

Cardiovascular Disease

This brief summarizes the contributions of Kaiser Permanente Research since 2007 on the topic of cardiovascular disease (CVD). Although CVD encompasses a wide array of health conditions, this brief will focus primarily on research related to stroke, coronary heart disease, and heart failure.

According to the Centers for Disease Control and Prevention, cardiovascular disease is responsible for more than 600,000 deaths in the United States each year.¹ Though mostly preventable, it is the leading cause of death in both men and women, and across nearly all racial and ethnic groups.¹ Coronary heart disease, or the accumulation of atherosclerotic plaque within the arterial vessels of the heart, is the most common form of heart disease, and is associated with 370,000 deaths each year.¹ An estimated 5.7 million Americans also suffer from heart failure, or the heart's inability to pump sufficient blood and oxygen to the body's organ systems.² Heart failure is a contributing cause in approximately 1 in 9 deaths, and half of patients with heart failure die within 5 years of diagnosis.²

Stroke, or a disruption in the blood supply to the brain caused by a burst or blocked blood vessel, occurs in nearly 800,000 Americans each year.³ Stroke kills approximately 140,000 Americans annually,⁴ and is a leading cause of significant long-term disability, with consequences that often require long-term skilled nursing care.³

Cardiovascular disease is an active area of study for Kaiser Permanente Research. Scientists across the program have used our rich, comprehensive, longitudinal data to advance knowledge in the areas of understanding risk, improving patient outcomes, and translating research findings into policy and practice. We have published more than 1,200 articles related to CVD

Kaiser Permanente Publications Related to Cardiovascular Disease since 2007



Source: Kaiser Permanente Publications Library and PLUM metrics, as of 3 March 2018.

a Number of citing journal articles, according to Scopus.

b Number of references in PubMed guidelines.

c Citations in DynaMed Plus, a point-of-care clinical reference tool.

since 2007. Together, these articles have been cited nearly 75,000 times. These articles are the product of observational studies, randomized controlled trials, meta-analyses, and other studies led by Kaiser Permanente scientists. Our unique environment – a fully integrated care and coverage model in which our research scientists, clinicians, medical group, and health plan leaders collaborate – enables us to contribute important knowledge about CVD, and many other topics of research.

Understanding Risk

Who is at risk for developing cardiovascular disease?

Among adults, Kaiser Permanente scientists have assessed a variety of risk factors, including diabetes,^{5,8} high blood pressure,^{5,8,9} high cholesterol,^{7,8,10} smoking,^{8,9} obesity,⁷ kidney disease¹¹⁻¹⁴ and genetics.¹⁵ Our researchers have also extensively studied CVD risk factors within pediatric populations, including congenital heart defects¹⁶, high blood pressure,¹⁷⁻¹⁹ and obesity.^{20,21}

In large part because of the emphasis on prevention in the Kaiser Permanente system,²² high cholesterol²³ and uncontrolled blood pressure²⁴⁻²⁶ are much less common among our members than in the broader U.S. population. In addition, the racial, ethnic, and

socioeconomic disparities in these risk factors seen nationally are not as large among our members.^{27,28}

What other health risks do people with cardiovascular disease face?

People with CVD face several associated health risks. While death is a well-known consequence of many cardiovascular diseases, superior risk-factor control within Kaiser Permanente has reduced CVD death rates among our members.²⁹⁻³² Nevertheless, CVD carries other significant risks, including long-term disability^{33,34} and long-term need for post-acute care following stroke,^{27,35,36} repeated hospitalization among patients with heart failure,³⁷⁻⁴³ and dementia⁴⁴⁻⁴⁶ and diabetes^{47,48} among heart failure and coronary heart disease patients.

Moreover, the medications used to treat various cardiovascular diseases carry significant risks and side effects. Patients receiving anticoagulants for prevention of stroke are at increased risk of severe bleeding events⁴⁹⁻⁵⁴ and mortality.⁵⁵ In addition, common treatments for heart failure and high blood pressure frequently have serious side effects, including high blood potassium⁵⁶ and risk of birth defects.⁵⁷

Improving Patient Outcomes

What strategies are effective in preventing cardiovascular disease?

Prevention strategies in CVD focus primarily on measuring and treating risk factors. Kaiser Permanente tracks the American Heart Association's "Life's Simple 7" cardiovascular health metrics, including physical activity,⁵⁸⁻⁶⁴ obesity,⁷ blood pressure,^{24-26,65-69} blood glucose,^{7,67,70,71} cholesterol,^{7,10,66,67} and smoking,⁵⁸ and uses them to measure treatment response and perform ongoing surveillance. This work is conducted by teams led by primary care physicians.^{65,72-74} Screening also plays a significant role in CVD prevention; for example, early identification of elevated blood pressure has been shown to improve outcomes in adult patients.^{75,76} Evidence also supports cholesterol screening in pediatric patients.^{77,78}

PHYSICAL FITNESS INSIGHTS

Kaiser Permanente researchers have published insights about physical fitness using data from CARDIA, a 30-year study of CVD risks and causes in 5,115 young adults in 4 U.S. cities



GREATER FITNESS
in young adulthood is associated with superior heart function in middle age⁶¹



SHORT BURSTS OF EXERCISE
(< 10 minutes) can reduce the risk of high blood pressure⁶²



ACTIVE COMMUTING
to work is associated with lower BMI, blood pressure, and cholesterol⁶⁴

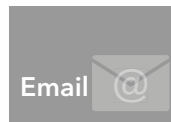


WALKING OR CYCLING
to neighborhood amenities is associated with lower BMI and lower lifetime CVD risk⁶⁴

What are the key factors in effective treatment of people with cardiovascular disease?

Risk-Factor Management. In addition to direct treatment of CVD, ongoing risk-factor management is a critical component of the care of these patients. Studies conducted in Kaiser Permanente have found improved outcomes from smoking cessation interventions,^{79,80} dietary advice,⁸⁰⁻⁸⁸ and physical activity interventions^{59,80,81,89-91} in patients with cardiovascular disease. Increased use of secure email between patients and clinicians has been associated with improved outcomes in patients with high blood pressure and diabetes.⁹²

KAISER PERMANENTE EMPLOYS EFFECTIVE STRATEGIES TO HELP PATIENTS WITH CVD



Email communication between physicians and patients with high blood pressure and/or diabetes was associated with improved performance scores⁹²



Rates of tPA administration for acute stroke increased in emergency departments with an on-call neurologist available by phone^{138,139}



Patients enrolled in a mail-order pharmacy program were more likely to adhere to recommended hypertension treatment⁶⁸



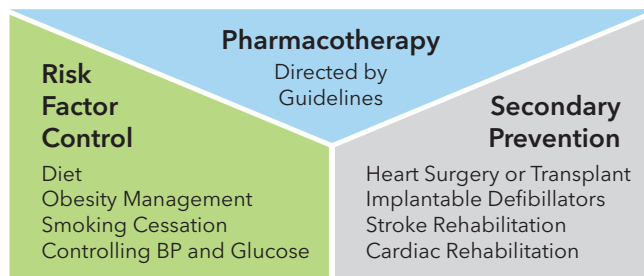
In a randomized trial, statin adherence and cholesterol control were enhanced by IVR reminders^{111,113-116}

Pharmacotherapy. Medications are an established component of evidence-based care for both CVD management and control of risk factors. While a discussion of specific medications is beyond the scope of this brief, our researchers have led or collaborated on key studies exploring the efficacy and safety of numerous medications in CVD populations. These have included large studies of glucose-lowering medications for control of type 2 diabetes and prevention of cardiovascular complications of diabetes,^{70,71,93-96} drugs to lower blood pressure,^{24,97-106} and cholesterol-lowering medications.^{101,102,107-109}

Given its importance in the care of patients with CVD, medication adherence has also been a significant focus of research in Kaiser Permanente. One large cohort study found that non-adherence to medications such as ACE inhibitors, statins, and beta-blockers was associated with increased risks of all-cause and cardiovascular mortality, revascularization (an invasive medical procedure that restores blood flow to blocked or narrowed coronary arteries), and cardiovascular hospitalization.¹¹⁰ We have evaluated several medication adherence interventions for patients with CVD involving clinical pharmacist^{65,108,111} or community health worker¹¹² outreach, interactive voice response calls and reporting,^{111,113-116} mail-order pharmacy programs,⁶⁸ or web-based medication self-management.¹¹⁷ Another study, conducted in our members with diabetes, found that addressing undertreatment

CVD MANAGEMENT

CVD management involves pharmacotherapy, risk factor control, and other secondary prevention



in addition to non-adherence could significantly improve outcomes for those with uncontrolled blood glucose, cholesterol, or blood pressure.⁷⁰

Other Secondary Prevention. In addition to medication and lifestyle modification, surgical procedures (including heart transplantation) and device implantation are also components of CVD management. Coronary revascularization has been studied extensively within Kaiser Permanente. Our researchers have explored the adoption¹¹⁸ of this family of technologies and geographic variations in their use.¹¹⁹ Others have found that improved patient outcomes are associated with the use of specific invasive procedures¹²⁰⁻¹²³ particular clinical characteristics,^{124,125} surgeons who perform more procedures,¹²⁶ and improved practices for managing blood clots.¹²⁷

For patients with certain severe heart conditions, heart transplantation is an important treatment strategy. Our researchers have found that receiving a heart from a donor with diabetes mellitus,¹²⁸ a history of transplant rejection,¹²⁹ and longer wait times before transplantation¹³⁰ are associated with poorer heart transplant outcomes. Another study described a DNA-based method for non-invasive diagnosis of heart transplant rejection,¹³¹ increasing the ease of post-transplant monitoring. Our research on implantable cardiac defibrillator (ICD) usage has explored how often these devices are used in off-label^{132,133} or non-guideline-directed fashion.¹³⁴ Other studies have found that mortality outcomes in patients with ICDs are associated with heart function, the heart's structure,³⁹ and higher BMI,¹³⁵ and have evaluated algorithms for the prediction of survival and sudden death in these patients.¹³⁶

In several studies, Kaiser Permanente researchers found that the absence of appropriate treatment intensification was more common than medication non-adherence in CVD patients with uncontrolled risk factors^{67,70,96,98,105,110}

Uncontrolled Risk Factor	Non-Adherence	Treatment Not Escalated
Blood Pressure	19-42%	26-78%
Blood Sugar	18-42%	26-47%
Cholesterol	19-49%	25-55%

Translating Research Findings into Policy & Practice

How has Kaiser Permanente research on cardiovascular disease contributed to changes in policy and practice?

As part of a learning health care organization that uses research to inform and improve practice, Kaiser Permanente's research, clinical, and operational partners have tested a range of interventions to reduce the risk of cardiovascular disease and improve outcomes for patients with CVD. For example, research supporting the efficacy of combining ACE inhibitors and

HEART ATTACKS AND HIGH BLOOD PRESSURE RATES

Thanks to interventions validated by our researchers, rates of heart attacks and high blood pressure dropped sharply in Kaiser Permanente Northern California between 1999 and 2014

	1999	2014
% With High Blood Pressure ¹⁰⁶	54%	10%
Heart Attacks per 100,000 Members ^{31,32}	274	185

thiazide diuretics in a single pill for blood pressure management¹⁰² led to broad adoption of this practice in Kaiser Permanente's blood pressure management program.²⁵ The spread of single-pill blood-pressure-lowering therapy increased the ease of removing beta-blockers as a first-line treatment, a transition prompted by our research data questioning the benefits of these medications.¹⁰⁴ Our research in acute stroke management¹³⁷ has led to implementation of effective telestroke programs with an on-call neurologist available via telemedicine technology to emergency department physicians in our Northern California¹³⁸ and Southern California regions.¹³⁹

Collectively, research from Kaiser Permanente authors has been cited nearly 400 times within recent consensus statements and clinical practice guidelines published by a wide range of entities, including the American Stroke Association and American Heart Association.¹⁴⁰ In addition, our researchers and clinician scientists have directly contributed as authors of the hypertension guidelines of the 8th Joint National Committee,¹⁴¹ the atrial fibrillation guidelines of the American College of Chest Physicians,¹⁴² the obesity guidelines of the American College of Cardiology, the American Heart Association, and The Obesity Society,¹⁴³ and two statements regarding physical activity from the American Heart Association.^{144,145} Finally, the hypertension management efforts implemented in our California regions^{24,25} have received widespread recognition,¹⁴⁶ particularly with respect to reducing racial disparities in blood pressure control.¹⁴⁷

Kaiser Permanente has shown considerable leadership in the field of cardiovascular disease research. We have endorsed and actively supported the U.S. Department of Health and Human Services' Million Hearts Initiative,¹⁴⁸ and our Colorado,¹⁴⁹ Northern California,¹⁵⁰ and Georgia¹⁵¹ regions have been recognized as Million Hearts Hypertension Control Champions. Kaiser Permanente has supported care improvement efforts in safety net health care providers that operate in the same communities.^{152,153} Our researchers have led or collaborated on many notable studies related to epidemiology, prevention, risk factors, and treatment of CVD, including the Coronary Artery Risk Development in Young Adults (CARDIA) study, the Cardiovascular Research Network (CVRN), and the Anticoagulation and Risk Factors in Atrial Fibrillation (ATRIA) study, all of which have been sponsored by the NIH's National Heart, Lung and Blood Institute.

Kaiser Permanente's nearly 170 research scientists and more than 1,600 support staff are based at 8 regional research centers and 1 national center. There are currently more than 2,500 studies underway, including clinical trials. Since 2007, our research scientists and clinicians have published more than 12,000 articles. Kaiser Permanente currently serves more than 12 million members in 8 states and the District of Columbia.

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