Association Between Obesity and Therapeutic Goal Attainment in Patients with Concomitant Hypertension and Dyslipidemia

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ASSOCIATION BETWEEN OBESITY AND THERAPEUTIC GOAL ATTAINMENT IN PATIENTS WITH CONCOMITANT HYPERTENSION AND DYSLIPIDEMIA

A Thesis
Submitted to the Graduate School of Pharmaceutical Sciences

Duquesne University

In partial fulfillment of the requirements for the degree of Master of Science in Pharmacy Administration

By
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August 2012
ASSOCIATION BETWEEN OBESITY AND THERAPEUTIC GOAL ATTAINMENT
IN PATIENTS WITH CONCOMITANT HYPERTENSION AND DYSLIPIDEMIA

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ABSTRACT

ASSOCIATION BETWEEN OBESITY AND THERAPEUTIC GOAL ATTAINMENT IN PATIENTS WITH CONCOMITANT HYPERTENSION AND DYSLIPIDEMIA

By

Ishveen Kaur Chopra

August 2012

Thesis supervised by Dr. Khalid M. Kamal

Objective: A retrospective study was conducted to examine variations in therapeutic (blood pressure (BP) and lipid) goal attainment and medication utilization pattern in patients with concomitant hypertension and dyslipidemia, specifically comparing obese versus non-obese patients.

Methods: GE Centricity EMR database (2004-2011) was utilized. 9,086 patients diagnosed with concomitant hypertension and dyslipidemia were evaluated. According to NHLBI guidelines, overweight is defined as a BMI of 25-29.9 kg/m² and obesity as a BMI ≥ 30 kg/m². Goal attainment and treatment pattern for BP and lipid levels were assessed based on JNC 7 and NCEP ATP III guidelines, respectively.
**Results:** Patients who were obese had higher baseline BP, lipid levels, were more likely to be prescribed antihypertensives and antilipemic agents, and were less likely to attain BP and dual BP/LDL-C goals.

**Conclusions:** Substantial proportion of patients with concomitant hypertension and dyslipidemia failed to attain BP and lipid goals, specifically in patients who were obese.
ACKNOWLEDGEMENT

I would especially like to thank Dr. Khalid M. Kamal for being my thesis advisor, encouraging me, and supervising me in different projects.

I would also like to thank Dr. Gibbs Kanyongo and Dr. Sean D. Candrilli for serving on my thesis committee. I appreciate the valuable suggestions they provided.

I am very grateful to Dr. Louis Civitarese for providing EMR data and valuable suggestions related to clinical aspects of thesis.

Finally, I wish to express my love and gratitude to my talented brother Avijeet Chopra and to my parents; for their understanding and endless love through the duration of my studies.
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<td>ACEI</td>
<td>Angiotensin converting enzyme inhibitor</td>
</tr>
<tr>
<td>ADA</td>
<td>American Diabetes Association</td>
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<tr>
<td>AHA</td>
<td>American Heart Association</td>
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<tr>
<td>ARB</td>
<td>Angiotensin II receptor blocker</td>
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<tr>
<td>BB</td>
<td>Beta-blocker</td>
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<tr>
<td>BMI</td>
<td>Body mass index</td>
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<tr>
<td>BP</td>
<td>Blood pressure</td>
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<tr>
<td>BRFSS</td>
<td>Behavioral Risk Factor Surveillance System</td>
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<td>CAD</td>
<td>Coronary artery disease</td>
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<tr>
<td>CCB</td>
<td>Calcium channel blocker</td>
</tr>
<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
</tr>
<tr>
<td>CHD</td>
<td>Coronary heart disease</td>
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<tr>
<td>CVD</td>
<td>Cardiovascular disease</td>
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<tr>
<td>DASH</td>
<td>Dietary Approaches to Stop Hypertension</td>
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<tr>
<td>DBP</td>
<td>Diastolic blood pressure</td>
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<tr>
<td>EMR</td>
<td>Electronic Medical Records</td>
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<tr>
<td>HBM</td>
<td>Health Belief Model</td>
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<tr>
<td>HDL-C</td>
<td>High-density lipoprotein cholesterol</td>
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<tr>
<td>HRQoL</td>
<td>Health-related quality of life</td>
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<td>JNC 7</td>
<td>Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<td>K/DOQI</td>
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<td>LDL-C</td>
<td>Low-density lipoprotein cholesterol</td>
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<td>LPT</td>
<td>Lost productive time</td>
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<td>NCEP</td>
<td>National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults</td>
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<td>ATP</td>
<td>Adult Treatment Panel</td>
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<td>NHANES</td>
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<td>NHLBI</td>
<td>National Heart, Lung, and Blood Institute</td>
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<td>PRISMA</td>
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<tr>
<td>QALY</td>
<td>Quality adjusted life years</td>
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<td>QoL</td>
<td>Quality of life</td>
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<td>SBP</td>
<td>Systolic blood pressure</td>
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CHAPTER ONE

INTRODUCTION

Obesity

Obesity has become a major public health concern in the United States (US), with about 97 million adults being either overweight or obese.\textsuperscript{1} It is a complex, multifactorial chronic condition that involves the integration of social, cultural, behavioral, psychological, metabolic, and genetic factors.\textsuperscript{1} It is an independent risk factor for high blood pressure (BP), high blood cholesterol, type 2 diabetes, coronary heart disease (CHD), stroke, gallbladder disease, osteoarthritis, sleep apnea and respiratory problems, and cancer (e.g., endometrial, breast, prostate, and colon cancers). It negatively impacts overall health-related quality of life (HRQoL) and is associated with an increase in all-cause mortality.\textsuperscript{1,2}

Definition and measurement

Obesity generally refers to excess body fat/adiposity, a characteristic that is difficult to measure directly.\textsuperscript{1,3} Currently, there is no precise clinical definition of obesity based on the degree of adiposity; it is defined based on the body mass index (BMI), which is calculated as weight in kilograms divided by height in meters squared \([\text{weight (kg)/height (m}^2])].\textsuperscript{1,3} According to the clinical guidelines developed by the National Heart, Lung, and Blood Institute (NHLBI), overweight is defined as BMI between 25 to 29.9 kg/m\(^2\) and obesity as BMI \(\geq 30\) kg/m\(^2\).\textsuperscript{1} BMI is an appropriate measure used for evaluating obesity-related morbidity and mortality. In addition, BMI
measurements are simple, inexpensive, and reliable and provide a standardized definition for purposes of national surveillance and international comparisons.\(^4\)

For clinical purposes, patient assessment should include evaluation of BMI, waist circumference, and their overall medical risk. The measurement of waist circumference assesses the risks associated with obesity or overweight. BMI provides an acceptable approximation of total body fat, but is unable to capture the variations in the percentage of body mass (degree of adiposity), i.e. it does not distinguish fat mass from lean mass.\(^5\) Thus, in some instances, a BMI value might overestimate the body fat in muscular patients, such as athletes, and in other instances might underestimate the body fat in patients with less muscle mass or edema, such as the elderly. The NHLBI panel recommends using BMI for classification of individuals who are overweight and obese and to estimate their relative risk of disease compared to those with normal weight. Whereas, waist circumference should be used for adult patients with BMI between 25 and 34.9 kg/m\(^2\) and should be used in conjunction with BMI to identify increased disease risks.\(^1,5\)

**Epidemiology**

The prevalence of obesity in adults (≥ 20 years) has increased significantly, becoming the second leading cause of preventable death in the US. According to the 2007-2008 National Health and Nutrition Examination Survey (NHANES), approximately 34.2% adults were overweight, 33.8% were obese, and 5.7% were extremely obese (BMI ≥ 30 kg/m\(^2\)).\(^6\) Societal, economic, and cultural factors have a major contribution in increasing obesity rates. For instance, change in environment and
technological advancements have resulted in a sedentary lifestyle and change in food habits (increased consumption of processed food) have resulted in an increased intake of calories, sugars, and fats.\textsuperscript{6} Data from the 2007-2008 NHANES suggested an estimated age-adjusted obesity prevalence of 34% compared to 23% in NHANES III (1988-1994). In 2010, there were 12 states with obesity prevalence of 30% or more compared to no state with 30% or more obesity prevalence in 2000.\textsuperscript{8}

There is a significant variation in obesity prevalence in adults based on age, gender, and race/ethnicity, according to data from the 2007-2008 NHANES.\textsuperscript{7} The likelihood of being obese is the highest in the age group of 40-59 years. The age-adjusted obesity prevalence is higher among women (35.5\%) than men (32.2\%). However, the prevalence of combined obesity and overweight is higher among men (72.3\%) compared to women (64.1\%). There has been no significant change in the prevalence of obesity in women over a 10 year period (1999-2009), however, there has been an increase in prevalence among men. Regarding race/ethnicity, non-Hispanic blacks have the highest prevalence of obesity (44.1\%) followed by Mexican-Americans (39.3\%), all Hispanics (37.9\%), and non-Hispanic whites (32.6\%).\textsuperscript{8} Moreover, the prevalence of obesity varied from 18.6\% to 34.4\% among states, with higher prevalence in the South (29.4\%) and in the Midwest (28.7\%) compared to the Northeast (24.9\%) and the West (24.1\%), based on the 2009 Behavioral Risk Factor Surveillance System (BRFSS) survey.\textsuperscript{8}
Socioeconomic burden

Obesity substantially increases the risk of morbidity from conditions such as hypertension, type 2 diabetes, hypercholesterolemia, CHD, stroke, asthma, arthritis, and cancer, thereby increasing the direct medical spending on diagnosis and treatment of these conditions. The estimated annual medical costs associated with adult obesity in the US is as high as $147 billion, accounting for about 10% of all US healthcare (medical) spending. In 2006, the per capita medical spending for people who were obese was $1,429 (42%) greater than that for people with normal weight. Across all payers, the increase in obesity-related costs ranged from 27% (non-patient services) to 80% (prescription drugs) from 1998-2006. The obesity-related annual direct costs for children are estimated at $14.3 billion and these costs are expected to increase further since these overweight and obese children and adolescents will transition to obese adults.

In addition to the direct medical costs, obesity has an overall impact on the indirect costs (productivity loss due to absenteeism, presenteeism, and disability). Studies suggest that there is a positive correlation between obesity and measures of absenteeism. For example, Serxner et al. observed that employees considered at-risk for obesity were 1.23 times more likely to be in high-absenteeism group compared to individuals with normal-weight. Similarly, workers who were obese tend to have a higher total lost productive time (LPT) compared to workers with normal-weight, and this was largely due to the presence of co-occurring conditions in workers who were obese. Furthermore, two-thirds of the total cost of LPT was attributable to presenteeism and one-third to absenteeism. Besides absenteeism and presenteeism, obesity also
results in increased disability payments and disability insurance premiums, premature mortality and/or reduction in quality adjusted life years (QALYs). Thus, overall indirect costs are substantial, accounting for about $66 billion annually.\textsuperscript{10}

**Hypertension**

Hypertension is usually referred as elevated systolic blood pressure (SBP) or diastolic blood pressure (DBP). According to the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC7) guidelines, hypertension is defined as SBP $\geq$ 140 mm Hg or DBP $\geq$ 90 mm Hg.\textsuperscript{12}

It is a major risk factor for cardiovascular disease (CVD) and is usually associated with considerable morbidity and mortality. Hypertension increases the risk of developing coronary artery disease (CAD), congestive heart failure, stroke, and kidney disease.\textsuperscript{12}

Although hypertension is common and has substantial risk associated with it, proper diagnosis and treatments have shown to reduce the risk.

**Epidemiology**

Hypertension is one of the most prevalent conditions in the US with approximately 76.4 million individuals aged 20 years and older having high blood BP.\textsuperscript{13}

The prevalence of hypertension has increased from 24\% to 32\% from 1988-1994 to 2005-2008. Hypertension has been indicated as a primary or contributing cause of mortality, with high BP associated mortality being 347,689 in 2008. The overall mortality rate associated with hypertension in 2007 was 18.3 per 100,000, an increase of 9\% from 1997.\textsuperscript{13}
The variations in hypertension rates have been assessed based on age, sex, and race/ethnicity.\textsuperscript{8,13} The prevalence of hypertension is the highest among individuals aged \( \geq 65 \) years, with 75\% of women and 65\% of men having high BP (2003 to 2006). The prevalence is higher in men than women until 45 years of age, but increases in women above 65 years of age. It is more common among women taking oral contraceptives, especially among obese and older women. The prevalence is the highest among African-Americans with an increase from 35.8\% (1988-1994) to 41.4\% (1999-2002).\textsuperscript{8} Moreover, the mortality is also higher among African-Americans, with mortality rate in females and males being 38.6\% and 50.3\%, respectively.

\textit{Socioeconomic burden}

In 2010, the direct medical costs associated with hypertension were estimated to be $69.9 billion. With increase in the aging population and rising obesity rates, hypertension has shown the greatest increase in medical costs and these costs are projected to be about $200.3 billion dollars by 2030.\textsuperscript{15} The direct medical costs associated with hypertension include hospitalizations for related cardiovascular events, renal disease, and ambulatory care visits. The costs associated with hypertension including healthcare services, medication, and indirect costs (e.g., missed days of work) account for about $76.6 billion.\textsuperscript{14} The office visits are 40\% higher for hypertensive patients aged \( \geq 60 \) years compared to individuals aged 45-54 years. According to the 2006 American Hospital Association report, hypertension-related productivity loss was estimated to be 181 work days lost per 1,000 workers. Variations were observed based on the region and state; Southeast had the highest productivity loss, at 200 missed days
per 1,000 employees and California had the highest workplace absenteeism followed by Texas, Florida, New York, and Illinois. In addition, productivity loss due to presenteeism has also been reported; the estimated average annual cost of presenteeism per employee with hypertension is $247. Furthermore, presence of CVD and stroke along with hypertension doubles the medical cost of hypertension management. Hypertension is a modifiable risk factor, making it a valuable target for controlling future total costs of CVD.

Hypertension management

In patients with hypertension, the primary goal is to control and treat SBP so as to achieve target levels (defined on page 62), with an overall goal of reducing morbidity and mortality associated with cardiovascular, cerebrovascular, and renal conditions. The JNC 7 guidelines provide recommendations for accurate measurement of BP, classification and staging, and treatment strategies. The treatment strategies comprise of both non-pharmacological and pharmacological treatments. Behavioral and lifestyle modifications are recommended for patients with prehypertension and hypertension. Besides lifestyle modifications, antihypertensive medications are indicated for patients with stage 1 or 2 hypertension. The choice for drug therapy includes single-drug therapy, fixed-dose combination therapy, or two drugs in combination and is based on hypertension stage, risk factors, target organ damage, and any compelling indications.
Dyslipidemia

Dyslipidemia generally refers to the number of lipid disorders. 80% of the lipid disorders have been linked to diet and lifestyle. Dyslipidemia consists of different categories including elevated low-density lipoprotein cholesterol (LDL-C), low high-density lipoprotein cholesterol (HDL-C), excess lipoprotein, hypertriglyceridemia, atherogenic dyslipidemia, and mixed lipid disorders. Dyslipidemia is also a risk factor for CHD, a major cause of death in the US.

Epidemiology

An estimated 90 million adults in the US have one or more type of lipid disorder, out of which 71 million have high LDL-C. According to data from the (combined) 2005-2006 and 2007-2008 NHANES, approximately 33.5 million adults (≥ 20 years) have total serum cholesterol levels ≥ 240 mg/dL, with a prevalence of 16.2%. The prevalence of high LDL-C was 33.5% in 2005-2008.

The 2007-2008 NHANES shows that the prevalence of lipid levels varies with age, sex, and race/ethnicity. The prevalence of total serum cholesterol is higher among women compared to that of men, whereas the prevalence of elevated LDL-C and low HDL-C is higher among women compared to that of men. In males, the prevalence of total cholesterol is the highest among Mexican-Americans (50.1%) followed by non-Hispanic whites (41.2%) and blacks (37.0%). Similarly, in females, the prevalence of total cholesterol is the highest among Mexican-Americans (46.5%) followed by non-Hispanic whites (47.0%) and blacks (41.2%). The prevalence of elevated LDL-C is the highest among Mexican-American men (41.9%) and the lowest among non-Hispanic
black women (27.7%). Similarly, the prevalence for low HDL-C levels is the highest among Mexican-American men (31.7%) and the lowest among non-Hispanic black women (6.6%). The prevalence of high LDL-C increases with age, being the highest for individuals ≥ 65 years (58.2%), followed by 41.2% for the age group of 40-64 years and the lowest in the age group 20-39 years (11.7%). Although high LDL-C levels can be managed and controlled successfully, yet one-third of the population have uncontrolled LDL-C levels.

*Socioeconomic burden*

Most of the total costs, including direct and indirect costs, associated with CVD and stroke are related to dyslipidemia and were estimated to be more than $400 billion in 2006. The direct costs attributed to dyslipidemia account for about two-thirds of the total costs.17

*Dyslipidemia management*

The Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III, or ATP III) focuses on Framingham risk assessment and treatment strategy for reduction of lipid levels.18 Controlling elevated LDL-C levels has been recommended as the primary target for therapy and the treatment focuses on both lifestyle modifications and use of lipid-lowering medications. The guidelines recommend that the intensity of risk-reduction therapy should be adjusted according to a person’s absolute risk. The risk assessment requires measurement of LDL-C as a part of
lipoprotein analysis and assessing the risk determinants, including presence or absence of CHD, other clinical forms of atherosclerotic disease, and other major risk factors (cigarette smoking, hypertension, low HDL cholesterol, family history of premature CHD, and age-men ≥ 45 years; women ≥ 55 years).

Concomitant hypertension and dyslipidemia

Hypertension and dyslipidemia are the most prevalent and modifiable risk factors for CVD, and they often co-exist.\textsuperscript{19} According to NHANES III (1988-1994), 30 million US adults have concomitant hypertension and dyslipidemia, with an estimated prevalence of about 15%. Among patients with hypertension, 64% also have dyslipidemia, and among patients with dyslipidemia, hypertension is present in 47% of the patients.\textsuperscript{20}

Studies have shown that patients with presence of concomitant hypertension and dyslipidemia have a greater than additive risk of CVD compared to either condition alone.\textsuperscript{21} Moreover, simultaneous presence of these conditions accelerates the course of atherosclerosis and the progression to cardiovascular morbidity and mortality. Both of these conditions cause endothelial dysfunction, which impairs endothelium-dependent arterial relaxation, promoting plaque formation, and development of clinical atherosclerotic disease that ultimately results in clinical sequelae of CVD such as myocardial infarction or stroke (Figure 1).\textsuperscript{19,22}
Figure 1: Interaction of hypertension and dyslipidemia in endothelial dysfunction in cardiovascular disease.

COX: cyclooxygenase; NO: nitric oxide
According to the NCEP ATP III guidelines, concomitant hypertension and dyslipidemia requires aggressive treatment, especially in persons with known CHD. The treatment involves lifestyle modifications and the use of both antihypertensive and lipid-lowering medications. The clinical choice of specific antihypertensive medication is based on the JNC 7 guidelines and requires consideration of benefits and effects of the therapy on quality of life (QoL), concomitant diseases, and costs. Selection of lipid-lowering drugs is based on recommendations of the NCEP ATP III guidelines.18

Concomitant obesity, hypertension, and dyslipidemia

Patients with high BMI are at an increased risk for hypertension and dyslipidemia, and conversely, a majority of patients with these metabolic conditions are either overweight or obese.23,24 Based on the 1999-2002 NHANES, an increase in prevalence of hypertension and dyslipidemia is associated with an increase in BMI. The prevalence of hypertension was the highest among morbidly obese individuals (51%). However, in the case of dyslipidemia, there was increase in prevalence as BMI increased up to 30 kg/m²; there was no increase in prevalence for any further increase in BMI.23

In addition, the distribution of BMI levels among individuals with hypertension or dyslipidemia was analyzed using the 1999-2002 NHANES. The prevalence of obesity was higher among patients with hypertension; approximately 85% of patients were either overweight or obese, and among these, 55% of patients were only obese. Similar trends were observed with dyslipidemia, in which high prevalence of obesity was observed in patients with one or more lipid disorders. Among patients with dyslipidemia, 84% of patients were either overweight or obese out of which 52% of the patients were obese.23
Besides increased risk of morbidity in obese patients with hypertension and dyslipidemia, obesity substantially increases the deleterious effect of dyslipidemia and hypertension on medical expenditures and lost productivity. Sullivan et al.\textsuperscript{25} showed that medical expenditures for hypertension or dyslipidemia were approximately 1.5 times higher for patients who were obese compared to that of normal-weight individuals. Regarding productivity loss, the number of missed work days was 3 times higher in individuals who were obese compared to that of normal-weight individuals with hypertension. Similarly, the number of missed work days was 1.5 times higher in individuals who were obese compared to that of normal-weight individuals with dyslipidemia.

**PROBLEM STATEMENT**

Obesity is associated with increased morbidity and mortality and has become a major public health concern, especially since 33.7% of the US adults are reported to be obese (BMI $\geq 30$ kg/m$^2$).\textsuperscript{7} Most of the obesity-related morbidity is linked to cardiovascular risk factors such as hypertension; the addition of dyslipidemia further adds to the incidence of CVD.\textsuperscript{19} Cardiovascular diseases are the leading cause of morbidity and mortality in the US; an estimated 82.6 million US adults have one or more type of CVD and 16.3 million adults have CHD, the most common heart disease in the US.\textsuperscript{13} As discussed earlier, the prevalence of hypertension and dyslipidemia substantially increases with an increase in BMI, suggesting an increased incidence of concomitant hypertension and dyslipidemia, and thus an increased burden on the healthcare system.\textsuperscript{24} Obesity
accounts for about 36% increase in costs for both inpatient and ambulatory care as well as increased utilization of physician and hospital services, specifically for patients with diabetes, hypertension, dyslipidemia or CVD. In addition, patients who are obese utilize more medications than individuals with normal-weight, and account for about 77% more in annual medication costs.\textsuperscript{9} Another study evaluating the costs of treating major obesity-related disorders demonstrated that about 65%-70% of the cost is attributed to obesity-related cardiovascular risk factors or CVD.\textsuperscript{9,10} Additionally, in middle-aged men, treatment of the five major obesity-related conditions (stroke, CHD, diabetes, hypertension, and high cholesterol levels) accounts for about $9,000 to $17,000 more compared to that of adults with normal-weight.\textsuperscript{10} Thus, the concomitant presence of obesity, high BP, and dyslipidemia adds to the complexity, morbidity, and cost of long-term management of CVD.\textsuperscript{19}

In order to reduce the cardiovascular risk, current guidelines for the treatment of obesity emphasize lifestyle modifications and control of associated risk factors such as hypertension and dyslipidemia, to decrease the obesity-related morbidity and mortality.\textsuperscript{26} Guidelines for the treatment of hypertension and dyslipidemia have been established in terms of risk assessment, recommended treatment patterns, and therapeutic goal attainment. The JNC7\textsuperscript{12} and the NCEP ATP III\textsuperscript{18} guidelines have established optimum BP and lipid targets, respectively, for reducing cardiovascular risk. Presence of both hypertension and dyslipidemia has additive risk of developing CVD, and thus, even relatively small reductions in both BP and LDL-C levels can result in large reductions in the risk for cardiovascular events.\textsuperscript{18,20} However, most of the patients fail to attain their therapeutic goal; more than 50% of patients with hypertension have failed to achieve
their BP goal\textsuperscript{27-29} and about 50% of the patients with dyslipidemia have failed to attain lipid goals\textsuperscript{30-32}. The attainment of therapeutic goals has only been evaluated in patients with hypertension, dyslipidemia, diabetes, or CVD. Knowing that obesity results in a cluster of medical conditions (high BP, high blood cholesterol, high triglycerides, and insulin resistance), attainment of recommended BP and lipid levels has not been examined in this population.

Current guidelines also emphasize the concomitant management of multiple risk factors such as hypertension and dyslipidemia. One study has examined BP and lipid goal attainment in patients with concomitant hypertension and dyslipidemia.\textsuperscript{34} However, studies have not evaluated attainment of guideline recommended BP and lipid targets and medication utilization patterns in obese versus non-obese patients with concomitant hypertension and dyslipidemia. The CHD risk associated with overweight and obesity appears to be mediated through the major risk factors, such as hypertension and dyslipidemia, suggesting importance of controlling BP and lipid levels in these individuals. Studies have also suggested that more aggressive treatment including medications and interventions is required for obese patients compared to non-obese patients\textsuperscript{75,76}. Thus, this study is designed to evaluate prevalence, medication utilization pattern, and therapeutic goal attainment in patients with concomitant hypertension and dyslipidemia stratified by BMI.
CONCEPTUAL FRAMEWORK

The objective of this study is to evaluate variations in therapeutic goal attainment and medication utilization pattern in obese versus non-obese patients and having concomitant hypertension and dyslipidemia, using retrospective data obtained from GE centrivity primary care electronic medical records (EMR) database. The database contains data from 2004-2011 with 155,483 active patients receiving care from 42 primary care providers in Southwestern Pennsylvania. The EMR database includes data from patient records including demographics and clinical diagnoses, prescribed medications, procedures, and laboratory test results. The study will evaluate the characteristics of obese patients not attaining required BP and lipid levels. The pattern of anti-hypertensive and lipid-lowering medication utilization will be identified in this population.

OVERALL HYPOTHESIS

The overall hypothesis of the study is that there is no variation in the attainment of blood pressure and lipid goals and medication utilization pattern in obese versus non-obese patients having concomitant hypertension and dyslipidemia.

STUDY OBJECTIVES

The specific objectives of the study are:
1. To examine distribution of patient-related factors, and clinical factors in patients with concomitant hypertension and dyslipidemia stratified by BMI.

2. To examine variation in blood pressure and lipid goal attainment in patients with concomitant hypertension and dyslipidemia stratified by BMI.

3. To examine variations in antihypertensive and antilipemic medication utilization pattern based on JNC7 and NCEP ATP III guidelines, respectively in patients with concomitant hypertension and dyslipidemia stratified by BMI.

4. To examine predictors of BP or/and lipid goal attainment in patients with concomitant hypertension and dyslipidemia.

**SIGNIFICANCE OF THE STUDY**

As discussed earlier, obesity is an independent risk factor for both hypertension and dyslipidemia and its concomitant presence might negatively impact the appropriate control of cardiovascular risk factors. The guidelines for management of hypertension and dyslipidemia are well established, but more than 50% of patients are not attaining recommended BP and lipid goals. This study will help in understanding variations in medication utilization pattern and therapeutic (BP and lipid) goal attainment in obese patients with concomitant hypertension and dyslipidemia in a real-world medical practice.

This study utilizes EMR database that contains clinical information useful for assessing the effect of obesity on achieving BP and lipid goals as well as evaluating cardiovascular risk profile of the patient population. These study results can be useful in
the following aspects. First, this information will help healthcare providers in making clinical decisions on intensity of preventive interventions (whether dietary advice should be strict and specific, when to provide suggestions for physical activity and when it should be intensified or individualized, and when and which medications should be prescribed) based on overall predicted risk. Second, for treatment to be effective patients should be aware of their risk status, and need and benefits of a multifactorial (combination of medications and lifestyle modification) approach to treatment. This can be achieved by healthcare professionals (physicians and pharmacists) by implementing interventions such as motivational interviewing, behavior modification techniques, or using a patient-centered approach. A patient-centered approach entails individualized planning and delivery of services, consideration of patient values and culture, a medical home, and an interdisciplinary team care. Third, the patients with high cardiovascular risk identified in the study can be monitored by the physicians using this EMR database for improving health status of these patients.

The study results can also have long-term implications. Identifying patients with multiple cardiovascular risk factors and proper management of risk factors in this population can reduce long-term obesity-related morbidity in these patients, thereby alleviating the associated healthcare burden (hospitalizations, medication costs, outpatient care, and physician visits). In addition, assessing cardiovascular risk and appropriate control of modifiable cardiovascular risk factors in obese patients is also important from employer and payer perspective. Obesity-related conditions have been implicated to have higher employer costs resulting from lost productivity and the increased cost of health and disability insurance. Spending on obesity-related conditions accounted for about
8.5% of Medicare spending, 11.8% of Medicaid spending, and 12.9% of private-payer spending (results from 2006 MEPS data).\textsuperscript{9} Timely and appropriate management of these risk factors can reduce these costs.

Current guidelines also recommend aggressive treatment strategies for individuals having multiple risk factors. Assessing medication prescribing pattern will provide insight into the following aspects: whether patients at high risk are prescribed medications, variations in number of medications prescribed to obese versus non-obese patients, type of medication prescribed, and effect of medications on attaining therapeutic goals attainment. This information helps in identifying two specific groups of patients: those who are not prescribed adequate medications and those who are prescribed adequate medications but are not attaining goals. Healthcare professionals can use this information in designing appropriate interventions with primary focus on improving medication adherence in patients with multiple risk factors.
Obesity is highly prevalent in US population and is an independent risk factor for high BP, high blood cholesterol, type 2 diabetes, and CHD.$^{1,2}$ Presence of multiple risk factors (hypertension, dyslipidemia, and diabetes) in obese patients negatively affects therapeutic (BP and lipid goal attainment) thereby increasing cardiovascular risk.

**Objectives**

The objective of the review was to identify studies assessing variations in BP or lipid goal attainment in obese population, specifically in the US population. In addition, studies assessing BP and lipid goal attainment in patients with other cardiovascular risk factors (hypertension, dyslipidemia, and diabetes) or CVD were also evaluated.

**Methods**

**Search strategy**

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines$^{35}$, a systematic literature search was conducted among peer-reviewed journals from January 2000 to March 2012 across four electronic databases including Pubmed, PsychInfo, Embase, and Cinahl (Figure 2).
Figure 2: Schematic presentation of methodology used and selection criteria.

676 articles identified through database search (Pubmed, PsychInfo, Embase, Cinahl)

Articles excluded
175 duplicate articles

501 articles were screened

Articles excluded
- 6 studies were clinical trials
- 34 non-English studies
- 86 studies were on patients < 18 years of age
- 301 studies were not relevant to topic

74 full text articles were reviewed

Articles excluded
- 2 studies focused on general population
- 32 studies did not focus on variations in BP or lipid goal attainment
- 4 studies not conducted in US population
- 13 studies were not relevant to BP or lipid goal attainment

23 studies included for evaluation

*Search and selection criteria conducted in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement criteria*
The search strategy included the following keywords or their combinations: hypertension, dyslipidemia, hyperlipidemia, hypercholesterolemia, diabetes, obesity, metabolic syndrome, coronary heart disease, cardiovascular, cardiovascular risk factors, cardiovascular conditions, blood pressure, low density lipoprotein, lipid, cholesterol, goal attainment, and goal achievement. The search was conducted to identify studies evaluating variations in the attainment of therapeutic goals in population having cardiovascular risk factor(s) or CVD(s). For the purpose of the review, the term therapeutic goal was referred to BP and lipid (LDL-C, HDL-C, triglyceride, and cholesterol) goals. The major cardiovascular risk factors were referred to health conditions that increase the risk of CVD. These include hypertension, dyslipidemia, diabetes, metabolic syndrome, and obesity. The CVDs were defined as the group of diseases that involve heart or blood vessels, which usually refer to cardiovascular system or atherosclerosis.

**Inclusion and exclusion criteria**

The studies were included in the review if they evaluated variations (e.g., patient-, provider-, clinical-, or treatment-related) in attaining BP or lipid goals. The search was limited to studies in English language and those conducted in the US population. The inclusion of articles was limited to population with cardiovascular risk factors or any cardiovascular condition; studies on population with health conditions not related to cardiovascular system were excluded. In addition, included studies focused on patient population receiving pharmacological treatment; studies focusing on any non-pharmacological interventions or with no indication of pharmacological treatment were
excluded. Studies evaluating the effect of specific pharmacological drug on BP or lipid goals were also excluded. Randomized clinical studies focusing on treatment for elevated BP or lipid levels and review studies evaluating BP or lipid goal attainments were excluded. Also excluded from the review were conference abstracts, dissertations, commentaries, editorials, or summary reports.

Data extraction

For the studies evaluating therapeutic goal attainment, the following information was collected: sample size, socio-demographic variables (age, race/ethnicity, and employment status), type of cardiovascular risk factor or CVD, therapeutic goal (BP, lipid level) evaluated, guidelines used for assessing therapeutic goals, setting/data source, different characteristics (e.g., patient-, provider-, clinical-, and treatment-related) resulting in variations, and disparities observed in therapeutic goal attainment. In addition, information on medication utilization pattern including type of medication class and number of medications, if any, as assessed by these studies was also collected.

Results

Therapeutic goal attainment in patients with cardiovascular risk factors or CVD

Based on the literature search methodology, 23 studies were identified that assessed variations in attainment of BP or lipid goals in patients with cardiovascular risk-factors or cardiovascular conditions. Tables 1-3 provide summary of the studies including information regarding sample size, setting/data source, cardiovascular risk factor or CVD present, factors evaluated, guidelines used, variations observed, and medication utilization pattern.
Studies primarily focused on patient population with either cardiovascular risk factors such as hypertension, dyslipidemia, and diabetes or cardiovascular conditions such as CAD (Figure 3). Current guidelines including JNC 7 for BP goal attainment and NCEP ATP III guidelines for lipid goal attainment were utilized by most of the studies. Moreover, the studies utilized different patient setting or data sources. Most of the studies obtained data from the claims database, patient chart reviews, or electronic medical records (EMR). Five studies utilized data collected from surveys such as NHANES, NCEP Evaluation Project Utilizing Novel E-technology (NEPTUNE II), and survey conducted on patients in West Virginia Breast and Cervical Cancer Screening Program. However, the clinical data for survey studies was obtained from screening and laboratory results.

Variations in BP goal and lipid goal attainment were observed in patient-, clinical-, provider- and medication-related factors (Figure 4). For the purpose of review, the results from the 23 studies are summarized into three categories. These include studies focusing on BP goal attainment, lipid goal attainment, and both BP and lipid goal attainment.
Figure 3: Evaluating studies based on population type assessed by the included studies.

CAD: Coronary artery disease; CHD: Coronary heart disease; CKD: Chronic kidney disease; CV: Cardiovascular

Figure 4: Evaluating studies based on factors assessed by the included studies.

Patient-related factors (age, gender, race), clinical factors (co-morbidities, lipid levels, hypertension stage, BMI), provider-related factors (provider type), and medication-related factors (medication type, number of prescribed medications).
Attainment of BP goals

Nine studies evaluated variations in BP goal attainment in patients with hypertension, diabetes, or stroke\textsuperscript{36-44} (Table 1). BP goal was evaluated based on the JNC 7 guidelines. However, Choe et al. (2007)\textsuperscript{39} evaluated studies based on BP goals recommended by JNC 7 and randomized clinical trial studies. Lower rates of BP control were observed among older patients (≥ 65 years of age), women, and African-American patients. However, Choe et al. (2007)\textsuperscript{39} showed that BP goal attainment was higher among older patients with diabetes and Shelley et al. (2011)\textsuperscript{43} showed that BP control rates were higher among women compared to men.

Regarding clinical factors, presence of complicated hypertension, isolated systolic hypertension, stage 2 hypertension, and BMI ≥ 30 resulted in lower rates of BP goal attainment. In addition, patients with co-morbidities including heart failure, chronic kidney disease, stroke, and ischemic heart disease were less likely to achieve BP targets. Similarly, presence of diabetes as co-morbidity in hypertensive patients was also associated with less likelihood of attaining BP. Presence of co-morbidities was not associated with BP goal attainment in stroke survivors. Choe et al. (2007)\textsuperscript{39} also observed the effect of elevated LDL-C on BP goal attainment in patients with diabetes; attainment of LDL-C goals was important for controlling BP.

BP goal attainment varied with type and number of medications; patients on angiotensin-converting enzyme inhibitors (ACEI) compared to other antihypertensive medications (angiotensin receptor blockers (ARBs), thiazide diuretics) were more likely to attain recommended BP goals. Andros et al. showed that patients with diabetes receiving no antihypertensive medication were more likely to attain BP goals. However,
Choe et al. (2007) showed that patients on antihypertensive therapy were more likely to attain BP goals. Use of more than one antihypertensive drug reduced the likelihood of BP goal attainment. Duggirala et al. (2005) showed that ≥ 1 annual visit to subspecialist physician was important for attaining BP goal in patients with diabetes.
<table>
<thead>
<tr>
<th>Study</th>
<th>Patient population</th>
<th>Setting/data source</th>
<th>CVD/CVD risk factor</th>
<th>Factors evaluated</th>
<th>Guideline</th>
<th>Study findings</th>
<th>Medication utilization pattern</th>
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<tbody>
<tr>
<td>Andros et al. (2006)&lt;sup&gt;36&lt;/sup&gt;</td>
<td>Patients aged ≥ 18 years. Type 1 DM (N = 1,011); Type 2 DM (N = 3,644)</td>
<td>Retrospective review of pharmacy claims and medical records; conducted in October 2003. Patients enrolled in 30 health plans, were part of a MCO located in sites in the Southeast, southwest, mid-Atlantic, Midwest, Northeast, North central, Western US</td>
<td>Diabetes</td>
<td>Type of antihypertensive medication class</td>
<td>JNC 7</td>
<td>Overall 26.3% of patients receiving antihypertensive therapy were at BP goal. BP goal attainment was higher among patients receiving no therapy (43.4%), followed by patients receiving ACEI (30.7%) compared to other drug classes (e.g., ARB, ACEI+ARB, diuretics)</td>
<td>Majority of patients were on ACEI, especially lisinopril. ACEIs, ACEI/diuretic, diuretic were top 3 drug regimens for diabetes and uncontrolled hypertension.</td>
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<td>Biskupiak et al. (2010)&lt;sup&gt;37&lt;/sup&gt;</td>
<td>Patient’s age: 18-64 years (N = 61,355) and ≥ 65 years (N = 47,796)</td>
<td>Retrospective cohort study using GE centricity EMR database (comprised of more than 70 consortium member institutions located in more than 40 US states); study period ranged from January 1, 2004 – December 31, 2007</td>
<td>Hypertension</td>
<td>Socio-demographic, clinical (BMI, hypertension stage, co-morbidities)</td>
<td>JNC 7</td>
<td>Age ≥ 65 years, African-American race, BMI ≥ 30, presence of complicated hypertension contributed to a lower likelihood of BP goal achievement.</td>
<td>ACEI: most commonly prescribed medication class in both elderly and non-elderly patients followed by diuretics and ARBs. ACEI/diuretic was most commonly seen combination followed by ARB/diuretic. Elderly patients were more likely to have more than 1 medication.</td>
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<td>Bisognano et al. (2007)&lt;sup&gt;38&lt;/sup&gt;</td>
<td>Patients aged ≥ 60 years; N = 388</td>
<td>Retrospective review of medical charts for patients treated at geriatric clinic; period January 1,1998-December 31, 1998.</td>
<td>Hypertension</td>
<td>Age, gender, co-morbidities, number of visits, medication type</td>
<td>JNC 7</td>
<td>BP goal was not achieved among patients with isolated systolic hypertension, diabetes, and heart failure and treatment with thiazide diuretics.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Study</td>
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<tr>
<td>Choe et al. (2007)</td>
<td>Patients aged ≥ 18 years; N = 362</td>
<td>Retrospective, cross-sectional study; data collected from patient’s chart and EMR, for years 2002, 2003 and 2004.</td>
<td>Diabetes</td>
<td>Demographic, clinical, medication type, number of medications</td>
<td>JNC 7 and RCTs</td>
<td>Overall 65% of patients attained BP goals. Patients who attained BP goals were more likely to be older, having achieved LDL-C goal, did not have higher BMI, were at least on 1 antihypertensive.</td>
<td>ACEI was the most commonly used antihypertensive agent. Among the patients treated, 35% were on monotherapy and 65% were on combination therapy.</td>
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<tr>
<td>Duggirala et al. (2005)</td>
<td>Patients aged ≥ 18 years; N = 1,231</td>
<td>Retrospective study utilizing data from patients’ medical records outpatient medical care delivered in the Division of Primary Care Internal Medicine or in the Department of Family Practice at the Mayo Clinic (Rochester, MN) from January 1, 2000-December 31, 2002.</td>
<td>Diabetes and hypertension</td>
<td>Demographic, clinical, patient lifestyle, type of medications, physician-related.</td>
<td>JNC 7</td>
<td>Lower rates of BP control observed in older patients, with isolated systolic hypertension, uncontrolled BP at inception, using oral hypoglycemic drugs, using 3 or more antihypertensive drugs. Use of nitrates, history of CHD, at least 1 annual visit to subspecialist increased likelihood of BP goal attainment.</td>
<td>Not reported</td>
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<tr>
<td>Gu et al. (2008)</td>
<td>Patients aged ≥ 18 years. N = 5,410</td>
<td>NHANES (1999-2004), a cross-sectional survey comprising of nationally representative sample of civilian non-institutionalized US population.</td>
<td>Hypertension</td>
<td>Socio-demographic, co-morbidities, type of antihypertensive drug class</td>
<td>JNC 7</td>
<td>BP control rates were lower in women, older age groups, non-Hispanic whites, and those with co-morbidities such as kidney disease, stroke, or ischemic heart disease. Among β-blockers and diuretics, control rate was higher among men.</td>
<td>Use of diuretics and ARBs was higher among women. Men were more likely to use ACEI. About 30% of patients used 2 antihypertensives. Use of 3 or more antihypertensives was lower among elderly people.</td>
</tr>
<tr>
<td>Study</td>
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<tr>
<td>Kesarwani et al. (2009) (^{42})</td>
<td>Patients aged ≥ 20 years; N = 438</td>
<td>NHANES (1999-2004), a cross-sectional survey comprising of nationally representative sample of civilian non-institutionalized US population.</td>
<td>Stoke survivors</td>
<td>Age, gender, co-morbidities</td>
<td>JNC 7</td>
<td>Overall, 46.5% of patients achieved BP goal. Men were more likely to attain BP goals compared to women. No differences were seen regarding presence of co-morbidities.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Shelley et al. (2011) (^{43})</td>
<td>Patients aged ≥ 18 years; N = 2,712</td>
<td>EMR for all adult, non-obstetric patients seen in any four FQHCs affiliated with Open door Medical Centers located in New York; from June 2007-October 2008</td>
<td>Hypertension</td>
<td>Socio-demographic, medications (number), presence of diabetes, BMI</td>
<td>JNC 7</td>
<td>BP control rates were lower among men, in blacks compared to whites and Hispanics, patients prescribed more than one medication, having diabetes, having higher BMI.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Weycker et al. (2008) (^{44})</td>
<td>Patients aged ≥ 18 years; N = 10,345</td>
<td>GEMS EMR database; initiated antihypertensive therapy between July 1, 2003- December 31, 2004</td>
<td>Hypertension</td>
<td>Co-morbidities, hypertension stage</td>
<td>JNC 7</td>
<td>BP control rates were lower among patients with stage 2 hypertension, patients with diabetes or chronic kidney disease, or with other cardiovascular risk-factors</td>
<td>Not reported</td>
</tr>
</tbody>
</table>

\(^{a}\)Consortium members: variety of practice types, ranging from solo practitioners to community clinics, academic medical centers, and large integrated delivery networks

ACEI: Angiotensin-converting enzyme inhibitors; ARB: angiotensin receptor blocker; BMI: Body mass Index; BP: Blood pressure; CHD: Coronary heart disease; CVD: Cardiovascular disease; DM: Diabetes mellitus; EMR: Electronic medical records; FQHCs: Federally qualified community health centers; GEMS: General Electric Medical System; JNC 7: Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure; LDL-C: Low-density lipoprotein cholesterol; MCO: Managed Care Organization; NHANES: National Health and Nutrition Examination Survey; RCT: Randomized clinical trial; US: United States
Attainment of lipid goals

Nine studies evaluated lipid goal attainment in patients with dyslipidemia, diabetes, CAD, CHD, chronic kidney disease, or at high-risk of CVD\textsuperscript{45-53} (Table 2). Lipid goal was evaluated based on NCEP ATP III guidelines. However, Mosca et al. (2005)\textsuperscript{49} used American Heart Association (AHA)-evidence based guidelines, Putzer et al. (2004)\textsuperscript{51} used American Diabetes Association (ADA) guidelines, and Stadler et al. (2010)\textsuperscript{52} used National Kidney Foundation/Kidney Disease Outcomes Quality Initiative (K/DOQI) guidelines. Most of the studies have evaluated LDL-C goals. In addition to LDL-C goals, HDL-C or triglyceride goals were also evaluated by Mosca et al. (2005)\textsuperscript{49}, Nichols et al. (2009)\textsuperscript{50}, Putzer et al. (2004)\textsuperscript{51}, and Virani et al. (2011)\textsuperscript{53}.

LDL-C goal attainment rates were lower among women and African-Americans. Massing et al. (2004)\textsuperscript{48} evaluated variations specific to gender and race; highest rates of goal attainment were observed among Caucasian men and lowest rates were observed among African-American men. However, varied results were obtained for age. Kauffman et al. (2010)\textsuperscript{47} observed lower rates of goal attainment among patients < 65 years of age in patients with CAD. Cone et al. (2011)\textsuperscript{46} results showed that LDL-C goal attainment increased until 70 years of age and then decreased. Stadler et al. (2010)\textsuperscript{52} assessed patients with chronic kidney disease and observed increased likelihood of LDL-C goal attainment with increasing age.

Regarding clinical-factors, presence of obesity or increasing BMI resulted in lower rates of LDL-C goal attainment. Presence of CHD risk > 20% and co-morbidities including hyper-triglyceridemia, diabetes, and CHD reduced the likelihood of LDL-C
goal attainment. However, increase in chronic disease score or increase in severity of illness has been associated with higher rates of LDL-C goal attainment.

Treatment-related variations such as use of statins, especially high efficacy statins are important for LDL-C goal attainment. In addition, Cone et al. (2011)\textsuperscript{46} showed that higher doses of simvastatin or lovastatin were useful in increasing rates of LDL-C goal attainment. Higher rates of LDL-C goal attainment were also observed among patients who were treated by subspecialist (Clark et al., 2005\textsuperscript{45}) and patients with higher number of primary care visits (Virani et al., 2011\textsuperscript{53}).

Variations were also observed for HDL-C and triglyceride goals. Putzer et al. (2004)\textsuperscript{51} showed that HDL-C goal attainment was higher among women, blacks, and patients with low BMI and with elevated triglyceride levels. Virani et al. (2011)\textsuperscript{53} observed lower rates of triglyceride goals among African-Americans, but higher rates were observed among men, 65-74 years age group, patients with CHD, diabetes, obesity, increased severity of illness, and higher number of primary care visits.
Table 2: Studies evaluating variations in attainment of lipid goals

<table>
<thead>
<tr>
<th>Study</th>
<th>Patient population</th>
<th>Setting/data source</th>
<th>CVD/CVD risk factor</th>
<th>Factors evaluated</th>
<th>Guideline</th>
<th>Study findings</th>
<th>Medication utilization pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clark et al. (2005)</td>
<td>Patient’s age = 20 – 75 years; N = 4,885</td>
<td>Data were collected from NEPTUNE II, a national survey of dyslipidemia management; data collected between May and September 2003</td>
<td>Dyslipidemia</td>
<td>Socio-demographic, clinical, therapy type, provider type</td>
<td>NCEP ATP III</td>
<td>LDL-C control rates were lower among African-Americans, women, patients having obesity, hypertriglyceridemia, and diabetes mellitus. Use of high-efficacy statin, treatment by subspecialist increases likelihood of treatment success.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Cone et al. (2011)</td>
<td>Patients on statin therapy N = 5,191</td>
<td>Retrospective cohort study using New Mexico Veterans Affairs Health Care System’s outcome database was studied, for period between 1998 and 2008</td>
<td>CAD or diabetes</td>
<td>Socio-demographic, BMI, medication type</td>
<td>NCEP ATP III</td>
<td>The likelihood of LDL-C goal increased with age until 70 years and started to decrease. LDL-C control rates were higher among men, higher dosage of simvastatin or lovastatin.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Kauffman et al. (2010)</td>
<td>Patients aged ≥ 18 years; N = 7,427</td>
<td>Retrospective study using Kaiser Permanente Colorado healthcare system. Patients enrolled in CPCRS for at least 1 year before April 1, 2008.</td>
<td>CAD</td>
<td>Socio-demographic, clinical, lipid lowering medication type</td>
<td>NCEP ATP III</td>
<td>Lower LDL-C control rates were observed in who were &lt; 65 years of age, were female, had dyslipidemia, and used non-statin medication, previous CK between 861 and 2000 IU/mL.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Massing et al. (2004)</td>
<td>Patients aged ≥ 21 years; N = 23,123</td>
<td>Medical record data collected from QAP II (patients from January 1995-March 1998) database, includes data from 1,171 physicians at 238 medical practices in 23 US states.</td>
<td>CAD</td>
<td>Patient’s race, gender</td>
<td>NCEP ATP III</td>
<td>LDL-C goal attainment was higher among Caucasian men and was lowest among African-American men.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Study</td>
<td>Patient population</td>
<td>Setting/data source</td>
<td>CVD/CVD risk factor</td>
<td>Factors evaluated</td>
<td>Guideline</td>
<td>Study findings</td>
<td>Medication utilization pattern</td>
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</tr>
<tr>
<td>Putzer et al. (2004)</td>
<td>N = 239</td>
<td>Patients were identified using computerized scheduling/billing database (includes patient visit data for university primary care clinic in Tampa, FL) for period March 1999-March 2001.</td>
<td>Diabetes</td>
<td>Socio-demographic, smoking status, BMI, medication type,</td>
<td>ADA</td>
<td>Overall 42%, 47%, and 70% patients attained HDL-C, LDL-C, and triglyceride goals, respectively. LDL-C goal was met among men, patients taking lipid lowering drug, and patients with hypertension. HDL-C goal was met among women, blacks, patients with lower BMI and triglyceride.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Nichols et al. (2009)</td>
<td>Patients aged ≥ 35 years; N = 5,158</td>
<td>Retrospective study using medical record data from Kaiser Permanente Northwest. Study period: July 2004-June 2006.</td>
<td>Dyslipidemia</td>
<td>Socio-demographic, clinical, lipid lowering medication type</td>
<td>NCEP ATP III</td>
<td>Patients with CHD, diabetes, or CHD risk &gt; 20% were less likely to attain LDL-C goals. Attainment of LDL-C, HDL-C, and triglyceride goals was higher among men.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Putzer et al. (2004)</td>
<td>N = 239</td>
<td>Patients were identified using computerized scheduling/billing database (includes patient visit data for university primary care clinic in Tampa, FL) for period March 1999-March 2001.</td>
<td>Diabetes</td>
<td>Socio-demographic, smoking status, BMI, medication type,</td>
<td>ADA</td>
<td>Overall 42%, 47%, and 70% patients attained HDL-C, LDL-C, and triglyceride goals, respectively. LDL-C goal was met among men, patients taking lipid lowering drug, and patients with hypertension. HDL-C goal was met among women, blacks, patients with lower BMI and triglyceride.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Stadler et al. (2010)</td>
<td>Patients aged ≥ 18 years; N = 4541</td>
<td>Cross-sectional study utilizing data maintained by Kaiser Permanente Colorado. Study period: January 1, 2002-December 31, 2005.</td>
<td>Chronic kidney disease</td>
<td>Demographic, BMI, smoking status, comorbidities, medication type, renal factors</td>
<td>K/DOQI guidelines</td>
<td>LDL-C goal attainment was observed among men, patients with increasing age, increasing chronic disease score, history of diabetes, and statins</td>
<td>Not reported</td>
</tr>
<tr>
<td>Study</td>
<td>Patient population</td>
<td>Setting/data source</td>
<td>CVD/CVD risk factor</td>
<td>Factors evaluated</td>
<td>Guideline</td>
<td>Study findings</td>
<td>Medication utilization pattern</td>
</tr>
<tr>
<td>------------------------</td>
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<td>--------------------------------------------------------------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Virani et al.</td>
<td>N = 21,801</td>
<td>Retrospective study utilizing VA Health Care System in the Midwest region (includes 3 states). Study period: October 1, 2007-September 30, 2008.</td>
<td>CHD</td>
<td>Socio-demographic, clinical, provider, facility characteristics</td>
<td>NCEP ATP III</td>
<td>LDL-C and triglyceride goal attainment was higher among patients age group 65-74 years, having diabetes, obesity, higher number of primary care visits, and increase in severity of illness. Lower control rates were observed among African-Americans.</td>
<td>Use of statins was highest among these patients, especially simvastatin.</td>
</tr>
</tbody>
</table>

Attainment of BP and lipid goals

Five studies evaluated both BP and lipid goals in patients with hypertension, hypercholesterolemia, CAD, diabetes, and dyslipidemia\textsuperscript{33,54-57} (Table 3). JNC 7 (for BP) and NCEP ATP III (for lipid) were the most commonly used guidelines, but Johnson et al. (2006)\textsuperscript{33} assessed patients based on JNC 6 and NCEP ATP II guidelines. The studies included in this review evaluated individual cardiovascular risk factors, but study by Johnson et al. (2006)\textsuperscript{33} focused on concomitant cardiovascular risk factors (hypertension and dyslipidemia). Each study focused on different population and different factors. These studies vary widely based on the factors evaluated, thereby making it difficult to identify consistent results.
<table>
<thead>
<tr>
<th>Study</th>
<th>Patient population</th>
<th>Setting/data source</th>
<th>CVD/CVD risk factor</th>
<th>Factors evaluated</th>
<th>Guideline</th>
<th>Study findings</th>
<th>Medication utilization pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahluwalia et al. (2010)</td>
<td>Uninsured, low-income, rural women aged 40-64 years; N = 733</td>
<td>Cross-sectional study in which data were collected by survey and screening. Patients were recruited from WV-BCCSP clinic. Data collected from middle of 2004-early 2007.</td>
<td>Hypertension or hypercholesterolemia</td>
<td>Socio-demographic, smoking status, BMI, lifestyle, family history of CHD</td>
<td>JNC 7 (BP) and NCEP ATP III (Lipid)</td>
<td>BP and total cholesterol levels were not met in women without a regular physician, lack of physical activity, less than 12 years of education.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Federman et al. (2005)</td>
<td>Patients age: 23-95 years; N = 19,660</td>
<td>Retrospective study conducted using EMR maintained by VA Connecticut Health Care System</td>
<td>CAD or diabetes or hypertension</td>
<td>Provider type</td>
<td>JNC 7 (BP) and NCEP ATP III (Lipid)</td>
<td>No difference seen among provider type for LDL-C control, but BP goal attainment was higher among attending physicians compared to residents.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Johnson et al. (2006)</td>
<td>N = 41,050</td>
<td>Retrospective study conducted using computerized data from South-central VA; period from October 1, 1998-September 30, 2001.</td>
<td>Concomitant hypertension and dyslipidemia</td>
<td>Presence of diabetes</td>
<td>JNC 6 (BP) and NCEP ATP II (Lipid)</td>
<td>BP goal attainment was higher among asymptomatic patients without diabetes. LDL-C goals were met among patients with concomitant diabetes and hypertension. Use of antihypertensives and antilipemic medications was higher among patients with concomitant hypertension, dyslipidemia, and diabetes.</td>
<td>Not reported</td>
</tr>
<tr>
<td>McDonald et al. (2009)</td>
<td>Patients aged ≥ 65 years; N = 3,810</td>
<td>NHANES (1999-2004), a cross-sectional survey comprising of nationally representative sample of civilian non-institutionalized US population.</td>
<td>Hypertension or dyslipidemia</td>
<td>Socio-demographic, doctor visits per year, presence of usual health care provider</td>
<td>JNC 7 (BP) and NCEP ATP III (Lipid)</td>
<td>BP control rate was lower among women. Patients with 2 or more doctor visits were more likely to attain LDL-C goal.</td>
<td>Not reported</td>
</tr>
</tbody>
</table>
Table 3 (Continued)

<table>
<thead>
<tr>
<th>Study</th>
<th>Patient population</th>
<th>Setting/data source</th>
<th>CVD/CVD risk factor</th>
<th>Factors evaluated</th>
<th>Guideline</th>
<th>Study findings</th>
<th>Medication utilization pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welch et al. (2007) 57</td>
<td>Patients aged ≥ 18 years; N = 8,450</td>
<td>Retrospective study utilizing outpatient electronic medical records for veterans obtained from patients visits to Atlanta VAMC. Study period: October 1, 2001-September 30, 2003.</td>
<td>Hypertension</td>
<td>Cardiovascular risk factors</td>
<td>JNC 7 (BP) and NCEP ATP III (Lipid)</td>
<td>Overall, 37% achieved BP goal, 45% achieved total cholesterol/HDL-C ratio &lt; 6, 14.3% achieved both BP and lipid goals. Patients with ≥ 3 cardiovascular risk factors were less likely to achieve dual goals.</td>
<td>ACEI were prescribed commonly. Use of antihypertensive agents lipid lowering medications was higher among patients with ≥ 3 cardiovascular risk factors.</td>
</tr>
</tbody>
</table>

Medication utilization pattern in patients with cardiovascular risk factors or cardiovascular conditions

Besides evaluating variations in therapeutic goal attainment, eight studies also examined medication utilization pattern (Tables 1-3). Use of both antihypertensive agents and antilipemic agents was more common among patients with ≥ 3 cardiovascular risk factors or presence of concomitant conditions. Regarding antihypertensive therapy, ACEI were the most commonly used antihypertensive medication class, followed by ARBs and thiazide diuretics. In addition, Andros et al. (2006)\textsuperscript{36} showed that lisinopril was the most commonly used ACEI. Among combination therapy, ACEI/diuretic was used by majority of patients. Gu et al. (2008)\textsuperscript{41} showed that the use of ACEI was more common among men whereas the use of ARBs and diuretics was primarily seen in women. Use of more than one antihypertensive medication was seen among elderly patients. For achieving recommended LDL-C goals, statins are preferred choice of therapy, especially simvastatin (Virani et al., 2011\textsuperscript{53}). Mosca et al. (2005)\textsuperscript{49} showed that fibrate or niacin therapy is primarily used for attaining recommended HDL-C and triglyceride levels.

Discussion

Studies conducted in a range of settings reflect variations in attainment of BP or lipid goals. A wide variety of studies were included in this review making it difficult to quantitatively compare all the information to identify specific factors that affect therapeutic goal attainment. Even among the studies assessing patients with similar cardiovascular risk factor or CVD, several factors (e.g., patient population, setting, year
of study, medication type, and factors evaluated) preclude a direct comparison of the included studies. Despite these limitations, some consistent differences in therapeutic goal attainment were identified. For example, in patients with diabetes or hypertension, factors resulting in lower BP goals included older age, female gender, African-American race, and presence of co-morbidities (e.g., heart failure, chronic kidney disease, and stroke).

Studies evaluated BP or lipid goals in patients with cardiovascular risk factors including hypertension, dyslipidemia, and diabetes. Obesity is highly prevalent and is an independent risk factor for high BP, high blood cholesterol, type 2 diabetes, and CHD\textsuperscript{1, 2}; studies exploring the effect of obesity on therapeutic goal attainment and underlying variations might be helpful in recognizing patient population at-risk of CVD. Moreover, there is lack of studies assessing variations in therapeutic goal attainment in patients with multiple cardiovascular risk factors. Current guidelines emphasize control of concomitant risk factors\textsuperscript{12, 18}. Hypertension and dyslipidemia are the most prevalent cardiovascular risk factors and studies have shown that concomitant presence of these factors further adds to the risk of CVD\textsuperscript{18, 20}. Johnson et al. (2006)\textsuperscript{33} assessed patients with concomitant hypertension and dyslipidemia, but their study evaluated the effect of presence or absence of diabetes. Also, they did not explore medication utilization pattern in these patients. Studies exploring patient-, clinical-, and treatment-related variations in these concomitant factors are needed. LDL-C is primarily recommended for assessing goal attainment, but including other lipids (HDL-C, total cholesterol, and triglycerides) for goal assessment might be useful in further reducing cardiovascular risk. In addition, medication utilization pattern was evaluated by very few studies.
The present study aims to retrospectively determine patient-related and clinical variations in therapeutic (BP and lipid) goal attainment in patients with concomitant hypertension and dyslipidemia. The study cohort will be stratified based on BMI to explore the role of obesity in therapeutic goal attainment. In addition, medication utilization pattern will be analyzed for this cohort. GE Centricity electronic medical records (EMR) will be used for assessing variations in therapeutic goal attainment and medication utilization pattern.
CHAPTER THREE

METHODOLOGY

Obesity is highly prevalent in US population and is an independent risk factor for high BP, high blood cholesterol, type 2 diabetes, and CHD.\textsuperscript{1,2} Presence of multiple risk factors (hypertension and dyslipidemia) in obese patients negatively affects the therapeutic (BP and lipid) goal attainment, thereby increasing cardiovascular risk. Thus, the overall objective of this study was to evaluate variations in therapeutic (BP and lipid) goal attainment and medication utilization pattern in obese versus non-obese patients having concomitant hypertension and dyslipidemia.

This chapter includes information on data source, patient selection criteria, study variables, data extraction, and statistical analyses.

Data source

Retrospective cohort study was conducted utilizing the GE Centricity Electronic Medical Records (EMR) database of a primary care physician group. This study was approved by Duquesne University Institutional Review Board.

Electronic Medical Records (EMR)

EMR generally refers to standardized electronic databases for healthcare, developed, maintained, and/or provided by clinicians and providers in direct patient care. The EMR systems contain information on all clinical, administrative, and laboratory encounters between a patient and provider.\textsuperscript{58,59} Currently, these EMR systems are
available at some of the large, integrated healthcare providers in the US, such as Kaiser Permanente, Harvard Pilgrim Health System, and the Department of Veterans Affairs (VA). The current government program, American Recovery and Reinvestment Act (ARRA) of 2009, enacted by President Obama in 2009 includes the Health Information Technology Extension Program with $19 billion in grants and loans for adopting certified EMR technology.58, 60

EMR systems have the potential to provide clinical data required for research and with technological advancement, it has become a valuable source for outcomes research. EMR offers various potential benefits in research by providing access to a fully integrated system with both clinical and healthcare utilization data. These EMR systems provide access to a more diverse patient population. In addition, it provides access to readily available, in-depth, more accurate, and complete data.60

**GE Centricity EMR Database**

This study utilized GE Centricity EMR database used by physician group. The database contains data from 2004-2011 with 155,483 active patients receiving care from 42 primary care providers in Southwestern Pennsylvania. The EMR dataset comprises of longitudinal patient data that includes patient demographics and clinical diagnoses, prescribed medications, procedures, and laboratory test results.

**Database organization**

GE centricity EMR database uses an Oracle® relational database.61 A database is a collection of tables which contain related information. A table in a relational database
is organized in rows and columns. Column, also known as field, represents a specific type of data stored in the table. For example, PERSON table includes columns such as person’s ID, sex, race, etc. Each row (also known as record) represents a set of related data about a single object. For example, each row in PERSON table represents demographic information for each person. In APPOINTMENTS table, each person can have multiple appointments, where each row contains information for one specific appointment. Figure 5 represents organization of data in EMR database.
Figure 5: GE Centricity EMR database organization.
Patient population

The patients aged ≥18 years diagnosed with concomitant hypertension and dyslipidemia and having ‘active’ status (patients with one or more visit(s) to the physician) were selected. Identification of cases with concomitant hypertension and dyslipidemia was based on the combination of information. Patients were classified as having hypertension if they met any of the following three criteria: (1) diagnosis of hypertension; or (2) or at least 1 elevated BP (≥140mmHg systolic or ≥90mmHg diastolic for patients not having any CVD, renal disease or diabetes and ≥130mmHg systolic or ≥80mmHg diastolic for patients with heart disease, renal disease or diabetes) followed by 1 antihypertensive prescription; or (3) at least 2 consecutive (1-3 months interval) elevated BP measurements. Patients were classified as having dyslipidemia if they met any of the following three criteria: (1) diagnosis of dyslipidemia; or (2) at least 1 prescription of antilipemic drug; or (3) at least 1 elevated fasting LDL-C level (LDL-C level evaluated based on the CHD risk factors, discussed in detail in therapeutic goal attainment {refer Table 7}). In addition, hypertension or dyslipidemia cases were confirmed if they had at least one more of the above mentioned diagnosis criteria post-index date (defined on page 48) (hypertension or dyslipidemia). International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes were used for diagnosis of hypertension (ICD-9: 401.xx) and dyslipidemia (ICD-9: 272.0, 272.1, 272.2, 272.4). Patients having both hypertension and dyslipidemia were then selected. The study cohort included patients with BMI reported at index date, at least 1 elevated LDL-C and BP measurement reported within 2 years prior to or at index date,
and at least 1 elevated LDL-C and BP measurement reported between 3 and 24 months post-index. Figure 6 represents the selection criteria for study cohort.
Figure 6: Selection criteria for study cohort.

Patient population in EMR database (N = 166,795)

Cases with ‘active’ status (N = 155,843)

Patients with hypertension (N= 30,549)

Patients with dyslipidemia (N = 25,255)

Patients with concomitant hypertension and dyslipidemia (N = 19,200)

Patients with age ≥18 years at index date were selected (N = 19,190)

Patients with BMI reported at index date (N = 18,376)

Patients with at least 1 LDL and BP measurements reported ≤24 months of index date (N = 14,447)

Patients with elevated LDL and BP measurement at index (N = 11,572)

Patients with at least 1 LDL and BP measurements reported between 3 months and 24 months post-index (N = 9,086)

BMI: Body mass index; BP: Blood pressure; EMR: electronic medical records; LDL: Low-density lipoprotein
Index date

For longitudinal measurement, the index date was identified. Hypertension index date was defined as the date at which any one of the above mentioned hypertension diagnosis criteria occurred at an earlier date. Similarly, dyslipidemia index date was defined as the date at which any one of the above mentioned dyslipidemia diagnosis criteria occurred at an earlier date. For concomitant hypertension and dyslipidemia, latter of the two cohort dates (hypertension or dyslipidemia) index was used. The latter date helps in identifying patients with diagnosis of both conditions. The overall description of index date is shown in Figure 7.
Figure 7: Index date for concomitant hypertension and dyslipidemia.

**HTN index date:** Date at which any one of the 3 HTN diagnosis criteria (diagnosis of HTN, at least 2 consecutive elevated BP reading or 1 elevated BP followed by 1 anti-HTN medication) occurred earlier for each patient

**DYS index date:** Date at which any one of the 3 DYS diagnosis criteria (diagnosis of DYS, at least 1 elevated LDL or at least 1 antilipemic medication) occurred earlier for each patient

**Concomitant HTN and DYS index date:** Latter of the two (HTN or DYS) index dates

BP: Blood pressure; DYS: Dyslipidemia; HTN: Hypertension; LDL: Low-density lipoprotein
Data extraction

The data is available in Microsoft SQL server 2005 management studio express. The data files exist as tables containing information for patient demographics, clinical diagnoses, prescribed medications, procedures, and laboratory test results. The data were extracted using Microsoft SQL. Specific tables and columns were identified and linked using unique ID. The related information in one table column was linked to information in another table column using Person ID (PID) as the primary key. PID is a unique identification for each person or contact in the PERSON table. The PID is used in most of the tables and is used to identify the information related to a specific person. Figure 8 represents some of the tables containing related information that were linked using PID.

Selection criteria were used to extract only the required information. Besides PID, other IDs in EMR database that were used include PVID (for each healthcare provider), HDID (heading ID for identifying information related to patient observations, laboratory results, etc.), and MID (medication ID for identifying information for specific medication). The required data were exported in Microsoft Excel (Excel). For statistical analyses, the data in Excel were imported into Statistical Package for Social Sciences (SPSS version 20.0).
Figure 8: Representation of linking pattern for tables in database.

PID: Person ID; it used to link all tables containing information related to each patient. Other IDs such as ApptID (appointment ID), MID (medication ID), INSID (insurance ID), OBSID (observation ID), order ID, PRID (Problem ID) are used to link tables with related information. For example, to have more information regarding insurance company, we can use INSID to link it to the table containing required information.
Study Variables

*Patient-related variables*

Patient-related variables included age, gender, race, marital status, insurance type, and area of residence. Information was obtained from PERSON table (contains demographic information). All of these variables were recorded at baseline.

*Age at index date*

It was calculated from the date of birth of each patient. The index date was used as a reference for calculating age. Age was categorized as: 18-44 years, 45-55 years, 56-64 years, 65-74 years, and ≥75 years.

*Gender*

The gender variable was used as the indicator of sex.

*Race*

For the purpose of analysis, the variable race was categorized as Caucasians, African-Americans, other minority classes, and undetermined (race was not reported).

*Marital status*

In the EMR database, marital status is categorized as married, single, divorced, widowed, separated, and others. For the purpose of analysis, marital status was grouped into four categories: married, single, divorced/widowed/separated, and undetermined (marital status was not reported).
Primary payer

EMR data contains information for type of insurance for each patient. This variable was categorized into five categories: Medicare, Medicaid, private insurance, self-pay, and other.

Area of residence

The EMR contains information on patient location which includes zip codes, city, and state. Using this available information, patient location was categorized into different counties. Further, counties were grouped into two categories: urban and rural. This urban/rural classification was used as the indicator of patient location.

Clinical variables

Clinical variables included BMI, co-morbidities, smoking status, diastolic and systolic BP, hypertension stage, LDL-C levels, HDL-C levels, total cholesterol levels, and triglyceride levels. Information on co-morbidities was obtained from PROBLEM table (contains information on diseases along with ICD-9-CM codes). Physical examination and laboratory results were obtained from OBS table. BMI, co-morbidities, and smoking status were assessed at baseline. BP and lipid levels were assessed both at baseline and follow-up for the purpose of evaluating therapeutic goal attainment.

BMI

To evaluate the effect of obesity on BP and lipid goal attainment, patients with concomitant hypertension and dyslipidemia were categorized into three cohorts based on
the patient’s BMI (calculated as weight (kg)/[height (m)]²): ≤24.9 kg/m² (includes both underweight and normal-weight individuals), 25.0-29.9 kg/m² (overweight), and ≥30.0 kg/m² (obese)\(^1\).

**Smoking status**

Cigarette smoking is one of the CHD risk factors. This variable consists of three categories: non-smoker, former smoker, and current smoker.

**Co-morbidities**

Presence of cardiovascular co-morbidities affects both BP and lipid levels as well as therapeutic goal attainment. Co-morbidities were identified based on the ICD-9-CM codes and are shown in Table 4. The type of co-morbidity and the number of co-morbidities were analyzed. For the purpose of analysis, the number of comorbidities were grouped into four categories: 0, 1, 2, ≥3 co-morbidities.
<table>
<thead>
<tr>
<th>Co-morbid conditions</th>
<th>ICD-9-CM codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes mellitus (Type II)</td>
<td>250.xx</td>
</tr>
<tr>
<td>Heart failure</td>
<td>428.xx</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>410.xx, 411.0x, 411.8x, 412.xx</td>
</tr>
<tr>
<td>Angina pectoris</td>
<td>411.1x, 413.xx</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>440.xx, 441.4x, 441.9x, 443.xx, 444.xx</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>414.0x, 414.8x, 414.9x, 429.2x</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>430.xx-434.xx, 435.9x, 436.xx-438.xx</td>
</tr>
<tr>
<td>Kidney disease</td>
<td>403.xx, 585.xx</td>
</tr>
</tbody>
</table>
Hypertension- and dyslipidemia-related variables

For baseline measurements, the lipid (LDL-C, HDL-C, total cholesterol, and triglyceride), and BP (both systolic and diastolic) measurements 2 years prior to or at index date were selected. If a patient had more than one measurement, then the measurements closest to index date were included for analysis. For post-index period, the lipid and BP measurements between 3-24 months of post-index were selected. If a patient had more than one measurement, then their last lipid or BP measurement during the evaluation period was included for analysis. The selection of baseline and post-index BP and lipid measurements are shown in Figure 9.
Figure 9: Selection of baseline and post-index BP and lipid measurements.

**BP:** Blood pressure

**Index date**
(Diagnosis of concomitant hypertension & dyslipidemia)

**Baseline:** BP or lipid value closest to index

**Post-index:** Last BP or lipid value during follow-up period
Based on the JNC 7 guidelines, diastolic and systolic BP measurements are grouped into four categories, collectively referred as hypertension stage as shown in Table 5.\textsuperscript{17} The patients included in study had elevated BP, thus for purpose of analysis only three categories were used: prehypertension, stage 1 hypertension, and stage 2 hypertension.

Similarly, based on the NCEP ATP III guidelines, lipid (LDL-C, HDL-C, total cholesterol, and triglyceride) measurements are also grouped into different categories as shown in Table 6.\textsuperscript{18} For the purpose of analysis LDL-C was grouped into three categories: Near optimal/above optimal (100-129 mg/dL), borderline high (130-159 mg/dL), and high/very high (≥160 mg/dL). HDL-C was grouped into two categories: low (<40 mg/dL) and high (≥40 mg/dL); total cholesterol categories included optimum (<200 mg/dL), borderline high (200-239 mg/dL), and high (≥240 mg/dL); triglyceride categories included optimum (<150 mg/dL), borderline high (150-199 mg/dL), and high (≥200 mg/dL).
<table>
<thead>
<tr>
<th>SBP (mmHg)</th>
<th>DBP (mmHg)</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 120</td>
<td>and &lt; 80</td>
<td>Normal</td>
</tr>
<tr>
<td>120-139</td>
<td>or 80-89</td>
<td>Prehypertension</td>
</tr>
<tr>
<td>140-159</td>
<td>or 90-99</td>
<td>Stage 1 hypertension</td>
</tr>
<tr>
<td>≥ 160</td>
<td>or ≥ 100</td>
<td>Stage 2 hypertension</td>
</tr>
</tbody>
</table>

DBP: Diastolic blood pressure; SBP: Systolic blood pressure
Table 6: Classification of LDL-C, HDL-C, total cholesterol, and triglyceride levels

<table>
<thead>
<tr>
<th>Lipid level (mg/dL)</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LDL cholesterol</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;100</td>
<td>Optimal (Desirable)</td>
</tr>
<tr>
<td>100-129</td>
<td>Near optimal/above optimal</td>
</tr>
<tr>
<td>130-159</td>
<td>Borderline high</td>
</tr>
<tr>
<td>160-189</td>
<td>High</td>
</tr>
<tr>
<td>≥190</td>
<td>Very high</td>
</tr>
<tr>
<td><strong>Serum HDL cholesterol</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;40</td>
<td>Low</td>
</tr>
<tr>
<td>≥40</td>
<td>High (Desirable)</td>
</tr>
<tr>
<td><strong>Total cholesterol</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;200</td>
<td>Normal (Desirable)</td>
</tr>
<tr>
<td>200-239</td>
<td>Borderline high</td>
</tr>
<tr>
<td>≥240</td>
<td>High</td>
</tr>
<tr>
<td><strong>Serum triglyceride level</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;150</td>
<td>Normal (Desirable)</td>
</tr>
<tr>
<td>150-199</td>
<td>Borderline-high</td>
</tr>
<tr>
<td>200-499</td>
<td>High triglycerides</td>
</tr>
<tr>
<td>≥500</td>
<td>Very high triglycerides</td>
</tr>
</tbody>
</table>

HDL: High-density lipoprotein; LDL: Low-density lipoprotein
**Therapeutic goal attainment**

Therapeutic goal attainment is the outcome variable and comprises of three different aspects: (1) inadequate attainment of BP goals; (2) inadequate attainment of lipid goals; (3) inadequate attainment of both BP and LDL-C goals.

BP goals were evaluated based on JNC 7 guidelines and were defined as either systolic/diastolic BP $<$140/90 mm Hg or $<$130/80 for patients with diabetes or chronic kidney disease.\(^\text{17}\)

Lipid goals were evaluated based on NCEP ATP III guidelines. LDL-C is considered the primary target for evaluating lipid goals. Table 7 shows the required LDL-C goals based on presence or absence of CHD and other clinical forms of atherosclerotic disease, and the CHD risk factors. CHD risk factors include hypertension, family history of CHD, HDL-C $<$40 mg/dL, cigarette smoking, age ($\geq$45 for men, $\geq$55 for women).\(^\text{18}\)

For other lipid levels (non-LDL-C), patients were considered at goal if they achieved post-index HDL-C $\geq$40 mg/dL, total cholesterol $<$200 mg/dL and triglycerides $<$150 (Refer Table 6).
Table 7: LDL-C goal classification

<table>
<thead>
<tr>
<th>LDL-C goal</th>
<th>CHD risk factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100 mg/dL</td>
<td>Presence of CHD or CHD risk equivalent (diabetes, peripheral arterial disease, abdominal aortic aneurysm, and symptomatic carotid artery disease)</td>
</tr>
<tr>
<td>&lt;130 mg/dL</td>
<td>≥ 2 CHD risk factors</td>
</tr>
<tr>
<td>&lt;160 mg/dL</td>
<td>0-1 CHD risk factor</td>
</tr>
</tbody>
</table>

CHD: Coronary heart disease
**Medication-related variables**

The medication-related information was obtained from MEDICATE table of the GE Centricity EMR database. These variables were assessed at both baseline and follow-up.

**Antihypertensive medications**

According to the JNC 7 guidelines, the commonly used antihypertensives medication classes include beta-blockers (BBs), alpha blockers, alpha and beta blockers, calcium channel blockers (CCBs), thiazide diuretics, other diuretics (potassium-sparing and loop diuretics), angiotensin-converting enzyme inhibitors (ACEIs), angiotensin II receptor blockers (ARBs), other antihypertensives (centrally acting and vasodilators). Combination drugs include ACEIs and CCBs, ACEIs and diuretics, ARBs and diuretics, BBs and diuretics, and diuretic and diuretic.\(^{17}\)

**Antilipemic medications**

According to the NCEP ATP III guidelines, the recommended antilipemic medication classes include statins, fibrates, bile acid sequestrants, and nicotinic acid.\(^{18}\)

**Medication prescribing pattern**

The medication prescribing pattern includes antihypertensive and antilipemic medication class and number of medications used in patients with concomitant hypertension and dyslipidemia stratified by BMI.
Antihypertensive medication prescribing pattern was determined by first-line antihypertensive drug class and number of prescribed medications during the baseline and follow-up period. The medication prescribing pattern was also analyzed for complicated and uncomplicated hypertension based on the presence of co-morbidities (diabetes, CVD, and renal disease). Complicated hypertension defined as stage 1 or stage 2 hypertension without co-morbidities and uncomplicated hypertension is defined as presence of co-morbidities in patients with elevated BP. It is based on the JNC 7 guidelines as shown in Table 8. For the purpose of analysis, for both uncomplicated and complicated hypertension, number of medications prescribed was analyzed.

Antilipemic medication prescribing pattern was based on type of medication class and number of medications used. NCEP ATP III guidelines recommend use of statins, nicotinic acid, fibrates or bile acid sequestrant. Moreover, medication prescribed pattern was separately analyzed for patients with high/or very high cardiovascular risk (patients having at least two risk factors or co-morbidities such as diabetes and CVD).
<table>
<thead>
<tr>
<th>Indication</th>
<th>Medication therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No compelling indication</strong></td>
<td></td>
</tr>
<tr>
<td>Stage 1 hypertension</td>
<td>Thiazide-type diuretics. May consider ACEI, ARB, BB, CCB, or combination.</td>
</tr>
<tr>
<td>Stage 2 hypertension</td>
<td>Two-drug combination for most (usually thiazide type diuretic and ACEI, or ARB, or BB, or CCB)</td>
</tr>
<tr>
<td><strong>Compelling indications</strong></td>
<td></td>
</tr>
<tr>
<td>Heart failure</td>
<td>≥2 drugs, ACEIs or BBs or ARBs or aldosterone blockers in combination with diuretics</td>
</tr>
<tr>
<td>Stable angina pectoris</td>
<td>≥2 drugs, BBs or CCBs</td>
</tr>
<tr>
<td>Unstable angina</td>
<td>≥2 drugs, BBs or ACEIs</td>
</tr>
<tr>
<td>Post-myocardial infarction</td>
<td>≥2 drugs, ACEIs or BBs or aldosterone antagonists</td>
</tr>
<tr>
<td>Diabetes</td>
<td>Combinations of ≥ 2 drugs with thiazide-type diuretics, BBs, ACEIs, ARBs, and CCBs</td>
</tr>
<tr>
<td>Chronic kidney disease</td>
<td>≥3 drugs, ACEIs or ARBs in a combination with diuretics or BBs</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>≥2 drugs, Combination of an ACEI and thiazide-type diuretic</td>
</tr>
</tbody>
</table>

ACEI: Angiotensin-converting enzyme inhibitor; ARB: Angiotensin II receptor blocker; BB: Beta-blocker; CCB: Calcium channel blocker
Statistical analysis

Microsoft SQL and Statistical Package for Social Sciences (SPSS version 20.0) were used for analytical purposes. Most of the variables as discussed in this section were measured on categorical scale. However, age, systolic and diastolic BP, LDL-C, HDL-C, triglyceride, and total cholesterol levels were also evaluated on continuous scale for purpose of statistical analysis. All analyses were evaluated at \( a \ priori \ p < 0.05 \). The data were prescreened for missing values and required assumptions were evaluated for univariate and multivariate statistical techniques used for analyses.

Objective 1: To examine distribution of patient-related and clinical factors in patients with concomitant hypertension and dyslipidemia stratified by body mass index.

For purpose of analysis, patients were classified into three cohorts based on their BMI: normal-weight, overweight, and obese individuals. Descriptive analyses were conducted to assess the baseline patient-related and clinical factors among normal-weight, overweight, and obese individuals and were compared using two-way contingency analysis for categorical variables and one-way ANOVA for continuous variables. Distribution of post-index BP and lipid measurements were also compared among three cohorts using one-way ANOVA.
Objective 2: To examine variation in BP and lipid goal attainment in patients with concomitant hypertension and dyslipidemia stratified by body mass index.

Descriptive analyses were conducted to assess the BP and/or lipid goal attainment among normal-weight, overweight, and obese individuals and were compared using two-way contingency analysis for categorical variables.

Objective 3: To examine variations in antihypertensive and antilipemic medication utilization pattern based on JNC 7 and NCEP ATP III guidelines, respectively in patients with concomitant hypertension and dyslipidemia stratified by body mass index.

Descriptive analyses were conducted to assess treatment pattern (antihypertensive or antilipemic medication class used and number of medications) among normal-weight, overweight and obese individuals and were compared using two-way contingency analysis.

Objective 4: To examine predictors of BP or/and lipid goal attainment in patients with concomitant hypertension and dyslipidemia.

Statistical analysis techniques, such as one-way ANOVA and two-way contingency analysis, do not adjust for confounding variables. Thus, multivariate analyses using logistic regression were conducted to evaluate effect of BMI on goal attainment while controlling for all other patient-related, clinical, and medication-related variables. For the purpose of analyses, dummy variables (a binary indicator that explains the absence or presence of a categorical effect) for each category were created for variables with more than two categories. The standard logistic regression was used in
which all the selected variables were entered into the multivariate logistic regression model simultaneously to evaluate association of BMI with inadequate goal attainment, while controlling for all other factors. In addition, the association of other factors with inadequate goal attainment was also evaluated in patients with concomitant hypertension and dyslipidemia. The significant predictors were then entered into stepwise regression model using Forward LR method to evaluate the contribution of these predictors.
CHAPTER FOUR

RESULTS

Obesity is highly prevalent in US population and is an independent risk factor for high BP, high blood cholesterol, type 2 diabetes, and CHD.\textsuperscript{1,2} Presence of multiple risk factors (hypertension and dyslipidemia) in obese patients negatively affects therapeutic (BP and lipid) goal attainment, thereby increasing cardiovascular risk. Thus, the overall objective of this study was to evaluate variations in therapeutic (BP and lipid) goal attainment and medication utilization pattern in obese versus non-obese patients having concomitant hypertension and dyslipidemia. In this chapter, results for the study objectives are presented.

Objective 1: To examine distribution of patient-related and clinical factors in patients with concomitant hypertension and dyslipidemia stratified by body mass index.

Patients with concomitant hypertension and dyslipidemia were classified into three cohorts based on their BMI: normal weight ($\leq$24.9 kg/m\textsuperscript{2}), overweight (25.0-29.9 kg/m\textsuperscript{2}), and obese ($\geq$30.0 kg/m\textsuperscript{2}) individuals. Using descriptive analyses, frequencies were reported for categorical variables and mean was reported for continuous variables. Moreover, these three cohorts were compared using two-way contingency table analysis for categorical variables and one-way ANOVA for continuous variables. Patient variables included age, gender, race, marital status, primary payer, and patient location. Clinical variables included cardiovascular conditions, smoking status, DBP, SBP,
hypertension stage, cardiovascular risk, LDL-C, HDL-C, total cholesterol, and triglyceride. For BP and lipid measurements, distributions of both baseline and post-index measurements were compared among three cohorts using one-way ANOVA.

**Patient-related variables**

In total population with concomitant hypertension and dyslipidemia (N = 9,086), 0.6% had a BMI ≤18.49 (underweight), 13.2% had BMI 18.5-24.9 kg/m² (normal-weight), 33% had BMI 25.0-29.9 kg/m² (overweight), 28.6% had BMI 30.0-34.9 kg/m² (moderately obese), 13.6% had BMI 35.0-39.9 kg/m² (severely obese), and 10.4% had BMI ≥40.0 kg/m² (very severely obese). For the purpose of analysis, patients were classified into three groups: normal weight (≤24.9 kg/m²), overweight (25.0-29.9 kg/m²), and obese (≥30.0 kg/m²). For the total population, mean age was 60.03±13.21 years with a mean BMI of 31.46±7.04 kg/m². For each BMI category, the mean BMI was 22.66±2.12 kg/m² (normal-weight), 27.65±1.41 kg/m² (overweight), 36.21±6.30 kg/m² (obese). Patients who had normal-weight were older (70.16±12.49 years) compared to patients who were overweight (mean age: 65.22±12.80 years) or obese (mean age: 60.03±12.68 years).

A two-way contingency table analysis (Table 9) indicated that age, gender, race, marital status, and primary payer showed significant \(P<0.05\) variation across BMI whereas patient location did not vary significantly across BMI. For total population, most of the patients were in the age group of 56-64 years (24.6%) followed by 65-74 years (23.4%), ≥75 years (22.7%), and 45-55 years (21.3%) compared to age group 18-44 years (7.9%). For each of the age groups, most of the patients were either overweight or
obese, except for age group ≥ 75 years of age (43.2%) who were more likely to have normal weight. The total population included more females (51.9%) compared to males (48.1%). Males were more likely to be overweight (50.9%) or obese (50.0%) compared to females who were more likely to have normal-weight (66.2%). Race was reported for about 89% of population and majority comprised of Caucasians (76.9%). Similarly, marital status was reported for about 34.8% of the population and majority of them were married (34.8%). Regarding primary payer, most of the patients were having private insurance (60.5%) followed by Medicare (27.9%). Patients who were obese (64.8%) were more likely to have private insurance versus patients who were normal-weight (49.1%) or overweight (58.5%) and patients who were normal-weight were more likely to have Medicare (38.6%) versus patients who were overweight (31.6%) and obese (22.7%). Majority of the patients were residing in urban areas (62.3%) compared to those residing in rural areas (37.7%). The significant difference in patient location based on BMI was not observed.
Table 9: Distribution of bio-demographic characteristics by BMI<sup>a</sup> (N = 9,086)

<table>
<thead>
<tr>
<th>Variables</th>
<th>All patients (N = 9,086)&lt;sup&gt;b&lt;/sup&gt;</th>
<th>≤24.9 kg/m&lt;sup&gt;2&lt;/sup&gt; (N = 1,256)&lt;sup&gt;b&lt;/sup&gt;</th>
<th>25.0-29.9 kg/m&lt;sup&gt;2&lt;/sup&gt; (N = 3,058)&lt;sup&gt;b&lt;/sup&gt;</th>
<th>≥30.0 kg/m&lt;sup&gt;2&lt;/sup&gt; (N = 4,772)&lt;sup&gt;b&lt;/sup&gt;</th>
<th>P value&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>18-44</td>
<td>718 (7.9%)</td>
<td>34 (2.7%)</td>
<td>170 (5.6%)</td>
<td>514 (10.8%)</td>
<td></td>
</tr>
<tr>
<td>45-55</td>
<td>1936 (21.3%)</td>
<td>147 (11.7%)</td>
<td>531 (17.4%)</td>
<td>1258 (26.4%)</td>
<td></td>
</tr>
<tr>
<td>56-64</td>
<td>2235 (24.6%)</td>
<td>227 (18.1%)</td>
<td>717 (23.4%)</td>
<td>1291 (27.1%)</td>
<td></td>
</tr>
<tr>
<td>65-74</td>
<td>2130 (23.4%)</td>
<td>306 (24.4%)</td>
<td>814 (26.6%)</td>
<td>1010 (21.2%)</td>
<td></td>
</tr>
<tr>
<td>≥75</td>
<td>2067 (22.7%)</td>
<td>542 (43.2%)</td>
<td>826 (27.0%)</td>
<td>699 (14.6%)</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Male</td>
<td>4367 (48.1%)</td>
<td>424 (33.8%)</td>
<td>1556 (50.9%)</td>
<td>2387 (50.0%)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>4719 (51.9%)</td>
<td>832 (66.2%)</td>
<td>1502 (49.1%)</td>
<td>2385 (50.0%)</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.019</td>
</tr>
<tr>
<td>Caucasians</td>
<td>6977 (76.9%)</td>
<td>947 (75.5%)</td>
<td>2337 (76.5%)</td>
<td>3693 (77.5%)</td>
<td></td>
</tr>
<tr>
<td>African-Americans</td>
<td>15 (0.2%)</td>
<td>5 (0.4%)</td>
<td>6 (0.2%)</td>
<td>4 (0.1%)</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>172 (1.9%)</td>
<td>17 (1.4%)</td>
<td>51 (1.7%)</td>
<td>104 (2.2%)</td>
<td></td>
</tr>
<tr>
<td>Undetermined</td>
<td>1909 (21.0%)</td>
<td>285 (22.7%)</td>
<td>659 (21.6%)</td>
<td>965 (20.2%)</td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>3160 (34.8%)</td>
<td>363 (28.9%)</td>
<td>1031 (33.7%)</td>
<td>1766 (37.0%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Divorced/Widowed/ Separated</td>
<td>786 (8.7%)</td>
<td>157 (12.5%)</td>
<td>253 (8.3%)</td>
<td>376 (7.9%)</td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>528 (5.8%)</td>
<td>70 (5.6%)</td>
<td>146 (4.8%)</td>
<td>312 (6.5%)</td>
<td></td>
</tr>
<tr>
<td>Undetermined</td>
<td>4612 (50.8%)</td>
<td>666 (53.0%)</td>
<td>1628 (53.2%)</td>
<td>2318 (48.6%)</td>
<td></td>
</tr>
<tr>
<td>Primary payer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicare</td>
<td>2536 (27.9%)</td>
<td>485 (38.6%)</td>
<td>967 (31.6%)</td>
<td>1084 (22.7%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Medicaid</td>
<td>385 (4.2%)</td>
<td>46 (3.7%)</td>
<td>93 (3.0%)</td>
<td>246 (5.2%)</td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>5500 (60.5%)</td>
<td>617 (49.1%)</td>
<td>1789 (58.5%)</td>
<td>3094 (64.8%)</td>
<td></td>
</tr>
<tr>
<td>Self-pay</td>
<td>576 (6.3%)</td>
<td>90 (7.2%)</td>
<td>184 (6.0%)</td>
<td>302 (6.3%)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>89 (1.0%)</td>
<td>18 (1.4%)</td>
<td>25 (0.8%)</td>
<td>46 (1.0%)</td>
<td></td>
</tr>
<tr>
<td>Patient location</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.077</td>
</tr>
<tr>
<td>Urban</td>
<td>5657 (62.3%)</td>
<td>810 (64.5%)</td>
<td>1923 (62.9%)</td>
<td>2924 (61.3%)</td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>3429 (37.7%)</td>
<td>446 (35.5%)</td>
<td>1135 (37.1%)</td>
<td>1848 (38.7%)</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Two-way contingency analysis was utilized for analysis.  
<sup>b</sup>Column percentages are reported unless otherwise specified. Data is presented as N (%).  
<sup>c</sup>Significance tested at P<0.05
Clinical variables

A two-way contingency table analysis (Table 10) indicated that presence of some cardiovascular conditions such as diabetes, CAD, peripheral vascular disease, and cerebrovascular disease showed significant ($P<0.05$) variation across BMI, whereas other cardiovascular conditions such as heart failure, myocardial infarction, angina pectoris, and kidney disease did not show any significant variation across BMI. Other clinical factors that showed significant ($P<0.05$) variation across BMI categories included number of cardiovascular conditions, smoking status, and cardiovascular risk. Hypertension stage did not show significant variation across BMI.

Each cardiovascular condition was grouped into two categories: cardiovascular condition present and cardiovascular condition absent. For the total population, most patients (37.3%) had diabetes. Among cardiovascular conditions significantly associated with BMI, diabetes rates were higher among obese patients (47.4%) compared to patients who had either normal-weight (21.7%) or overweight (27.9%). However, rates of CAD were higher among normal-weight patients (19.7%) versus overweight (19.0%) and obese (16.0%) patients. Similarly, the rates of peripheral vascular disease were also higher among normal-weight patients (12.8%) versus overweight (9.5%) or obese (7.2%) patients and the rates of cerebrovascular disease were higher among normal-weight patients (16.4%) compared to overweight (12.4%) or obese (8.9%) patients.

For the total population, majority of the patients (42.8%) had no cardiovascular condition followed by patients with one cardiovascular condition (35.8%). Majority of overweight patients (46.5%) did not have any CV condition followed by patients who had
normal-weight (46.5%) compared to obese patients (38.4%). Majority of the obese patients had one (39.7%) or two (14.4%) CV conditions when compared to normal-weight or overweight patients. Cardiovascular risk was categorized based on the CV conditions and CV risk factors. Majority of the patients had high CV risk (57.2%) followed by intermediate risk (38.2%). Majority of the obese patients were in high risk category (61.6%) compared to normal-weight (53.5%) or overweight (51.8%) patients. For high risk category, most of the patients were overweight (44.0%) followed by normal-weight (43.6%) versus obese patients (33.1%). For hypertension stage, most of the patients were in prehypertension category (54.3%) followed by stage 1 (35.3%) and stage 2 (10.4%). However, no differences were observed across BMI for each hypertension stage. Most of the patients were non-smokers (54.6%) and significant variations were also observed for each category of smoking status across BMI. For non-smoker category, most of the patients had normal-weight (56.2%) compared to overweight (54.6%) and obese (5.1%) patients. Similarly, for current smoker category, most of the patients had normal-weight (14.3%) compared to overweight (10.7%) and obese (11.5%) patients. However, for former-smoker category, most of the patients were obese (34.4%) or overweight (34.7%) compared to patients with normal-weight (29.5%).
Table 10: Distribution of clinical characteristics by BMI\textsuperscript{a} (N = 9,086)

<table>
<thead>
<tr>
<th>Variables</th>
<th>All patients (N = 9,086\textsuperscript{b})</th>
<th>(\leq 24.9) kg/m(^2) (N = 1,256\textsuperscript{b})</th>
<th>25.0-29.9 kg/m(^2) (N = 3,058\textsuperscript{b})</th>
<th>(\geq 30.0) kg/m(^2) (N = 4,772\textsuperscript{b})</th>
<th>(P) value\textsuperscript{d}</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV conditions (present)\textsuperscript{c}</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>3387 (37.3%)</td>
<td>273 (21.7%)</td>
<td>853 (27.9%)</td>
<td>2261 (47.4%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Heart failure</td>
<td>440 (4.8%)</td>
<td>65 (5.2%)</td>
<td>132 (4.3%)</td>
<td>243 (5.1%)</td>
<td>0.249</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>275 (3.0%)</td>
<td>45 (3.6%)</td>
<td>101 (3.3%)</td>
<td>129 (2.7%)</td>
<td>0.148</td>
</tr>
<tr>
<td>Angina pectoris</td>
<td>132 (1.5%)</td>
<td>26 (2.1%)</td>
<td>34 (1.1%)</td>
<td>72 (1.5%)</td>
<td>0.052</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>1593 (17.5%)</td>
<td>248 (19.7%)</td>
<td>582 (19.0%)</td>
<td>763 (16.0%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>795 (8.7%)</td>
<td>161 (12.8%)</td>
<td>290 (9.5%)</td>
<td>344 (7.2%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>1011 (11.1%)</td>
<td>206 (16.4%)</td>
<td>380 (12.4%)</td>
<td>425 (8.9%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Kidney disease</td>
<td>477 (5.2%)</td>
<td>69 (5.5%)</td>
<td>163 (5.3%)</td>
<td>245 (5.1%)</td>
<td>0.853</td>
</tr>
<tr>
<td>(No.\ of CV conditions)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>3889 (42.8%)</td>
<td>584 (46.5%)</td>
<td>1474 (48.2%)</td>
<td>1831 (38.4%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>1</td>
<td>3249 (35.8%)</td>
<td>402 (32.0%)</td>
<td>954 (31.2%)</td>
<td>1893 (39.7%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1245 (13.7%)</td>
<td>162 (12.9%)</td>
<td>396 (12.9%)</td>
<td>687 (14.4%)</td>
<td></td>
</tr>
<tr>
<td>(\geq 3)</td>
<td>703 (7.7%)</td>
<td>108 (8.6%)</td>
<td>234 (7.7%)</td>
<td>361 (7.6%)</td>
<td></td>
</tr>
</tbody>
</table>

Cardiovascular risk

| Hypertension stage         |                                               |                                                 |                                                 |                                                 | 0.671            |
| Prehypertension            | 4931 (54.3\%)                                | 688 (54.8\%)                                   | 1643 (53.7\%)                                   | 2600 (54.5\%)                                   |                  |
| Stage 1                    | 3210 (35.3\%)                                | 437 (34.8\%)                                   | 1110 (36.3\%)                                   | 663 (34.8\%)                                     |                  |
| Stage 2                    | 945 (10.4\%)                                 | 131 (10.4\%)                                   | 305 (10.0\%)                                    | 509 (10.7\%)                                     |                  |

Smoking status

| Smoking status             |                                               |                                                 |                                                 |                                                 | 0.001            |
| Non-smoker                | 4704 (54.6\%)                                | 662 (56.2\%)                                   | 1571 (54.6\%)                                   | 2471 (54.1\%)                                   |                  |
| Current                   | 1001 (11.6\%)                                | 169 (14.3\%)                                   | 309 (10.7\%)                                    | 523 (11.5\%)                                     |                  |
| Former-smoker             | 2917 (33.8\%)                                | 347 (29.5\%)                                   | 998 (34.7\%)                                    | 1572 (34.4\%)                                    |                  |

\textsuperscript{a}Two-way contingency analysis was utilized for analysis.
\textsuperscript{b}Column percentages are reported unless otherwise specified. Data presented as N (%).
\textsuperscript{c}N (%) represents percentage of patients having above mentioned CV conditions. Comparison group is absence of CV condition.
\textsuperscript{d}Significance tested at \(P<0.05\)
One-way ANOVA (Table 11) indicated that DBP, LDL-C, HDL-C, total cholesterol, and triglyceride measurements both at baseline and post-index showed significant ($P<0.05$) variation across BMI. Systolic blood pressure did not show significant variation across BMI.

On average, the total population with concomitant hypertension and dyslipidemia did not have optimum BP (mean SBP = 138.80 ± 30.09 mm Hg and mean DBP = 84.49 ± 29.33 mm Hg) and lipid levels (mean LDL-C = 142.94 ± 29.51 mg/dL, mean total cholesterol = 217.23 ± 40.15 mg/dL, and mean triglyceride = 174.61 ± 104.79 mg/dL) at baseline. However, on average, patients had optimum HDL-C levels (50.90 ± 14.14 mg/dL). Mean DBP was higher for patients who were obese ($M = 84.34$, $SD = 33.30$ mm Hg). Regarding lipid levels, mean LDL-C (mg/dL) was higher for patients who were overweight ($M = 144.80$, $SD = 30.63$). Mean triglyceride levels were higher ($M = 188.47$, $SD = 113.41$ mg/dL) and mean HDL-C was lower ($M = 47.86$, $SD = 12.44$ mg/dL) for patients who were obese. Interestingly, mean total cholesterol was higher for normal-weight patients ($M = 220.30$, $SD = 37.82$ mg/dL).

On average, the total population did not have optimum BP (mean SBP = 134.79 ± 25.59 mmHg and mean DBP = 81.25 ± 14.27 mmHg) and lipid levels (mean LDL-C = 123.20 ± 31.69 mg/dL, mean total cholesterol = 202.66 ± 38.31 mg/dL, and mean triglyceride = 163.58 ± 87.50 mg/dL) at post-index. However, on average, patients had optimum HDL-C levels (50.50 ± 14.28 mg/dL). Mean DBP was higher for patients who were obese ($M = 82.22$, $SD = 14.31$ mm Hg). Mean triglyceride levels were higher ($M = 176.24$, $SD = 91.82$ mg/dL) and mean HDL-C was lower ($M = 47.34$, $SD = 12.53$ mg/dL) for patients who were obese. Interestingly, mean LDL-C ($M = 125.04$, $SD =$
31.31mg/dL) and mean total cholesterol ($M = 208.41, SD = 37.53$ mg/dL) was higher for patients with normal-weight.
Table 11: Distribution of baseline and post-index BP and lipid levels by BMI\(^a\) (N = 9,086)

<table>
<thead>
<tr>
<th>Variables</th>
<th>All patients (N = 9,086)(^b)</th>
<th>≤24.9 kg/m(^2) (N = 1,256)(^b)</th>
<th>25.0-29.9 kg/m(^2) (N = 3,058)(^b)</th>
<th>≥30.0 kg/m(^2) (N = 4,772)(^b)</th>
<th>P value(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP (mm Hg)</td>
<td>138.80 ± 30.09</td>
<td>138.78 ± 13.81</td>
<td>138.60 ± 12.60</td>
<td>138.94 ± 39.65</td>
<td>0.889</td>
</tr>
<tr>
<td>DBP (mm Hg)</td>
<td>84.49 ± 29.33</td>
<td>82.19 ± 25.02</td>
<td>84.34 ± 33.30</td>
<td>85.19 ± 27.59</td>
<td>0.005</td>
</tr>
<tr>
<td>LDL-C (mg/dL)</td>
<td>142.94 ± 29.51</td>
<td>143.48 ± 28.69</td>
<td>144.80 ± 30.63</td>
<td>141.62 ± 28.93</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HDL-C (mg/dL)</td>
<td>50.90 ± 14.14</td>
<td>59.76 ± 16.80</td>
<td>52.08 ± 13.78</td>
<td>47.86 ± 12.44</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total cholesterol (mg/dL)</td>
<td>217.23 ± 40.15</td>
<td>220.30 ± 37.82</td>
<td>218.45 ± 39.89</td>
<td>215.64 ± 40.83</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Triglyceride (mg/dL)</td>
<td>174.61 ± 104.79</td>
<td>140.19 ± 76.94</td>
<td>166.79 ± 96.15</td>
<td>188.47 ± 113.41</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Post-index</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP (mm Hg)</td>
<td>134.79 ± 25.59</td>
<td>134.26 ± 13.1</td>
<td>134.64 ± 11.91</td>
<td>135.02 ± 33.33</td>
<td>0.601</td>
</tr>
<tr>
<td>DBP (mm Hg)</td>
<td>81.25 ± 14.27</td>
<td>78.50 ± 13.08</td>
<td>80.87 ± 14.52</td>
<td>82.22 ± 14.31</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LDL-C (mg/dL)</td>
<td>123.20 ± 31.69</td>
<td>125.04 ± 31.31</td>
<td>123.76 ± 32.15</td>
<td>122.35 ± 31.47</td>
<td>0.013</td>
</tr>
<tr>
<td>HDL-C (mg/dL)</td>
<td>50.50 ± 14.28</td>
<td>59.76 ± 17.14</td>
<td>51.68 ± 13.75</td>
<td>47.34 ± 12.53</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total cholesterol (mg/dL)</td>
<td>202.66 ± 38.31</td>
<td>208.41 ± 37.53</td>
<td>203.45 ± 38.67</td>
<td>200.65 ± 38.11</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Triglyceride (mg/dL)</td>
<td>163.58 ± 87.50</td>
<td>133.58 ± 74.15</td>
<td>155.84 ± 81.49</td>
<td>176.24 ± 91.82</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

DBP: Diastolic blood pressure; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol; SBP: Systolic blood pressure

\(^a\) One-way ANOVA was utilized for analyses

\(^b\) Results are presented as Mean ± SD

\(^c\) Significance tested at P<0.05
Objective 2: To examine variations in BP and lipid goal attainment in patients with concomitant hypertension and dyslipidemia stratified by BMI.

For BP and LDL-C, patients were classified into two categories: those at goal (BP or LDL-C) and not at goal (BP or LDL-C). These goals were based on the JNC 7 and the NCEP ATP III guidelines. Using descriptive analyses, frequencies were reported for categorical variables across the three BMI categories and the cohorts were compared using two-way contingency table analysis. In addition to the evaluation of variations in attainment of post-index LDL-C goals, variations in other lipids (HDL-C, total cholesterol, and triglycerides) were evaluated across the three BMI categories.

Variations in BP goal attainment by BMI

Two-way contingency table analysis (Figure 10) indicated a significant difference ($P<0.001$) in BP goal attainment across BMI. Overall, 15% of patients attained BP goals and 85% did not attain BP goals. Among patients who attained BP goals, higher proportion of patients had normal-weight (19.6%) followed by those who were overweight (16.1%) or obese (13.2%). Among patients who did no attain BP goals, higher proportion of patients were obese (86.8%) followed by those who were overweight (83.9%) or normal-weight (80.4%). Clearly, BP goal attainment was lower among patients who were obese.
Figure 10: Variations in BP goal attainment by body mass index\textsuperscript{a} (N = 9,086).

\textsuperscript{a}Two-way contingency analysis was utilized for analysis.
Significance tested at $P<$0.05.
Variations in LDL-C goal attainment by BMI

Two-way contingency table analysis (Figure 1) indicated a significant difference ($P<0.05$) in LDL-C goal attainment across BMI. Overall, 26% of patients attained LDL-C goals and 74% did not attain LDL-C goals. Among patients who attained LDL-C goals, higher proportion of patients were overweight (27.6%) followed by normal-weight (26.0%) and obese (25.0%). Among patients who did not attain LDL-C goals, higher proportion of patients were obese (75.0%) followed by normal-weight (74.0%) and overweight (72.4%) patients. Similar to results seen in BP control, LDL-C goal attainment was lower among obese patients.
Figure 11: Variations in LDL-C goal attainment by body mass index\textsuperscript{a} (N = 9,086).

\[ P = 0.038 \]

LDL-C: Low-density lipoprotein cholesterol

\textsuperscript{a}Two-way contingency analysis was utilized for analysis.

Significance tested at \( P<0.05 \).
Variations in combined BP and LDL-C goals by BMI

Two-way contingency table analysis (Figure 12) indicated a significant difference ($P<0.001$) in combined BP and LDL-C goal attainment across BMI. Overall, most of the patients (64.1%) did not attain combined BP and LDL-C goals compared to 33.1% of patients who attained either one or both of these goals. Among patients, who did not attain combined BP and LDL-C goals, most of them were obese (66.3%) compared to normal-weight (60.4%) or overweight (62.0%). For patients attaining one or both of these goals, most of them had normal-weight (39.6%) followed by overweight (38.0%) compared to obese patients (33.7%). Again, higher proportions of patients who were obese were not at combined BP and LDL-C goals.
Figure 12: Variations in combined BP and LDL-C goals by body mass index\textsuperscript{a} (N = 9,086).

\textsuperscript{a}Two-way contingency analysis was utilized for analysis. Significance tested at $P<0.05$. $P<0.001$

BP: Blood pressure; LDL-C: Low-density lipoprotein cholesterol
Variations in HDL-C levels by BMI

Two-way contingency table analysis (Figure 13) indicated a significant difference ($P<0.05$) in HDL-C levels across BMI. As per the NCEP ATP III guidelines, HDL-C levels $\geq 40$ mg/dL are considered desirable. Overall, 75.7% of patients had HDL-C $< 40$ mg/dL and 24.3% had HDL-C $\geq 40$ mg/dL. Among patients who had HDL-C $< 40$ mg/dL, higher proportion of patients were obese (77.1%) followed by overweight (74.0%) and normal-weight (66.0%). Among patients who had HDL-C $\geq 40$ mg/dL, higher proportion of patients had normal-weight (34.0%) followed by overweight (26.0%) and obese (22.9%) patients. Thus, higher proportion of patients who were obese had less than the desirable HDL-C levels.
Figure 13: Variations in HDL-C levels by body mass index (N = 1,852).

HDL-C: High density lipoprotein cholesterol

*Two-way contingency analysis was utilized for analysis.
Significance tested at $P<0.05$. $P = 0.026$
Variations in total cholesterol levels by BMI

Two-way contingency table analysis (Figure 14) indicated a significant difference ($P<0.001$) in total cholesterol levels across BMI. As per the NCEP ATP III guidelines, total cholesterol levels $< 200$ mg/dL are considered desirable. Overall, 33.7% of patients had total cholesterol levels $< 200$ mg/dL and 66.3% had total cholesterol levels $\geq 200$ mg/dL. Among patients with total cholesterol levels $< 200$ mg/dL, higher proportion of patients were obese (36.2%) followed by overweight (33.1%) and normal-weight (26.2%) patients. Among patients with total cholesterol levels $\geq 200$ mg/dL, higher proportion of patients were normal-weight (73.8%) followed by overweight (66.9%) and obese (63.8%) patients. Interestingly, higher proportion of obese patients had desirable total cholesterol levels compared to patients who had normal-weight or were overweight.
Figure 14: Variations in total cholesterol levels by body mass index\textsuperscript{a} (N = 4,852).

\textsuperscript{a}Two-way contingency analysis was utilized for analysis. Significance tested at $P<0.05$. 

\[ P < 0.001 \]
Variations in triglyceride levels by BMI

Two-way contingency table analysis (Figure 15) indicated a significant difference ($P<0.001$) in triglyceride levels across BMI. According to the NCEP ATP III guideline, triglyceride levels $< 150$ mg/dL are considered desirable. Overall, 25.4% of patients had triglyceride levels $< 150$ mg/dL and 74.6% had triglyceride levels $\geq 150$ mg/dL. Among patients with triglyceride levels $< 150$ mg/dL, higher proportion of patients had normal-weight (35.2%) followed by overweight (28.6%) and obese (22.3%) patients. Among patients with triglyceride levels $\geq 150$ mg/dL, higher proportion of patients were obese (77.7%) followed by overweight (71.4%) and normal-weight (64.8%) patients. Thus, higher proportion of patients who were obese did not have desirable triglyceride levels.
Figure 15: Variations in triglyceride levels by body mass index\textsuperscript{a} (N = 4,267).

\textsuperscript{a}Two-way contingency analysis was utilized for analysis. Significance tested at $P<0.05$. 

$P<0.001$
Objective 3: To examine variations in hypertension and dyslipidemia medication utilization pattern based on JNC 7 and NCEP ATP III guidelines, respectively in patients with concomitant hypertension and dyslipidemia stratified by BMI.

Using descriptive analyses, frequencies were reported for categorical variables across the three BMI categories and the cohorts were compared using two-way contingency table analysis. Medication utilization pattern comprises of type of medication (antihypertensive or antilipemic), medication class, and number of medications. Medication prescribing pattern for anti-hypertensive and antilipemic medication was evaluated for both baseline and follow-up.

Variation in antihypertensive and/or antilipemic medications use at baseline and during follow-up by BMI

Two-way contingency table analysis (Figure 16) indicated that there was a significant \( P<0.05 \) relationship between medication type (antihypertensive or antilipemic) and BMI at baseline as well as during follow-up. Regarding medication prescribing pattern at baseline and during follow-up, 36.1% and 30.1% of total population was prescribed both antihypertensive and antilipemic medications; 37.2% and 30.2% were prescribed only antihypertensives; 9.1% and 15.7% were prescribed only antilipemics; and 17.6% and 24.1% were not prescribed any medication. Patients who were obese were more likely to be prescribed both antihypertensive and antilipemic; baseline (37.3%) as well as during follow-up (31.6%). In addition, patients who were obese had less likelihood of not being prescribed any medication; baseline (16.8%) and follow-up (22.8%). However, patients who had normal-weight were more likely to be
prescribed only antihypertensive medication both at baseline (39.4%) and follow-up (32.8%). Patients who were overweight were more likely to be prescribed only antilipemic medication both at baseline (10.1%) and follow-up (16.8%).

Variations in total number of medications (combining both antihypertensive and antilipemic) at baseline and during follow-up by BMI

Two-way contingency table analysis (Figure 17) indicated that there was a significant \( P<0.05 \) relationship between total number of medications (combining both antihypertensive and antilipemic) and BMI at baseline. Most of the patients were prescribed one medication both at baseline (26.2%) and during follow-up (31.5%). Patients who were obese were less likely to be not prescribed any medication; baseline (16.8%) and follow-up (22.8%). However, patients who were obese were more likely to be prescribed at least four medications; baseline (19.7%) and follow-up (11.1%). For patients who were prescribed one, two or three medications, a different pattern was observed at baseline and during follow-up across BMI. At baseline, patients with normal-weight (28.3%) were more likely to be prescribed one medication whereas during follow-up, patients who were overweight (32.5%) were more likely to be prescribed one medication. At baseline, patients who were overweight were more likely to be prescribed two (23.6%) or three (16.0%) medications. However, during follow-up, obese patients were more likely to be prescribed two (22.4%) or three (12.7%) medications.
Figure 16: Variations in medication type (antihypertensive or antilipemic) at baseline and post-index by body mass index\(^a\) (N = 9,086).

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Post-index</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AH+AL</strong></td>
<td>All patients: 36.1</td>
<td>All patients: 30.0</td>
</tr>
<tr>
<td></td>
<td>Normal: 31.8</td>
<td>Normal: 27.8</td>
</tr>
<tr>
<td><strong>AH (only)</strong></td>
<td>All patients: 37.3</td>
<td>All patients: 31.6</td>
</tr>
<tr>
<td></td>
<td>Normal: 37.2</td>
<td>Normal: 32.8</td>
</tr>
<tr>
<td><strong>AL (only)</strong></td>
<td>All patients: 39.4</td>
<td>All patients: 30.2</td>
</tr>
<tr>
<td></td>
<td>Normal: 35.7</td>
<td>Normal: 29.6</td>
</tr>
<tr>
<td><strong>No AH+AL</strong></td>
<td>All patients: 37.6</td>
<td>All patients: 29.9</td>
</tr>
<tr>
<td></td>
<td>Normal: 37.6</td>
<td>Normal: 29.9</td>
</tr>
</tbody>
</table>

AH: Antihypertensives; AL: Antilipemics

\(^a\)Two-way contingency analysis was utilized for analysis. Significance tested at \(P<0.05\).
Figure 17: Variations in total number of medications (combining both antihypertensive and antilipemic) at baseline by BMI\textsuperscript{a} (N = 9,086).

Baseline

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
BMI & All patients & Normal \\ \hline
0 & 17.6 & 19.2 \\ 1 & 16.8 & 18.1 \\ 2 & 26.2 & 28.3 \\ 3 & 26.4 & 26.5 \\ 4 & 23.0 & 21.9 \\ \hline
\end{tabular}
\end{table}

Baseline: \(P = 0.001\)

Post-index

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
BMI & All patients & Normal \\ \hline
0 & 24.1 & 26.9 \\ 1 & 25.0 & 26.9 \\ 2 & 31.5 & 30.5 \\ 3 & 32.5 & 31.0 \\ 4 & 21.1 & 22.4 \\ \hline
\end{tabular}
\end{table}

Post-index: \(P = 0.004\)

AH: Antihypertensives; AL: Antilipemics
\textsuperscript{a}Two-way contingency analysis was utilized for analysis. Significance tested at \(P<0.05\).
Variations in antihypertensive medication utilization at baseline and during follow-up by BMI

Two-way contingency table analysis (Table 12 and Table 13) was conducted to evaluate baseline antihypertensive medication prescribing pattern across three BMI categories. The baseline medication-related factors that showed significant variation ($P<0.05$) across BMI included antihypertensive medication class such as ACEI, thiazide diuretics, and other diuretics, combination therapy (ACEIs and diuretics), and number of medications. The follow-up medication-related factors that showed significant ($P<0.05$) variation across BMI included antihypertensive medication class such as ACEI, CCB, and other diuretics. Among total population, most patients were prescribed ACEI both at baseline (30.0%) and during follow-up (23.4%) followed by BBs (baseline, 29.0% and follow-up, 18.5%).

ACEIs were more likely to be prescribed to patients who were obese; baseline (32.1%) and during follow-up (25.3%). At baseline, thiazide diuretics were significantly more likely to be prescribed to patients who were obese (17.8%), but during follow-up, no significant difference was observed across BMI. At baseline, ACEI-diuretic combination was significantly more likely to be prescribed to patients who were overweight (5.5%), but no significant difference was observed across BMI.

At baseline, most patients (36.1%) were prescribed one antihypertensive medication followed by 26.7% who were not prescribed any medication. However, during follow-up, most patients were not prescribed any medication (39.8%). Patients who were obese were significantly less likely to be not prescribed any medication (25.1%), but significantly were more likely to be prescribed at least four medications
(11.4%) at baseline. However, during follow-up, no significant difference regarding number of medications was observed across BMI.
Table 12: Variations in antihypertensive medication utilization at baseline by BMI\textsuperscript{a} (N = 9,086)

<table>
<thead>
<tr>
<th>Variables</th>
<th>All patients (N = 9,086)\textsuperscript{c}</th>
<th>≤24.9 kg/m\textsuperscript{2} (N = 1,256)\textsuperscript{c}</th>
<th>25.0-29.9 kg/m\textsuperscript{2} (N = 3,058)\textsuperscript{c}</th>
<th>≥30.0 kg/m\textsuperscript{2} (N = 4,772)\textsuperscript{c}</th>
<th>(P) value\textsuperscript{b}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medication class-Monotherapy (Prescribed)\textsuperscript{d}</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACEI</td>
<td>2726 (30.0%)</td>
<td>342 (27.2%)</td>
<td>851 (27.8%)</td>
<td>1533 (32.1%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ARB</td>
<td>1150 (12.7%)</td>
<td>152 (12.1%)</td>
<td>368 (12.0%)</td>
<td>630 (13.2%)</td>
<td>0.258</td>
</tr>
<tr>
<td>BB</td>
<td>2636 (29.0%)</td>
<td>375 (29.9%)</td>
<td>904 (29.6%)</td>
<td>1357 (28.4%)</td>
<td>0.438</td>
</tr>
<tr>
<td>CCB</td>
<td>1861 (20.5%)</td>
<td>283 (22.5%)</td>
<td>602 (19.7%)</td>
<td>976 (20.5%)</td>
<td>0.321</td>
</tr>
<tr>
<td>Combined alpha- &amp; BBs</td>
<td>271 (3.0%)</td>
<td>37 (2.9%)</td>
<td>86 (2.8%)</td>
<td>148 (3.1%)</td>
<td>0.761</td>
</tr>
<tr>
<td>Alpha 1 blockers</td>
<td>472 (5.2%)</td>
<td>48 (3.8%)</td>
<td>166 (5.4%)</td>
<td>258 (5.4%)</td>
<td>0.061</td>
</tr>
<tr>
<td>Thiazide diuretics</td>
<td>1519 (16.7%)</td>
<td>181 (14.4%)</td>
<td>490 (16.0%)</td>
<td>848 (17.8%)</td>
<td>0.008</td>
</tr>
<tr>
<td>Other diuretics</td>
<td>839 (9.2%)</td>
<td>100 (8.0%)</td>
<td>189 (6.2%)</td>
<td>550 (11.5%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Other antihypertensives</td>
<td>578 (6.4%)</td>
<td>80 (6.4%)</td>
<td>176 (5.8%)</td>
<td>322 (6.7%)</td>
<td>0.214</td>
</tr>
<tr>
<td>Medication class-Combination therapy (Prescribed)\textsuperscript{d}</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACEIs and CCBs</td>
<td>313 (3.4%)</td>
<td>45 (3.6%)</td>
<td>94 (3.1%)</td>
<td>174 (3.6%)</td>
<td>0.383</td>
</tr>
<tr>
<td>ACEIs and diuretics</td>
<td>439 (4.8%)</td>
<td>39 (3.1%)</td>
<td>138 (5.5%)</td>
<td>229 (4.8%)</td>
<td>0.001</td>
</tr>
<tr>
<td>ARBs and diuretics</td>
<td>742 (8.2%)</td>
<td>89 (7.1%)</td>
<td>254 (8.3%)</td>
<td>399 (8.4%)</td>
<td>0.320</td>
</tr>
<tr>
<td>BBs and diuretics</td>
<td>102 (1.1%)</td>
<td>14 (1.1%)</td>
<td>32 (1.0%)</td>
<td>56 (1.2%)</td>
<td>0.873</td>
</tr>
<tr>
<td>Diuretic and diuretic</td>
<td>466 (5.1%)</td>
<td>58 (4.6%)</td>
<td>161 (5.3%)</td>
<td>247 (5.2%)</td>
<td>0.666</td>
</tr>
<tr>
<td>No. of medications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.002</td>
</tr>
<tr>
<td>0</td>
<td>2424 (26.7%)</td>
<td>362 (28.8%)</td>
<td>862 (28.2%)</td>
<td>1200 (25.1%)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2777 (30.6%)</td>
<td>385 (30.7%)</td>
<td>953 (31.2%)</td>
<td>1439 (30.2%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1893 (20.8%)</td>
<td>247 (19.7%)</td>
<td>628 (20.5%)</td>
<td>1018 (21.3%)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1057 (11.6%)</td>
<td>148 (11.8%)</td>
<td>339 (11.1%)</td>
<td>570 (11.9%)</td>
<td></td>
</tr>
<tr>
<td>≥4</td>
<td>935 (10.3%)</td>
<td>114 (9.1%)</td>
<td>276 (9.0%)</td>
<td>545 (11.4%)</td>
<td></td>
</tr>
</tbody>
</table>

ACEI: Angiotensin-converting enzyme inhibitor, ARB: Angiotensin II receptor blocker; BB: Beta blocker; CCB: Calcium channel blocker
Combination therapy: Fixed-dose combination of antihypertensive medications
\textsuperscript{a}Two-way contingency analysis was utilized; \textsuperscript{b}Significance tested at \(P<0.05\)
\textsuperscript{c}Column percentages are reported unless otherwise specified. Data presented as N (%).
\textsuperscript{d}N (%) represents percentage of patients prescribed above mentioned antihypertensives. Comparison group is the above mentioned specific antihypertensive not prescribed.
Table 13: Variations in antihypertensive medication utilization at follow-up by BMI\(^a\) (N = 9,086)

<table>
<thead>
<tr>
<th>Variables</th>
<th>All patients (N = 9,086)(^c)</th>
<th>≤24.9 kg/m(^2) (N = 1,256)(^c)</th>
<th>25.0-29.9 kg/m(^2) (N = 3,058)(^d)</th>
<th>≥30.0 kg/m(^2) (N = 4,772)(^d)</th>
<th>(P) value(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medication class-Monotherapy (Prescribed)(^a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACEI</td>
<td>2126 (23.4%)</td>
<td>277 (22.1%)</td>
<td>644 (21.1%)</td>
<td>1205 (25.3%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ARB</td>
<td>844 (9.3%)</td>
<td>98 (7.8%)</td>
<td>301 (9.8%)</td>
<td>445 (9.3%)</td>
<td>0.110</td>
</tr>
<tr>
<td>BB</td>
<td>1678 (18.5%)</td>
<td>251 (20.0%)</td>
<td>571 (18.7%)</td>
<td>856 (17.9%)</td>
<td>0.235</td>
</tr>
<tr>
<td>CCB</td>
<td>1268 (14.0%)</td>
<td>204 (16.2%)</td>
<td>425 (13.9%)</td>
<td>639 (13.4%)</td>
<td>0.034</td>
</tr>
<tr>
<td>Combined alpha- &amp; BBs</td>
<td>303 (3.3%)</td>
<td>37 (2.9%)</td>
<td>94 (3.1%)</td>
<td>172 (3.6%)</td>
<td>0.315</td>
</tr>
<tr>
<td>Alpha 1 blockers</td>
<td>349 (3.8%)</td>
<td>47 (3.7%)</td>
<td>111 (3.6%)</td>
<td>191 (4.0%)</td>
<td>0.691</td>
</tr>
<tr>
<td>Thiazide diuretics</td>
<td>1016 (11.2%)</td>
<td>129 (10.3%)</td>
<td>337 (11.0%)</td>
<td>550 (11.5%)</td>
<td>0.428</td>
</tr>
<tr>
<td>Other diuretics</td>
<td>712 (7.8%)</td>
<td>90 (7.2%)</td>
<td>183 (6.0%)</td>
<td>439 (9.2%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Other antihypertensives</td>
<td>465 (5.1%)</td>
<td>64 (5.1%)</td>
<td>152 (5.0%)</td>
<td>249 (5.2%)</td>
<td>0.889</td>
</tr>
<tr>
<td>Medication class-Combination therapy (Prescribed)(^a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACEIs and CCBs</td>
<td>197 (2.2%)</td>
<td>32 (2.5%)</td>
<td>61 (2.0%)</td>
<td>104 (2.2%)</td>
<td>0.525</td>
</tr>
<tr>
<td>ACEIs and diuretics</td>
<td>422 (4.6%)</td>
<td>45 (3.6%)</td>
<td>141 (4.6%)</td>
<td>236 (4.9%)</td>
<td>0.124</td>
</tr>
<tr>
<td>ARBs and diuretics</td>
<td>485 (5.3%)</td>
<td>68 (5.4%)</td>
<td>162 (5.3%)</td>
<td>255 (5.3%)</td>
<td>0.988</td>
</tr>
<tr>
<td>BBs and diuretics</td>
<td>62 (0.7%)</td>
<td>9 (0.7%)</td>
<td>22 (0.7%)</td>
<td>31 (0.6%)</td>
<td>0.924</td>
</tr>
<tr>
<td>Diuretic and diuretic</td>
<td>206 (2.3%)</td>
<td>36 (2.9%)</td>
<td>68 (2.2%)</td>
<td>102 (2.1%)</td>
<td>0.298</td>
</tr>
<tr>
<td>No. of medications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.110</td>
</tr>
<tr>
<td>0</td>
<td>3615 (39.8%)</td>
<td>500 (39.8%)</td>
<td>1278 (41.8%)</td>
<td>1837 (38.5%)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2806 (30.9%)</td>
<td>397 (31.6%)</td>
<td>940 (30.7%)</td>
<td>1469 (30.8%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1470 (16.2%)</td>
<td>201 (16.0%)</td>
<td>455 (14.9%)</td>
<td>814 (17.1%)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>702 (7.7%)</td>
<td>91 (7.2%)</td>
<td>224 (7.3%)</td>
<td>387 (8.1%)</td>
<td></td>
</tr>
<tr>
<td>4+</td>
<td>493 (5.4%)</td>
<td>67 (5.3%)</td>
<td>161 (5.3%)</td>
<td>265 (5.6%)</td>
<td></td>
</tr>
</tbody>
</table>

ACEI: Angiotensin-converting enzyme inhibitor, ARB: Angiotensin II receptor blocker; BB: Beta blocker; CCB: Calcium channel blocker
Combination therapy: Fixed-dose combination of antihypertensive medications
\(^a\)Two-way contingency analysis was utilized; \(^b\)Significance tested at \(P<0.05\)
\(^c\)Column percentages are reported unless otherwise specified. Data presented as N (%).
\(^d\)N (%) represents percentage of patients prescribed above mentioned antihypertensives. Comparison group is the above mentioned specific antihypertensive not prescribed.
Two-way contingency table analysis (Table 14 and Table 15) was conducted to evaluate baseline antilipemic medication prescribing pattern across the three BMI categories. At baseline and during follow-up, significant difference ($P<0.05$) was observed for the antilipemic medication class such as statins and fibrates as well as number of medications across BMI. Overall, most patients were prescribed statins both at baseline (39.6%) and during follow-up (42.4%). At baseline, patients who were overweight were more likely to be prescribed statins (41.3%) whereas during follow-up, patients who were obese were more likely to be prescribed statins (43.6%). Patients who were obese were more likely to be prescribed fibrates both at baseline (6.2%) and during follow-up (4.3%).

Regarding number of antilipemic medications, most patients were not prescribed any antilipemic medication both at baseline (54.7%) and follow-up (54.3%) followed by one medication (baseline, 40.8% and follow-up, 42.2%). Patients with normal-weight were more likely to be not prescribed any antilipemic medication both at baseline (58.6%) and follow-up (54.3%). Patients who were overweight (41.5%) or obese (41.0%) were more likely to be prescribed one medications at baseline. However, during follow-up, patients who were obese (43.5%) were more likely to be prescribed one medication. In addition, patients who were overweight (baseline, 4.8% and follow-up, 3.7%) or obese (baseline, 4.7% and follow-up, 3.8%) were more likely to be prescribed at least two medications.
Table 14: Variations in antilipemic medication utilization at baseline by BMI\(^a\) (N = 9,086)

<table>
<thead>
<tr>
<th>Variables</th>
<th>All patients (N = 9,086)(^b)</th>
<th>≤24.9 kg/m(^2) (N = 1,256)(^c)</th>
<th>25.0-29.9 kg/m(^2) (N = 3,058)(^c)</th>
<th>≥30.0 kg/m(^2) (N = 4,772)(^c)</th>
<th>(P) value(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medication class (Prescribed)(^d)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statins</td>
<td>3602 (39.6%)</td>
<td>454 (36.1%)</td>
<td>1262 (41.3%)</td>
<td>1886 (39.5%)</td>
<td>0.007</td>
</tr>
<tr>
<td>Fibrates</td>
<td>473 (5.2%)</td>
<td>31 (2.5%)</td>
<td>148 (4.8%)</td>
<td>294 (6.2%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Nicotinic acid</td>
<td>348 (3.8%)</td>
<td>59 (4.7%)</td>
<td>119 (3.9%)</td>
<td>170 (3.6%)</td>
<td>0.172</td>
</tr>
<tr>
<td>Bile acid sequestrants</td>
<td>121 (1.3%)</td>
<td>20 (1.6%)</td>
<td>40 (1.3%)</td>
<td>61 (1.3%)</td>
<td>0.682</td>
</tr>
<tr>
<td><strong>No. of medications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.020</td>
</tr>
<tr>
<td>0</td>
<td>4974 (54.7%)</td>
<td>736 (58.6%)</td>
<td>1644 (53.8%)</td>
<td>2594 (54.4%)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3703 (40.8%)</td>
<td>479 (38.1%)</td>
<td>1268 (41.5%)</td>
<td>1956 (41.0%)</td>
<td></td>
</tr>
<tr>
<td>≥2</td>
<td>409 (4.5%)</td>
<td>41 (3.3%)</td>
<td>146 (4.8%)</td>
<td>222 (4.7%)</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Two-way contingency analysis was utilized; \(^b\)Significance tested at \(P<0.05\)
\(^c\)Column percentages are reported unless otherwise specified. Data presented as N (%).
\(^d\)N (%) represents percentage of patients prescribed above mentioned antilipemic. Comparison group is the above mentioned specific antilipemic not prescribed.
Table 15: Variations in antilipemic medication utilization during follow-up by BMI\textsuperscript{a} (N = 9,086)

<table>
<thead>
<tr>
<th>Variables</th>
<th>All patients (N = 9,086)\textsuperscript{c}</th>
<th>≤24.9 kg/m\textsuperscript{2} (N = 1,256)\textsuperscript{c}</th>
<th>25.0-29.9 kg/m\textsuperscript{2} (N = 3,058)\textsuperscript{c}</th>
<th>≥30.0 kg/m\textsuperscript{2} (N = 4,772)\textsuperscript{c}</th>
<th>P value\textsuperscript{b}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medication class (Prescribed)\textsuperscript{d}</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statins</td>
<td>3850 (42.4%)</td>
<td>468 (37.3%)</td>
<td>1301 (42.5%)</td>
<td>2081 (43.6%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fibrates</td>
<td>326 (3.6%)</td>
<td>25 (2.0%)</td>
<td>96 (3.1%)</td>
<td>205 (4.3%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Nicotinic acid</td>
<td>193 (2.1%)</td>
<td>23 (1.8%)</td>
<td>70 (2.3%)</td>
<td>100 (92.1%)</td>
<td>0.626</td>
</tr>
<tr>
<td>Bile acid sequestrants</td>
<td>121 (1.3%)</td>
<td>22 (1.8%)</td>
<td>39 (1.3%)</td>
<td>60 (1.3%)</td>
<td>0.375</td>
</tr>
<tr>
<td>No. of medications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>0</td>
<td>4934 (54.3%)</td>
<td>750 (59.7%)</td>
<td>1669 (54.6%)</td>
<td>2515 (52.7%)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3832 (42.2%)</td>
<td>477 (38.0%)</td>
<td>1277 (41.8%)</td>
<td>2078 (43.5%)</td>
<td></td>
</tr>
<tr>
<td>≥2</td>
<td>320 (3.5%)</td>
<td>29 (2.3%)</td>
<td>112 (3.7%)</td>
<td>179 (3.8%)</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a}Two-way contingency analysis was utilized; \textsuperscript{b}Significance tested at \textit{P}<0.05
\textsuperscript{c}Column percentages are reported unless otherwise specified. Data presented as N (%).
\textsuperscript{d}N (%) represents percentage of patients prescribed above mentioned antilipemic. Comparison group is the above mentioned specific antilipemic not prescribed.
Variations in antihypertensive medication prescribing pattern in patients with complicated/uncomplicated hypertension stratified by BMI

According to JNC7 guidelines hypertension can be classified into complicated (presence of diabetes and CVD) and uncomplicated hypertension (stage 1 and stage 2). Patients with these conditions are recommended at least two medications for treatment comprising of combination of different antihypertensive medication class. For the purpose of analysis, patients were grouped into three categories based on number of medications: 0, 1 and ≥2. These groups were compared across three BMI categories using two-way contingency table analysis (Figure 18).

For uncomplicated hypertension, there was a significant difference ($P<0.05$) in number of medications prescribed across BMI. Overall, majority of patients (57.5%) were prescribed at least two medications compared to patients who were prescribed one (27.6%) or no (14.7%) medication. Among patients who were prescribed at least two medications, most of them were obese (60.5%) compared to the normal-weight (57.7%) or overweight (53.7%) patients.

For complicated hypertension, there was no significant difference ($P>0.05$) in number of medications prescribed across BMI. However, most of the patients were prescribed at least two medications (67.1%) and included higher proportion of obese patients (68.4%).
Figure 18: Variations in antihypertensive medication prescribing pattern in patients with uncomplicated/complicated hypertension stratified by BMI$^a$.

HTN: Hypertension

Two-way contingency analysis was utilized for analysis.
Significance tested at $P<0.05$. 

$P = 0.010$

$P = 0.193$
Variations in antilipemic medication prescribing pattern in patients with high or very high cardiovascular risk stratified by BMI

NCEP ATP III guidelines recommend use of antilipemic medications in patients with high cardiovascular risk (presence of at least two risk factors) or very high cardiovascular risk (co-morbid conditions such as diabetes or cardiovascular conditions). Two-way contingency table analysis (Figure 19) indicated that there was a significant difference ($P<0.05$) in the patients who were prescribed/not prescribed any antilipemic medications across BMI.

Regarding patients with high cardiovascular risk, majority of them (69.6%) were prescribed medication and 30.4% were not prescribed any medication. Among patients who were prescribed medication, most of them were obese (73.1%) followed by overweight (68.8%) or normal-weight (60.4%) patients. Among patients who were not prescribed any medication, majority of them had normal-weight (39.6%) compared to overweight (31.2%) or obese (26.9%) patients.

Regarding patients with very high cardiovascular risk, majority of them (71.1%) were prescribed medication and 28.9% were not prescribed any medication. Among patients who were prescribed medication, most of them were obese (72.2%) or overweight (72.4%) compared to normal-weight patients (63.2%). Among patients who were not prescribed any medication, most of them had normal-weight (36.8%) compared to overweight (27.6%) or obese (27.8%) patients.
Figure 19: Variations in antilipemic medication prescribing pattern in patients with high cardiovascular risk stratified by BMI.²

Two-way contingency analysis was utilized for analysis. Significance tested at $P<0.05$.

CV: Cardiovascular

²Two-way contingency analysis was utilized for analysis.
Objective 4: To examine predictors of BP or/and lipid goal attainment in patients with concomitant hypertension and dyslipidemia.

Logistic regression was conducted to examine whether BMI was a predictor of BP or/and lipid goal attainment in patients with concomitant hypertension and dyslipidemia. BP and LDL-C are the primary targets for treatment of hypertension and dyslipidemia, respectively. For BP and/or LDL-C, the specific goals for successful treatment of these conditions are provided in JNC7 and NCEP ATP III guidelines, respectively. The outcome variable was goal attainment categorized as “at goal” and “not at goal”. The focus of the study was to determine predictors of inadequate goal attainment, thus “at goal” was used as the reference category. Moreover, other lipids (total cholesterol, triglyceride, and HDL-C) were also evaluated. For these lipids, there are no specific goals in the guidelines, thus the outcome variable was classified into two categories based on the optimum levels of these lipids. The predictor variables included age, gender, primary payer, patient location, BMI, presence/absence of each cardiovascular condition (diabetes, heart failure, myocardial infarction, angina pectoris, CAD, peripheral vascular disease, cerebrovascular disease, and kidney disease), hypertension stage, cardiovascular risk, smoking status, baseline clinical measurements (DBP, SBP, LDL-C, total cholesterol, HDL-C, and triglycerides), and number of antihypertensive medication and number of antilipemic medications used at follow-up.

The standard logistic regression was used in which all the selected variables were entered into the multivariate logistic regression model simultaneously to evaluate association of BMI with inadequate goal attainment, while controlling for all other factors. For assessing the appropriateness, adequacy, and usefulness of the model, test
statistics such as goodness of fit of the model, the Hosmer-Lemeshow test, and Nagelkerke $R^2$ were evaluated (these statistics for these tests are reported under each table). The goodness of fit model includes a test of the full model with all predictors against a constant only model and a statistically significant test ($P<0.05$) indicates that the predictors, as a set, reliably distinguishes between the categories of outcome variable. The goodness of fit of a model is also indicated by the Hosmer-Lemeshow test and non-significant test ($P>0.05$) indicates that the observed values are not significantly different from those predicted by the model and that the overall model fit is good. Nagelkerke $R^2$ indicates the usefulness of the explanatory variables in the model in predicting the response variable and can be referred to as measure of effect size. For each of the predictors included in the model, Wald statistics, odds ratio, $P$ value, and 95% confidence intervals were reported. The significant predictors were then entered into stepwise regression model using Forward LR method to evaluate the contribution of each of these predictors.

*Predictors of inadequate BP goal attainment*

The results of standard logistic regression are presented in Table 16. In multivariate logistic regression analysis, BMI was significantly associated with BP goal attainment in patients with concomitant hypertension and dyslipidemia ($P<0.001$). Increase in BMI increased the likelihood of not attaining BP goal: overweight (OR=1.345, $P=0.003$) and obese (OR=1.562, $P<0.001$) each versus normal-weight patients.
Age was also significantly associated with BP goal attainment ($P=0.001$).

Increase in age was more likely to be associated with not attaining BP goals: 56-64 year old (OR=1.494, $P=0.003$), 65-74 year old (OR=1.433, $P=0.002$), and ≥75 (OR=2.131, $P<0.001$) each versus 18-44 year old. However, no significant difference was observed in age group 45-55 year olds when compared to 18-44 year olds. Females were more likely to be associated with not attaining goals (OR=1.214, $P=0.007$) compared to males.

Increased likelihood of not attaining BP goals was also associated in patients with diabetes (OR=3.803, $P<0.001$) versus those not having diabetes and patients with kidney disease (OR=2.302, $P=0.001$) versus those not having kidney disease. However, patients with CAD (OR=0.702, $P=0.004$) were less likely to have inadequate goal attainment versus patients who did not have CAD. Regarding hypertension stage, patients with stage 1 (OR=1.888, $P<0.001$) and stage 2 hypertension (OR=2.244, $P<0.001$) were more likely to have inadequate BP goals compared with patients with prehypertension and likelihood of not attaining goals increased with higher BP levels. Moreover, BP goals were not attained in patients with high (≥240 mg/dL) total cholesterol levels (OR=1.397, $P=0.006$).

Number of antihypertensive medications used at follow-up were also associated with BP goal attainment. Increase in the number of medications resulted in increased likelihood of not attaining BP goals: one medication (OR=1.495, $P<0.001$), two medications (OR=2.222, $P<0.001$), three medications (OR=2.981, $P<0.001$), and at least four medications (OR=5.410, $P<0.001$) each versus no medication.
Table 16: Multivariate analysis of factors associated with inadequate BP goal attainment\(^a\) (N = 9,086)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wald</th>
<th>Odds ratio</th>
<th>P value(^b)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMI categories</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤24.9 kg/m(^2)</td>
<td>20.094</td>
<td></td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥25.0-29.9 kg/m(^2)</td>
<td>8.984</td>
<td>1.345</td>
<td>.003</td>
<td>1.108 1.632</td>
</tr>
<tr>
<td>≥30.0 kg/m(^2)</td>
<td>19.985</td>
<td>1.562</td>
<td>.000</td>
<td>1.285 1.900</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td>26.887</td>
<td></td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>18-44 Reference</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45-55</td>
<td>1.278</td>
<td>1.149</td>
<td>.258</td>
<td>.903 1.462</td>
</tr>
<tr>
<td>56-64</td>
<td>8.787</td>
<td>1.494</td>
<td>.003</td>
<td>1.146 1.948</td>
</tr>
<tr>
<td>65-74</td>
<td>9.763</td>
<td>1.601</td>
<td>.002</td>
<td>1.192 2.151</td>
</tr>
<tr>
<td>≥75</td>
<td>20.859</td>
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<td>.156   .894 2.013</td>
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</table>

CV: Cardiovascular; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol

<sup>a</sup>Standard logistic regression was utilized.

<sup>b</sup>Significance level: P<0.05

<sup>c</sup>Reference category for each of the CV condition: absence of that specific CV condition.

A test of the full model with all the predictors against a constant only model: $\chi^2 = 845.085$, P<0.001.

Hosmer-Lemeshow test: P = 0.314.

Variance in BP goal attainment (Nagelkerke R square test): 16.9%.

Percentage of cases correctly classified by the model: 84.7%.
Stepwise logistic regression (Table 17) was conducted in which only significant variables ($P<0.05$) entered the model and final step in the model (Step 15) accounted for 16.5% of the variance in BP goal attainment. Presence/absence of diabetes accounted for 7.4% of the variance. Presence/absence of diabetes and hypertension stage 1 together accounted for 9.1% of variance.

The other significant predictors were added in the model in the following sequence: hypertension stage 2, age group ≥75 years, number of antihypertensive medications = 2, number of antihypertensive medications ≥4, number of antihypertensive medications = 3, number of antihypertensive medications = 1, gender (female), presence/absence of kidney disease, age group 56-64 years, presence/absence of CAD, age group 45-55 years, BMI ≥30.0 kg/m$^2$, and BMI 25.0-29.9 kg/m$^2$.

BMI 25.0-29.9 kg/m$^2$ added at Step 14 and BMI ≥30.0 kg/m$^2$ added at Step 15 together with other variables (Presence/absence of diabetes, hypertension stage 1, hypertension stage 2, age group ≥75 years, number of antihypertensive medications = 2, number of antihypertensive medications ≥4, number of antihypertensive medications = 3, number of antihypertensive medications = 1, gender (female), presence/absence of kidney disease, age group 56-64 years, presence/absence of CAD, age group 45-55 years) accounted for 16.5% of variance.
Table 17: Stepwise logistic regression for BP goal attainment

<table>
<thead>
<tr>
<th>Steps</th>
<th>Variables</th>
<th>$R^2$</th>
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<tbody>
<tr>
<td>Step1</td>
<td>DM</td>
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<tr>
<td>Step2</td>
<td>DM; hypertension stage 1</td>
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<td>Step3</td>
<td>DM; hypertension stage 1; hypertension stage 2</td>
<td>0.108</td>
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<tr>
<td>Step4</td>
<td>DM; hypertension stage 1; hypertension stage 2; age $\geq 75$ years</td>
<td>0.119</td>
</tr>
<tr>
<td>Step5</td>
<td>DM; hypertension stage 1; hypertension stage 2; age $\geq 75$ years; number of antihypertensive medications = 2</td>
<td>0.125</td>
</tr>
<tr>
<td>Step6</td>
<td>DM; hypertension stage 1; hypertension stage 2; age $\geq 75$ years; number of antihypertensive medications = 2, $\geq 4$</td>
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<td>Step7</td>
<td>DM; hypertension stage 1; hypertension stage 2; age $\geq 75$ years; number of antihypertensive medications = 2, $\geq 4$, 3</td>
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<td>Step8</td>
<td>DM; hypertension stage 1; hypertension stage 2; age $\geq 75$ years; number of antihypertensive medications = 2, $\geq 4$, 3, 1</td>
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<tr>
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<td>DM; hypertension stage 1; hypertension stage 2; age $\geq 75$ years; number of antihypertensive medications = 2, $\geq 4$, 3, 1; gender</td>
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<tr>
<td>Step13</td>
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<td>Step14</td>
<td>DM; hypertension stage 1; hypertension stage 2; age $\geq 75$ years, 65-74 years, 45-55 years; kidney disease; number of antihypertensive medications = 2, $\geq 4$, 3, 1; gender; CAD; BMI $\geq 30.0$ kg/m$^2$</td>
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</tr>
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<td>Step15</td>
<td>DM; hypertension stage 1; hypertension stage 2; age $\geq 75$ years, 65-74 years, 45-55 years; kidney disease; number of antihypertensive medications = 2, $\geq 4$, 3, 1; gender; CAD; BMI $\geq 30.0$ kg/m$^2$; BMI 25.0-29.9 kg/m$^2$</td>
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</table>

BMI: Body mass index; BP: Blood pressure; DM: Diabetes mellitus; CAD: Coronary artery disease
$R^2$ reported is Nagelkerke R square
Predictors of LDL-C goal attainment

The results of standard logistic regression are presented in Table 18. In multivariate logistic regression analysis, BMI was not a significant predictor of LDL-C goal attainment ($P=0.845$) in patients with concomitant hypertension and dyslipidemia. Regarding gender, females (OR=1.137, $P=0.026$) were more likely to be associated with not attaining LDL-C goals.

Patients with diabetes (OR=1.630, $P<0.001$) were more likely to be associated with not attaining LDL-C goals compared with patients not having diabetes. However, patients with angina pectoris versus not having angina pectoris (OR=0.504, $P=0.001$) and patients with kidney disease versus not having kidney disease (OR=0.655, $P<0.001$) were less likely to be associated with not attaining LDL-C goals. The likelihood of not attaining LDL-C goal increased with increase in cardiovascular risk: patients at intermediate cardiovascular risk (OR=1.885, $P<0.001$) and patients at high cardiovascular risk (OR=3.550, $P<0.001$) each versus patients at low cardiovascular risk.

Regarding baseline clinical measurements, patients with borderline high (OR=1.233, $P=0.017$) or high/very high (OR=1.253, $P=0.047$) LDL-C had increased likelihood of not attaining LDL-C goals. Similarly, patients with borderline high (OR=2.005, $P<0.001$) or high (OR=3.523, $P<0.001$) total cholesterol were more likely to fail to attain LDL-C goals. However, patients with high/very high triglycerides (OR=0.861, $P=0.031$) were less likely to fail to attain LDL-C goals. Patients prescribed one antihypertensive medication had increased likelihood of not attaining BP goals (OR=1.139, $P=0.037$). However, patients prescribed one antilipemic medication were less likely to fail to attain LDL-C goals (OR=0.666, $P<0.001$).
Table 18: Multivariate analysis of factors associated with inadequate LDL-C goal attainment \(^a\) (N = 9,086)

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<tr>
<th>Variables</th>
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<th>Odds ratio</th>
<th>P value$^b$</th>
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<td>No. of antilipemic medications</td>
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<td>.320</td>
<td>.858</td>
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</tbody>
</table>

CV: Cardiovascular; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol
<sup>a</sup>Standard logistic regression was utilized.
<sup>b</sup>Significance level: P<0.05
<sup>c</sup>Reference category for each of the CV condition: absence of that specific CV condition.
A test of the full model with all the predictors against a constant only model: χ² = 554.993, P<0.001.
Hosmer-Lemeshow test: P = 0.055.
Variance in LDL-C goal attainment (Nagelkerke R square test): 11.9%.
Percentage of cases correctly classified by the model: 73.4%.
Stepwise logistic regression (Table 19) was conducted in which only significant variables ($P<0.05$) entered the model and final step in the model (Step 11) accounted for 8.3% of the variance in LDL-C goal attainment. Baseline high total cholesterol accounted for 1.9% of the variance. Baseline total cholesterol and diabetes together accounted for 3.9% of variance.

The other significant predictors were added in the model in the following sequence: borderline high total cholesterol at baseline, number of antilipemic medications = 1, high cardiovascular risk, intermediate cardiovascular risk, kidney disease, angina pectoris, gender, high/very high LDL-C, borderline high LDL-C at baseline.
Table 19: Stepwise logistic regression for LDL-C goal attainment

<table>
<thead>
<tr>
<th>Steps</th>
<th>Variables</th>
<th>R²</th>
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<tbody>
<tr>
<td>Step1</td>
<td><strong>High total cholesterol at baseline</strong></td>
<td>0.019</td>
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<tr>
<td>Step2</td>
<td>High total cholesterol at baseline; <strong>DM</strong></td>
<td>0.039</td>
</tr>
<tr>
<td>Step3</td>
<td>High total cholesterol at baseline; <strong>borderline high total cholesterol at baseline</strong></td>
<td>0.056</td>
</tr>
<tr>
<td>Step4</td>
<td>High total cholesterol at baseline; DM; borderli<strong>e high total cholesterol at baseline; number of antilipemic medications = 1</strong></td>
<td>0.065</td>
</tr>
<tr>
<td>Step5</td>
<td>High total cholesterol at baseline; DM; borderline high total cholesterol at baseline; number of antilipemic medications = 1; <strong>high CV risk</strong></td>
<td>0.072</td>
</tr>
<tr>
<td>Step6</td>
<td>High total cholesterol at baseline; DM; borderline high total cholesterol at baseline; number of antilipemic medications = 1; high CV risk; <strong>intermediate CV risk</strong></td>
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<tr>
<td>Step7</td>
<td>High total cholesterol at baseline; DM; borderline high total cholesterol at baseline; number of antilipemic medications = 1; high CV risk; intermediate CV risk; <strong>KD</strong></td>
<td>0.078</td>
</tr>
<tr>
<td>Step8</td>
<td>High total cholesterol at baseline; DM; borderline high total cholesterol at baseline; number of antilipemic medications = 1; high CV risk; intermediate CV risk; KD; <strong>angina pectoris</strong></td>
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</tr>
<tr>
<td>Step9</td>
<td>High total cholesterol at baseline; DM; borderline high total cholesterol at baseline; number of antilipemic medications = 1; high CV risk; intermediate CV risk; KD; angina pectoris; <strong>gender</strong></td>
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</tr>
<tr>
<td>Step10</td>
<td>High total cholesterol at baseline; DM; borderline high total cholesterol at baseline; number of antilipemic medications = 1; high CV risk; intermediate CV risk; KD; angina pectoris; gender; <strong>high/very high LDL-C at baseline</strong></td>
<td>0.081</td>
</tr>
<tr>
<td>Step11</td>
<td>High total cholesterol at baseline; DM; borderline high total cholesterol at baseline; number of antilipemic medications = 1; high CV risk; intermediate CV risk; KD; angina pectoris; gender; high/very high LDL-C; <strong>borderline high LDL-C at baseline</strong></td>
<td>0.083</td>
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</tbody>
</table>

DM: Diabetes mellitus; CV: cardiovascular risk; KD: Kidney disease; LDL-C: Low-density lipoprotein cholesterol
R² reported is Nagelkerke R square
Predictors of inadequate BP and LDL-C (combined) goal attainment

The results of standard logistic regression are presented in Table 20. In multivariate logistic regression analysis, patients who were obese had increased likelihood of failure to attain dual BP and LDL-C goal (OR=1.193, \( P=0.023 \)). Regarding gender, females (OR=1.197, \( P=0.001 \)) were more likely to be associated with not attaining combined goals.

Patients with diabetes versus not having diabetes (OR=2.241, \( P<0.001 \)) were more likely to be associated with not attaining combined goal whereas patients with angina pectoris versus not having angina pectoris (OR=0.586, \( P=0.008 \)) were less likely to be associated with not attaining combined goals. Patients with stage 1 (OR=1.320, \( P<0.001 \)) and stage 2 hypertension (OR=1.456, \( P<0.001 \)), each versus prehypertension were more likely to be associated with not attaining combined BP and LDL-C goals. Increased cardiovascular risk increased the likelihood of not attaining combined goals: intermediate cardiovascular risk (OR=1.668, \( P<0.001 \)) and high cardiovascular risk (OR=2.718, \( P<0.001 \)) each versus low cardiovascular risk. Patients with borderline high LDL-C were more likely to be associated with not attaining combined BP/LDL-C goals (OR=1.209, \( P=0.019 \)). In addition presence of borderline high total cholesterol (OR=1.676, \( P<0.001 \)) or high/very high total cholesterol (OR=2.765, \( P<0.001 \)) increased the likelihood of not attaining combined goals.

Patients prescribed one antilipemic medication were less likely to be associated with not attaining combined goals (OR=0.720, \( P<0.001 \)) versus patients prescribed no medication. Increased likelihood of not attaining combined goals was associated with increase in number of prescribed antihypertensive medications: one medication
(OR=1.320, \(P<0.001\)), two medications (OR=1.382, \(P<0.001\)), three medications (OR=1.390, \(P=0.001\)), at least four medications (OR=1.415, \(P=0.005\)) each versus no medication.
Table 20: Multivariate analysis of factors associated with inadequate combined BP and LDL-C goal attainment (N = 9,086)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wald</th>
<th>Odds ratio</th>
<th>P value</th>
<th>95% CI</th>
<th>Lower</th>
<th>Upper</th>
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<td>25.0-29.9 kg/m²</td>
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<tr>
<td>Borderline high (130-159 mg/dL)</td>
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Table 20 (Continued)

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<th>Variables</th>
<th>Wald</th>
<th>Odds ratio</th>
<th>P value&lt;sup&gt;b&lt;/sup&gt;</th>
<th>95% CI</th>
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<th>Upper</th>
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<td>3</td>
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</tr>
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<td>Reference</td>
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<td>.969</td>
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</tbody>
</table>

CV: Cardiovascular; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol

<sup>a</sup>Standard logistic regression was utilized.

<sup>b</sup>Significance level: P<0.05

<sup>c</sup>Reference category for each of the CV condition: absence of that specific CV condition.

A test of the full model with all the predictors against a constant only model: $\chi^2 = 773.965, P<0.001$.

Hosmer-Lemeshow test: $P = 0.833$.

Variance in combined BP and LDL-C goal attainment (Nagelkerke R square test): 12.3%.

Percentage of cases correctly classified by the model: 66.3%.
Stepwise logistic regression (Table 21) was conducted in which only significant variables \((P<0.05)\) entered the model and final step in the model (Step 15) accounted for 11.1% of the variance in combined BP and LDL-C goal attainment. Presence/absence of diabetes accounted for 6.3% of the variance. Presence/absence of diabetes and high total cholesterol at baseline accounted for 7.4% of variance.

The other significant predictors were added in the model in the following sequence: borderline high total cholesterol at baseline, number of antilipemic medication = 1, high cardiovascular risk, intermediate cardiovascular risk, hypertension stage 1, hypertension stage 2, gender, number of antihypertensive medications = 1, 2, \(\geq 4\), 3, angina pectoris, and borderline high LDL-C at baseline.
### Table 21: Stepwise logistic regression for combined BP and LDL-C goal attainment

<table>
<thead>
<tr>
<th>Steps</th>
<th>Variables</th>
<th>$R^2$</th>
</tr>
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<tbody>
<tr>
<td>Step1</td>
<td>DM</td>
<td>0.047</td>
</tr>
<tr>
<td>Step2</td>
<td>DM; <strong>high total cholesterol at baseline</strong></td>
<td>0.086</td>
</tr>
<tr>
<td>Step3</td>
<td>DM; high total cholesterol at baseline; <strong>borderline high total cholesterol at baseline</strong></td>
<td>0.094</td>
</tr>
<tr>
<td>Step4</td>
<td>DM; high total cholesterol at baseline; borderline high total cholesterol at baseline; <strong>number of antilipemic medication = 1</strong></td>
<td>0.101</td>
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<tr>
<td>Step5</td>
<td>DM; high total cholesterol at baseline; borderline high total cholesterol at baseline; number of antilipemic medication = 1; <strong>high CV risk</strong></td>
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<tr>
<td>Step6</td>
<td>DM; high total cholesterol at baseline; borderline high total cholesterol at baseline; number of antilipemic medication = 1; high CV risk; <strong>intermediate CV risk</strong></td>
<td>0.120</td>
</tr>
<tr>
<td>Step7</td>
<td>DM; high total cholesterol at baseline; borderline high total cholesterol at baseline; number of antilipemic medication = 1; high CV risk; intermediate CV risk; <strong>hypertension stage 1</strong></td>
<td>0.122</td>
</tr>
<tr>
<td>Step8</td>
<td>DM; high total cholesterol at baseline; borderline high total cholesterol at baseline; number of antilipemic medication = 1; high CV risk; intermediate CV risk; hypertension stage 1; <strong>hypertension stage 2</strong></td>
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</tr>
<tr>
<td>Step9</td>
<td>DM; high total cholesterol at baseline; borderline high total cholesterol at baseline; number of antilipemic medication = 1; high CV risk; intermediate CV risk; hypertension stage 1; hypertension stage 2; <strong>gender</strong></td>
<td>0.126</td>
</tr>
<tr>
<td>Step10</td>
<td>DM; high total cholesterol at baseline; borderline high total cholesterol at baseline; number of antilipemic medication = 1; high CV risk; intermediate CV risk; hypertension stage 1; hypertension stage 2; gender; <strong>number of antihypertensive medications = 2</strong></td>
<td>0.129</td>
</tr>
<tr>
<td>Step11</td>
<td>DM; high total cholesterol at baseline; borderline high total cholesterol at baseline; number of antilipemic medication = 1; high CV risk; intermediate CV risk; hypertension stage 1; hypertension stage 2; gender; <strong>number of antihypertensive medications = 1, 2</strong></td>
<td>0.130</td>
</tr>
<tr>
<td>Step12</td>
<td>DM; high total cholesterol at baseline; borderline high total cholesterol at baseline; number of antilipemic medication = 1; high CV risk; intermediate CV risk; hypertension stage 1; hypertension stage 2; gender; number of antihypertensive medications = 1, 2; <strong>angina pectoris</strong></td>
<td>0.131</td>
</tr>
<tr>
<td>Step13</td>
<td>DM; high total cholesterol at baseline; borderline high total cholesterol at baseline; number of antilipemic medication = 1; high CV risk; intermediate CV risk; hypertension stage 1; hypertension stage 2; gender; number of antihypertensive medications = 1, 2, ≥4; angina pectoris</td>
<td>0.133</td>
</tr>
<tr>
<td>Step14</td>
<td>DM; high total cholesterol at baseline; borderline high total cholesterol at baseline; number of antilipemic medication = 1; high CV risk; intermediate CV risk; hypertension stage 1; hypertension stage 2; gender; number of antihypertensive medications = 1, 2, ≥4, 3; angina pectoris</td>
<td>0.134</td>
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<tr>
<td>Steps</td>
<td>Variables</td>
<td>$R^2$</td>
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<tr>
<td>-------</td>
<td>-----------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Step15</td>
<td>DM; high total cholesterol at baseline; borderline high total cholesterol at baseline;</td>
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</tr>
<tr>
<td></td>
<td>number of antilipemic medication = 1; high CV risk; intermediate CV risk;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>hypertension stage 1; hypertension stage 2; gender; number of antihypertensive medications = 1, 2, ≥4, 3; angina pectoris; <strong>borderline high LDL-C at baseline</strong></td>
<td></td>
</tr>
</tbody>
</table>

DM: Diabetes mellitus; CV: cardiovascular risk; LDL-C: Low-density lipoprotein cholesterol

$R^2$ reported is Nagelkerke R square
Predictors of not attaining optimum total cholesterol levels

The results for standard logistic regression are presented in Table 22. According to NCEP ATP III guidelines, cholesterol level < 200 is defined as optimum total cholesterol level. In multivariate logistic regression analysis, patients who were overweight (OR=0.809, \(P=0.047\)) or obese (OR=0.774, \(P=0.016\)) were less likely to be associated with failure to attain optimum total cholesterol levels. Regarding gender, females (OR=1.547, \(P<0.001\)) were more likely to be associated with not attaining optimum total cholesterol levels.

Presence of diabetes versus absence of diabetes (OR=0.740, \(P=0.008\)) and presence of CAD versus absence of CAD (OR=0.731, \(P=0.007\)) were less likely to be associated with not attaining optimum total cholesterol levels. Regarding baseline clinical measurements, borderline high LDL-C (OR=1.519, \(P<0.001\)) or high/very high LDL-C (OR=1.594, \(P<0.001\)), high total cholesterol (OR=2.349, \(P<0.001\)), and high/very high triglyceride (OR=1.225, \(P=0.015\)) were more likely to be associated with not attaining optimum total cholesterol levels. Interestingly, patients with higher HDL-C levels (desirable) were also more likely to be associated with failure to attain optimum total cholesterol levels (OR=1.492, \(P<0.001\)).

Patients prescribed antilipemic medications were less likely to be associated with not attaining optimum total cholesterol levels: one medication (OR=0.320, \(P<0.001\)) and at least two medications (OR=0.586, \(P=0.002\)) each versus no medication. Patients prescribed at least four antihypertensive medications were also less likely to be associated with not attaining optimum cholesterol levels (OR=0.721, \(P=0.034\)).
Table 22: Multivariate analysis of factors associated with not attaining optimum total cholesterol levels\(^a\) (N = 4,852)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wald</th>
<th>Odds ratio</th>
<th>(P) value(^b)</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
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<tbody>
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<td>BMI categories</td>
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<tr>
<td>(\leq 24.9) kg/m(^2)</td>
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<td>.053</td>
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<tr>
<td>Reference</td>
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<td></td>
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<tr>
<td>25.0-29.9 kg/m(^2)</td>
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<td>Age (years)</td>
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<td>(\geq 75)</td>
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<td>1.347</td>
<td>1.776</td>
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<td>1.876</td>
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<td>13.037</td>
<td>1.594</td>
<td>.000</td>
<td>1.238</td>
<td>2.054</td>
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</table>
Table 22 (Continued)

<table>
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<tr>
<th>Variables</th>
<th>Wald</th>
<th>Odds ratio</th>
<th>P value&lt;sup&gt;b&lt;/sup&gt;</th>
<th>95% CI</th>
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<td><strong>Total cholesterol (baseline)</strong></td>
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<tr>
<td>Borderline high (200-239 mg/dL)</td>
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</tr>
<tr>
<td>Reference</td>
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<td></td>
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<tr>
<td>High (≥240 mg/dL)</td>
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<td>2.349</td>
<td>.000</td>
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<tr>
<td><strong>Triglyceride (baseline)</strong></td>
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<td>Low (&lt;40 mg/dL)</td>
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<tr>
<td>Reference</td>
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<tr>
<td>Desirable (≥40 mg/dL)</td>
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<td>Former-smoker</td>
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<td><strong>Cardiovascular risk</strong></td>
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<td>Intermediate</td>
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<td>1.060</td>
<td>.714</td>
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<td>.953</td>
<td>.618</td>
<td>.791</td>
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<td>≥2</td>
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<td>.586</td>
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</table>

CV: Cardiovascular; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol
<sup>a</sup>Standard logistic regression was utilized.
<sup>b</sup>Significance level: P<0.05
<sup>c</sup>Reference category for each of the CV condition: absence of that specific CV condition.

A test of the full model with all the predictors against a constant only model: $\chi^2 = 757.727, P<0.001$.

Hosmer-Lemeshow test: $P = 0.363$.

Variance in total cholesterol levels (Nagelkerke R square test): 18.7%.

Percentage of cases correctly classified by the model: 70.6%.
Stepwise logistic regression (Table 23) was conducted in which only significant variables \(P<0.05\) entered the model and final step in the model (Step 9) accounted for 17.1% of the variance in total cholesterol levels. Number of antilipemic medications = 1 accounted for 6.4% of the variance. Number of antilipemic medications = 1 and high total cholesterol at baseline accounted for 12.3% of variance.

The other significant predictors were added in the model in the following sequence: DM, gender, CAD, HDL-C at baseline, number of antilipemic medications ≥2, number of antihypertensive medications ≥4, and high/very high triglyceride at baseline.
Table 23: Stepwise logistic regression for total cholesterol levels

<table>
<thead>
<tr>
<th>Steps</th>
<th>Variables</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step1</td>
<td>Number of antilipemic medications = 1</td>
<td>0.064</td>
</tr>
<tr>
<td>Step2</td>
<td>Number of antilipemic medications = 1; <strong>high total cholesterol at baseline</strong></td>
<td>0.123</td>
</tr>
<tr>
<td>Step3</td>
<td>Number of antilipemic medications = 1; high total cholesterol at baseline; <strong>DM</strong></td>
<td>0.142</td>
</tr>
<tr>
<td>Step4</td>
<td>Number of antilipemic medications = 1; baseline total cholesterol; DM; <strong>gender</strong></td>
<td>0.156</td>
</tr>
<tr>
<td>Step5</td>
<td>Number of antilipemic medications = 1; baseline total cholesterol; DM; gender; <strong>CAD</strong></td>
<td>0.163</td>
</tr>
<tr>
<td>Step6</td>
<td>Number of antilipemic medications = 1; baseline total cholesterol; DM; gender; CAD; <strong>HDL-C at baseline</strong></td>
<td>0.166</td>
</tr>
<tr>
<td>Step7</td>
<td><strong>Number of antilipemic medications</strong> = 1, ≥2; baseline total cholesterol; DM; gender; CAD; HDL-C at baseline</td>
<td>0.168</td>
</tr>
<tr>
<td>Step8</td>
<td>Number of antilipemic medications = 1, ≥2; baseline total cholesterol; DM; gender; CAD; HDL-C at baseline; <strong>number of antihypertensive medications ≥4</strong></td>
<td>0.170</td>
</tr>
<tr>
<td>Step9</td>
<td>Number of antilipemic medications = 1, ≥2; baseline total cholesterol; DM; gender; CAD; HDL-C at baseline; number of antihypertensive medications ≥4; <strong>high/very high triglyceride at baseline</strong></td>
<td>0.171</td>
</tr>
</tbody>
</table>

DM: Diabetes mellitus; CAD: Coronary artery disease; HDL-C: High-density lipoprotein cholesterol
R² reported is Nagelkerke R square
Predictors of not attaining optimum triglyceride levels

The results from standard logistic regression are reported in Table 24. According to the NCEP ATP III guidelines, triglyceride level $< 150$ is defined as optimum triglyceride level. In multivariate logistic regression analysis, BMI was a significant predictor of combined BP and LDL-C goal attainment ($P<0.001$) in patients with concomitant hypertension and dyslipidemia and likelihood of failure to attain optimum triglyceride levels increased with increase in BMI: overweight (OR=1.332, $P=0.042$) and obese (OR=1.864, $P<0.001$). Regarding gender, females (OR=1.543, $P<0.001$) were more likely to be associated with not attaining optimum triglyceride levels.

Presence of high/very high triglyceride levels at baseline versus borderline high triglyceride (OR=4.448, $P<0.001$) was more likely to be associated with not attaining optimum triglyceride levels. In addition, presence of higher HDL-C levels (desirable) at baseline (OR=0.771, $P=0.007$) was less likely to be associated with not attaining optimum triglyceride levels.

Patients prescribed one antilipemic medication versus no medication (OR=0.795, $P=0.004$) were less likely to be associated with not attaining optimum triglyceride levels whereas patients prescribed two antihypertensive medications versus no medication (OR=1.998, $P=0.002$) were more likely to be associated with not attaining optimum triglyceride levels.
Table 24: Multivariate analysis of factors associated with not attaining optimum triglyceride levels\(^a\) (N = 4,267)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wald</th>
<th>Odds ratio</th>
<th>(P) value(^b)</th>
<th>95% CI</th>
<th>Lower</th>
<th>Upper</th>
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</thead>
<tbody>
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<td><strong>BMI categories</strong></td>
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<td>≤24.9 kg/m(^2)</td>
<td>26.726</td>
<td>1.000</td>
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<tr>
<td>25.0-29.9 kg/m(^2)</td>
<td>4.137</td>
<td>1.332</td>
<td>.042</td>
<td>1.010</td>
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<tr>
<td>≥30.0 kg/m(^2)</td>
<td>19.914</td>
<td>1.864</td>
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<tr>
<td><strong>Age (years)</strong></td>
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<td>.637</td>
<td>.798</td>
<td>1.447</td>
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<td>45-55</td>
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<td>1.074</td>
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<td>1.131</td>
<td>.494</td>
<td>.795</td>
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<td>1.103</td>
<td>.608</td>
<td>.759</td>
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<td>.167</td>
<td>.544</td>
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<td>.334</td>
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# Table 24 (Continued)

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<th>Variables</th>
<th>Wald</th>
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<th>$P$ value&lt;sup&gt;b&lt;/sup&gt;</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
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<td>Total cholesterol (baseline)</td>
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<td>Borderline high (200-239 mg/dL)</td>
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<td>High (≥240 mg/dL)</td>
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<td>Borderline high (150-199 mg/dL)</td>
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<td>High/very high (≥200 mg/dL)</td>
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<td>HDL-C (baseline)</td>
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<td>Desirable (≥40 mg/dL)</td>
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<td>Low</td>
<td>Reference</td>
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<td>.770</td>
<td>.220</td>
<td>.508</td>
<td>1.168</td>
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<td>0</td>
<td>Reference</td>
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<td>2.240</td>
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<td>6.564</td>
<td>1.351</td>
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<td>1.073</td>
<td>1.701</td>
</tr>
<tr>
<td>3</td>
<td>.065</td>
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<tr>
<td>≥4</td>
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<td>.892</td>
<td>1.889</td>
</tr>
<tr>
<td>No. of antilipemic medications</td>
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<td></td>
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<td></td>
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<tr>
<td>0</td>
<td>Reference</td>
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<td>8.075</td>
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<td>9.246</td>
<td>1.998</td>
<td>.002</td>
<td>1.279</td>
<td>3.121</td>
</tr>
</tbody>
</table>

CV: Cardiovascular; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol
<sup>a</sup>Standard logistic regression was utilized.
<sup>b</sup>Significance level: $P$≤0.05
<sup>c</sup>Reference category for each of the CV condition: absence of that specific CV condition.
A test of the full model with all the predictors against a constant only model: $\chi^2 = 484.218$, $P$<0.001.
Hosmer-Lemeshow test: $P = 0.670$.
Variance in triglyceride levels (Nagelkerke R square test): 16.6%.
Percentage of cases correctly classified by the model: 75.0%.
Stepwise logistic regression (Table 25) was conducted in which only significant variables ($P<0.05$) entered the model and final step in the model (Step 8) accounted for 16.1% of the variance in triglyceride levels. Baseline high/very high triglyceride levels accounted for 13.3% of the variance. Baseline high/very high triglyceride levels and BMI $\geq 30.0$ kg/m$^2$ together accounted for 14.1% of variance in attaining optimum triglyceride levels.

The other significant predictors were added in the model in the following sequence: gender, number of antilipemic medications $\geq 2$, number of antilipemic medications $= 1$, HDL-C at baseline, number of antihypertensive medications $= 2$; and BMI = 25.0-29.9 kg/m$^2$. 
### Table 25: Stepwise logistic regression for triglyceride levels

<table>
<thead>
<tr>
<th>Steps</th>
<th>Variables</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>High/very high triglyceride at baseline</td>
<td>0.133</td>
</tr>
<tr>
<td>Step 2</td>
<td>High/very high triglyceride at baseline; <strong>BMI $\geq$ 30.0 kg/m$^2$</strong></td>
<td>0.141</td>
</tr>
<tr>
<td>Step 3</td>
<td>High/very high triglyceride at baseline; <strong>BMI $\geq$ 30.0 kg/m$^2$</strong>; gender</td>
<td>0.147</td>
</tr>
<tr>
<td>Step 4</td>
<td>High/very high triglyceride at baseline; <strong>BMI $\geq$ 30.0 kg/m$^2$</strong>; gender; <strong>number of antilipemic medications $\geq$ 2</strong></td>
<td>0.153</td>
</tr>
<tr>
<td>Step 5</td>
<td>High/very high triglyceride at baseline; <strong>BMI $\geq$ 30.0 kg/m$^2$</strong>; gender; <strong>number of antilipemic medications $\geq$ 2, 1</strong></td>
<td>0.156</td>
</tr>
<tr>
<td>Step 6</td>
<td>High/very high triglyceride at baseline; <strong>BMI $\geq$ 30.0 kg/m$^2$</strong>; gender; number of antilipemic medications $\geq$ 2, 1; <strong>HDL-C at baseline</strong></td>
<td>0.158</td>
</tr>
<tr>
<td>Step 7</td>
<td>High/very high triglyceride at baseline; <strong>BMI $\geq$ 30.0 kg/m$^2$</strong>; gender; number of antilipemic medications $\geq$ 2, 1; <strong>HDL-C at baseline; number of antihypertensive medications = 2</strong></td>
<td>0.160</td>
</tr>
<tr>
<td>Step 8</td>
<td>High/very high triglyceride at baseline; <strong>BMI $\geq$ 30.0 kg/m$^2$</strong>; gender; number of antilipemic medications $\geq$ 2, 1; <strong>HDL-C at baseline; number of antihypertensive medications = 2; BMI = 25.0-29.9 kg/m$^2$</strong></td>
<td>0.161</td>
</tr>
</tbody>
</table>

BMI: Body mass index; HDL-C: High-density lipoprotein cholesterol

$R^2$ reported is Nagelkerke $R$ square.
Predictors of not attaining optimum HDL-C levels

The results for standard logistic regression are presented in Table 26. According to NCEP ATP III guidelines, HDL-C ≥ 40 is defined as optimum HDL-C level. In multivariate logistic regression analysis, patients who were obese were more likely to be associated with not attaining optimum levels of HDL-C (OR=1.933, \( P=0.009 \)). Regarding gender, females were less likely to be associated with not attaining optimum HDL-C levels (OR=0.591, \( P<0.001 \)).

Presence of borderline high total cholesterol (OR=0.801, \( P=0.027 \)) or high total cholesterol (OR=0.529, \( P=0.008 \)) at baseline was less likely to be associated with not attaining optimum HDL-C levels whereas presence of borderline high (OR=1.507, \( P=0.013 \)) or high/very high (OR=2.187, \( P<0.001 \)) triglyceride levels were more likely to be associated with failure to attain optimum HDL-C levels. Patients who were current smokers were also more likely to fail to attain optimum HDL-C levels (OR=1.626, \( P=0.009 \)). Patients prescribed two antihypertensive medications were less likely to fail to attain optimum HDL-C levels (OR=0.713, \( P=0.045 \)).
Table 26: Multivariate analysis of factors associated with not attaining optimum HDL-C levels (N = 1,852)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wald</th>
<th>Odds ratio</th>
<th>( P ) value&lt;sup&gt;b&lt;/sup&gt;</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI categories</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤24.9 kg/m(^2)</td>
<td>8.194</td>
<td></td>
<td>.017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤25.0-29.9 kg/m(^2)</td>
<td>2.733</td>
<td>1.536</td>
<td>.098</td>
<td>.923</td>
<td>2.554</td>
</tr>
<tr>
<td>≥30.0 kg/m(^2)</td>
<td>6.923</td>
<td>1.933</td>
<td>.009</td>
<td>1.183</td>
<td>3.159</td>
</tr>
<tr>
<td>Age (years)</td>
<td>3.776</td>
<td></td>
<td>.437</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45-55</td>
<td>1.924</td>
<td>.765</td>
<td>.165</td>
<td>.524</td>
<td>1.117</td>
</tr>
<tr>
<td>56-64</td>
<td>1.638</td>
<td>.771</td>
<td>.201</td>
<td>.518</td>
<td>1.148</td>
</tr>
<tr>
<td>65-74</td>
<td>.297</td>
<td>.876</td>
<td>.586</td>
<td>.544</td>
<td>1.411</td>
</tr>
<tr>
<td>≥75</td>
<td>.022</td>
<td>1.041</td>
<td>.883</td>
<td>.613</td>
<td>1.766</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>15.469</td>
<td>.591</td>
<td>.000</td>
<td>.455</td>
<td>.768</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary payer</td>
<td>13.168</td>
<td></td>
<td>.051</td>
<td></td>
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</tr>
<tr>
<td>Medicare</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicaid</td>
<td>.424</td>
<td>1.219</td>
<td>.515</td>
<td>.672</td>
<td>2.211</td>
</tr>
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<td>Private</td>
<td>2.498</td>
<td>1.324</td>
<td>.114</td>
<td>.935</td>
<td>1.876</td>
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<tr>
<td>Self-pay</td>
<td>.174</td>
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<td>.676</td>
<td>.648</td>
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<tr>
<td>Other</td>
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<td>.236</td>
<td>.066</td>
<td>.084</td>
<td>.665</td>
</tr>
<tr>
<td>Patient location</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Urban</td>
<td>2.850</td>
<td>1.228</td>
<td>.091</td>
<td>.967</td>
<td>1.559</td>
</tr>
<tr>
<td>Rural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CV conditions (present)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>3.339</td>
<td>.692</td>
<td>.068</td>
<td>.467</td>
<td>1.027</td>
</tr>
<tr>
<td>Heart failure</td>
<td>.147</td>
<td>1.119</td>
<td>.702</td>
<td>.629</td>
<td>1.989</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>1.154</td>
<td>.716</td>
<td>.283</td>
<td>.389</td>
<td>1.317</td>
</tr>
<tr>
<td>Angina pectoris</td>
<td>1.016</td>
<td>1.699</td>
<td>.314</td>
<td>.606</td>
<td>4.760</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>.559</td>
<td>1.147</td>
<td>.455</td>
<td>.801</td>
<td>1.642</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>1.612</td>
<td>1.360</td>
<td>.204</td>
<td>.846</td>
<td>2.186</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>.168</td>
<td>.909</td>
<td>.682</td>
<td>.577</td>
<td>1.433</td>
</tr>
<tr>
<td>Kidney disease</td>
<td>.260</td>
<td>1.156</td>
<td>.610</td>
<td>.662</td>
<td>2.017</td>
</tr>
<tr>
<td>Hypertension stage (baseline)</td>
<td>1.453</td>
<td></td>
<td>.484</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prehypertension</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 1</td>
<td>.883</td>
<td>1.134</td>
<td>.347</td>
<td>.872</td>
<td>1.474</td>
</tr>
<tr>
<td>Stage 2</td>
<td>.235</td>
<td>.910</td>
<td>.628</td>
<td>.621</td>
<td>1.333</td>
</tr>
<tr>
<td>LDL-C (baseline)</td>
<td>2.146</td>
<td></td>
<td>.342</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near/above optimal (100-129 mg/dL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borderline high (130-159 mg/dL)</td>
<td>.935</td>
<td>.845</td>
<td>.334</td>
<td>.601</td>
<td>1.188</td>
</tr>
<tr>
<td>High/very high (≥160 mg/dL)</td>
<td>.082</td>
<td>1.075</td>
<td>.775</td>
<td>.656</td>
<td>1.762</td>
</tr>
</tbody>
</table>
Table 26 (Continued)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wald</th>
<th>Odds ratio</th>
<th>( P ) value(^b)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td><strong>Total cholesterol (baseline)</strong></td>
<td>7.830</td>
<td>.020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desirable (&lt;200 mg/dL)</td>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borderline high (200-239 mg/dL)</td>
<td>4.919</td>
<td>.701</td>
<td><strong>.027</strong></td>
<td>.511</td>
</tr>
<tr>
<td>High (≥240 mg/dL)</td>
<td>6.928</td>
<td>.529</td>
<td><strong>.008</strong></td>
<td>.329</td>
</tr>
<tr>
<td><strong>Triglyceride (baseline)</strong></td>
<td>25.118</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desirable (&lt;150 mg/dL)</td>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borderline high (150-199 mg/dL)</td>
<td>6.144</td>
<td>1.507</td>
<td><strong>.013</strong></td>
<td>1.090</td>
</tr>
<tr>
<td>High/very high (≥200 mg/dL)</td>
<td>25.009</td>
<td>2.187</td>
<td><strong>.000</strong></td>
<td>1.610</td>
</tr>
<tr>
<td><strong>Smoking status</strong></td>
<td>8.988</td>
<td>.029</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-smoker</td>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>6.743</td>
<td>1.626</td>
<td><strong>.009</strong></td>
<td>1.127</td>
</tr>
<tr>
<td>Former-smoker</td>
<td>.401</td>
<td>.919</td>
<td>.527</td>
<td>.706</td>
</tr>
<tr>
<td><strong>Cardiovascular risk</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>.192</td>
<td>.902</td>
<td>.661</td>
<td>.567</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>No. of antihypertensive medications</strong></td>
<td>8.435</td>
<td>.077</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1.649</td>
<td>.833</td>
<td>.199</td>
<td>.631</td>
</tr>
<tr>
<td>2</td>
<td>4.007</td>
<td>.713</td>
<td><strong>.045</strong></td>
<td>.512</td>
</tr>
<tr>
<td>3</td>
<td>1.840</td>
<td>1.442</td>
<td>.175</td>
<td>.850</td>
</tr>
<tr>
<td>≥4</td>
<td>.047</td>
<td>.937</td>
<td>.828</td>
<td>.523</td>
</tr>
<tr>
<td><strong>No. of antilipemic medications</strong></td>
<td>2.535</td>
<td>.282</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1.699</td>
<td>.849</td>
<td>.192</td>
<td>.664</td>
</tr>
<tr>
<td>≥2</td>
<td>1.524</td>
<td>.729</td>
<td>.217</td>
<td>.442</td>
</tr>
<tr>
<td>Constant</td>
<td>3.192</td>
<td>2.100</td>
<td>.074</td>
<td></td>
</tr>
</tbody>
</table>

CV: Cardiovascular; LDL-C: Low-density lipoprotein cholesterol

\(^a\)Standard logistic regression was utilized.

\(^b\)Significance level: \( P < 0.05 \)

\(^c\)Reference category for each of the CV condition: absence of that specific CV condition.

A test of the full model with all the predictors against a constant only model: \( \chi^2 = 99.516, P < 0.001 \).

Hosmer-Lemeshow test: \( P = 0.897 \).

Variance in HDL-C levels (Nagelkerke R square test): 24.1%.

Percentage of cases correctly classified by the model: 75.9%.
Stepwise logistic regression (Table 27) was conducted in which only significant variables ($P<0.05$) entered the model and final step in the model (Step 7) accounted for 21.2% of the variance in HDL-C levels. Gender and high/very high triglycerides at baseline accounted for 20.1% of the variance.

The other significant predictors were added in the model in the following sequence: current smoker, high total cholesterol at baseline, borderline high total cholesterol at baseline, borderline high triglyceride levels at baseline, and BMI $\geq 30.0$ kg/m$^2$. 
Table 27: Stepwise logistic regression for HDL-C levels

<table>
<thead>
<tr>
<th>Steps</th>
<th>Variables</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step1</td>
<td>Gender</td>
<td>0.198</td>
</tr>
<tr>
<td>Step2</td>
<td>Gender; <strong>High/very high triglyceride levels at baseline</strong></td>
<td>0.201</td>
</tr>
<tr>
<td>Step3</td>
<td>Gender; High/very high triglyceride levels at baseline; <strong>current smoker</strong></td>
<td>0.204</td>
</tr>
<tr>
<td>Step4</td>
<td>Gender; High/very high triglyceride levels at baseline; current smoker; <strong>high total cholesterol at baseline</strong></td>
<td>0.206</td>
</tr>
<tr>
<td>Step5</td>
<td>Gender; High/very high triglyceride levels at baseline; current smoker; high total cholesterol at baseline; <strong>borderline high total cholesterol at baseline</strong></td>
<td>0.208</td>
</tr>
<tr>
<td>Step6</td>
<td>Gender; High/very high triglyceride levels at baseline; current smoker; high total cholesterol at baseline; borderline high total cholesterol at baseline; <strong>borderline high triglyceride levels at baseline</strong></td>
<td>0.210</td>
</tr>
<tr>
<td>Step7</td>
<td>Gender; High/very high triglyceride levels at baseline; current smoker; high total cholesterol at baseline; borderline high total cholesterol at baseline; borderline high triglyceride levels at baseline; <strong>BMI ≥30.0 kg/m²</strong></td>
<td>0.212</td>
</tr>
</tbody>
</table>

BMI: Body mass index; DM: Diabetes mellitus

R² reported is Nagelkerke R square
Assumptions underlying statistical tests

Prior to analysis, data were subjected to the assumptions for different statistical tests used for the study objectives.

Assumptions underlying two-way contingency table analysis

Assumption 1: The observations for a two-way contingency table analysis are independent of each other.

According to this assumption, each observation should be independent of another observation. The study design included observations that were independent of each other, thus meeting this assumption. The study was designed such that each patient was selected based on the unique patient ID and there was no overlapping of data for each patient.

Assumption 2: Two-way contingency analyses yield a statistic that is approximately distributed as a chi-square when the sample size is relatively large.

Overall, this study has a sample size of N = 9,086. Moreover, to meet this assumption, the data were grouped into categories such that the expected frequencies for each cell were greater than or equal to 5. This assumption was tested using two-way contingency analysis.

Assumptions underlying one-way ANOVA

Assumption 1: The dependent variable is normally distributed for each of the populations as defined by the different levels of the factor.
This study has large sample size and according to the central limit theorem, the sample size of 30 cases per group is sufficiently large to yield accurate \( p \) values. Thus, the DV was assumed to be normally distributed.

*Assumption 2: The variances of the dependent variable are the same for all populations.*

Levene’s test was used to assess this assumption of homogeneity of variance (Table 28). The homogeneity of variances is assumed when the \( p \) value for Levene’s test is not significant \((P>0.05)\). For the variables in which this assumption was violated, the statistics (Browne-Forsythe or Welch) that do not assume equality of population variances were used as a replacement for \( F \)-test.
Table 28: Levene’s test for homogeneity of variance assumption underlying one-way ANOVA (BMI as the independent variable)

<table>
<thead>
<tr>
<th>Variable</th>
<th>F statistic</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP (mm Hg)</td>
<td>0.502</td>
<td>0.606</td>
</tr>
<tr>
<td>DBP (mm Hg)</td>
<td>0.505</td>
<td>0.603</td>
</tr>
<tr>
<td>LDL-C (mg/dL)</td>
<td>2.075</td>
<td>0.126</td>
</tr>
<tr>
<td>HDL-C (mg/dL)*</td>
<td>73.87</td>
<td>0.000</td>
</tr>
<tr>
<td>Total cholesterol (mg/dL)</td>
<td>2.298</td>
<td>0.101</td>
</tr>
<tr>
<td>Triglyceride (mg/dL)*</td>
<td>34.9</td>
<td>0.000</td>
</tr>
</tbody>
</table>

| **Post-index**            |             |         |
| SBP (mm Hg)               | 0.748       | 0.474   |
| DBP (mm Hg)               | 0.062       | 0.940   |
| LDL-C (mg/dL)             | 1.937       | 0.144   |
| HDL-C (mg/dL)*            | 95.47       | 0.000   |
| Total cholesterol (mg/dL) | 1.857       | 0.156   |
| Triglyceride (mg/dL)*     | 33.05       | 0.000   |

*For variables HDL-C and triglyceride (both baseline and post-index), Levene’s test was significant (P<0.05) and thus this assumption was violated. For HDL-C and triglyceride measurements, Welch test (that does not assume homogeneity of variances) was used for analysis.
Assumption 3: The observations for a one-way ANOVA and scores on test variable are independent of each other.

The study was designed such that the observations and scores on test variables were independent of each other. Each clinical measure (BP, lipid level) were measured at a different period of time. Thus, for each patient, the clinical measures assessed at baseline were independent of clinical measures assessed at follow-up.

Assumptions underlying logistic regression

For objective 4, the analysis includes dichotomous outcome variable and mix set of predictors (discrete, and dichotomous). Thus, logistic regression technique is appropriate for complex and varied data sets and does not require normality, linearity, and homoscedasticity assumptions.

Assumption 1: Ratio of cases to variables is adequate.

According to this assumption, there should be adequate number of cases for each discrete category of predictor. In other words, the combinations of discrete variables should not result in cells with no cases. There should be at least five times the cases as cells in the study design. The data were grouped such that there was adequate number of cases in each discrete category of predictors used and no cell had zero cases. Also, the presence of large sample size was useful in meeting this assumption.
Assumption 2: Adequacy of expected frequencies.

According to this assumption, all expected frequencies are greater than 1 and no more than 20% are less than five. This assumption was met because of the large sample size and proper grouping of variables. Further, the data were also screened using SPSS crosstabs and desired expected frequencies were confirmed.

Assumption 3: Absence of multicollinearity.

Logistic regression is highly sensitive to extremely high correlation among predictor variables. Multicollinearity is examined using tolerance statistics or variance inflation factor (VIF) statistics. If tolerance statistic is > 0.1 or VIF is < 10, then there is no problem for multicollinearity. For the predictor variables with more than two categories, dummy variables were created and were examined for multicollinearity. The redundant variables (number of cardiovascular conditions, type of antihypertensive or antilipemic medication) were identified in the initial examination of multicollinearity and were not included for analysis. Table 29 shows the tolerance statistics and VIF statistics for the predictor variables that were included in the model.
<table>
<thead>
<tr>
<th>Variables</th>
<th>Collinearity statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tolerance</td>
</tr>
<tr>
<td>Age: 45-55 years</td>
<td>.322</td>
</tr>
<tr>
<td>Age: 56-64 years</td>
<td>.265</td>
</tr>
<tr>
<td>Age: 65-74 years</td>
<td>.237</td>
</tr>
<tr>
<td>Age: ≥75 years</td>
<td>.220</td>
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<tr>
<td>Medicaid</td>
<td>.797</td>
</tr>
<tr>
<td>Private</td>
<td>.540</td>
</tr>
<tr>
<td>Self-pay</td>
<td>.835</td>
</tr>
<tr>
<td>Other</td>
<td>.958</td>
</tr>
<tr>
<td>25.0-29.9 kg/m²</td>
<td>.409</td>
</tr>
<tr>
<td>≥30.0 kg/m²</td>
<td>.368</td>
</tr>
<tr>
<td>CV risk: Intermediate</td>
<td>.414</td>
</tr>
<tr>
<td>CV risk: High</td>
<td>.377</td>
</tr>
<tr>
<td>Hypertension stage 1</td>
<td>.894</td>
</tr>
<tr>
<td>Hypertension stage 2</td>
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</tr>
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Reference categories:

- Age: 18-44 years; Insurance type: Medicare; BMI: ≤24.9 kg/m²; CV risk: low; Hypertension stage: Prehypertension; Smoking status: Non-smoker; No. of antihypertensives = 0; No. of antilipemics = 0; LDL-C: optimal/above optimal; Total cholesterol: optimal; Triglyceride: optimal; HDL-C: <40 mg/dL.
CHAPTER 5

DISCUSSION AND CONCLUSIONS

This chapter includes discussion, conclusions, study limitations, study implications, and opportunities for future research.

DISCUSSION

Obesity is associated with increased risk of hypertension, dyslipidemia, diabetes, metabolic syndrome, and CVD.\textsuperscript{1} Most of the obesity-related cardiovascular morbidity is linked to the increased prevalence of cardiovascular risk factors, such as hypertension, dyslipidemia, or glucose intolerance.\textsuperscript{1,2} All these factors predispose or increase the probability of developing CVD. Hypertension and dyslipidemia are highly prevalent risk factors and their prevalence substantially increases with increase in BMI. Further, it has been suggested that concomitant presence of increased BP, elevated lipid levels, and higher BMI decreases the probability of attaining optimum BP and lipid levels, thereby increasing the risk of CVD.\textsuperscript{18,23,24} However, these risk factors are modifiable if managed appropriately and in a timely manner. Current obesity treatment guidelines have strongly emphasized the control of BP and lipid levels in patients who are obese by implementing lifestyle modifications and pharmacological treatment. Further, JNC7 and NCEP ATP III guidelines recommend simultaneous management of risk factors (hypertension and dyslipidemia).\textsuperscript{12,18} Although disease management guidelines have been established, previous research suggests that more than 50\% of patients do not attain recommended BP and lipid goals. Further, to the best of our knowledge, no studies to date have examined
obesity in relation to the attainment of recommended BP and lipid goals in patients with concomitant hypertension and dyslipidemia.

To achieve the study objective, GE Centricity EMR database was utilized since it is rich in clinical data and reflects a real-world clinical practice. The other advantage of EMR data is that it can be analyzed longitudinally and in a real-time basis for the entire population under care and provides large sample sizes. The ability of EMR data to provide clinical information (e.g., BMI, BP, lipid levels) is by far the most important advantage over commonly used administrative claims databases. EMR also provides a quick, less expensive, and more comprehensive approach to conducting outcomes research and facilitates accurate assessment of the proportion of patients with hypertension or dyslipidemia in whom BP or lipid levels are not controlled. The information regarding medication type and number of medications prescribed is also available in the EMR data. Such outcome studies using EMR data can assist physicians in quickly identifying all the patients with multiple risk factors and can specifically target those who are not at goal.

Thus, this study was conducted using EMR database to examine the variations in therapeutic (BP and lipid) goal attainment and medication utilization pattern in patients with concomitant hypertension and dyslipidemia, specifically comparing obese versus non-obese patients. Using EMR database, this study provides information regarding therapeutic goal attainment and medication prescribing pattern in context of real world medical practice.
**Patient and clinical profile of patients with concomitant hypertension and dyslipidemia**

Overall, 19,190 adult patients (≥18 years) had concomitant hypertension and dyslipidemia, which accounts for about 12.3% of total EMR patient population. Johnson et al. (2006) reported 23.8% of population with concomitant hypertension and dyslipidemia in a Veteran Affairs population. This variation in prevalence might be due to different population and setting. For overall US population, information available from NHANES III (1988-1994) suggests that 15% of US adults have concomitant hypertension and dyslipidemia.

Among patients with concomitant hypertension and dyslipidemia, majority of them were middle-aged (mean = 60.03 years), had private insurance, were either obese or overweight, had diabetes and were at high cardiovascular risk. A multitude of research studies have shown similar trend for age, BMI, and prevalence of diabetes. In the study by Johnson et al., most patients with concomitant hypertension and dyslipidemia were middle-aged (mean = 60.3 years). Other studies have shown that prevalence of hypertension or dyslipidemia increased with BMI or patients with higher BMI were more likely to have hypertension or dyslipidemia. Similarly, it has been suggested that there is an association between diabetes, hypertension, and dyslipidemia.

The reason for higher proportion of patients having private insurance can be attributed to the majority of our study population consisting of patients less than 65 years of age. Further, more than one-half of population was at high cardiovascular risk which can be attributed to the higher proportion of patients having diabetes or other cardiovascular conditions.
Our study results showed that 51.9% of females had concomitant hypertension and dyslipidemia. Similar results have been shown by Selby et al. (2004); 49.5% of females had concomitant hypertension and dyslipidemia in a Kaiser Permanente population.

**Patient and clinical profile of obese versus non-obese patients with concomitant hypertension and dyslipidemia**

Most of the patients who were overweight or obese were less than 65 years of age and comprised of males and this was consistent with NHANES and Centers for Disease Control and Prevention (CDC) 2008-2010 statistics. The 2008-2010 statistics indicate higher prevalence of obesity in younger population (< 65 years of age) and higher rate of obesity among males (30.0%) compared to females (27.1%) in Pennsylvania (PA). Since our population represents the Southwestern region of PA; higher proportion of males compared to females were either overweight (35.6% vs. 31.8%) or obese (54.7% vs. 50.5%).

Regarding clinical characteristics, patients who were obese or overweight were more likely to have higher diastolic BP, elevated levels of triglycerides, and lower levels of HDL-C. Surprisingly, they were less likely to have higher levels of LDL-C and total cholesterol levels. Patients who were obese or overweight were more likely to have diabetes and had at least one cardiovascular condition. The results for BP, triglyceride, HDL-C, diabetes, and cardiovascular risk are consistent with previous research. However, contradictory results were seen with LDL-C and total cholesterol levels. It has been shown that BP increases with weight gain and decreases with weight loss.
Obesity has the most profound effect on hypertension and risk estimates from population studies suggest that about 75% of hypertension can be attributed to obesity alone.\textsuperscript{63} Evidence suggests that the neuroendocrine mechanisms and the factors derived from adipose tissues could play a major role\textsuperscript{65,66}; however, the exact mechanisms relating obesity to hypertension remains unclear. Obesity also has a strong effect on lipoprotein metabolism and an increase in weight is shown to be associated with higher levels of triglycerides, elevated LDL-C, and low HDL-C. However, normal-weight patients were observed to have higher levels of LDL-C and total cholesterol compared to overweight and obese patients. A possible explanation could be that LDL-C and total cholesterol concentrations are generally associated with visceral obesity which can be more appropriately determined using waist circumference. Although, BMI is highly correlated with adiposity, it measures lean mass as well as fat mass.\textsuperscript{65} The association between obesity and LDL-C is complex and the exact mechanism has not been fully elucidated.

Obesity-related hypertension is associated with additional factors of metabolic syndrome (insulin resistance and glucose intolerance) resulting in increased risk of diabetes. Studies have suggested that obesity accounts for about 50% of change in insulin sensitivity, but it is difficult to define the precise contribution of obesity to insulin resistance.\textsuperscript{65,66} Obesity is an independent risk factor for CVD, i.e., obese patients are at increased cardiovascular risk, especially the risk of developing diabetes or metabolic syndrome.\textsuperscript{1,12}

Regarding all other cardiovascular conditions (heart failure, myocardial infarction, CAD, peripheral vascular disease, and cerebrovascular disease), either there was no significant difference across BMI or prevalence was higher among non-obese
patients. In our study, patients who were obese were more likely to be younger or middle-aged population compared to non-obese patients who were older (≥65 years). Similarly, for cardiovascular conditions, younger and middle-aged patients were less likely to have these cardiovascular conditions compared to older patients. Obesity undoubtedly increases the risk for developing CVD, but age is one of the non-modifiable risk factor for CVD, i.e., proper management of cardiovascular factors decreases with increase in age and cardiovascular conditions increase with increase in age.

**Therapeutic (BP and lipid) goal attainment in patients with concomitant hypertension and dyslipidemia**

In patients with concomitant hypertension and dyslipidemia, higher proportion of patients failed to attain BP (85.0%), LDL-C (74.0%), and dual BP/LDL-C (64.1%) goals. These findings are consistent with the results of Johnson et al. (2006) study which assessed goal attainment in patients with concomitant hypertension and dyslipidemia in Veteran Affairs population. Johnson et al. evaluated different population subgroups (patients with diabetes, without diabetes, with CVD, and without CVD) and reported that a higher proportion of patient population did not attain BP and LDL-C goals; not at BP goal (55.9% - 75.7%), not at LDL-C goal (52% - 69%), and not at dual BP and LDL-C goals (75.6% - 87%). Previous research suggests that the presence of multiple risk factors can result in decreased control of BP and LDL-C levels. Additionally, our study indicated that at least one-third of the patients were not receiving any antihypertensive medication and at least one-half of patients were not receiving any antilipemic medication. For patients receiving medications and yet showing poor control lack of
adherence to the medications has been suggested as one the potential reasons for inadequate attainment of LDL-C goals.\textsuperscript{31, 33} Statin dose needs to be titrated to the level required for maximum reduction of lipids and lack of proper dosage has also been suggested as one of the reasons for failure of LDL-C goal attainment.\textsuperscript{31}

In addition, higher proportion of patients failed to attain optimum total cholesterol (66.3%), triglyceride (74.6%), and HDL-C (75.7%) levels. Failure to attain non LDL-C lipid levels (total cholesterol, triglyceride, and HDL-C) could largely be due to the lack of clinical attention as they are not recommended by the disease management guidelines\textsuperscript{18} for specific treatment targets. This is primarily because of insufficient evidence to support recommendations. However, research is being conducted for the role of these lipids in reducing cardiovascular risk.

Further, to identify factors associated with therapeutic goal attainment and quantify the role of obesity in therapeutic goal attainment in patients with concomitant hypertension and dyslipidemia, multivariate analysis was conducted. These results have been grouped into four categories based on the type of factors associated with therapeutic goal attainment: BMI, patient-related factors, clinical factors, and medication-related factors.

\textit{BMI and therapeutic goal attainment}

Higher proportion of obese and overweight failed to attain BP, LDL-C, and dual BP/LDL-C targets as well as optimum HDL-C and triglyceride levels compared to those with normal-weight. After adjusting for confounders such as age, gender, cardiovascular conditions, hypertension stage at baseline, smoking status, cardiovascular risk, baseline
lipid levels, and number of antihypertensive and antilipemic medications, obese patients remained less likely to attain BP goals, dual BP/LDL-C goals, optimum HDL-C, and triglyceride levels compared to normal-weight patients. However, after adjusting for confounders, no significant difference in obese versus non-obese was observed for LDL-C goal attainment. Similar to obese patients, overweight patients were less likely to attain BP goals and optimum triglyceride levels, after adjusting for confounding factors. Previous research has shown similar trends for BP or LDL-C goal attainment with respect to BMI.

Obesity has consistently been associated with the failure of BP goal attainment.37,39,43 Blood pressure increases with increase in BMI65, thus weight loss has been recommended in achieving optimum BP levels. Our study results indicated that obese patients were more likely to be prescribed antihypertensives, and yet, few obese patients attained BP goal. As suggested by the disease management guidelines, the probable reason for higher proportion of obese patients not attaining BP targets could be that patients with multiple risk factors might be more resistant to therapy, thereby making it difficult to manage risk factors in these patients.12,18 In such patients, combination therapy comprising of pharmacological treatment and lifestyle interventions have been recommended for attaining adequate BP goals.

Significantly higher proportion of obese patients did not attain LDL-C goals, however, this difference was not significant after adjusting for other patient-related and clinical factors. According to the NCEP ATP III guidelines, there is a strong relationship between obesity and risk for CHD, but it is not classified among the risk factors that modify LDL-C treatment goals.18 Majority of BMI associated risk on LDL-C goals are
mediated by other risk factors such as high BP and elevated lipid levels. This is consistent with our study results. Nichols et al. (2009) studied patients with dyslipidemia who had initiated antilipemic therapy and were on therapy for at least one year. Obesity was not a significant predictor of LDL-C goal attainment, suggesting that managing obesity might be a better approach than lowering LDL-C in patients who are either overweight or mildly obese. Even NCEP ATP III guidelines recommend considering obesity as a direct target for clinical intervention rather than an indicator for lipid-modifying treatment.

Optimum levels of other lipid levels such as triglycerides and HDL-C were less likely to be attained in obese patients. Unlike LDL-C, in which the effect of obesity is mediated by other factors, the study results suggest that the effect of obesity has a direct effect on attaining optimum triglycerides and HDL-C levels. This is an interesting finding and needs further research to determine the relation between obesity and different lipid types. Another interesting finding was that overweight or obese patients were more likely to attain optimum total cholesterol levels compared to patients with normal weight.

Patient-related factors associated with therapeutic goal attainment

Patient’s age was associated with BP goal attainment only and no differences were observed for LDL-C goal or dual BP/LDL-C goals. Those above 55 years of age were less likely to attain BP goal and with increase in age, the likelihood of failure to attain BP goal also increased. Further, females were less likely to attain BP, LDL-C, dual BP/LDL-C goals as well as optimum total cholesterol and triglyceride levels. Females
were more likely to attain only optimum levels of HDL-C and these findings are consistent with other published research\textsuperscript{51, 68}.

Evidence indicate that number of co-morbid conditions and high cardiovascular risk in the elderly result in inadequate goal attainment.\textsuperscript{37} McDonald et al. (2009) utilized NHANES data from 1999-2004 and concluded that age was not a significant predictor of LDL-C goal attainment.\textsuperscript{56} Wong et al. (2003) showed that the estimated attributable risk percent is higher in women resulting in lower rates of BP goal attainment.\textsuperscript{67}

Previous studies have also shown that males are more likely to attain LDL-C levels and optimum triglyceride levels.\textsuperscript{45, 46, 50, 51, 52} In addition, our study population comprised of more older-aged (≥65 years) women (55.6%) compared to older-aged men (36.1%), suggesting that increased likelihood of failure to attain lipid goals/optimum levels in women might result from increase in cardiovascular risk and co-morbidities with age. However, the exact reason for variation in LDL-C goal attainment by gender is not known and needs further research. The probable reason for the finding that females were more likely to attain optimum levels of HDL-C could be that women in general tend to have higher HDL-C levels than men.\textsuperscript{51, 68}

\textit{Clinical factors associated with therapeutic goal attainment}

Presence of diabetes was associated with a decreased likelihood of attaining BP, LDL-C, and dual BP/LDL-C goals. Diabetes has been consistently associated with failure to attain BP and/or LDL-C goals.\textsuperscript{38, 41, 43} The probable reason, based on the previous research, could be that patients are not receiving adequate therapy for hypertension (at least two antihypertensive medications) or for dyslipidemia (statin
therapy).\textsuperscript{38, 41, 43} For patients who were prescribed recommended medications, disease management guidelines suggest that various factors, such as patient-related factors (adherence to complex medical regimen), provider-related factors (attitude, experience, and practice patterns), and treatment-related costs, might result in patients not taking their prescribed medication\textsuperscript{12}, thereby resulting in decreased attainment of goals in patients with concomitant hypertension and dyslipidemia. However, patients with diabetes were more likely to attain optimum total cholesterol levels. The overview of anti-diabetic medications by Keiden et al. (2002) indicated that some of these anti-diabetic medications such as metformin and insulin decrease cholesterol levels.\textsuperscript{69}

Presence of CAD was more likely to be associated with BP goal attainment and total cholesterol levels whereas presence of angina pectoris was more likely to be associated with attainment of LDL-C goals. The attainment of recommended goals in patients could be due to better monitoring of BP and lipid levels in these patients to avoid any further disease-related complications. Presence of kidney disease increased the likelihood of not attaining BP goals. The evidence shows that the presence of renal dysfunction plays a key role in increasing BP.\textsuperscript{70} However, patients with kidney disease were more likely to attain LDL-C goals. The reason for attainment of LDL-C goals in patients with kidney disease is not known.

Patients with stage 1 and stage 2 hypertension were less likely to attain BP and dual BP/LDL-C goals compared to patients with prehypertension. Similarly, patients at intermediate or high cardiovascular risk were less likely to attain LDL-C or dual BP/LDL-C goals. A number of reasons have been cited in the literature for the failure to achieve recommended goals. First, for effective control of BP, JNC 7 recommends
combination of two or more lifestyle modifications such as Dietary Approaches to Stop Hypertension (DASH) eating plan, dietary sodium reduction, physical activity, and weight reduction in overweight or obese as well as recommended anti-hypertensive medications. Lack of compliance to this behavioral modifications coupled with complex treatment regimen might result in lower likelihood of attaining BP goals.

Second, it has also been shown that only 36% of patients are adherent to both antihypertensive and antilipemic medications after one year of treatment which can further explain the lack of goal attainment in most patients. Finally, results from a meta-analysis study indicated that a patient’s health belief played an important role in adherence. The Health Belief Model (HBM) was one of the first models and is one of the most widely recognized conceptual frameworks of health behavior. HBM adapted theory from behavioral sciences to health problems and comprised of four components (perceived susceptibility, perceived severity, perceived benefits, and perceived barriers) which indicated individual’s “readiness to act”. These HBM components, specifically “perceived severity” have been studied as predictors of patients’ adherence to treatment.

Further, actual disease severity (health status) has also been suggested as a factor in adherence to treatment. Thus, based on HBM, it has been suggested that patients with lower disease severity have increased likelihood of not being adherent to treatment regimen. Similarly, poor adherence has been indicated for patients with more serious health conditions and this reduced adherence results from physical and emotional challenges of adhering to complex treatment regimens.

Patients with higher LDL-C levels and higher total cholesterol at baseline were less likely to attain LDL-C and dual BP/LDL-C goals as well as optimum total
cholesterol levels. In our study population with concomitant hypertension and
dyslipidemia, most of the patients were at intermediate (38.2%) or high (57.2%)
cardiovascular risk, which might be the reason for lower likelihood of LDL-C control in
patients who had higher LDL-C levels at baseline. Lack of appropriate control of LDL-C
levels might further have negative effect on attaining BP goals. However, the exact
relation between LDL-C goal attainment and BP goal attainment is not known. There
might be some link between different lipids as well as lipids and cardiovascular risk
factors. However, the exact reason for the effect of total cholesterol on BP and LDL-C
goals is not known.

Patients with higher triglyceride levels were more likely to attain LDL-C goals.
The probable reason could be that triglycerides are considered secondary target of
treatment and it could be that triglyceride levels are monitored especially in patients with
diabetes, atherogenic dyslipidemia, and metabolic syndrome to further reduce
cardiovascular risk. However, optimum total cholesterol, triglyceride, and HDL-C
levels were not attained in patients with higher triglyceride levels at baseline. The exact
reason for association between non-LDL lipids and triglyceride levels is not known and
needs further research. Higher HDL-C levels at baseline were associated with increased
likelihood of attaining optimum triglyceride levels. Higher HDL-C levels, especially ≥60
is considered a protective factor and decreases cardiovascular risk and might also have
some effect on overall lipid profile.

Increased likelihood of not attaining optimum HDL-C levels was observed in
patients who were current smokers. This finding is consistent with previous research that
suggests that cigarette smoking depresses HDL-C level in the blood and this result in excessive buildup of cholesterol levels.\textsuperscript{73,74}

\textit{Medication-related factors associated with therapeutic goal attainment}

Patients prescribed at least one antihypertensive medication were less likely to attain BP and dual BP/lipid goals compared to patients not prescribed any medication. Further, the likelihood of attaining BP goals decreased with increase in number of antihypertensive medications prescribed. This is an interesting but a counterintuitive finding since anti-hypertensive medications have shown to be effective for BP control. Physicians suggest that BP is more difficult to control than lipid levels and is even harder with very high BP \{Dr. Louis Civitarese (Preferred Primary Care Physician Group), personal conversation, June 21, 2012\}. Our study results showed that most of the patients were at prehypertension stage (borderline high BP). So, it is possible that patients who had borderline high BP were not prescribed any medication, but were still able to achieve recommended BP target by lifestyle modifications (e.g., DASH diet plan, reduced dietary sodium intake, exercise, and weight reduction). As discussed earlier, two or more lifestyle modifications are recommended by JNC 7 for effective BP control. Further, guidelines recommend that for the therapy to be effective, patient should be motivated to take the medication. Lack of patient compliance to the prescribed medication regimen as well as recommended dosage might be associated with increased likelihood of not attaining BP goals. Several factors such as physician-related (experience, attitude), physician-patient communication, cost of medication, complexity of care\textsuperscript{18} might contribute to lack of patient compliance to prescribed medications.
Optimum triglyceride levels were not attained in patients prescribed two antihypertensive medications and optimum total cholesterol levels were more likely to be attained in patients prescribed at least four medications. The reason for this finding is not known and needs further research.

Patients prescribed one antilipemic medication were more likely to achieve LDL-C and dual BP/LDL-C goals. Most of the patients were prescribed statins, which are effective in lowering LDL-C levels and other lipid levels. In addition, use of statins is recommended in patients at high or very high cardiovascular risk. Similarly, optimum total cholesterol and triglyceride levels were attained in patients prescribed at least one antilipemic medication.

**Medication prescribing pattern**

Patients with multiple risk factors such as hypertension, dyslipidemia, and obesity are considered to be at high cardiovascular risk. Further, patients with cardiovascular conditions such as diabetes, heart disease, stroke, and kidney disease are considered to be at very high cardiovascular risk. The JNC 7 and NCEP ATP III guidelines recommend simultaneous control of factors, especially modifiable risk factors (hypertension, dyslipidemia, and obesity) by implementing both lifestyle modifications and pharmacological treatment. As discussed previously in the Methods section, aggressive treatment is also recommended for these patients for attaining recommended BP and lipid goals. For example, patients with complicated hypertension are recommended at least two antihypertensive medications. Further, the information regarding type of medication and number of medications prescribed is available in EMR. It is important to evaluate
whether the guideline recommended pharmacological treatment is being implemented appropriately for attaining optimum BP and lipid levels. Thus, both antihypertensive and antilipemic medications and prescribing pattern was analyzed in patients with concomitant hypertension and dyslipidemia and differences in medication prescribing pattern were also evaluated for obese versus non-obese patients.

*Medication prescribing pattern in patients with concomitant hypertension and dyslipidemia*

About 60% of patients were prescribed antihypertensive medications either alone or in combination with antilipemic medication. The JNC7 guidelines recommend at least two antihypertensive medications be prescribed to these patients; 57.5% or 67.1% of patients with uncomplicated or complicated hypertension, respectively, were prescribed the recommended number of medications. Only 39% patients were prescribed antilipemic medication either alone or in combination with antihypertensive medications. NCEP ATP III guidelines recommend at least one antilipemic medication for patients at high or very high cardiovascular risk and lifestyle intervention for patients at low or intermediate risk. Among patients at high or very high risk, about 70% of population was prescribed at least one antilipemic medication.

An analysis of the 1999-2000 NHANES demonstrated that only 58.4% of patients were treated for hypertension and only 12% of patients with dyslipidemia were prescribed antilipemic medication. Beaton et al. (2004) study of diabetic patients (population at high cardiovascular risk) in managed care plan showed that 64% patients were prescribed antihypertensive medications and 28% were prescribed antilipemic
medications.\textsuperscript{75} Welch et al. (2005) study results showed that antilipemic medications were prescribed to 55.3\% of patients at high cardiovascular risk.\textsuperscript{57} Our study shows improved treatment rates and this might be due to physicians adhering to treatment guidelines. Another reason for higher proportion of patients being prescribed could be that most of the patients in our study have multiple conditions (hypertension, dyslipidemia, diabetes, and obesity). Still, about one-third of patients with complicated hypertension or at high cardiovascular risk were not receiving at least two antihypertensives or at least one antilipemic, respectively. The probable reason could be less number of physician office visits which might result from complexity of care\textsuperscript{12} (transportation, difficulty in scheduling appointments, and life’s competing demands).

In patients with concomitant hypertension and dyslipidemia, ACEI was the most common antihypertensive medication class prescribed followed by beta blockers, calcium channel blockers, thiazide diuretics and ARBs. Among combination therapy (both fixed dose and other combinations), ACEI and diuretics combination was the most commonly used followed by ARBs and diuretics combination. Among antilipemic medications, higher proportions of patients were using statins. All of these medication classes have shown beneficial effect in clinical controlled outcome trials and thus are recommended by JNC7 and NCEP ATP III guidelines. In addition, results are consistent with other studies which have reported ACEI (mono-therapy) and ACEI-diuretics (combination therapy) to be used more commonly compared to other antihypertensive medications\textsuperscript{36, 37, 39} and statins being the most commonly prescribed antilipemic medications\textsuperscript{49, 53}.  

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Medication prescribing pattern in obese versus non-obese patients with concomitant hypertension and dyslipidemia

Most of the obese patients were prescribed both antihypertensive and antilipemic medication. Higher proportion of obese patients were prescribed at least two antihypertensives medications compared with normal-weight and overweight patients. In addition, higher proportion of obese patients were also prescribed at least one antilipemic medication compared with normal-weight and overweight patients. The probable reason could be that higher proportion of obese patients had co-morbid conditions like diabetes and were at high cardiovascular risk, as shown by our study results. Having multiple risk factors like hypertension, dyslipidemia, obesity, and diabetes can further increase the cardiovascular risk, thus making it necessary to control these risk factors.

Regarding antihypertensive medication class, significantly higher proportion of obese patients were prescribed ACEI and/or diuretics as well as other diuretics at baseline. Thiazide diuretics or in combination with ACEIs are the most commonly used in different populations and are shown to be effective for treating hypertension. Thus, for achieving recommended BP targets in this population, ACEI and diuretics were commonly prescribed. However, significant difference for thiazide diuretics was not observed at follow-up because these drugs are most commonly recommended for initial therapy.

Regarding antilipemic medications prescribed at baseline, statins were prescribed to higher proportion of overweight patients followed by obese patients. However, at follow-up higher proportion of obese patients were prescribed statins. Statins are the most effective treatment for elevated LDL-C. Obese patients were at high cardiovascular
risk followed by overweight patients and thus, statins were prescribed to these patients for effective control of LDL-C levels.

**CONCLUSIONS**

In conclusion, substantial proportion of patients with concomitant hypertension and dyslipidemia failed to attain BP and lipid goals. The study results also demonstrated that in patients with concomitant hypertension and dyslipidemia, obesity appears to be an independent risk factor for the failure to attain BP goal as well as optimum levels of triglycerides and HDL-C. Further, patients who were overweight or obese failed to attain BP goals, despite being prescribed higher number of antihypertensive medications. Higher likelihood of failure to attain BP or LDL-C goals was also observed for women and patients who also had diabetes. Inadequate goal attainment observed in this study are consistent with findings in other populations, suggesting that further work is required to determine the underlying reasons for these differences to improve the management of patients with hypertension, dyslipidemia, and obesity. Patients who are obese might inherently have more severe hypertension and dyslipidemia that are more difficult to control. The potential reasons for these differences could not be assessed in our observational study, but it appears that a combination of pharmacologic and lifestyle therapies might be the best approach to narrow this treatment gap. Our results suggest that quality improvement projects should be directed at patients with high cardiovascular risk, particularly those who are obese, to eliminate the existing treatment gap, thereby improving the control of blood pressure and lipid levels.
STUDY IMPLICATIONS

The study results provide insight into the variations in therapeutic goal attainment (BP and lipid) and medication prescribing pattern in patients with concomitant hypertension and dyslipidemia, with a primary focus on obese versus non-obese patients. It is evident from the study findings that there is inadequate BP or/and LDL-C goal attainment in patients with concomitant hypertension and dyslipidemia, especially in obese patients. The study results can be interpreted in the context of real-world medical practice and can be useful in the following aspects.

First, the study results have identified population at increased cardiovascular risk, i.e. patients with multiple risk factors. The physician group using this EMR database can identify and follow-up these patients and immediately implement appropriate strategies, tailored specifically for each patient based on their cardiovascular risk profile. For example, our study identified patients in whom BP and/or LDL-C goals were not attained. Based on this information, physicians can review the patient information in the EMR and can specifically intervene on patients not attaining recommended BP or LDL-C goals. Moreover, the EMR provides advantage of having complete clinical information and the data available from EMR can be analyzed in an ongoing and real-time basis for the entire populations under care, which can be useful for physicians in monitoring health status of patients regularly and in a timely manner.

Second, the study results will also help physicians in making clinical decisions on the intensity of preventive interventions. This includes dietary advice which can be strict and specific based on the patient’s risk factors, suggestions for physical activity along
with duration and intensity, and prescribing the recommended medications, all tailored individually based on the patient’s overall predicted risk.

Lastly, the use of EMR for outcomes research may be used to help improve the overall process of care, especially in primary care practice. EMR provides a patient-centered data and patients with multiple conditions can be identified easily. Thus, physicians can treat patients taking all the multiple conditions into account. For example, our study showed that some patients had concomitant hypertension, dyslipidemia, diabetes, and obesity, while others had only concomitant hypertension and dyslipidemia. This information plays a vital role in designing a patient-centered approach, i.e., treatment strategies tailored specifically based on the health status of each patient. EMR provides both pre- and post-diagnosis information which can be helpful for improving follow-up of test results and overall health status. For example, physicians can monitor patients not at BP or LDL-C goals from time to time.

LIMITATIONS

Although this study provides insight into the factors associated with BP and lipid goal attainment as well as medication utilization pattern in a real-world practice using EMR database, but there are some limitations. First, the study results are based on a specific patient population and may not be generalizable to other populations. Second, the EMR database used contains data from one physician group from a limited geographical area and results may not be generalizable to other physician practices. Moreover, the differences in the evaluation of patient by different providers within the
practice itself might result in variations in management of hypertension and dyslipidemia. Third, EMR does not provide information related to lifestyle modifications (diet and physical activity), an important factor for management of hypertension and dyslipidemia. Fourth, race/ethnicity being another important variable associated with hypertension or dyslipidemia was excluded from the multivariate analysis because there were about 21% of missing or undetermined cases. Fifth, BMI was used as the indicator of obesity for this study. Recent studies have suggested that the use of waist circumference or waist/hip ratio might be a more accurate measure of visceral obesity, specifically for determining cardiovascular risk. EMR does not contain information on waist circumference, thus this measure was not used along with BMI. However, BMI is still an accepted measure of obesity and was an appropriate for this study as main focus was on attainment of therapeutic goals and medication prescribing pattern. Lastly, EMR database provides information regarding medications prescribed to patients, but information related to actual utilization of medications (proportions of prescriptions filled, proportions of prescriptions not filled, patient compliance) is not available. The information regarding medication dosage is also not available, which might affect BP or lipid goal attainment.

OPPORTUNITIES FOR FUTURE RESEARCH

Based on the study findings, it is evident that variations in therapeutic goal attainment and medication prescribing pattern do exist among patients with concomitant hypertension and dyslipidemia, especially in obese versus non-obese patients. Further research needs to be conducted to better understand these differences. Additional studies
should evaluate the mechanistic link between obesity and failure to achieve recommended therapeutic goals.

The lifestyle modification (diet and physical activity) is recommended by guidelines for treatment of hypertension and dyslipidemia. Studies focusing on effect of both non-pharmacological or and pharmacological treatment approach might be useful in designing appropriate interventions for attaining recommended therapeutic goals.

Adherence to treatment (pharmacological or non-pharmacological) is important for managing hypertension, dyslipidemia, and obesity. Studies have suggested that patient motivation to take prescribed medications and to maintain a health-promoting lifestyle play an important role in the management of hypertension. Patient attitudes are influenced by cultural differences, beliefs, and previous experiences with healthcare system. To understand these differences, healthcare professionals should have increased communication with the patients. Thus, studies should explore the role of physician-patient communication on attainment of recommended therapeutic goals. Further studies focusing on role of pharmacist-physician collaboration in management of BP and lipid goals in patients at-risk might be useful in designing interventions with improved patient adherence. Studies should also focus on relationship between physician-related factors (physician’s experience, knowledge, and attitude) and attainment of therapeutic goals.

Time needed to attain BP and lipid goals is also an important aspect of managing hypertension and dyslipidemia. Studies evaluating the time needed to attain goals and identifying factors that are associated with time taken to attain goals might provide useful information for designing patient-centered strategy for managing cardiovascular risk factors appropriately.
REFERENCES

1. National Heart Lung and Blood Institute.


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Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III).


32. Ford ES, Mokdad AH, Giles WH, Mensah GA. Serum total cholesterol concentrations and awareness, treatment, and control of hypercholesterolemia


60. FasterCures, Think Research, Using electronic medical records to bridge patient care and research. White paper, Fall 2005.


64. How obesity threatens America’s future, 2011.


68. American Heart Association.

70. High blood pressure and chronic kidney disease.


73. Lazaro T. Lowering HDL cholesterol by smoking.


