CHAPTER FIVE

Coronary Artery Disease

Coronary Artery Disease

Coronary artery disease, the atherosclerotic narrowing of the arteries that supply blood to the heart, is one of the most common chronic diseases in the United States. One million Americans develop angina or acute myocardial infarction annually; approximately 20% of American deaths are caused by coronary artery disease. For those who survive, the sequelae of coronary artery disease, including congestive heart failure, chronic angina and cardiac arrhythmia, are serious threats to long term survival and quality of life.

An impressive armamentarium of tests and procedures is used in the diagnosis, management and treatment of coronary artery disease, from echocardiography to coronary artery bypass grafting. The high prevalence of coronary artery disease and the vast array of available technology mean that the stakes are high — in morbidity and mortality as well as in spending. The rates at which these interventions are used, however, are highly variable, and the likelihood that a patient with coronary artery disease will have a particular test or procedure depends in large measure on where the patient lives and seeks care.

This chapter examines the variability in treatment of Blue Cross Blue Shield of Michigan members with coronary artery disease. It focuses on:

- The use of diagnostic testing
- The use of therapeutic interventions
- The association between diagnostic testing and treatment

Diagnostic Testing for Coronary Artery Disease

Diagnosis, Prognosis and the Effectiveness of Therapy: the Use of Stress Testing

The stress test is one of the most important means of evaluating the cardiovascular status and functional capacity of patients with suspected or known coronary artery disease. For patients with suspected coronary artery disease, the combination of electrocardiogram response, exercise time, heart rate, rhythm and blood pressure

can be invaluable diagnostic tools. For those with known coronary artery disease, the stress test is important in evaluating the risk of future cardiac events and for assessing response to therapy.

There are two basic forms of stress testing: non-imaging and imaging (with either echocardiography or nuclear studies). While non-imaging stress testing is always performed with exercise, imaging stress tests can be performed either with exercise or with a pharmacological stress agent such as dipyridamole or dobutamine. In 1997, the American College of Cardiology and the American Heart Association released a consensus paper on the choice of test for patients with known or suspected coronary artery disease. They argued that for patients with interpretable baseline electrocardiograms and adequate exercise capacity, the initial test should be a non-imaging stress test. Substantial controversy, however, surrounds the choice between imaging and non-imaging stress testing. Those who argue for non-imaging stress testing as the first choice in patients who can exercise and have an interpretable baseline electrocardiogram point to the long history of demonstrated utility for both diagnosis and prognosis. Proponents of imaging stress testing point to recent literature that suggests imaging studies are both more sensitive and more specific than non-imaging stress tests in diagnosing coronary artery disease in selected populations.

There is controversy about both the evidence and the ramifications of choosing the imaging test as a first diagnostic approach. Many of the studies evaluating the marginal yield of imaging versus non-imaging studies have been done under ideal settings, in non-random selections of patients, raising concern about the generalizability of the findings for settings in which care for patients with coronary artery disease is typically delivered. For imaging stress testing to be worthwhile, its marginal benefit should be large enough to offset the additional costs. An additional concern is that using imaging as a first evaluation could lower the diagnostic threshold, dramatically increasing the number of patients who go on to subsequent evaluations and treatments, which have their own associated costs and risks.

The Use of Non-Imaging Stress Testing

In patients who can exercise and have an interpretable baseline electrocardiogram, non-imaging stress testing is of demonstrated usefulness for both diagnosis and prognosis. Use of non-imaging testing was highly variable among hospital referral regions, however, ranging from fewer than 9 tests per 1,000 adult BCBSM members to more than 27.

Hospital referral regions where rates of non-imaging stress testing were higher than the state average of 18.1 tests per 1,000 members were Lansing (27.6); Flint (22.1); Pontiac (21.5); Marquette (20.0); Royal Oak (19.8) and Petoskey (18.5).

Among hospital referral regions where rates of non-imaging stress testing were lower than the state average were St. Joseph (8.9); Muskegon (12.6); Kalamazoo (14.6); Ann Arbor (15.2) and Saginaw (15.3).

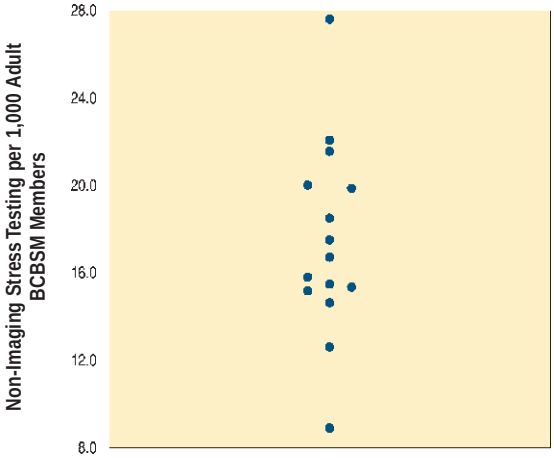
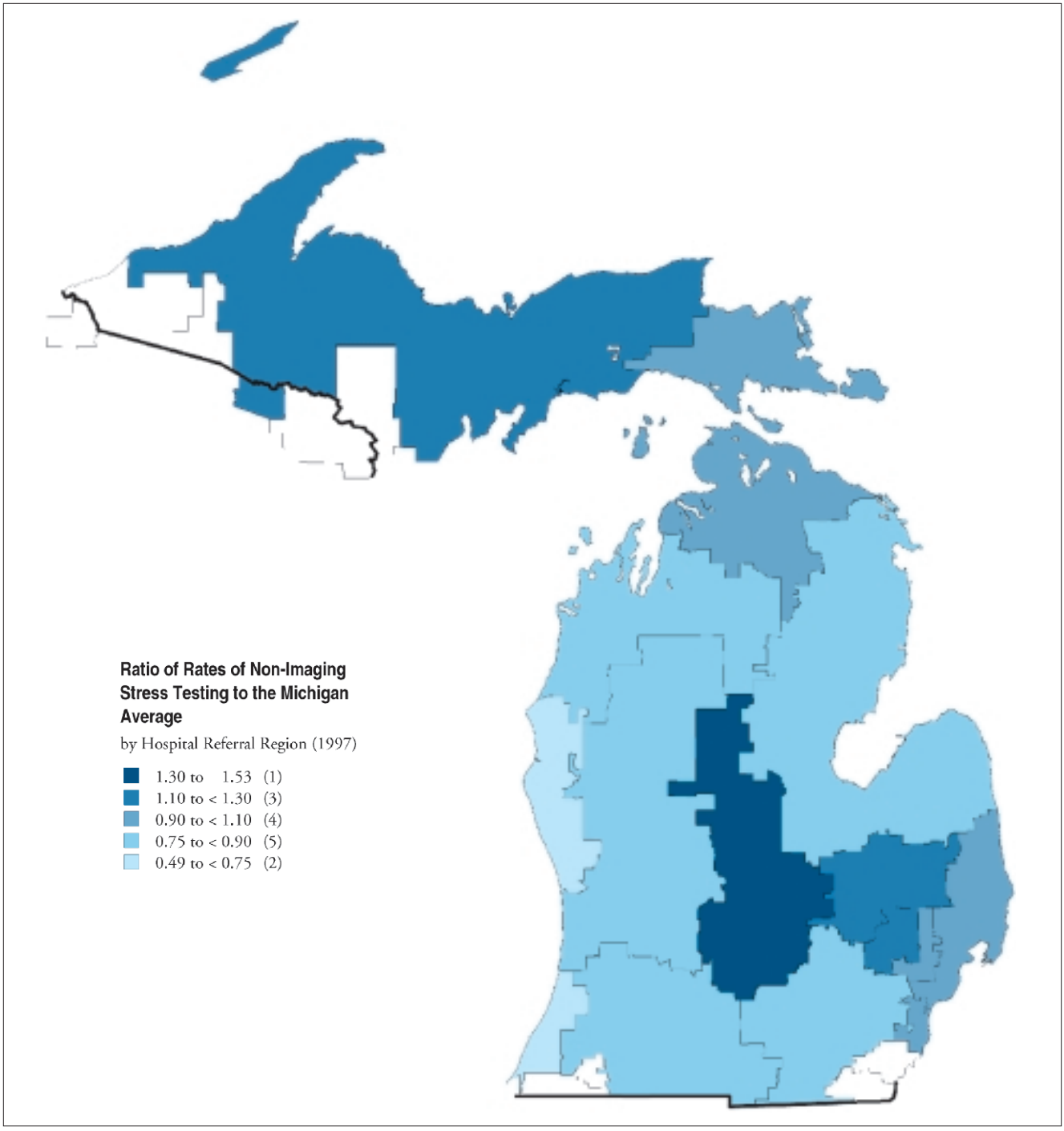


Figure 5.1. Rates of Adult Non-Imaging Stress Testing Among Hospital Referral Regions (1997)

Rates of non-imaging stress testing ranged from fewer than 9 to more than 27, after adjustment for differences in population age and sex. Each point represents one of the hospital referral regions in Michigan.



Map 5.1. Adult Non-Imaging Stress Testing (1997)

One hospital referral region had a rate of non-imaging stress testing at least 30% higher than the state average; two hospital referral regions had rates more than 25% below the average.

The Use of Imaging Stress Testing in BCBSM Members With Coronary Artery Disease

Recent literature has suggested that imaging studies with either echocardiography or nuclear studies are more sensitive and more specific than non-imaging stress tests in making the diagnosis of coronary artery disease in selected populations. However, the benefit over non-imaging stress testing in the general population, and for assessing prognosis, is less certain. In 1997, 60% of stress tests in adult BCBSM members were imaging stress tests. Use of imaging stress testing varied by a factor of more than two, ranging from about 17 per 1,000 adult BCBSM members to more than 35.

Imaging stress testing was performed at rates higher than the state average of 28.2 per 1,000 members among residents of the hospital referral regions in Royal Oak (35.4); Detroit (34.8); Pontiac (33.9); Dearborn (32.2) and Saginaw (31.3).

Stress testing was less common than the state average among members in the hospital referral regions in Grand Rapids (16.9); Marquette (17.8); Lansing (17.9); Kalamazoo (19.2) and Muskegon (19.7).

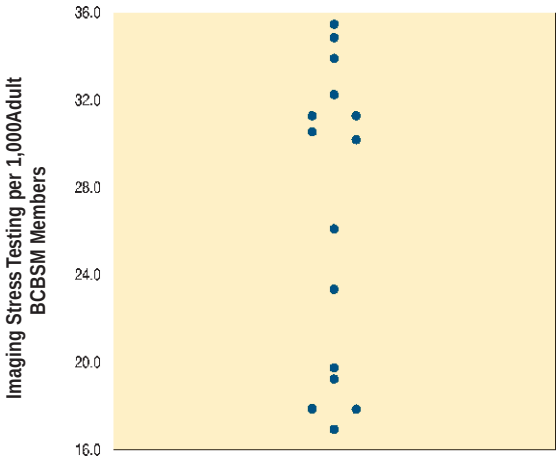
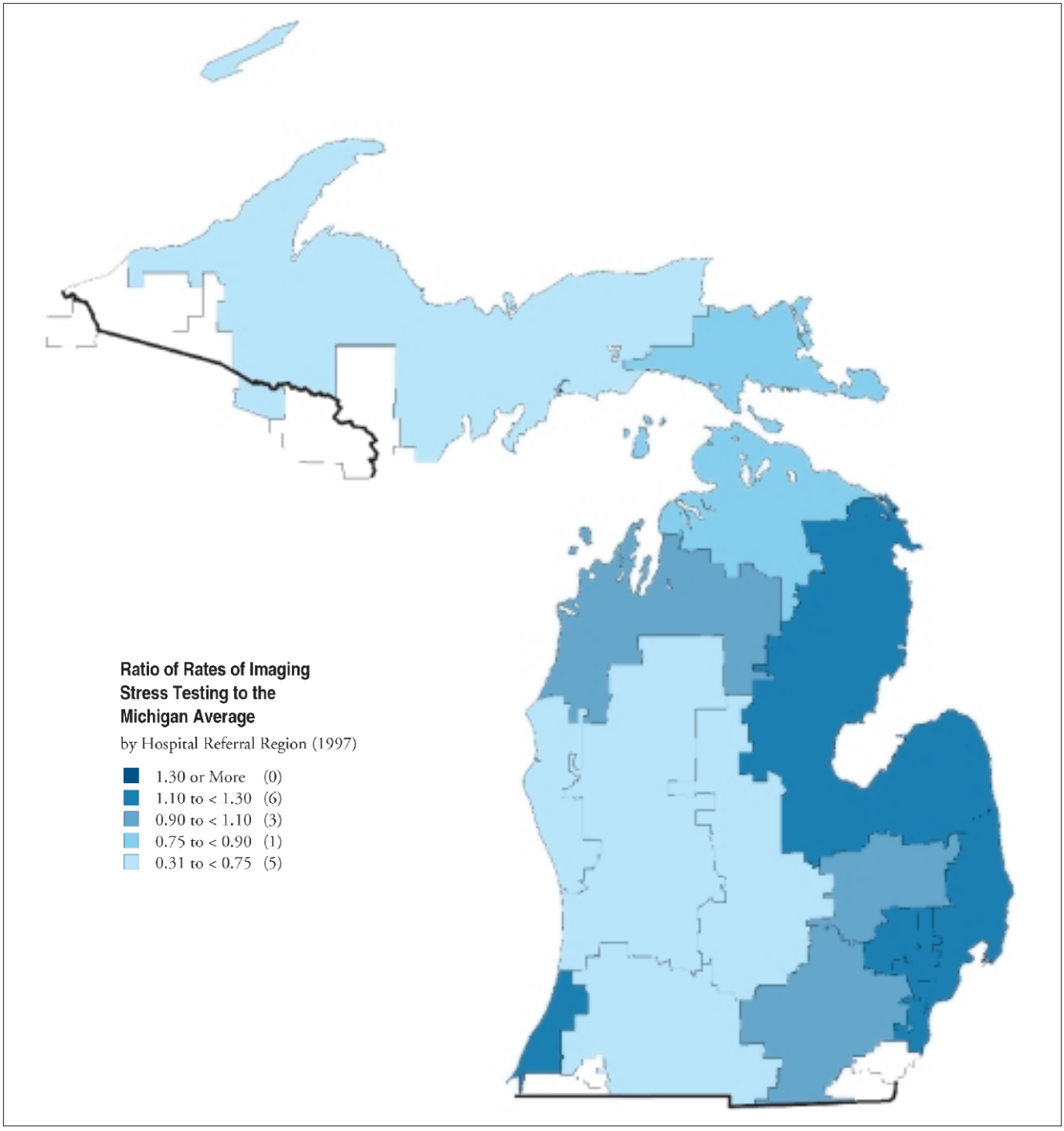


Figure 5.2. Rates of Adult Imaging Stress Testing Among Hospital Referral Regions (1997)

Rates of imaging stress testing ranged from about 17 per 1,000 adult members to about 35, after adjustment for differences in population age and sex. Each point represents one of the hospital referral regions in Michigan.



Map 5.2. Rates of Adult Imaging Stress Testing (1997)

No hospital referral region had a rate more than 30% higher than the state average; five hospital referral regions had rates more than 25% below it.

Is There Evidence of Substitution Between Imaging and Non-Imaging Stress Testing?

Imaging and non-imaging stress test studies are used in similar clinical situations to evaluate patients with suspected or known coronary artery disease. Given the similar functions of the two tests, we would expect that the use of imaging stress testing in a particular region would reduce the use of non-imaging stress testing. To evaluate whether regional preferences for one test or the other explain the variability in testing rates, we plotted the imaging and non-imaging stress testing rates against one another. If one test were being substituted for the other, then areas with areas with high rates of one kind of test would have low rates of the other (Figure 5.3). The fact that there is no correlation (R^2 = .02) suggests that variations were mainly attributable to the rates at which individual physicians recommended testing of both kinds.

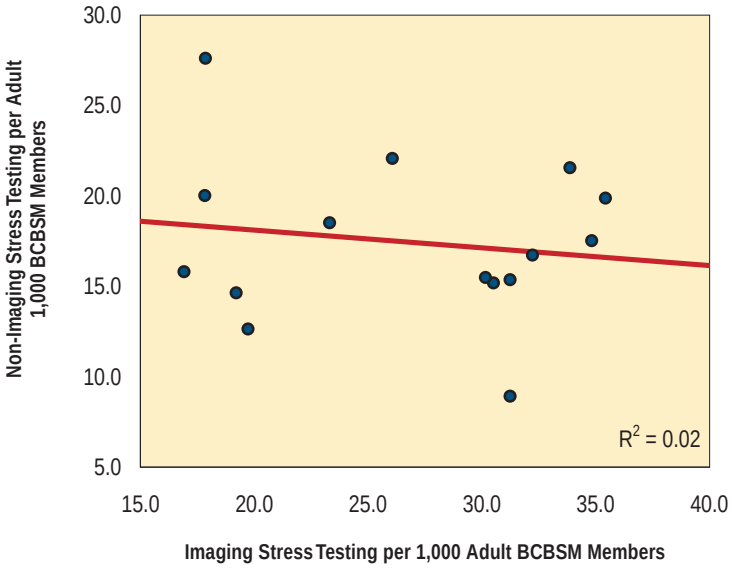


Figure 5.3. The Relationship Between Rates of Adult Imaging Stress Testing and Adult Non-Imaging Stress Testing in Hospital Referral Regions (1997)
Age and sex adjusted rates of imaging stress and non-imaging stress were not correlated, indicating that there was no substitution effect (R^2 = .02).

The Evaluation of Left Ventricular Ejection Fraction: the Use of Echocardiography and Nuclear Scanning

Left ventricular function, in addition to cardiovascular status and functional capacity, is a critical factor in the evaluation of patients with known coronary artery disease. It is the most important prognostic factor, after age, in assessing the risk of perioperative mortality among patients undergoing coronary artery bypass grafting surgery, and is a critical element for physicians and patients to consider when deciding about the need for additional testing or interventions following acute myocardial infarction.

The two most common methods of evaluating left ventricular function are nuclear studies and echocardiography. These tests are principally used to evaluate left ventricular function, but they are also used for other functions such as assessing myocardial ischemia, myocardial viability and valvular disease.

Echocardiography

In 1997, more than 3% of adult and child BCBSM members underwent echocardiography, but rates were not uniform among hospital referral regions; use of the procedure varied by a factor of 2.7. Among the hospital referral regions where rates of echocardiography were higher than the state average of 33.1 per 1,000 BCBSM members were Royal Oak (47.7); Pontiac (44.5); Detroit (44.3) and Dearborn (42.5).

Rates of echocardiography were lower than the state average among members in the hospital referral regions in Muskegon (17.5); Marquette (18.7); Petoskey (18.7) and Kalamazoo (19.4).

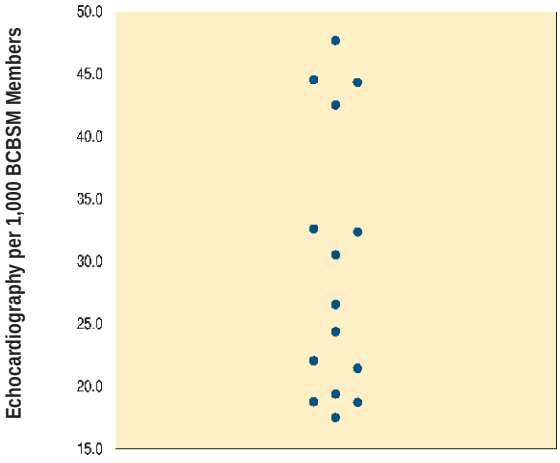
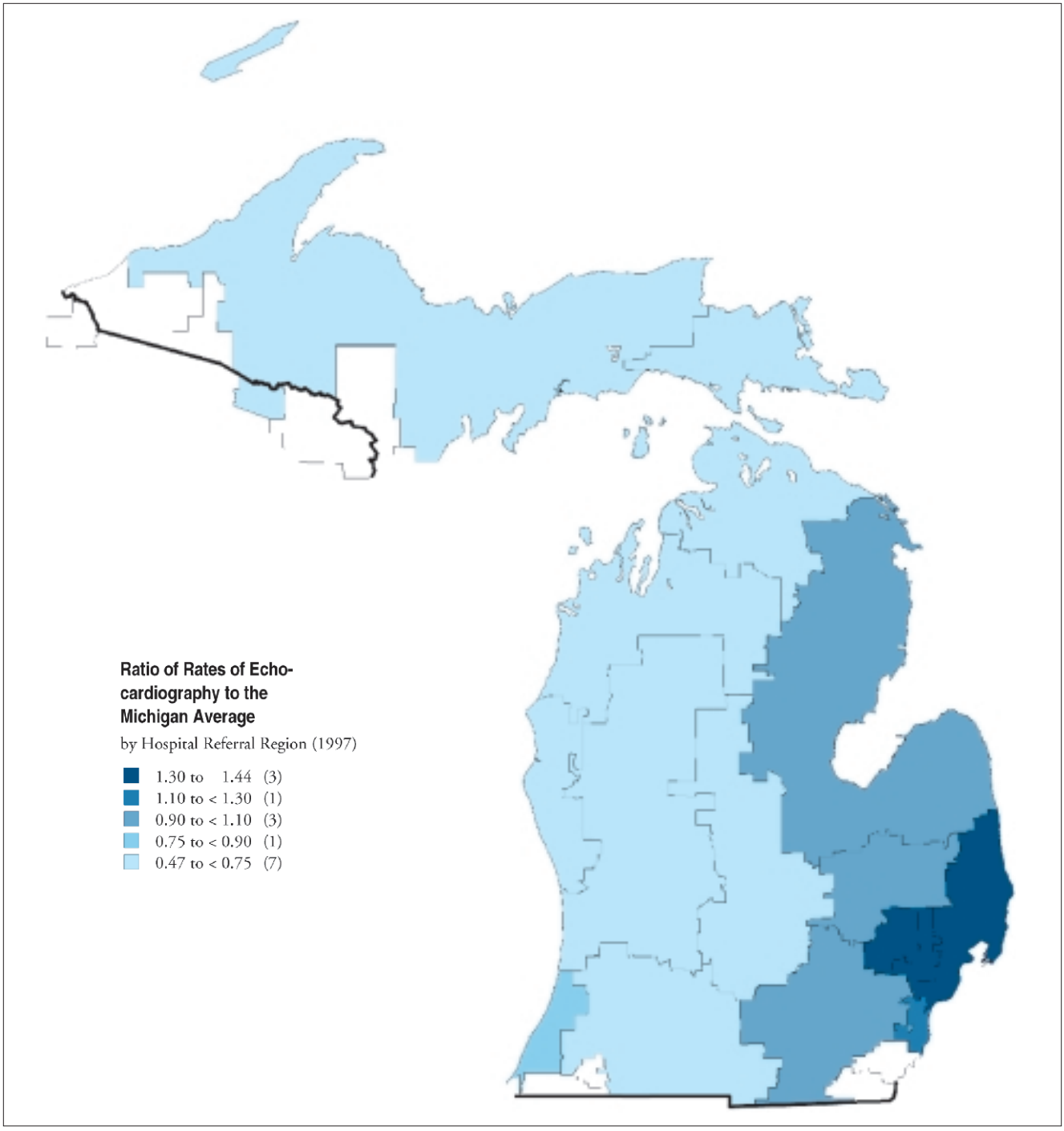


Figure 5.4. Rates of Adult and Child Echocardiography Among Hospital Referral Regions (1997)
Rates of echocardiography ranged from 17.5 to more than 47 per 1,000 members, after adjustment for differences in the age and sex of local populations. Each point represents one of the hospital referral regions in Michigan.



Map 5.3. Adult and Child Echocardiography (1997)

Seven hospital referral regions had rates more than 25% lower than the state average; three regions had rates at least 30% higher than the average.

The Evaluation of Coronary Anatomy: the Use of Coronary Angiography

The “gold standard” for determining whether someone has coronary artery disease is coronary angiography, and the test is used in all candidates for cardiac revascularization. A cannula is inserted into an artery, usually in the groin, through which a small catheter is inserted and advanced into the coronary arteries. Dye is injected through the catheter, and a radiogram is taken.

There is considerable controversy about the utility of coronary angiography in the routine management of patients with acute coronary syndromes. Many non-randomized studies have evaluated the variation in coronary angiography, both as cohort studies using administrative data and in sub-group studies within large randomized trials. In general, these studies have found large geographic, race and gender variations in the use of the test. Very few of these studies have found a survival benefit. On the other hand, four randomized trials of routine invasive diagnostic strategy versus a conservative strategy in patients with acute coronary syndromes have all found either no differences in outcomes, or improved survival in the conservatively managed group.

Coronary Angiography

More than 17,000 coronary angiograms were performed on adult BCBSM members in 1997. Rates varied by a factor of two among hospital referral regions, ranging from fewer than 6 procedures per 1,000 adult members to more than 11.

Rates of coronary angiography were substantially higher than the average of 9 per 1,000 adult BCBSM members among residents of the hospital referral regions in Saginaw (11.3); Dearborn (11.0); St. Joseph (10.5) and Detroit (10.2).

Among the hospital referral regions where rates of coronary angiography were substantially lower than the state average were Muskegon (5.4); Petoskey (6.7); Grand Rapids (7.0) and Lansing (7.5).

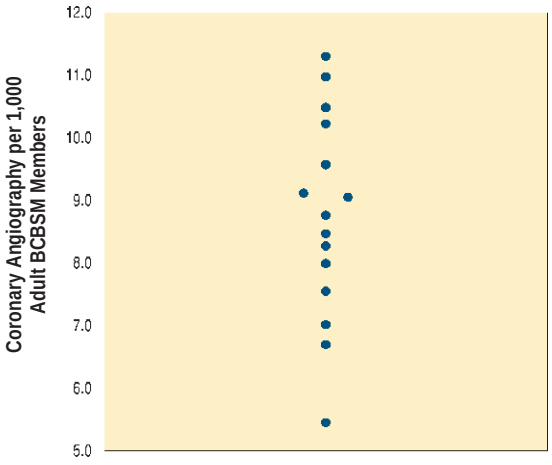
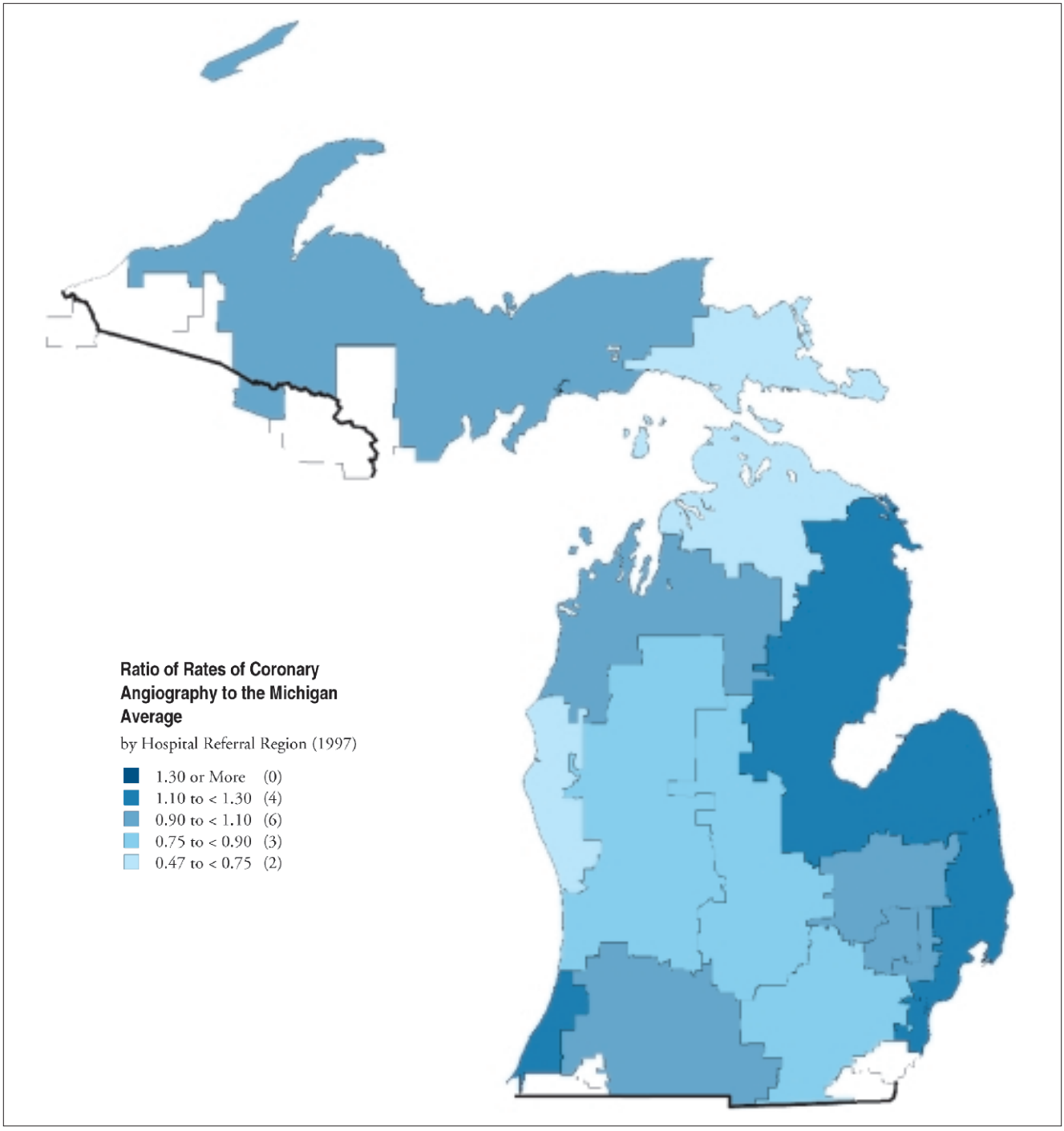


Figure 5.5. Age and Sex Adjusted Rates of Adult Coronary Angiography Among Hospital Referral Regions 1997)
Rates of coronary angiography ranged from about 5 to about 11 per 1,000 adult BCBSM members, after adjustment for differences in the age and sex of local populations. Each point represents one hospital referral region.



Map 5.4. Adult Coronary Angiography (1997)

No hospital referral region had a rate more than 30% higher than the state average; two regions had rates more than 25% below it.

Therapeutic Interventions for Coronary Artery Disease

Revascularization: Coronary Artery Bypass Grafting Surgery and Percutaneous Transluminal Coronary Angioplasty

Although most patients with coronary artery disease are treated medically, a growing number of patients undergo cardiac revascularization, either coronary artery bypass graft surgery or percutaneous transluminal coronary angioplasty. Bypass procedures use either a vein harvested from the leg, or the vein and an artery (usually the internal mammary artery from the chest), to bypass an atherosclerotic narrowing of the coronary artery. The efficacy of bypass, which has been in use since the 1960s, has been evaluated in several well-known clinical trials. These studies found that, compared to medical treatment, surgery offers better symptom improvement and, in specific patient sub-groups, can result in increased survival. However, there are substantial risks, including death in 2% to 8% of patients, and stroke or other neurologic events in 1% to 10% of those undergoing surgery.

Percutaneous transluminal coronary angioplasty is a more recent technology. In this procedure, a catheter is inserted into a coronary artery and down the vessel to the atherosclerotic obstruction. Until the 1990s, these catheters had balloons on their tips and were used to "crack" the plaque and expand the vessel. In the 1990s, a variety of "drillers, scrapers, shavers, burners, welders and melters," which remove the obstructing tissue, became available. In large part these devices were developed to try to lower what many considered the Achilles' heel of the procedure, the high rate of restenosis (30-50%). The other major risk associated with percutaneous transluminal coronary angioplasty is acute closure of the vessel at the time of the procedure. If the vessel cannot be reopened promptly, there is risk of death (1%), or the need to undergo an emergency bypass procedure to go around the blockage (2 to 4%), or risk of acute myocardial infarction (2% to 4%), or both (2% to 4%). In the early 1990s coronary stents — devices that buttress open the angioplasty site — were found in clinical trials to reduce the risk of acute closure. The Food and Drug Administration approved the use of stents in 1995. Follow-up studies have suggested that the use of stenting can cut the rate of restenosis in half. This finding has catalyzed tremendous growth in the use of stents.

Coronary Artery Bypass Grafting

In 1997, 2,400 coronary artery bypass grafting procedures were performed on adult BCBSM members. Rates of bypass varied by a factor of two among hospital referral regions, from less than 0.8 per 1,000 adult members to more than 1.5.

The rate of bypass surgery was higher than the state average of 1.2 per 1,000 members among residents of the hospital referral regions in Dearborn (1.6); Saginaw (1.5); Flint (1.4); Ann Arbor (1.4) and Traverse City (1.3).

Rates of bypass surgery among residents of other hospital referral regions were lower than the average, including St. Joseph (0.8); Muskegon (1.0) and Pontiac (1.0).

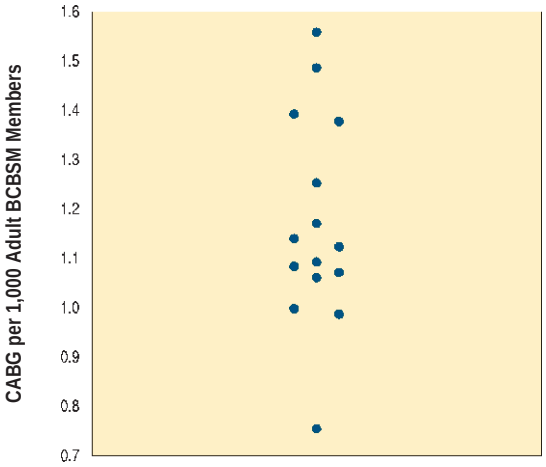
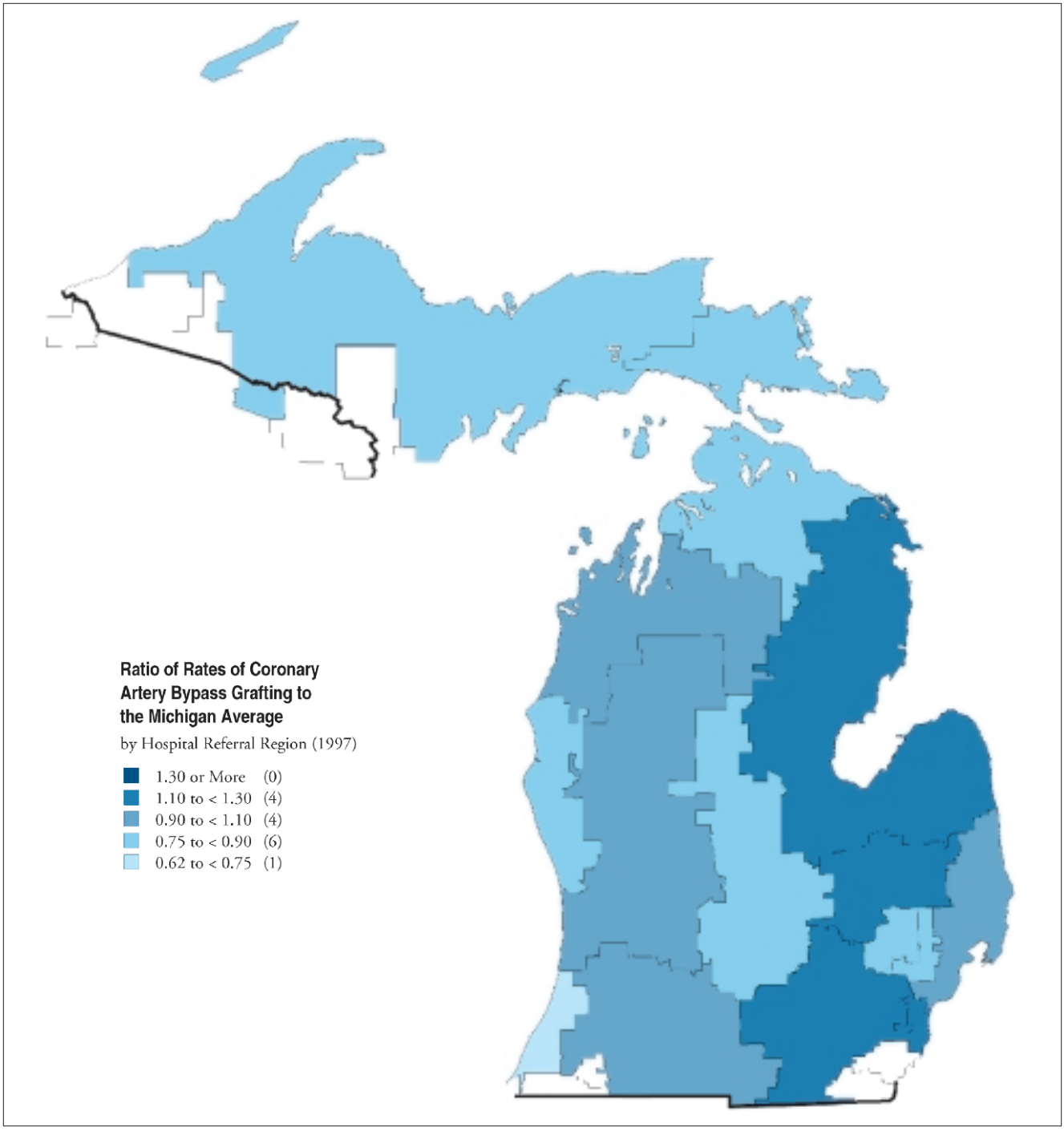


Figure 5.6. Rates of Adult Coronary Artery Bypass Grafting Surgery Among Michigan Hospital Referral Regions (1997)
Rates of bypass surgery ranged from less than 1.0 to 1.6 per 1,000 adult BCBSM members, after adjustment for differences in the age and sex of local populations. Each point represents one hospital referral region in Michigan.



Map 5.5. Adult Coronary Artery Bypass Grafting Surgery (1997)

Rates of coronary artery bypass surgery were generally higher in the eastern part of the state. One hospital referral region had a rate at least 30% higher than the state average; one region had a rate more than 25% lower than the average.

Percutaneous Coronary Interventions

In 1997, more than 5,000 percutaneous coronary interventions were performed on adult BCBSM members. The average rate among members was 2.5; but age and sex adjusted rates among local populations varied by a factor of almost two.

Rates of percutaneous coronary interventions per 1,000 adult BCBSM members were higher than the state average among residents of the hospital referral regions in Saginaw (3.3); Detroit (3.2); Dearborn (3.1) and St. Joseph (3.0).

Among residents of other hospital referral regions, rates were lower than the state average including those in Muskegon (1.7); Grand Rapids (1.7); Flint (1.9) and Marquette (1.9).

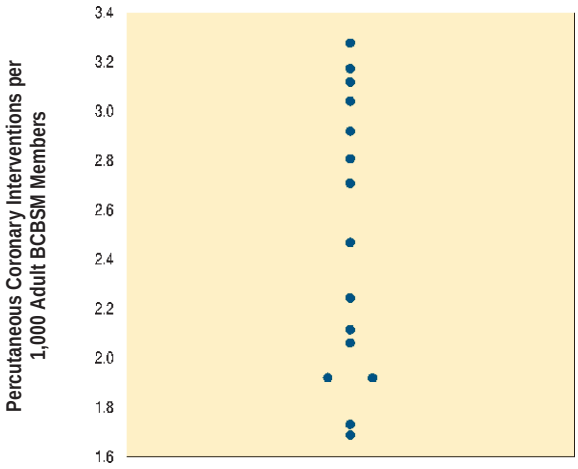
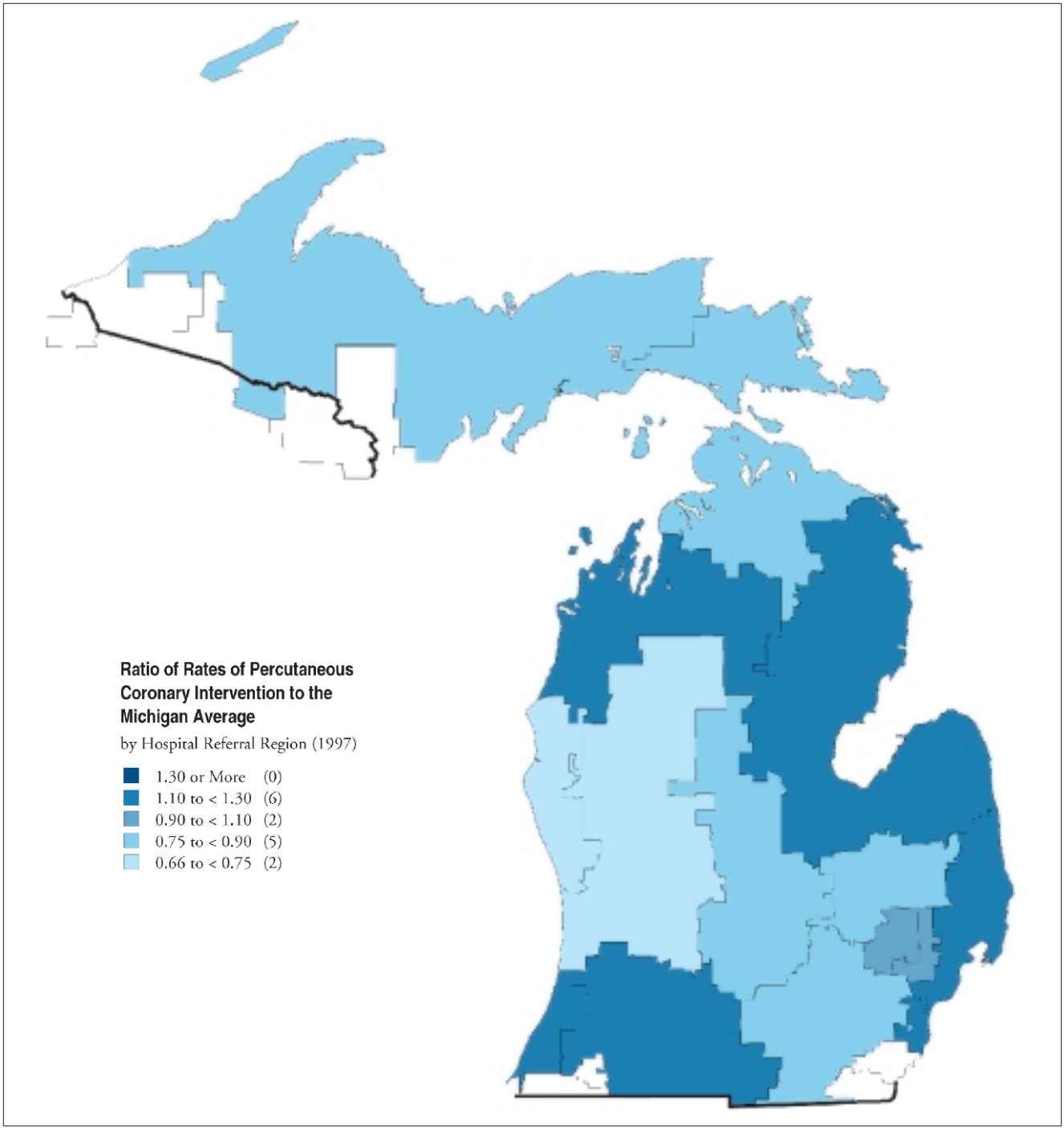


Figure 5.7. Rates of Adult Percutaneous Coronary Interventions Among Michigan Hospital Referral Regions (1997)
Rates of percutaneous coronary interventions ranged from less than 1.7 to more than 3.2 per 1,000 adult BCBSM members, after adjustment for differences in the age and sex of local populations. Each point represents one of the hospital referral regions in Michigan.



Map 5.6. Adult Percutaneous Coronary Interventions (1997)

No hospital referral region had a rate more than 30% higher than the state average; two regions had rates more than 25% below it.

Total Revascularization

In 1997, more than 7,400 revascularization procedures were performed on adult BCBSM members. The average rate was 3.7; but age and sex adjusted rates among local populations varied by a factor of 1.7.

Rates of revascularization per 1,000 adult BCBSM members were higher than the state average in Saginaw (4.8); Dearborn (4.7); Detroit (4.3); Traverse City (4.1) and Kalamazoo (4.0).

Other hospital referral regions had rates substantially lower than the state average, including Muskegon (2.7), Grand Rapids (2.9) and Marquette (3.0).

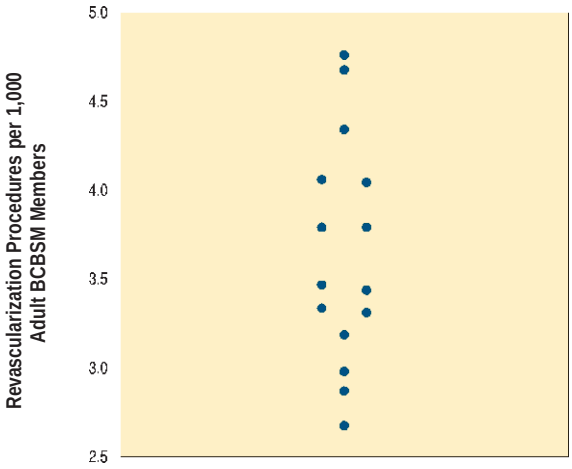
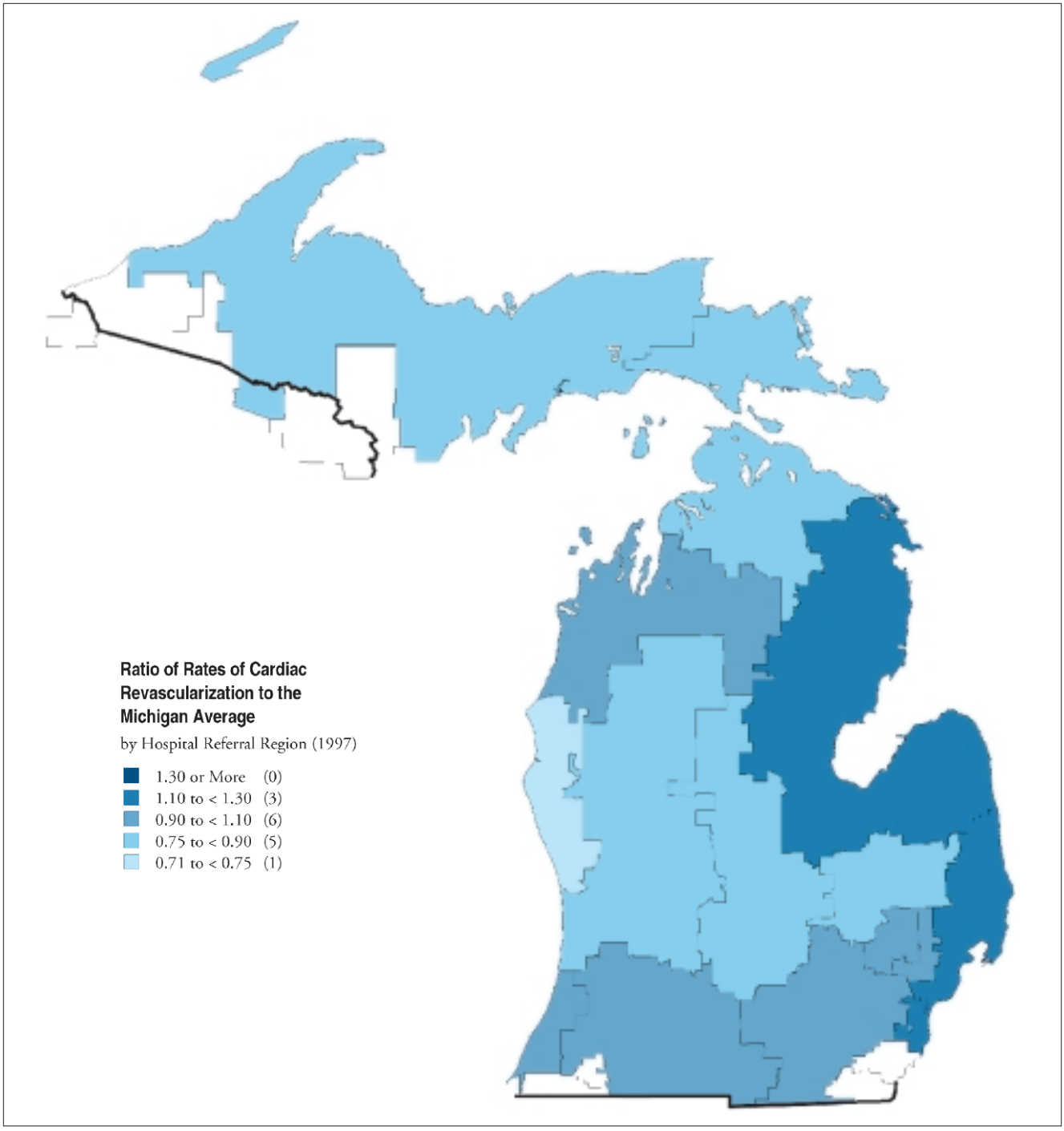


Figure 5.8. Rates of Adult Revascularization Procedures Among Michigan Hospital Referral Regions (1997)
Rates of revascularization procedures ranged from 2.7 to 4.8 per 1,000 adult BCBSM members, after adjustment for differences in the age and sex of local populations. Each point represents one of the hospital referral regions in Michigan.



Map 5.7. Adult Revascularization Procedures (1997)

No hospital referral region had a rate more than 30% higher than the state average; one region had a rate more than 25% below it.

The Association between Diagnostic Testing and Cardiac Revascularization

Rates of diagnostic testing and therapeutic intervention vary substantially from region to region in Michigan. Are these patterns random, or is there some relationship among the procedures?

Some patterns can be seen by looking at the maps on the preceding pages: for instance, areas with low rates of diagnostic testing have low rates of therapeutic interventions. The Muskegon hospital referral region, for example, had the lowest rates of both coronary angiography and cardiac revascularization in the state; the Saginaw hospital referral region had the highest rates of both.

This relationship can be tested more formally by plotting the two rates against each other. Figure 5.9 shows the relationship between coronary angiography and cardiac revascularization among hospital referral regions. There is a strong relationship between the diagnostic test and the therapeutic intervention ($R^2 = 0.81$). Nearly all of the variability in the therapeutic procedure, cardiac revascularization, is associated with the diagnostic test, coronary angiography. Interestingly, the relationship between coronary angiography and catheter-based revascularizations such as angioplasty is much stronger ($R^2 = 0.80$) than the relationship between angiography and bypass surgery ($R^2 = 0.12$).

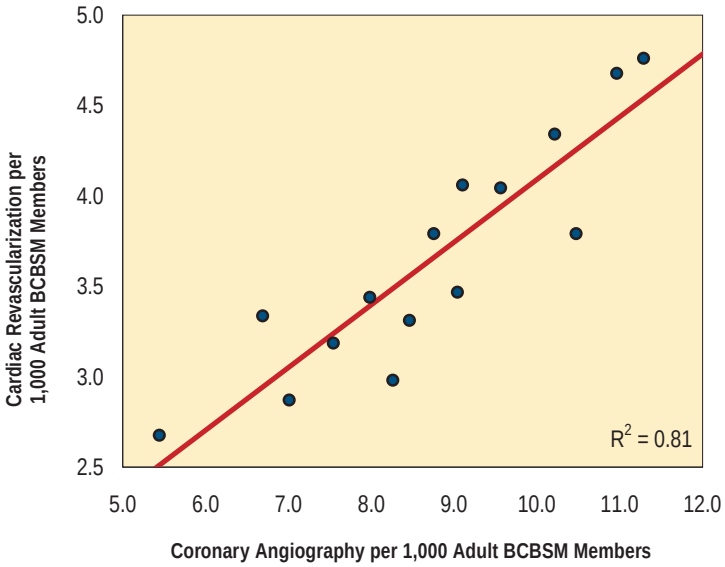


Figure 5.9. The Relationship Between Rates of Coronary Angiography and Cardiac Revascularization in Hospital Referral Regions (1997)
About 80% of the variability in rates of cardiac revascularization can be attributed to differences in rates of coronary angiography. Each point represents one hospital referral region.

It can be argued that the relationship is obvious, since all revascularization procedures require a cardiac catheterization; but the relationship is linear and true at all levels of coronary angiography intensity. BCBSM members in Saginaw were twice as likely to undergo cardiac catheterization and cardiac revascularization procedures as those in Muskegon. Is this because they had twice as much heart disease or because they are twice as likely to be tested with coronary angiography?

There are other, similar, patterns. There is a moderately strong relationship between the intensity of coronary angiography and the intensity of imaging stress testing ($R^2 = 0.40$). There is no relationship between the intensity of non-imaging stress testing and subsequent coronary angiography ($R^2 = 0.04$).

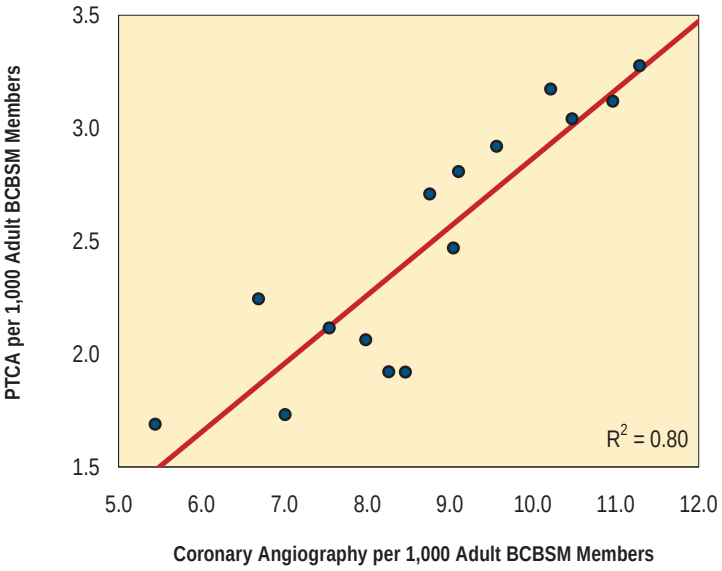


Figure 5.10. The Relationship Between Rates of Coronary Angiography and Rates of Percutaneous Transluminal Coronary Angioplasty in Hospital Referral Regions (1997)
About 80% of the variability in rates of PTCA can be attributed to differences in rates of coronary angiography. Each point represents one hospital referral region.

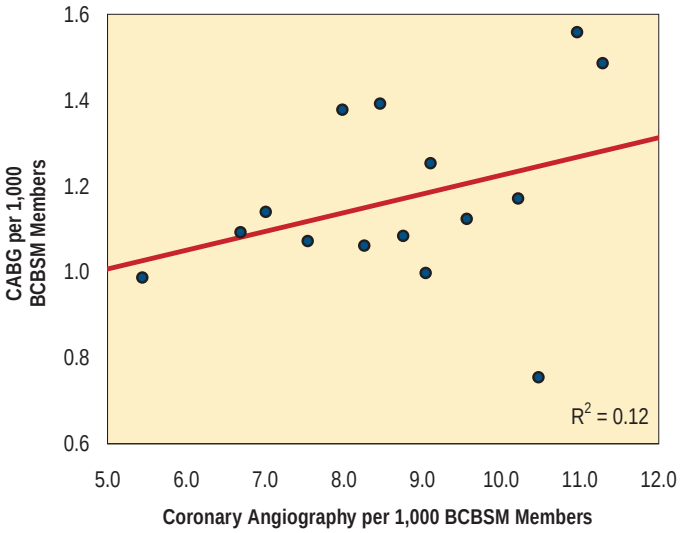


Figure 5.11. The Relationship Between Rates of Coronary Angiography and Coronary Artery Bypass Grafting in Hospital Referral Regions (1997)

There was a much weaker correlation between rates of angiography and bypass surgery (R^2 = 0.12) than between angiography and angioplasty. Each point represents one hospital referral region.

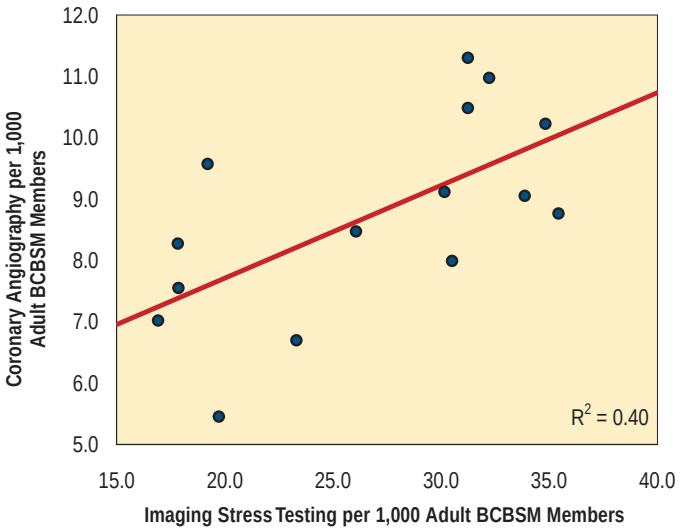


Figure 5.12. The Relationship Between Rates of Imaging Stress Testing and Coronary Angiography in Hospital Referral Regions (1997)

There was a moderately strong relationship (R^2 = 0.40) between rates of imaging stress testing and rates of coronary angiography. Each point represents one hospital referral region.

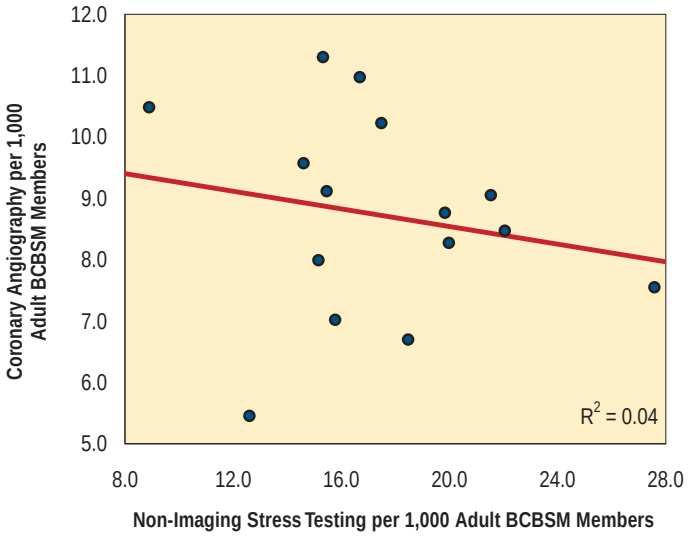


Figure 5.13. The Relationship Between Rates of Non-Imaging Stress Testing and Coronary Angiography in Hospital Referral Regions (1997)

There was virtually no relationship (R^2 = 0.04) between rates of non-imaging stress testing and rates of coronary angiography. Each point represents one hospital referral region.

What Do These Relationships Mean?

Population-based studies of cardiac risk factors and symptoms suggest that up to 50% of the population has at least two cardiac risk factors. Given this large pool of potential patients, the use of diagnostic tests is likely to result in subsequent testing and interventions. The relationship between diagnosis and treatment reflects this phenomenon.

Is this wrong? While we are unable to answer with certainty, several issues need to be addressed. First, the strongest relationship between diagnostic intensity and therapeutic intensity is between coronary angiography and PTCA. There is also a relationship between diagnostic tests and the likelihood of coronary artery bypass grafting, but it is much weaker. Unlike bypass surgery, most literature addressing outcomes in patients undergoing angioplasty suggests that the procedure does not lead to improved survival, with the exception of certain instances in which angioplasty is used to treat acute myocardial infarction. For most patients, PTCA is done to decrease symptoms, not to prolong life.

Treating symptoms is an important goal. However, there are other options available to address symptoms for many patients, including pharmacologic management with such agents as beta blockers, and risk factor modification such as changes in diet and exercise patterns. The choice of treatment must be made in terms of the relative risks and benefits of these treatment options. The choice of treatment should be driven by informed patients, not by the relative diagnostic intensity of the region in which they live.

Another issue is the importance of the kind of test chosen to assess a patient's coronary disease. Coronary angiograms and imaging stress tests are associated with downstream testing and interventions, but non-imaging stress testing is not. This is of particular interest given the recent guideline from the American College of Cardiology and the American Heart Association recommending the use of non-imaging stress tests in most clinical situations. BCBSM members are much more likely to get imaging stress testing than non-imaging stress tests. This issue is an area worth pursuing.

Avoidance of Future Morbidity and Mortality: Secondary and Tertiary Prevention in Coronary Artery Disease

Patients who have had a clinical event related to coronary artery disease, such as an acute myocardial infarction, angioplasty or bypass surgery, are at high risk for a subsequent cardiac event. Recent randomized trials of lipid-lowering therapy following bypass surgery estimated that up to 30% of patients who have an acute myocardial infarction have a repeat revascularization, or die within five years of the initial procedure.

Appropriate post-event treatment can dramatically lower the risk of recurrent cardiac events. In particular, aggressive treatment of lipid abnormalities and use of beta blockers can reduce the risk of a subsequent event by up to 30%. Despite multiple studies supporting the use of these treatments, research suggests that many patients are under treated, exposing them to increased risk of death or a morbid event.

We evaluated the use of beta blockers and lipid lowering agents for all BCBSM members who were admitted to hospitals for acute myocardial infarction or cardiac revascularization from January through November 1997. For those who were discharged alive, we assessed the use of beta blockers and lipid lowering agents in the 30 days following discharge. We also assessed the proportion of patients readmitted for any cause within 30 days of discharge.

Beta blockers are one of the most important agents for reducing cardiac events in patients with established vascular disease. For over 20 years, trial after trial has found that these agents can lower the risk of death and acute myocardial infarction in numerous patient populations. Despite these studies, recent evidence from the Cooperative Cardiovascular Project, a national study of Medicare patients, found that 51% of eligible patients do not receive beta blockers after acute myocardial infarction.

Since 1994, several studies have been published on the efficacy of lipid-lowering agents in patients following cardiac revascularization. These studies suggest that lowering patients' cholesterol, particularly low-density lipids, might lower the risk of a recurrent event by 30%. Despite these findings, lipid-lowering drugs are not universally applied in usual practice.

The Use of Beta Blockers Following Acute Myocardial Infarction or Cardiac Revascularization

In 1997, 60% of BCBSM members received beta blockers in the 30 days following discharge for acute myocardial infarction, bypass surgery, or angioplasty. The rate varied from 42% to 71%. While not all patients are eligible for this treatment, the majority are, and there is no reason to expect that eligibility varies by region. This suggests that there is substantial underutilization of an important therapy.

In three Michigan hospital referral regions, the proportion of patients receiving beta blockers was over 70%: Ann Arbor (70.7%); Muskegon (70.7%) and Dearborn (70.1%).

In three hospital referral regions, the proportion of patients receiving beta blockers was under 50%: Traverse City (42.3%), St. Joseph (48.8%) and Flint (49.0%).

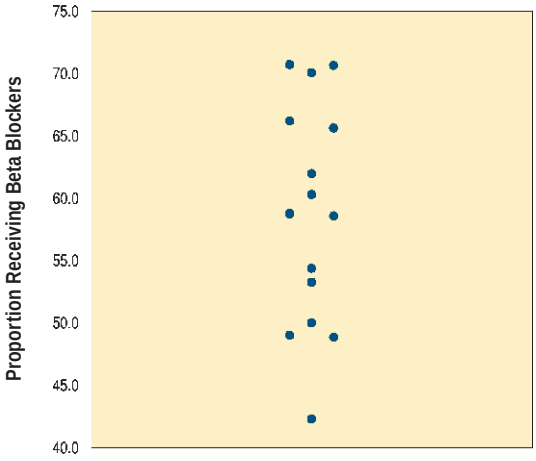
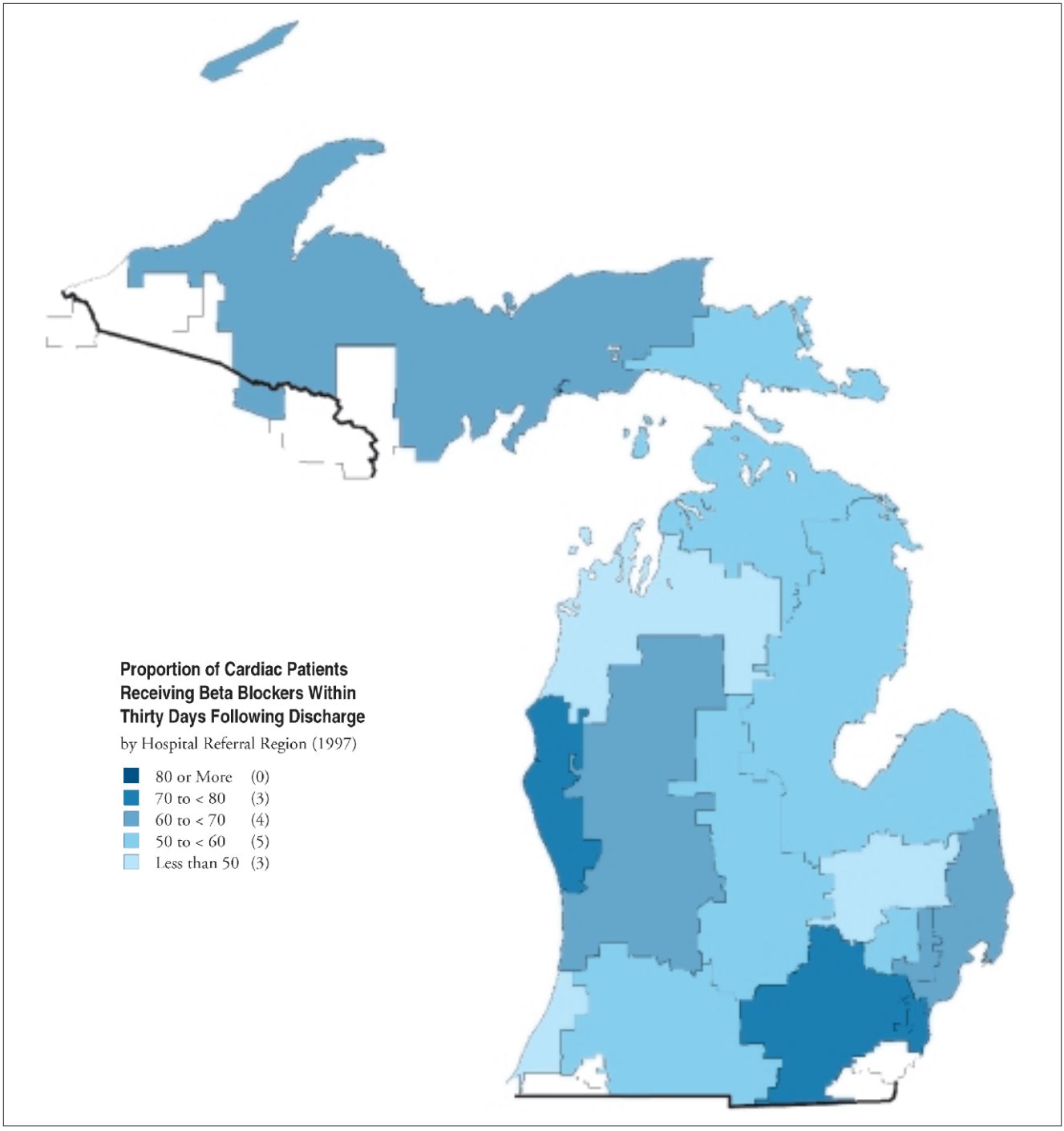


Figure 5.14. Proportion of Cardiac Patients Receiving Beta Blockers (1997)
The likelihood that a BCBSM member who had had a cardiac event or revascularization procedure would also receive a prescription for beta blockers ranged from 42% to 71%. Each point represents one of the hospital referral regions in Michigan.



Map 5.8. Proportion of Cardiac Patients Receiving Beta Blockers (1997)

No hospital referral region had a rate of more than 80%. Three hospital referral regions had rates of less than 50%.

The Use of Lipid Lowering Agents following Acute Myocardial Infarction or Cardiac Revascularization

In 1997, 57% of BCBSM members received lipid lowering therapy in the 30 days following discharge for an acute myocardial infarction or for a cardiac revascularization procedure. The rate varied from 44% to 65% among regions. While not all patients are eligible for this treatment, the majority of patients with established coronary disease have lipid abnormalities that should be treated. Interestingly, there was a moderately strong association (R^2 = .38) between the use of beta-blockers and lipid lowering agents (Figure 5.16). This suggests that physicians were consistent in their use or non-use of secondary prevention measures in this population.

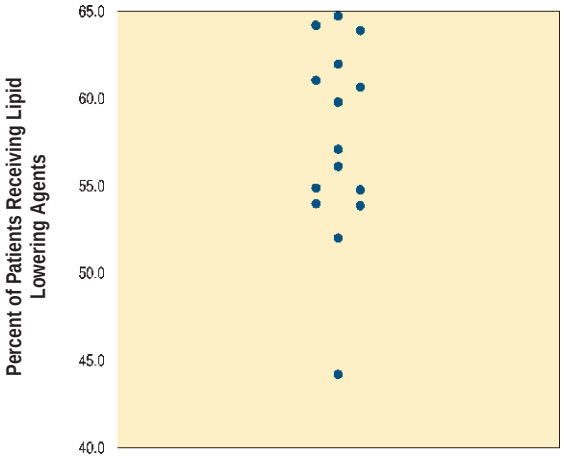


Figure 5.15. Proportion of Cardiac Patients Receiving Lipid Lowering Agents (1997)

The likelihood that a BCBSM member who had had a cardiac event or revascularization procedure would also receive a prescription for lipid-lowering agents ranged from 44% to 65%. Each point represents one of the hospital referral regions in Michigan.

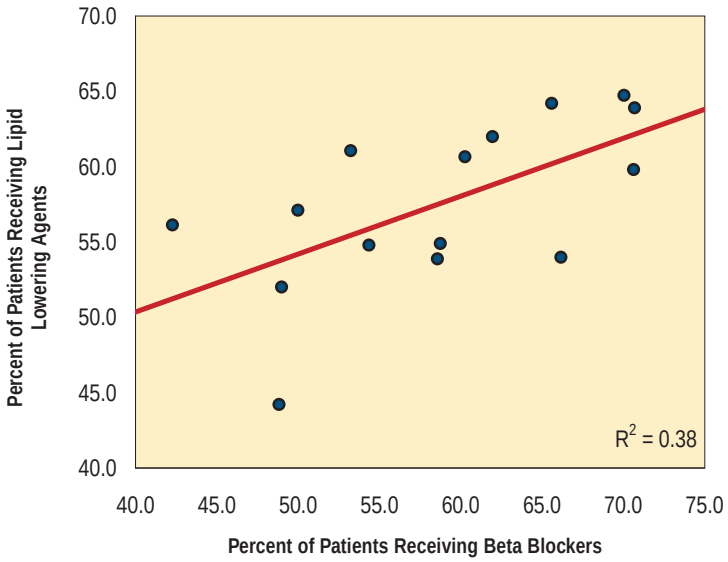
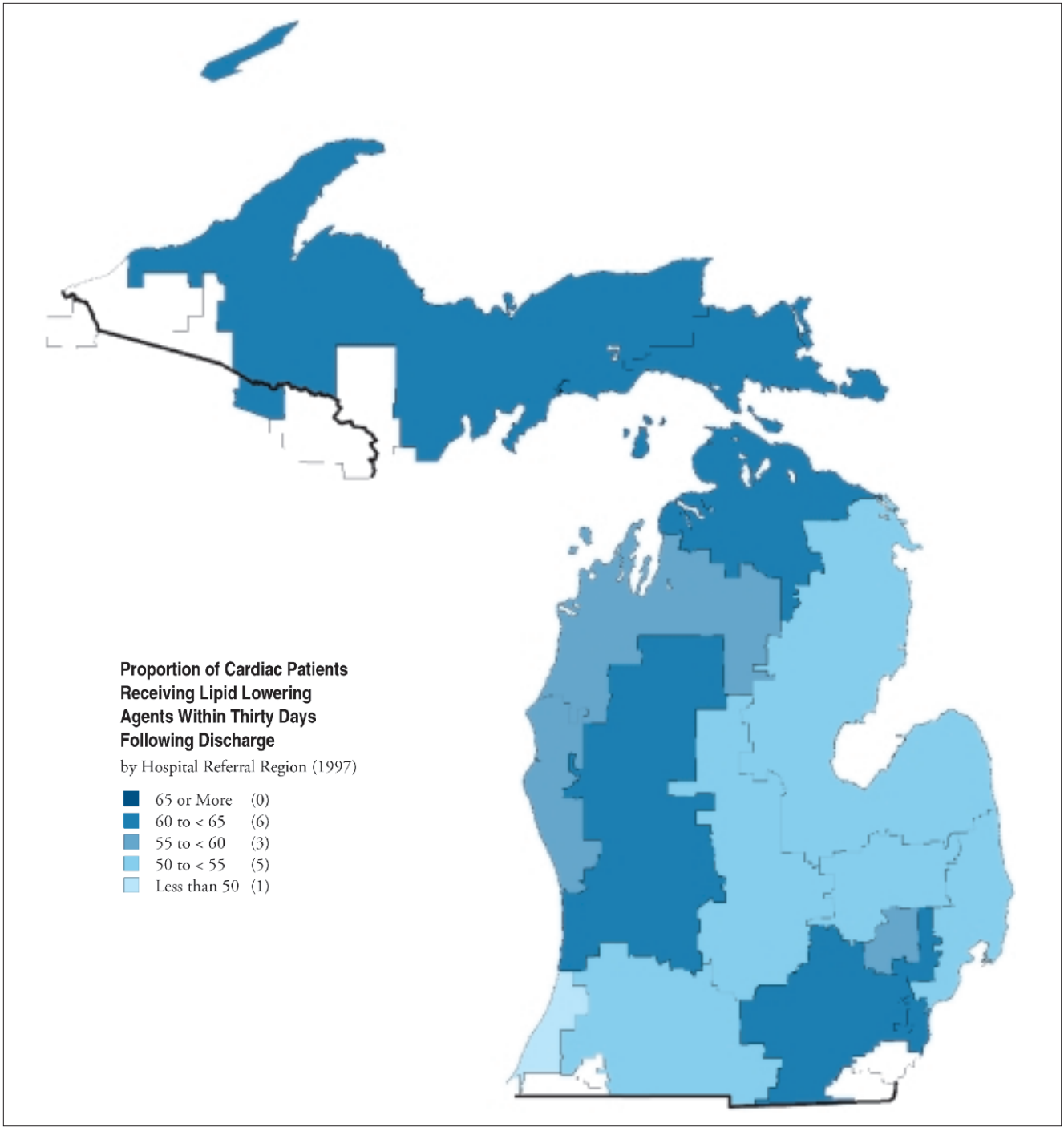


Figure 5.16. The Relationship Between the Use of Beta Blockers and the Use of Lipid Lowering Agents in Patients With Discharges for Acute Myocardial Infarction or Cardiac Revascularization Procedures (1997)

There was a moderately strong relationship between the prescription of beta blockers and prescription of lipid-lowering agents for patients who had had cardiac events or revascularizations. This is probably an indication that physicians who prescribed one therapy were likely to prescribe the other, and that those who did not prescribe one were likely not to prescribe either.



Map 5.9. Proportion of Cardiac Patients Receiving Lipid Lowering Agents (1997)

No hospital referral region had a rate of more than 65%. One region had a rate less than 50%.

Readmission Within Thirty Days of Discharge for Acute Myocardial Infarction or Cardiac Revascularization

One measure that has been used to assess the quality of care for patients who are hospitalized is the proportion of patients who are readmitted to the hospital within 30 days of discharge from a hospitalization for acute myocardial infarction or cardiac revascularization. In 1997, 13% of BCBSM members discharged for these conditions were readmitted within 30 days; rates ranged from 5% to 17%.

There was no association ($R^2 = .02$) between the use of lipid lowering agents and 30-day readmission rates (Figure 5.18); nor was there an association ($R^2 = .04$) between use of beta blockers and the likelihood of readmission within 30 days (Figure 5.19). This suggests that either the beneficial effects of lipid lower drugs and beta blockers do not go into effect in less than 30 days, or other factors, such as bed supply, are driving readmission rates.

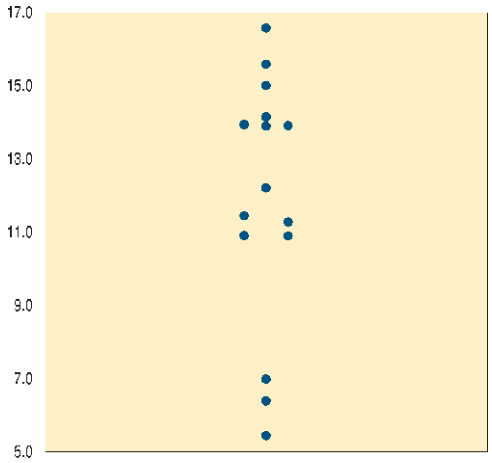
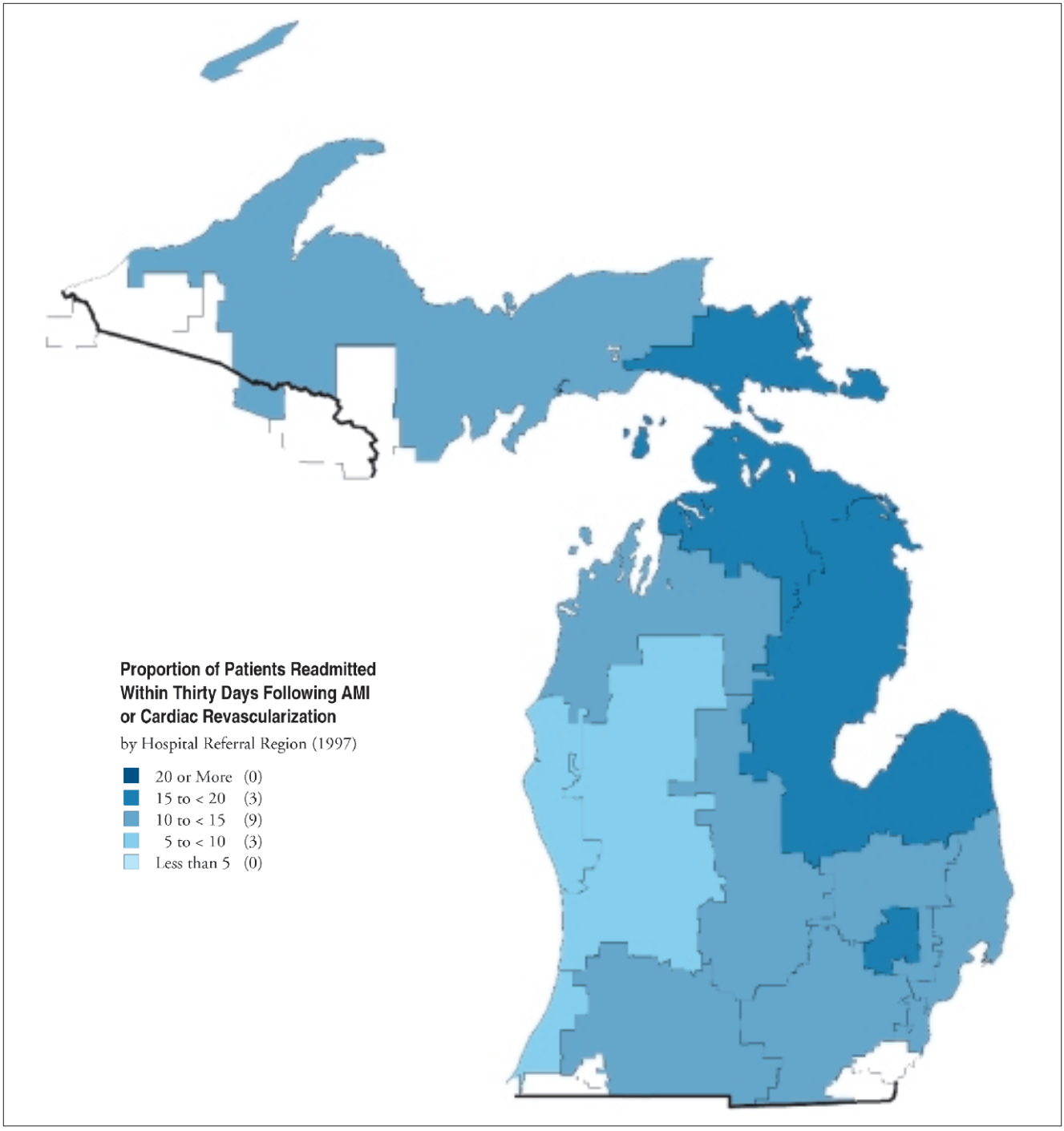


Figure 5.17. Rates of Readmission Within 30 Days of Discharge for AMI or Revascularization (1997)
Rates of readmission ranged from 5% to 17%. Each point represents one of the hospital referral regions in Michigan.



Map 5.10. Rates of Readmission Within 30 Days of Discharge for AMI or Revascularization (1997)

No hospital referral regions had 30-day readmission rates of more than 20%. Three regions had rates of less than 10%.

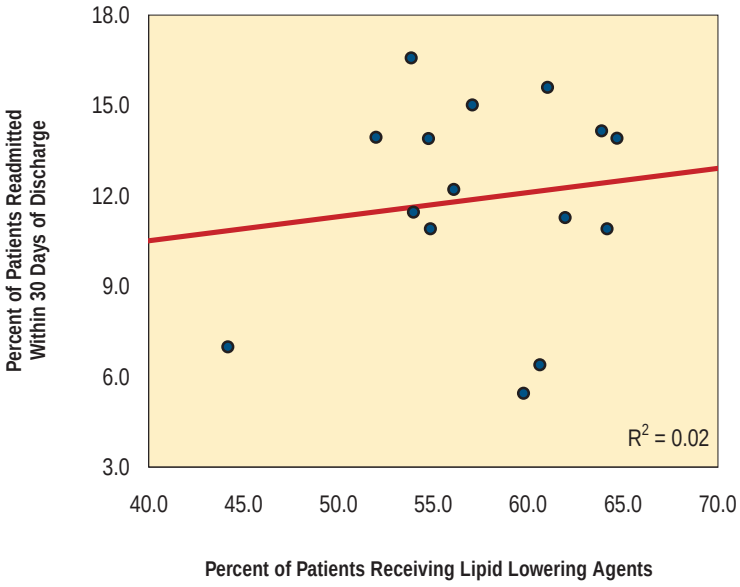


Figure 5.18. The Association Between Use of Lipid-Lowering Agents and 30-Day Readmission Rates (1997)
There was virtually no relationship between the prescription of lipid-lowering agents following AMI or revascularization and the likelihood of readmission within 30 days of discharge (R^2= .02). Each point represents one hospital referral region in Michigan.

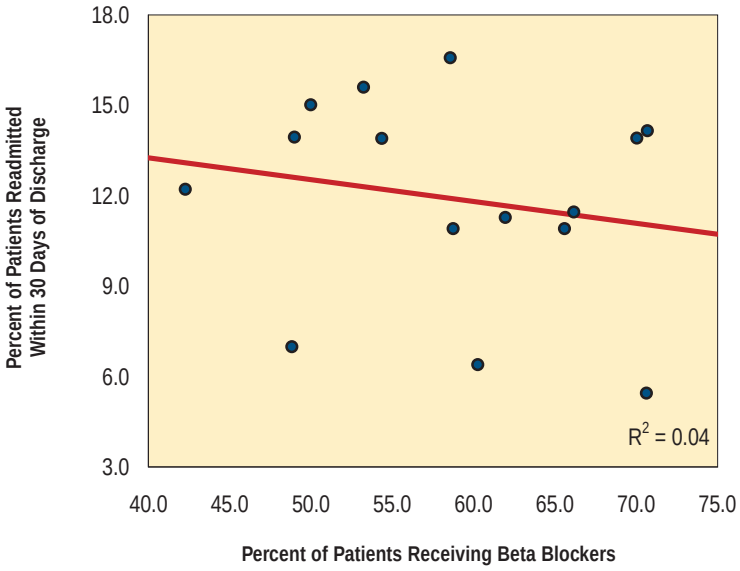


Figure 5.19. The Association Between Use of Beta Blockers and 30-Day Readmission Rates (1997)
There was virtually no relationship between the prescription of beta blockers following AMI or revascularization and the likelihood of readmission within 30 days of discharge (R^2= .04). Each point represents one hospital referral region in Michigan.

Chapter Five Table Note

Age and sex adjusted rates of diagnostic tests and therapeutic interventions were drawn from the BCBSM data base. Rates are expressed per 1,000 adult BCBSM members or per 1,000 adult and child BCBSM members, and are for 1997. Specific codes used to define the numerator for rates and methods of age and sex adjustment are given in the Appendix on Methods.

CHAPTER FIVE TABLE

Rates of Diagnostic Tests and Therapeutic Interventions for Coronary Disease by Hospital Referral Regions (1997)

HRR City	Adult BCBSM Members Included in Data Analysis (1997)	Non-Imaging Stress Testing per 1,000 Adult BCBSM Members (1997)	Imaging Stress Testing per 1,000 Adult BCBSM Members (1997)	Echocardiography per 1,000 BCBSM Members (all ages) (1997)	Coronary Angiography per 1,000 Adult BCBSM Members (1997)	Coronary Artery Bypass Graffing per 1,000 Adult BCBSM Members (1997)	Percutaneous Coronary Intervention per 1,000 Adult BCBSM Members (1997)	Cardiac Revascularization per 1,000 Adult BCBSM Members (1997)	% of Patients in Cohort Receiving Beta Blockers (1997)	% of Patients in Cohort Receiving Lipid Lowering Agents (1997)	% of Patients in Cohort Readmitted Within 30 Days Following Discharge for AMI or Revascularization (1997)
Ann Arbor	232,860	15.2	30.5	32.6	8.0	1.4	2.1	3.4	70.7	63.9	14.1
Dearborn	88,420	16.7	32.2	42.5	11.0	1.6	3.1	4.7	70.1	64.7	13.9
Detroit	335,730	17.5	34.8	44.3	10.2	1.2	3.2	4.3	66.2	54.0	11.4
Flint	156,788	22.1	26.1	32.3	8.5	1.4	1.9	3.3	49.0	52.0	13.9
Grand Rapids	176,389	15.8	16.9	21.4	7.0	1.1	1.7	2.9	60.3	60.6	6.4
Kalamazoo	121,238	14.6	19.2	19.4	9.6	1.1	2.9	4.0	54.4	54.8	13.9
Lansing	142,280	27.6	17.9	24.3	7.5	1.1	2.1	3.2	58.8	54.9	10.9
Marquette	49,397	20.0	17.8	18.7	8.3	1.1	1.9	3.0	62.0	62.0	11.3
Muskegon	46,541	12.6	19.7	17.5	5.4	1.0	1.7	2.7	70.7	59.8	5.4
Petoskey	55,322	18.5	23.3	18.7	6.7	1.1	2.2	3.3	53.2	61.0	15.6
Pontiac	119,907	21.5	33.9	44.5	9.0	1.0	2.5	3.5	50.0	57.1	15.0
Royal Oak	170,738	19.8	35.4	47.7	8.8	1.1	2.7	3.8	65.6	64.2	10.9
Saginaw	174,146	15.3	31.3	30.5	11.3	1.5	3.3	4.8	58.6	53.8	16.6
St. Joseph	23,184	8.9	31.3	26.5	10.5	0.8	3.0	3.8	48.8	44.2	7.0
Traverse City	54,538	15.5	30.2	22.0	9.1	1.3	2.8	4.1	42.3	56.1	12.2
Michigan	1,978,316	18.1	28.2	33.1	9.0	1.2	2.5	3.7	60.4	57.2	12.5