men often begins substernally and spreads across the left precordium down the left arm.

3. *What tests would you anticipate to be in the diagnostic workup of women experiencing angina?*

The diagnostic phase for women with angina often begins with a resting 12-lead ECG. This test is useful in women due to their higher proportion of silent or unrecognized infarctions. Conversely, the exercise ECG is not considered a good test in women due to high false-positive rates and other problems associated with women exercising at adequate intensity levels. Other noninvasive cardiac diagnostic tests might include nuclear myocardial perfusion scans and exercise echocardiogram. Of these three tests, the exercise echocardiogram is the best test for women. It is associated with the highest accuracy rates and is especially sensitive to single vessel disease, which occurs more frequently in women than in men.

4. *What nursing diagnoses would be appropriate for this patient during hospitalization? What special implications do these diagnoses have in women?*

- **Decreased Cardiac Output**: With the sudden onset of angina and need to undergo a PCI to open a blockage of the right coronary artery, Patient M is at risk for decreased cardiac output. Women should be taught to take angina seriously and to have it evaluated by a physician as soon as possible. This is especially critical in women because they have an unfavorable prognosis post-MI. After PCI, women also have higher mortality rates and, therefore, should be carefully assessed. Complications must be recognized early in their course so they can be corrected and managed successfully.
- **Pain**: Patient M really has two etiologies of her pain: chest pain and epigastric discomfort referred from her biliary tract disease. It is important to recognize that angina is often more severe in women than men (and both stable and unstable angina are more frequent in women), and therefore, necessary pharmacologic therapy may be more intense. In women, angina is managed best by either nitrates or calcium channel blockers, although the dosage may not be the same as it is in men. Because women have been excluded from many clinical drug trials testing cardiac medications, the optimal dose of various medications to treat women is less well known. Further research is needed to guide this area of clinical practice.
- **Knowledge Deficit**: Like any other patient undergoing diagnostic testing and an invasive cardiac procedure, not to mention the cholecystectomy, Patient M should be taught about various components of her illness and hospitalization. These components include her disease process, diagnostic tests, medications, risk factor modification, and the recovery process, with emphasis on the long-term positive outcomes associated with PCI in women. In addition, when teaching female cardiac patients, it is vital to search for patient teaching materials that discuss the unique concerns of women with CHD.

CASE STUDY 3

Case Study 3 Analyses

1. *What coronary risk factors are present? What risk factors are negative?*

Patient Y has the following cardiovascular risk factors:

- Age: Older than 60 years of age
- Positive family history: Both parents died from CHD
- Hypertension: 172/68 mm Hg
- Hypercholesterolemia: Total cholesterol 239 mg/dL; HDL 40 mg/dL; LDL 159 mg/dL; ratio 5.9; triglycerides 248 mg/dL
- Body composition: Percentage of body fat is 42%
- Menopause: Received HRT for 20 years
- Stress: Rated as a 5 on a 0 to 10 scale

The following cardiovascular risk factors are negative:

- Personal history of cardiovascular or cerebrovascular disease
- Diabetes
- Smoking history
- History of alcohol consumption
- Sedentary lifestyle (Reports walking one mile per day)

2. *Is the patient's chest pain syndrome typical or atypical for women? Why or why not?*

As in the previous case study, Patient Y's chest pain syndrome is fairly typical for women. She experienced chest discomfort in the anterior region of her chest, which then radiated to her neck, jaw, and back. The chest pain was also accompanied by shortness of breath, which may or may not occur in women, just like other associated symptoms such as nausea, diaphoresis, or lightheadedness.

3. *What is the common picture of a woman's general health and cardiac status when referred for CABG?*

Like Patient Y, women who are referred for CABG surgery tend to be older with more comorbidities or multiple health problems, including hypertension, hypothyroidism, sleep apnea, arthritis, hiatal hernia, and sciatica. In terms of cardiac status, women tend to be referred more often for unstable angina, in comparison to men who usually are referred on the basis of a positive exercise ECG. In addition, women tend to have a lower incidence of prior MI before surgery and thus have better EFs, fewer diseased arteries or more single vessel disease (50% have single-vessel disease versus 25% two-vessel and 25% three-vessel disease), and more left ventricular hypertrophy and mitral regurgitation.

4. *What significance does the patient's perioperative MI have for her long-term prognosis?*

Women who suffer an MI have a worse prognosis than men, which is why timely diagnosis with an appropriate workup and treatment is so important in women experiencing anginal symptoms. When women go on to infarct, they have a much greater chance of not surviving, both in the early postinfarct period as well as later in their clinical course.

5. *What nursing diagnoses would be appropriate for this patient during hospitalization? What special implications do these diagnoses have in women?*

- **Decreased Cardiac Output**: Patient Y was a woman with complaints of angina who underwent CABG surgery. During the surgical procedure, she suffered an inferior-posterior and right ventricular infarct. Despite the fact that her left ventricular EF was preserved at 60% post-MI, she should be carefully observed for early signs of heart failure, as well as any other complications during the postoperative period.

- **Pain**: Again, prior to surgical intervention, Patient Y's angina should be carefully assessed and treated with nitrates or calcium channel blockers to prevent an acute MI, which would significantly impact her prognosis and long-term outcome. While postsurgical pain is most likely incisional, it is still important to assess for the return of angina, which could signal reocclusion of one of the bypass grafts.
- **Activity Intolerance**: Patient Y is 76 years of age with multiple health problems, including arthritis. She will likely be slow to mobilize in the postoperative phase to begin with, which is compounded by the problems she developed with postoperative atrial fibrillation. After her ventricular rate was controlled and the pseudoaneurysm was addressed, her cardiac rehabilitation activity and exercise program was appropriately resumed.
- **Body Image Disturbance**: This is a potential nursing diagnosis for Patient Y given her feelings of depression in the postdischarge phase. These feelings could be considered a normal part of recuperation and a reflection of perceived changes in body image due to the sternotomy and leg incisions. After being discharged home, she did complain of continued incisional pain that could be partially alleviated by wearing a supportive bra to decrease tension from the breasts.
- **Knowledge Deficit**: As with Patient M in Case Study 2, Patient Y has a knowledge deficit regarding her cardiac disease and surgical procedure. Patient teaching for Patient Y should incorporate elements such as disease process, cardiac medications, activity restriction, caring for the surgical incision, risk factor modification, outpatient cardiac rehabilitation, and the recovery process. She would also benefit from gender and sex-specific patient teaching aids, if available, so she could relate to the unique concerns and needs of women who have faced CHD and CABG surgery.

6. *Identify ways to assess both short- and long-term outcomes of women post-CABG surgery.*

Patient outcomes may be measured both during the hospitalization and postdischarge phases. During the hospitalization phase, examples of clinical outcomes to be assessed for a population of female cardiac patients include complication rates (e.g., perioperative MIs, dysrhythmias, pseudoaneurysms); length of stay (both intensive care unit and hospital length of stay); and readmissions (both intensive care units and hospital readmissions), along with the clinical reasons.

After the hospitalization phase, patient outcomes may be assessed again. Examples of outcomes to be measured in the early discharge phase include pain, appetite, wound healing (incisions in surgical patients), rest/sleep patterns, psychologic comfort, and exercise patterns. Teaching and learning outcomes are also important to assess, including whether the female cardiac patient understood her discharge instructions related to activity and exercise, cardiac medications, diet, and when to return to work. Quality of life becomes an important consideration for this population. Research suggests that women experience more days of restricted activity due to continuing cardiac symptomatology, such as recurring chest pain and dyspnea. Ability to return to work and previous hobbies and pastimes would be an important area to assess in this regard.

CASE STUDY 4

Case Study 4 Analyses

1. *What coronary risk factors are present? What risk factors are negative?*

Positive cardiovascular risk factors for Patient A include the nonalterable factors of age and menopause and the alterable factor of smoking history. The risk factors that were negative in her history include family history of CHD, hypertension, hyperlipidemia, obesity, sedentary lifestyle, or psychosocial concerns.

2. *Is the patient's chest pain syndrome typical or atypical for women? Why or why not?*

Patient A's cardiac event is atypical for women in terms of initial presentation of the disease process. MI and sudden cardiac death are more commonly a first manifestation of CHD in men, while angina is the most common presenting scenario for women. Women tend to lag behind men in both the occurrence and incidence of CHD, as well as sudden cardiac death events. In terms of Patient A's history, it is possible that she initially suffered an MI, which was not recognized, and went on to develop heart failure as a post-MI complication. This then explains her increased risk for earlier reinfarction and higher mortality.

CASE STUDY 5

Case Study 5 Analyses

1. *What coronary risk factors are present? What risk factors are negative?*

Patient H has the following cardiovascular risk factors:

- Age: 60 years of age
- Positive family history: Mother and grandmother both died prematurely from an MI
- Hypertension
- Hyperlipidemia
- Diabetes
- Obesity: Weight 240 pounds; height 5'2"
- Sedentary lifestyle
- Postmenopausal

The following cardiovascular risk factors are negative:

- Personal history of cardiovascular or cerebrovascular disease
- Smoking history
- History of alcohol consumption
- Perceived stress

2. *Is the patient's chest pain syndrome typical or atypical for women? Why or why not?*

Patient H's chest pain was located substernally and radiated down both arms and to her neck and jaw. In addition, she was short of breath, diaphoretic, and nauseated. This clinical picture is fairly typical in women. Unlike the usual presentation in men, women may complain of no chest pain or chest pain that does or does not radiate. The pain may also be accompanied by other cardiac symptoms such as diaphoresis, dyspnea, or lightheadedness, but not necessarily so; in some cases, these symptoms are absent altogether.

3. *What nursing diagnoses would be appropriate for this patient during hospitalization? What special implications do these diagnoses have in women?*

Nursing diagnoses that would apply in this case study include decreased cardiac output, pain, activity intolerance, and knowledge deficit. The nursing implications that these diagnoses have in women have been discussed in previous case studies. In women who have suffered an MI, it is important to assess for other health problems or conditions that could impact their recovery because their morbidity and mortality rates are already higher than women with angina or those who have undergone a revascularization procedure.

4. *What special implications exist with regard to dosing cardiac medications in women?*

Historically, research did not include women in clinical trials on the efficacy of cardiac medications. The optimal dose of these medications in women requires further study because, for the most part, they were tested on men. It may be that women need less, more, or the same dose as men. Further research including women is needed to determine the therapeutic dosage ranges for various cardiac medications, such as nitrates, beta blockers, or calcium channel blockers.

5. *Describe the common response to activity of women with CHD.*

In general, women with CHD tend to be older than their male counterparts. As a result, women presenting with cardiac problems may also have other significant comorbidities such as diabetes, hypertension, and arthritis which may slow their activity progression. Therefore, during the acute phase, it is essential to involve either physical therapy and/or cardiac rehabilitation to begin mobilizing the patient and progressing with activity as appropriate to the patient's condition.

6. *What factors influence women's involvement in cardiac rehabilitation programs?*

Many factors have been studied regarding women's participation in formal outpatient cardiac rehabilitation programs. Some of the most common reasons women give for decreased attendance include family commitments, financial concerns, and medical problems, such as increasing angina and/or other cardiac symptoms.

CASE STUDY 6

Case Study 6 Analyses

1. *Based on the information, which woman has the best prognosis? The worst prognosis? Why?*

Patient B has the best prognosis. She has a long-standing history of stable angina that has been adequately managed with nitrates and an ACE inhibitor. Women with angina have a better prognosis than those who suffer an MI, one of the main reasons why it is so important to accurately assess a woman's cardiovascular risk factors and work on modifying those areas possible to prevent an MI from ever happening. After a woman has an MI, the mortality rates are significantly higher.

On the other hand, Patient R and Patient L have the worst prognoses of the women presented in this vignette. Women who undergo CABG surgery have double the perioperative mortality rate of men and also fare poorer in the early postoperative period, generally complaining of more angina, dyspnea, and reduced mobility. These findings may be due to the fact that women tend to be older at the time of surgery, have more advanced disease, and significant comorbidities. However, five- and 10-year survival rates between men and women are comparable.

2. *What are some of the complications associated with each of these medical and surgical therapies?*

- **Medical Management**: A possible complication or adverse effect associated with medical management focuses on the dosage of cardiac medications used to treat women with CHD. Women may have a different vasomotor tone compared to men and, thus, may require less nitrates. Only further research will give us the answers to guide clinical practice decisions.
- **Thrombolytic Therapy**: The main complication associated with thrombolytic therapy in women is bleeding, especially intracranial bleeding. The reason for this increased incidence in women may be dose related.
- **PCI**: The most common reported complications associated with angioplasty include bradycardia, hypotension, bleeding, and vascular complications. However, dissection is becoming less common as advances and improvements are made in angioplasty catheters.
- **CABG Surgery**: During the operative phase, incomplete revascularization (resulting in angina, dyspnea, and sub-sequent restricted activity) may occur due to women's smaller coronary arteries and difficulty in anastomosis. However, improved surgical tools and techniques have minimized the difficulties. Reports have also shown that women have longer hospital stays, greater complication rates, and higher postoperative morbidity (as previously suggested), but similar long-term outcomes.

IMPLICATIONS FOR FURTHER RESEARCH

Much of the early research about women and CHD was descriptive. In the past, women were largely excluded from large-scale clinical CHD trials investigating diagnostic and therapeutic interventions. Although sex-specific cardiovascular research has increased over the last two decades, women continue to be under-represented during study design, conduction, and analysis [338]. This section will explore some of the more common reasons for this exclusion and federal programs that have turned this trend around. In addition, areas in need of further research in relation to women and CHD will be highlighted.

FACTORS AFFECTING THE CURRENT RESEARCH BASE

Women of reproductive age have been excluded from cardiovascular studies due to the possible risks to any potential fetus, while older women have been excluded because they often have multiple health problems that may create health risks or confuse the research findings. As a result, women have had restrictions in clinical care, such as the underutilization of thrombolytic therapy for the management of evolving MIs. Age-based exclusions of women from clinical trials on invasive diagnostic or therapeutic techniques have also limited the participation of women [7; 325; 326].

Additionally, sample sizes of existing studies have traditionally been too small to either evaluate effects or draw conclusions about care for women. As a result, the findings of studies conducted with men, as well as with younger populations, have been used to diagnose and treat women and older adults. In other words, studies done on men were driving clinical practice with female patients. Yet, research indicates that differences exist in cardiovascular risk factors, disease presentation, diagnosis, and response of women to various CHD treatments [122; 327].

At the federal level, two major initiatives have been instituted to expand the base of research related to women-specific health issues. The NIH has mandated investigators include women and minorities in clinical research populations for health-related studies. At the very least, the investigator must adequately justify any decisions to exclude potential subjects from these studies [328]. A second factor that has influenced the research base related to women's health is the development of the NIH Interdisciplinary Women's Health Research Center, formed to encourage studies related to issues affecting women's health [329]. In a 2016 AHA Scientific Statement, Mehta and colleagues discuss the need to develop strategies to increase the inclusion of women of all ages in clinical cardiovascular research [338]. Examples of possible strategies include raising the mandatory inclusion rates and requiring sex-stratified data reporting.

The Women's Health Initiative (WHI), a 15-year study of 160,000 women, was undertaken as the largest NIH clinical trial to answer questions regarding postmenopausal women's health. The WHI specifically addressed the major health problems of menopausal women, including CHD, cancer, and osteoporosis [330]. In relation to CHD, the WHI studied the effects of low-fat diets for prevention as well as the risks and benefits of hormone replacement therapy [330]. As discussed, the WHI trials investigated both combination (estrogen plus progestin) and unopposed estrogen hormone therapy. Both trials were cut short prior to the projected completion dates. In July 2002, the WHI halted the combination therapy trials due to a significantly increased incidence of breast cancer. In February 2004, the unopposed estrogen study was stopped when researchers determined that the heightened risk of stroke was unacceptable to continue the trial. In the case of the combination hormone study, researchers found an increased risk for MI, stroke, and venous thromboembolism. The estrogen-only study resulted in increased risk of stroke and venous thromboembolism, but no difference in the risk of

RESEARCH QUESTIONS
Cardiovascular Risk Factors
• What is the epidemiologic basis of the major cardiovascular risk factors in women? Are these the same major risk factors as seen in men? • Why do cardiovascular risk factors seem to differ in men and women? • What role do diabetes and other comorbidities, such as altered coagulation parameters, play in the development of CHD in women? • What is the relationship between estrogen and lipid metabolism? • What is the relationship between clopidogrel therapy and the prevention of CHD in women? • What are the benefits of antioxidant therapy in women? • What are the mechanisms by which psychosocial risk factors (e.g., anxiety, stress, depression, marital conflict, poor social support) influence the development and progression of CHD? • What is the relationship between rotating shift work and CHD in women in relation to other risk factors such as hypertension, hyperlipidemia, diabetes, sleep quality/duration, and social support?
Clinical Manifestations and Course
• What are the unique pathophysiologic characteristics of atherosclerosis among women? • Why does CHD have a later onset in women compared with men? What role does normal aging play in disease progression? • What are effective interventions to decrease treatment delays (i.e., time to presentation, time to diagnosis, time to treatment) for ethnically diverse women with CHD? • Why is the clinical course of CHD in women different from that in men (after controlling for age, extent of disease, and coexisting illness)? • What are the clinical outcomes of women with CHD who do or do not undergo invasive diagnostic or therapeutic procedures? • What factors are driving the higher risk of death in women post-MI? • What are the responses of women to cardiac medications? • What are the complications of dysrhythmia in women? • What factors predict readiness and effectiveness of cardiac teaching in women?
Impact of CHD on Patient and Family
• What meanings do women attach to a cardiac event at different life phases (i.e., premenopausal, menopausal, postmenopausal)? • What are the common themes expressed in support groups between female cardiac patients? Cardiac family members? • Which nursing interventions do women perceive to be most helpful in adjusting to a diagnosis of CHD?
Intervention Studies
• Why do women not receive diagnostic studies or therapeutic interventions to the same extent as men? • What is the long-term effectiveness of PCI in women with diffuse multivessel disease? • What is the comparative efficacy of cardiac procedures (e.g., thrombolytic therapy, PCI, atherectomies, stents, CABG surgery) in women? • Is there comparability of symptomatic improvement in men and women with medical and surgical therapies?
Cardiac Rehabilitation
• Which interventions can be started early during hospitalization for PCI, MI, or CABG surgery to increase the likelihood women will participate in outpatient cardiac rehab? • What factors affect the enrollment and completion rates for women in outpatient cardiac rehabilitation programs by cardiac rehab indication? What factors are associated with keeping women in these programs? • What factors determine specific patient assessments in the cardiac rehab setting? • What effect does cardiac rehab attendance have on the frequency of patients meeting recommended guidelines for lipid management? • What female-specific strategies are effective in optimizing diabetes management during cardiac rehab?

Table 8 continues on next page.

RESEARCH QUESTIONS *(Continued)*
Prevention Strategies
• What effect does primary prevention have on CHD mortality rates of women younger than 55 years of age?
• What strategies for risk factor reduction are effective in various subgroups of women (e.g., working mothers, middle-aged and older women)?
• What culturally appropriate primary and secondary prevention strategies are effective in reducing cardiovascular risk of women across the life span? In various clinical and community settings?
• What strategies are effective in improving pharmacologic treatment rates for secondary prevention by both the clinicians and female patients?
• Do nurse-run clinics significantly affect the success of women making heart-healthy lifestyle changes, reducing their risk for CHD?
• What interventions are most effective for improving cardiovascular health behaviors among women across the life span and racial/ethnic groups?
• What are the modifiable risk factors contributing to sex disparities in applying evidence-based guidelines in prevention and treatment of women with CHD?
Source: [48; 62; 75; 280; 338; 341; 345] *Table 8*

MI [316; 317]. There is some controversy regarding the trials' designs and whether the findings are universally applicable [331; 332]. However, the FDA continues to recommend against the routine use of hormone replacement therapy as preventive treatment for CHD in postmenopausal women [333].

AREAS IN NEED OF FURTHER RESEARCH

Beyond the large NIH trials that have been initiated, other research by various disciplines is needed about women and CHD. This research involves asking questions such as those listed in ***Table 8***, related to cardiovascular risk factors, the impact of CHD on the patient and family, the clinical course of women with CHD, and intervention studies. For instance, why do women fail to receive diagnostic studies or therapeutic interventions to the same extent that men do? Many studies have shown less active or aggressive diagnosis and management of CHD in women. Fewer women with positive noninvasive cardiac tests are catheterized and fewer women have revascularization by either PCI or CABG surgery compared to men [122; 205; 225; 334]. The question remains: Are men overtreated, or are women undertreated?

A comparison of symptomatic improvement in men and women treated with certain medical and surgical therapies is another area worthy of scientific investigation. Some authors have advocated that physicians may guard against the adverse outcome of increased perioperative mortality in women by preferentially prescribing medical therapy; only when medical therapy is unsatisfactory are the women referred for invasive procedures. As a result of these later referrals, when women are treated, they tend to be at more advanced age with more frequent comorbidities and more serious symptoms and are more often seen on an urgent or emergency basis. Overall, the evidence does not substantiate deliberate negative bias, but at the same time, it does not exclude inappropriate overuse of invasive procedures in men or underuse in women [334; 335]. Or could it be that CHD is different in women? Only further research will reveal the answers.

SUMMARY

For many years, women have been excluded from many of the larger studies investigating areas related to CHD. Women have been excluded during reproductive years due to risk to the fetus and during later years due to potential comorbidities. New NIH outreach programs and strategic plans for women's health research are changing these trends [336; 337]. Continued research is necessary to advance scientific knowledge to assist healthcare providers in providing better care to female cardiac patients.

RESOURCES

American Heart Association
Go Red for Women
https://www.goredforwomen.org

Centers for Disease Control and Prevention: CHD Facts
https://www.cdc.gov/heartdisease/facts.htm

National Heart, Lung, and Blood Institute: Ischemic CHD
https://www.nhlbi.nih.gov/health/coronary-heart-disease

National Institutes of Health, Office of Research on Women's Health
https://orwh.od.nih.gov

Women Heart: The National Coalition for Women with CHD
https://www.womenheart.org

Implicit Bias in Health Care

The role of implicit biases on healthcare outcomes has become a concern, as there is some evidence that implicit biases contribute to health disparities, professionals' attitudes toward and interactions with patients, quality of care, diagnoses, and treatment decisions. This may produce differences in help-seeking, diagnoses, and ultimately treatments and interventions. Implicit biases may also unwittingly produce professional behaviors, attitudes, and interactions that reduce patients' trust and comfort with their provider, leading to earlier termination of visits and/or reduced adherence and follow-up. Disadvantaged groups are marginalized in the healthcare system and vulnerable on multiple levels; health professionals' implicit biases can further exacerbate these existing disadvantages.

Interventions or strategies designed to reduce implicit bias may be categorized as change-based or control-based. Change-based interventions focus on reducing or changing cognitive associations underlying implicit biases. These interventions might include challenging stereotypes. Conversely, control-based interventions involve reducing the effects of the implicit bias on the individual's behaviors. These strategies include increasing awareness of biased thoughts and responses. The two types of interventions are not mutually exclusive and may be used synergistically.

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