A Report of the Dartmouth Atlas Project

The Dartmouth Atlas Project works to accurately describe how medical resources are distributed and used in the United States. The project offers comprehensive information and analysis about national, regional, and local markets, as well as individual hospitals and their affiliated physicians, in order to provide a basis for improving health and health systems. Through this analysis, the project has demonstrated glaring variations in how health care is delivered across the United States.

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The Dartmouth Institute
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Dartmouth-Hitchcock
DEPARTMENT OF SURGERY

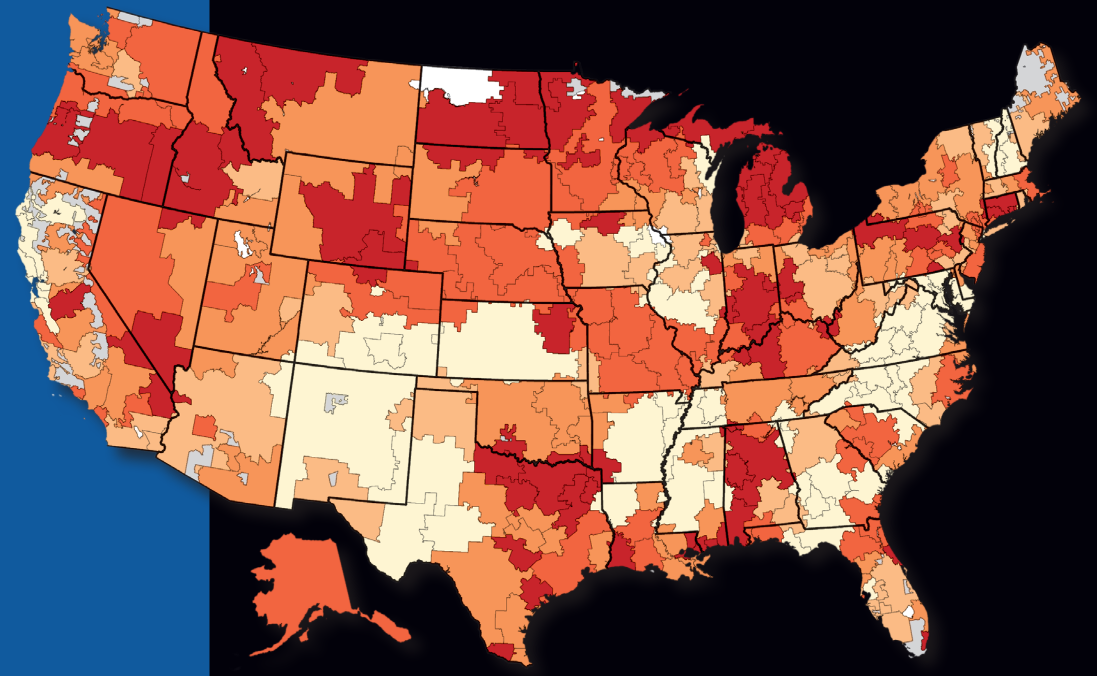
THE Dartmouth INSTITUTE
FOR HEALTH POLICY & CLINICAL PRACTICE

Variation in the Care of Surgical Conditions

Dartmouth Atlas of Health Care

Variation in the Care of Surgical Conditions

A Dartmouth Atlas of Health Care Series



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Introduction

Twenty-first century surgery is among the great accomplishments of medicine. Surgeons have led some of the most important improvements in care quality, safety, and efficiency. Surgical methods are now highly effective for some of the most serious and previously intractable medical conditions, ranging from arthrosclerosis to obesity to chronic back pain. Today, surgical procedures work better and entail lower risk, less pain, and less time in the hospital.

As the scope and quality of surgical care continues to advance, there is still much that remains to be done to optimize care for patients. For many conditions, surgery is one of several care options, and in some instances, there are several types of surgical procedures available. Research into the effectiveness and adverse effects of a surgical procedure compared to alternatives is often incomplete. While quality has generally improved over time, outcomes can differ across hospitals and surgeons. Too often, treatment options, whether medical or surgical, are recommended without patients fully understanding the choices and participating in the decision; and these recommendations can vary markedly from one physician to the next. Finally, the costs of care continue to rise and often differ across health care systems, even the most reputable and prestigious. Why can the “best” surgical care at one academic medical center cost twice as much as another?

This Dartmouth Atlas of Health Care series reports on unwarranted regional variation in the care of several conditions for which surgery is one important treatment option. Unwarranted variation is the differences in care that are not explained by patient needs or preferences. Each report begins with an examination of the underlying condition, the available treatment options before surgery, and the role of shared decision-making. The care during surgery is then presented, including aspects of quality, risks, and costs. The next section is concerned with the care of patients after surgery, including hospital readmissions and ambulatory care.

The bottom line is that the greatest promise of surgery still lies before us. These reports show that quality is often excellent, but not in all places. Variation in surgical rates is high and represents both gaps in outcomes research and poor patient decision quality. Outcomes differ from place to place even when controlling for patient differences. The opportunities for better and more efficient care are substantial and will require renewed efforts in research and clinical quality improvement.

Variation in decision-making for surgical conditions

Experienced leaders and educators in surgery often emphasize to their trainees and students that performing an operation is easy: choosing the right patients for surgery is much more difficult. Over the last decade, important changes have occurred related to how surgeons and patients decide whether, when, where, and how to best perform surgery. In the past, surgeons commonly played a paternalistic role, and many surgeons made decisions for their patients, relying on their own training and experience.

When surgeons—and more importantly, patients—face a decision regarding surgery, making the "right" choice can be clear and straightforward in certain situations. For example, patients with hip fracture almost always need to undergo surgery. For nearly every patient, surgical repair offers better pain control, improved functional status, and lower mortality when compared to treatment with conservative measures. Further, most patients who experience hip fracture are over the age of 65 and have access to surgical care, as they receive their health care benefits through Medicare. Because of this important constellation of circumstances—the treatment works well, is readily available, and is actively sought by both physicians and patients—hip fracture care is fairly uniform and regional rates vary relatively little, as shown in previous work by the Dartmouth Atlas and others (Figure I.1).[1,2]

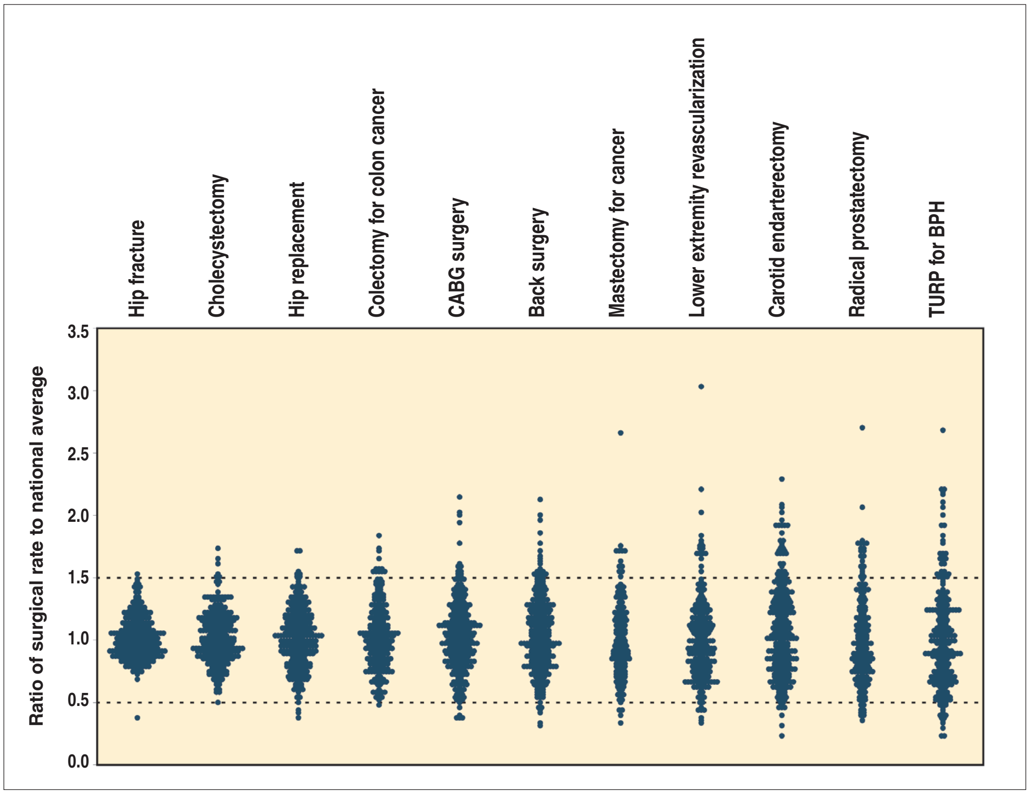
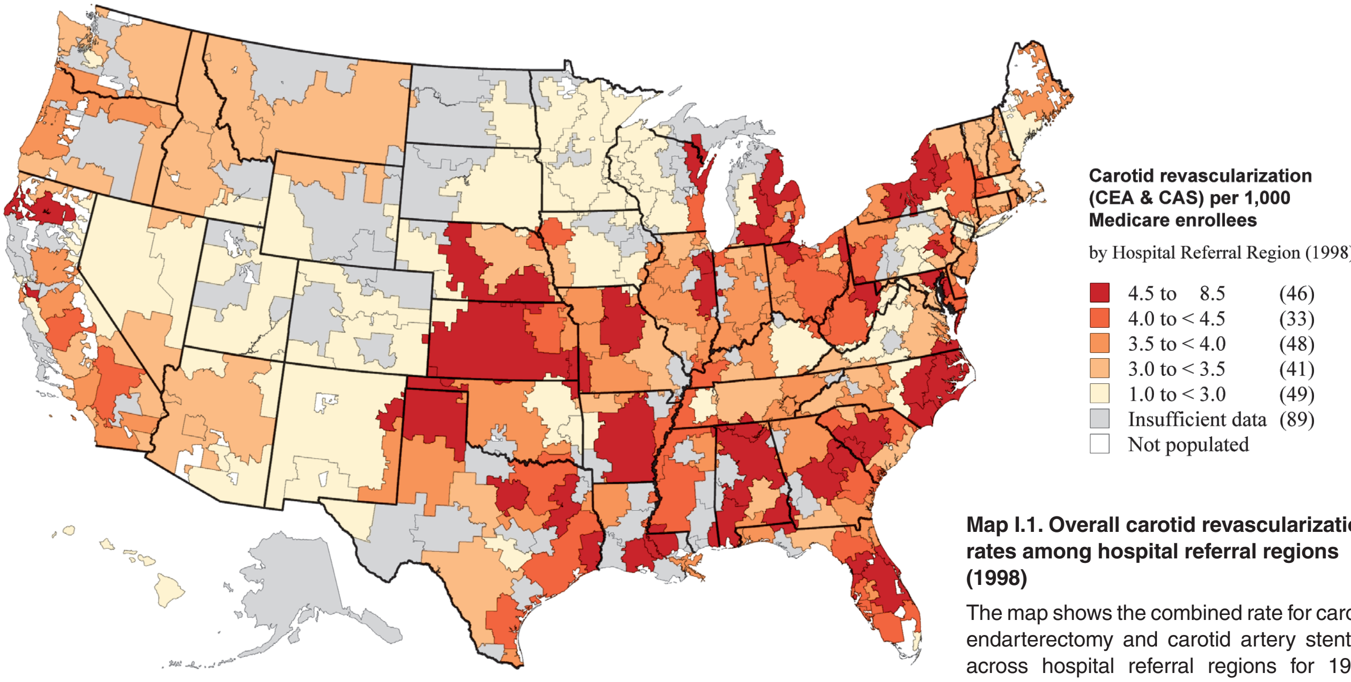


Figure I.1. Variation profiles of 11 surgical procedures among hospital referral regions (2010)

Each point represents the ratio of observed to expected (national average) Medicare rates in the 306 U.S. hospital referral regions. Rates are adjusted for age, sex, and race. High and low outlier regions are distinguished by dotted lines.



Map I.1. Overall carotid revascularization rates among hospital referral regions (1998)

The map shows the combined rate for carotid endarterectomy and carotid artery stenting across hospital referral regions for 1998. Rates are adjusted for age, sex, and race.

For many other illnesses, the choice of surgery is much less clear. For example, patients with asymptomatic carotid artery stenosis have a small but measurable risk of stroke as a result of narrowing within the carotid artery (the blood vessel in the neck that supplies the brain).[3] For certain patients with carotid disease, the risk of surgery to remove the plaque is fairly low, and removal of plaque can reduce the patient's risk of stroke over time. However, in patients with other illnesses, the chance of complications from surgery may be higher than the risk of stroke from the plaque itself.[4]

Because of this uncertainly about who should undergo carotid revascularization, treatment decisions vary considerably. Unlike hip fracture treatment, carotid surgery varies dramatically across the United States, as the Dartmouth Atlas has previously shown.[5] Carotid procedures are performed commonly in some regions, but rarely in others, resulting in marked regional differences in the use of revascularization. Many of these differences appear to be explained by differences in local medical opinion of the value of surgical care (Map I.1).

New developments that have influenced surgical decision-making

How can surgeons and patients make the best decisions? In the past, many investigators reasoned that the surgeons who achieved the best results were likely to have the largest practices, and using this seemingly simple metric would ensure that patients received good surgical care. However, this assumption ignored the fact that it is difficult for surgeons to know who really achieves the "best" results. Many outcomes (such as death after carotid surgery) occur uncommonly, and a single surgeon has little ability to compare his or her results to those of other surgeons.

Given this challenge, over the last two decades, efforts to organize, measure, and improve results in surgical practice via quality improvement initiatives have developed, despite substantial obstacles. Patterns of surgical practice vary broadly across different regions of the United States, making it challenging to study and compare patients and outcomes. Further, the process of collecting, studying, and improving surgical outcomes represented a formidable challenge a decade ago, when most medical information lived in paper records, arranged in leaning stacks of bulging charts.

One important development in measuring care has been the development of clinical registries. These registries are used to study the clinical characteristics and outcomes of patients undergoing surgery and have supported many quality improvement initiatives, such as those shown in Table I.1.

Table I.1. Surgical registries and quality improvement organizations

Quality Improvement Initiative	Organization	Surgical Specialty	Focus	Funding
American College of Surgeons National Surgical Quality Improvement Initiative (ACS-NSQIP)	American College of Surgeons	Many	Measuring and reporting patient characteristics and outcomes	Hospitals
Veterans Affairs National Surgical Quality Improvement Program	Veterans Affairs	Many	Measuring and reporting patient characteristics and outcomes	Federal
Society of Thoracic Surgeons National Database (STS)	Society of Thoracic Surgeons	Thoracic surgery	Limiting risk with cardiac and thoracic procedures	Surgeons
Vascular Quality Initiative (VQI)	Society for Vascular Surgery	Vascular surgery	Improving care of patients with vascular disease	Surgeons and hospitals

Surgeons interested in measuring and improving their surgical results collaborated by systematically tracking patient outcomes. In many ways, these new efforts represented an important and novel strategy toward reducing variation by using clinically derived information to improve surgical decisions and care (Figure I.2). As information for surgeons and patients increased (the green arrow), uncertainty for patients decreased (the red arrow). This simple but effective approach helped to limit variation in surgical treatments.

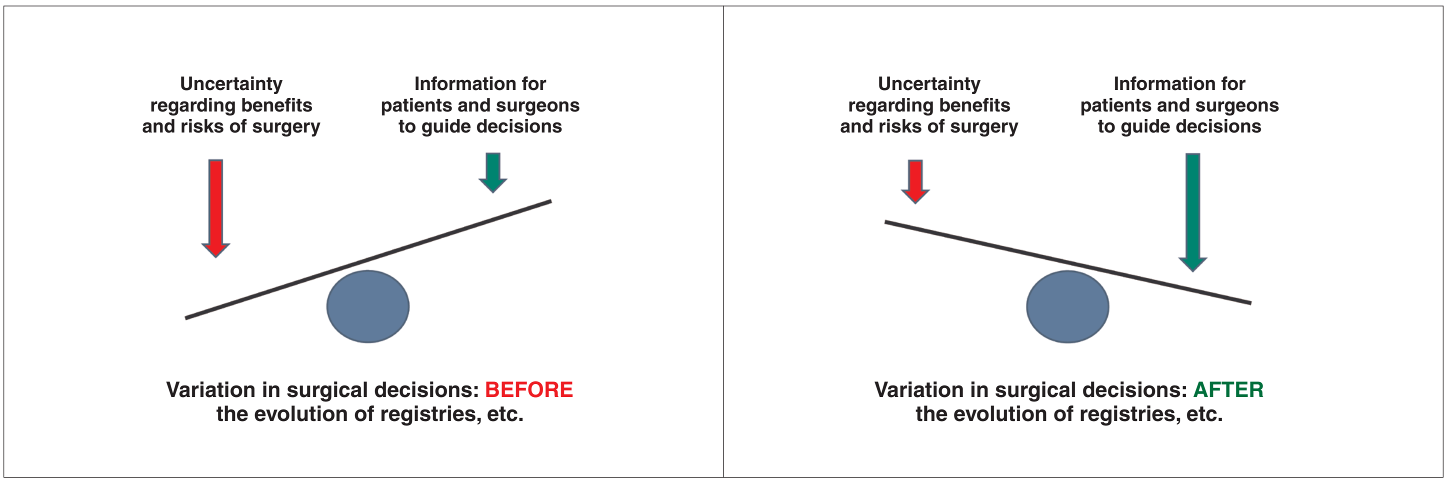


Figure I.2. How information and uncertainty can affect variation in surgical care

Three other changes occurred during this time that helped create a spirit of engagement and excitement for quality improvement efforts and surgical outcomes research. While there were some differences, these general changes are outlined below:

> ***1. Less invasive methods became commonly available in surgery.*** In recent years, across nearly every surgical specialty, rapid advances in surgical technology have helped offer patients the ability to undergo major surgery without the need for a major recovery. Several examples illustrate this trend. Working inside body cavities no longer requires large abdominal or chest incisions, and surgeons instead use video cameras and small instruments in laparoscopic and endoscopic surgery. In vascular surgery, the blood vessels themselves are often the pathway to perform procedures (i.e., endovascular techniques). And finally, with the development of radiofrequency ablation, locally acting chemotherapeutics, and laser thermablation, the key objectives of a surgical procedure can be accomplished using a much less invasive approach. Patients rapidly learned about many of these approaches and sought out these less invasive procedures, and surgeons retrained to offer these new approaches.

2. Surgeons learned about data management and quality improvement. In places like Northern New England,[6,7] the Veterans Administration,[8] and others,[9] leaders in surgical outcomes assessment built the systems necessary to study and improve surgical care. These regional and national quality improvement efforts grew to become the infrastructure that allowed surgeons and patients to know when, how, where, and why surgical procedures were being performed. These initiatives set the stage for an emphasis on achieving the best outcomes.

3. Surgeons, patients, and payers put a new emphasis on measuring and reporting. Armed with gigabytes of data and advanced analytic systems, surgeons were now able to quickly analyze their outcomes. The ability to determine the structural and process measures associated with the best outcomes allowed surgeons new insights into what works and what does not. For example, surgeons used information from studies based on registries to demonstrate the benefits of processes of care, such as perioperative antibiotic administration, or of evolving procedures, such as bariatric surgery for patients with morbid obesity. Payers' and patients' expectations grew; they demanded the best operation, at the right time, with the highest quality.

Challenges to improving surgical decision-making and the goals of this series

Of course, several challenges accompanied these new developments. Who will pay for continued efforts to organize and measure surgical practice? How should results be shared and compared, especially among competitors? Would efforts to use the newest, latest, or most profitable device win out over the goal of improving quality and efficiency? Would surgeons, a group steeped in tradition and often slow to change, adopt these new approaches?

These questions have different answers in different settings. In some cases, such as in coronary bypass surgery, cardiac surgeons adopted outcomes assessment and quality improvement broadly, quickly, and enthusiastically. However, in other settings, such as surgery for prostate cancer or lower extremity vascular disease, efforts toward quality measurement and outcomes assessment have been taken up more slowly, and the impact of these initiatives remains less striking.

Why might some surgeons improve their decisions using these new strategies while other surgeons choose not to try these approaches? In this series of reports, we will use several examples to illustrate the challenges. We will describe, across a broad spectrum of conditions, advances in surgical decision-making, including shared decision-making, which have resulted in less variation in care, improved patient satisfaction, and better outcomes. We will also describe settings wherein these strategies have been less successful, and variations in surgery rates and surgical decision-making remain. In these latter cases, we will outline the potential to improve surgical practice by refining the methods we use to select patients for intervention.

This series will study these conditions and their challenges in much the same way that surgeons approach these problems: by considering the challenges in care that occur before surgery, during surgery, after surgery, and beyond surgery. Within each condition, we will follow the patient along these choices and decisions and learn where the greatest challenges, most important uncertainties, and best evidence lie in making decisions about surgery. Further, we will examine the implications of these uncertainties and identify settings where more effective choices surrounding surgical care could result in healthier populations and potentially even lower costs.

Table I.2. Structure of each report

Before surgery	Determinants of condition and treatment decisions
	Incidence of condition
	Regional variation in condition/covariates related to the condition
	Treatment options - effectiveness, trade-offs, and knowledge gaps
	Issues related to decision quality and shared decision-making
	Examples of quality improvement efforts or attempts to limit variation in treatments for condition
During surgery	Technical quality and outcomes
	Variation in procedure rates
	Cross-sectional rates of competing treatments
	Technical quality and results (short-term outcomes related to treatments)
	Example where regional quality improvement efforts may hold potential benefits in improving care
After surgery	Post-procedure care and long-term outcomes
	Downstream effects of treatment on condition
	Readmission or re-interventions after treatments for condition
Beyond surgery	Implications for surgeons, patients, and society
	How variation in treatments for the condition reflects opportunities for quality and efficiency gains
	How, why, and where efforts to limit variation are needed and might help
	How to move ahead in limiting variation or improving care in surgical treatments for condition

Influencing the key decision-makers: Patients, primary care physicians, surgeons, and policymakers

In the past, when it came to making a decision about surgery, the surgeon's recommendation was considered the most important opinion. His or her perspective was often critical in determining the use of a particular surgical procedure, especially for "preference-sensitive" care: care for conditions where there is no single "right" rate for every population or patient.

Current models of care suggest that better outcomes occur when full information about treatment options is shared with patients, who are then assisted in sharing the decision with the physician. This information often needs to come not only from surgeons, but also from primary care physicians who help patients choose among the different options, each with their likely outcomes and trade-offs. (For more information about patient-centered medical decision-making, please visit the Dartmouth Center for Informed Choice at http://tdi.dartmouth.edu/research/engaging/informed-choice and the Informed Medical Decisions Foundation at www.informedmedicaldecisions.org). In addition to reaching patients, the best information needs to reach policymakers who make decisions about how we spend our health care dollars, such that our resources provide the most effective care for patients with surgical conditions.

Shared Decision-Making

Dale Collins Vidal, MD

Professor of Surgery, Geisel School of Medicine; Director, Center for Shared Decision Making, Dartmouth-Hitchcock

Much of the striking variation in the use of surgical procedures reported in this Dartmouth Atlas series can be attributed to differing physician opinions about the value of one surgery over another, or a single surgical option compared to other treatments such as medication, active surveillance, or physical therapy. Each option can have different potential benefits as well as short and long-term side effects. For a given condition, any of the options may be a reasonable alternative. The decision is often further complicated by incomplete evidence regarding both benefit and harm.

It is particularly important to note that many informed patients have different perspectives than their physicians about the benefits and trade-offs of treatment options. The final choice of treatment should be made by patients who have been informed about the choices, including the pros and cons of each approach and any uncertainty about the evidence that supports each option. In addition, the health care team needs to help patients clarify their own goals and partner with patients to make joint decisions.

This process of engaging patients in decisions about their care is known as shared decision-making. Shared decision-making is a collaborative process that allows patients and their providers to make health care treatment decisions together, taking into account the best scientific evidence available, as well as the patient's values and preferences. The right choice for one patient may not be the same as the next. In this series, Dartmouth Atlas investigators will consider many clinical situations where there is no single "right" choice and highlight areas where shared decision-making may have an important role for patients with surgical conditions.

In summary, this series of Atlas reports is intended to help patients, physicians, and policymakers recognize where improvements in science have helped to limit variation and improve surgical care; but more importantly, for each of the surgical conditions we study, we hope to identify specific clinical settings and situations where variation in the treatment of surgical condition remains, and outline the best opportunities for improvement in surgical care that lie ahead.

Variation in the Care of Surgical Conditions: Obesity

The Michigan Bariatric Surgery Collaborative

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The burden of obesity in the United States

Obesity is now an epidemic in the United States. Currently, more than one-third of U.S. adults (35.7%) and one-sixth of U.S. children and adolescents (16.9%) are obese.[1] Obesity substantially increases the risks of hypertension, dyslipidemia (high blood fats), heart disease, stroke, obstructive sleep apnea, type II diabetes, and osteoarthritis. It also increases the risks of endometrial, breast, prostate, and colon cancer, and is associated with higher mortality from all causes.[2] The annual medical cost of obesity is striking; estimates have increased from $78.5 billion in 1998 to $147 billion in 2008, accounting for almost 10% of all medical spending.[3] While many Americans attempt lifestyle modification and pharmacologic therapy to lose weight, these treatments are often unsuccessful and, on average, produce modest weight loss at best. While bariatric surgery—or modification of the digestive system to limit caloric intake—is invasive and has risks, it has been shown to reliably produce significant and sustainable weight loss in most patients.

This report discusses the growing problem of obesity in the U.S. population and shows different approaches to its treatment over time and by region. It focuses on the surgical treatment of obesity, including the decision to use surgery, the technical quality of surgical care, and patient outcomes. The trends and regional variation presented in this report reflect a combination of factors: the rise of obesity rates; the development of new therapies, particularly less invasive and more effective surgical techniques; and evolving policies related to safety and insurance coverage. Most importantly, regional variation raises questions about a lack of consensus within the medical community regarding the use of bariatric surgery and the role of patients in making fully informed decisions about their care. And finally, while progress has been made in understanding the best ways to limit obesity using surgical and medical approaches, areas in need of further improvement are highlighted.

Before surgery

Trends and variation in the prevalence of obesity and related comorbidities

The prevalence of obesity in the United States has steadily increased over the past two decades (Map 1.1). While less than 15% of the population was obese in each state in 1990, by 2010, all 50 states had rates greater than 20%, and 39 had rates greater than 25%. Moreover, in 15 states in the eastern and central U.S., more than 30% of the population was obese.

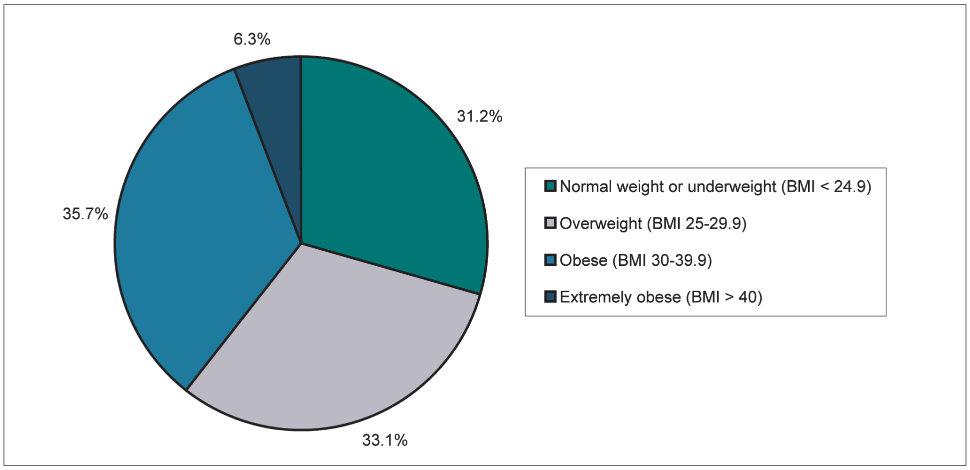
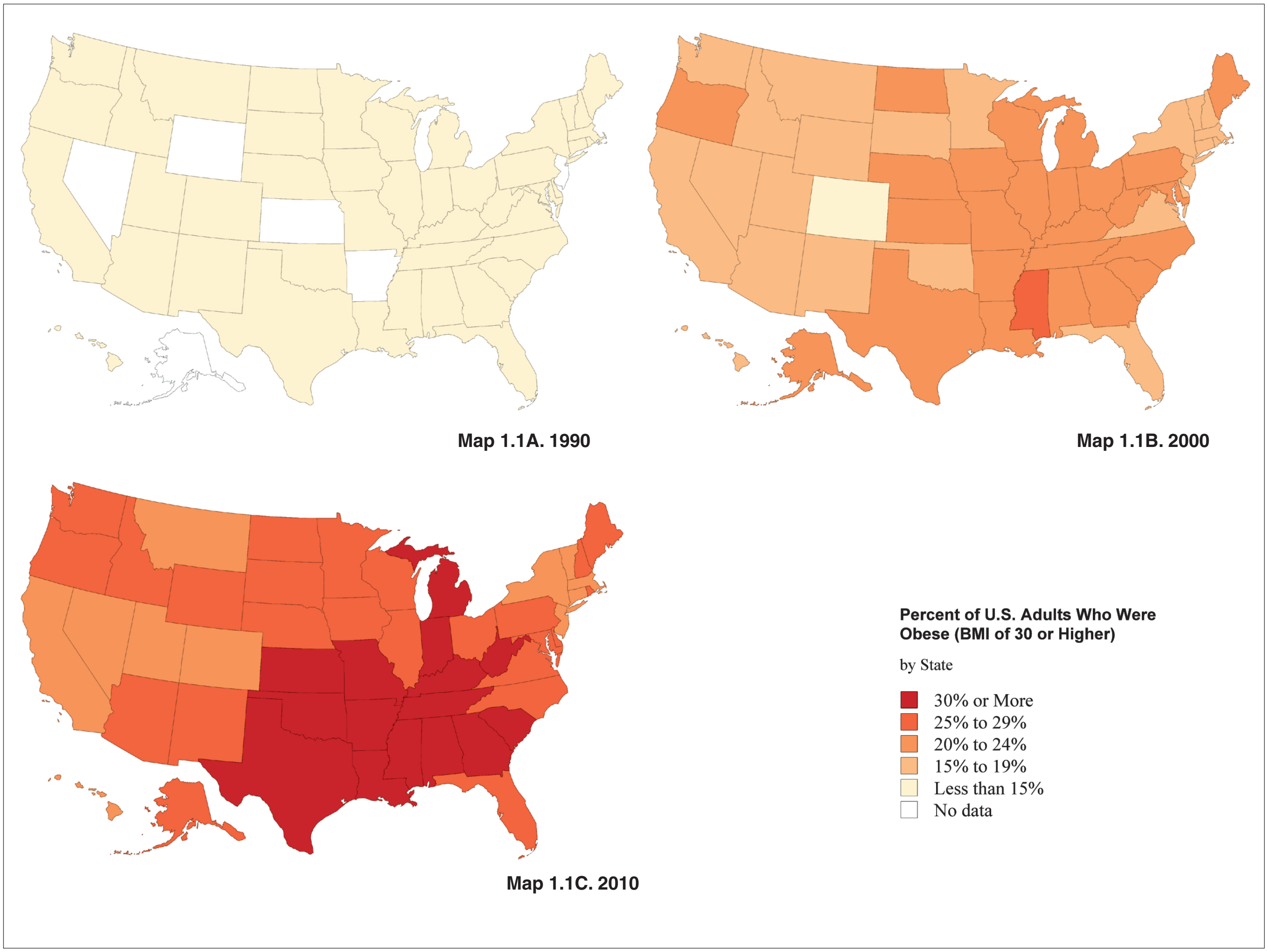


Figure 1.1. Burden of obesity among Americans (2009-10)

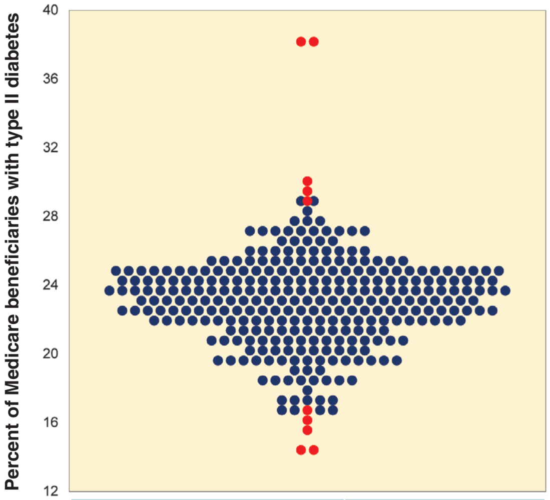
Source: The Centers for Disease Control and Prevention; National Health and Nutrition Examination Survey (NHANES).



Map 1.1. Obesity trends among U.S. adults

BMI ≥30, or about 30 lbs. overweight for 5’4” person.

Source: The Centers for Disease Control and Prevention; Behavioral Risk Factor Surveillance System (BRFSS).

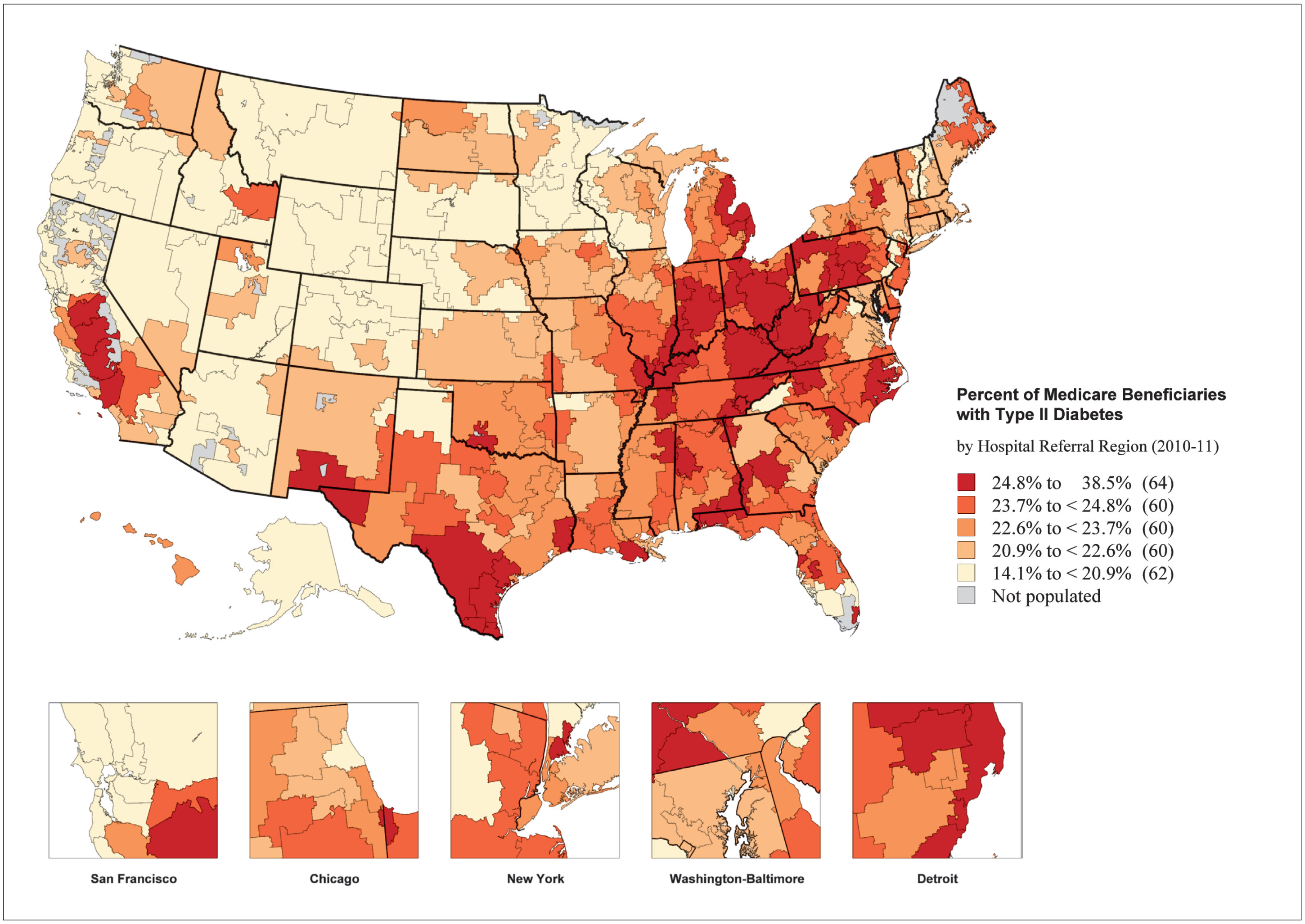


McAllen, TX	38.5%
Harlingen, TX	38.5%
Corpus Christi, TX	30.3%
Dearborn, MI	29.3%
Toledo, OH	29.0%
Fort Collins, CO	16.4%
San Mateo County, CA	16.3%
Santa Rosa, CA	15.6%
Boulder, CO	14.1%
Grand Junction, CO	14.1%

Just as rates of obesity differ across the United States, the rates of other illnesses associated with obesity also vary across the country. For example, the incidence of type II diabetes varies across the United States (Figure 1.2), with the highest rates of diabetes evident in southeastern regions (Map 1.2), where rates of obesity are also high. The national average rate of type II diabetes during 2010-11 was 23%. Less than 15% of Medicare beneficiaries living in the Colorado hospital referral regions of Grand Junction (14.1%) and Boulder (14.1%) had type II diabetes during 2010-11. The incidence of type II diabetes was more than twice as high among Medicare beneficiaries living in the Texas hospital referral regions of McAllen (38.5%), Harlingen (38.5%), and Corpus Christi (30.3%).

Figure 1.2. Percent of Medicare beneficiaries with type II diabetes among hospital referral regions (2010-11)

Each blue dot represents the rate of type II diabetes in one of 306 hospital referral regions in the U.S. Red dots indicate the regions with the 5 lowest and 5 highest rates.



Map 1.2. Percent of Medicare beneficiaries with type II diabetes (2010-11)

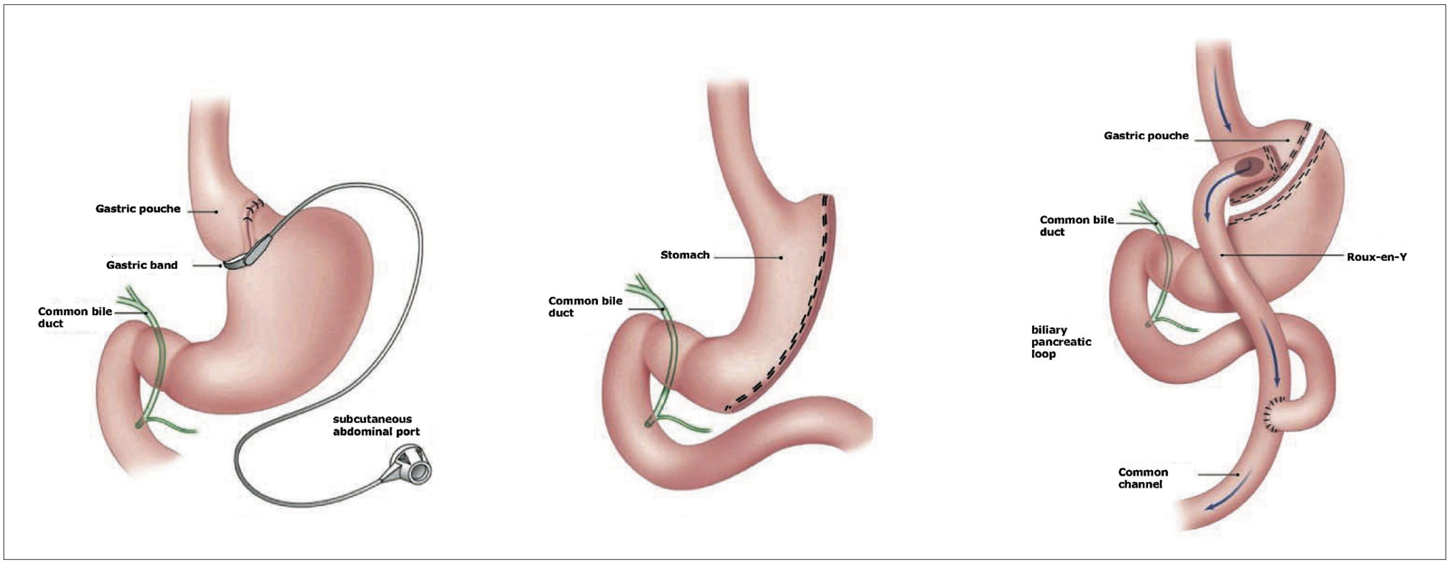
Rates are adjusted for age, sex, and race.

Treatment options and success rates

Treatments for obesity can be classified into medical and surgical therapies. Medical therapies include lifestyle modification or medications that limit fat absorption, such as orlistat. The long-term effectiveness of these therapies is modest for most patients. Medical therapies generally lead to an initial loss of 3-10% of body weight,[4-8] but sustained weight loss requires the indefinite continuation of therapy, which can be difficult for many patients.

Surgical therapy, while more invasive, is also more efficacious. In bariatric surgery, the gastrointestinal tract (the stomach and/or intestines) is modified or reconstructed to promote weight loss. Many of the initial procedures performed by surgeons—such as jejunocolic bypass, jejunoileal bypass, and vertical banded gastroplasty—had significant adverse effects and have been abandoned.[9] Currently, the most common bariatric, or weight-loss, procedures currently offered to patients are adjustable gastric banding, sleeve gastrectomy, and Roux-en-Y gastric bypass (Figure 1.3). In the past, a traditional open surgical approach was used for these procedures, but the overwhelming majority of bariatric surgery today is performed via laparoscopy, using small cameras and instruments inserted into the abdomen in a less invasive approach.

Bariatric procedures vary in complexity. Adjustable gastric banding—the least complex option—involves the placement of a synthetic, inflatable band around the stomach to create a small gastric pouch and a restricted gastric outlet, which limits food and caloric intake (Figure 1.3A). A sleeve gastrectomy, in contrast, removes part of the stomach, leaving a narrow sleeve, which preserves gastrointestinal continuity but restricts food and caloric intake (Figure 1.3B). In Roux-en-Y gastric bypass—the most complex of the three commonly offered procedures—the stomach is divided to create a small gastric pouch, the small intestine is divided, and the distal segment of small intestine (the part of the intestine further away from the stomach) is surgically connected to the gastric pouch to bypass the proximal segment (the part of the intestine closest to the stomach) (Figure 1.3C). This not only restricts food and caloric intake, but also decreases the amount of small intestine available for nutrient absorption.



A. ADJUSTABLE GASTRIC BANDING	B. SLEEVE GASTRECTOMY	C. ROUX-EN-Y GASTRIC BYPASS
Relative Use		
Performed in this country since 2001, it initially rose in popularity but has recently been surpassed by sleeve gastrectomy in the U.S.	Originally was a component of the duodenal switch procedure, has now gained in popularity as a stand-alone operation.	Among the most frequently used procedures in the U.S., accounting for a significant portion of the bariatric surgery performed in recent years.
Procedure Description		
Involves the laparoscopic placement of an adjustable silicone band around the upper part of the stomach.	Involves removal of 85% of the stomach, leaving a tubular shaped stomach.	Involves the use of a stapler to create a small gastric pouch and a length of resected bowel to bypass a portion of the digestive tract.
Weight Loss Mechanism		
Limits the amount of food that can be eaten at any one time and slows rate of emptying from the stomach to the intestines.	Limits the amount of food that can be eaten at any one time and secretion of hormones that cause hunger.	Restricts both the intake and the absorption of food.
Procedure Reversible?		
Fully reversible with band.	Not reversible.	Not easily or fully reversible.

Figure 1.3. Three commonly performed bariatric procedures

Source: Caiazzo R, Pattou F. Adjustable gastric banding, sleeve gastrectomy or gastric bypass. Can evidence-based medicine help us to choose? *J Visc Surg.* (2013);150:85-95. Previously cited in: Caiazzo R, Arnalsteen L, Pattou F. Principes du traitement chirurgical de l'obésité sévère. *Médecine des Maladies Métaboliques.* (2008);2(5):468-472.

Numerous reviews of bariatric surgery outcomes report that substantial and sustained weight loss can be achieved following surgery in most study patients.[10-13] Further, a majority of bariatric surgery patients experience complete resolution of many weight-related comorbidities, including diabetes, hypertension, hyperlipidemia, and obstructive sleep apnea. Patients have also reported improvements in their quality of life, especially in aspects such as depression, functional status, and self-esteem.

However, surgery is not without risk. A small number of patients do not experience sustained weight loss. While most patients have few problems related to surgery, nearly 10% are readmitted to the hospital in the period following the procedure. Risks of two complications after surgery are shown in Figure 1.4. A small number of patients (3-5%) experience infection at the surgical site; many of these patients will need another surgical procedure. Mortality after bariatric surgery is very low, occurring on average in 1 out of 300 patients. Helping patients to understand these risks—especially the uncommonly low ones—is a major goal of the visual display in Figure 1.4.

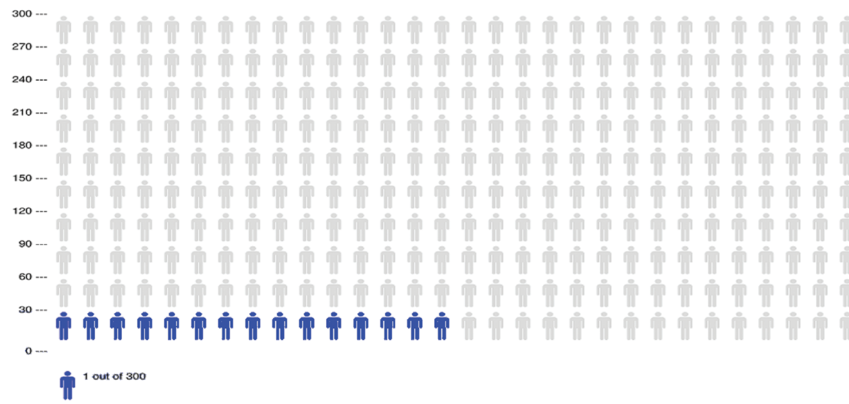


Figure 1.4A. Surgical site infection
15 out of 300.

Figure 1.4B. Death within 30 days of surgery
1 out of 300.

Figure 1.4. Risks of complications from bariatric surgery

Reaching the right decision

Bariatric surgery is not always the best choice for treating obesity. Some patients do not feel that their weight is a problem or may not want to take steps to lose weight. Some patients prefer medical therapy and are successful in maintaining their weight loss. For other patients, their expectations of improvement in physical or emotional health resulting from surgery may not be realistic, or their concurrent medical problems may increase the risk of death or another adverse outcome. Bariatric surgery programs and insurers usually require that patients undergo a supervised course of medical therapy before considering surgery. Physical and psychological screenings are also necessary, and some programs require that patients take a knowledge exam to demonstrate that they understand the likely benefits and possible risks. The latter is particularly important because most bariatric surgery patients have a poor understanding of the outcomes.

When bariatric surgery is medically appropriate, the next question is whether it is the right choice for a patient. Arriving at an informed, high-quality decision involves three requirements: 1) the patient receives balanced information in a format that is understandable; 2) the patient has the opportunity to clarify his or her values and preferences related to the options; and 3) the patient is invited into the decision-making process. Together, this process is known as shared decision-making and is often facilitated by decision aids.

A growing body of literature, including numerous publications from the Dartmouth Institute of Health Policy and Clinical Practice, supports the use of decision aids and shared decision-making for preference-sensitive surgical decisions.[14,15] The decision faced by morbidly obese patients considering elective bariatric surgery is complex and must take into account numerous factors: patient preferences, procedure characteristics, surgical risks, surgeon experience, insurance coverage,

Treatment Options	Decision Support Tool Components			Patient Outcomes
	Patient Needs	Decision Support	Decision Quality	
Medical therapy Adjustable gastric band Sleeve gastrectomy Roux-en-Y gastric bypass Duodenal switch	Clarification of individual values and preferences Knowledge of procedure risks, benefits, and other considerations	**Continuously updated, patient-specific data regarding risks and benefits** Guidance for the patient/surgeon interaction Other considerations	Assessment of patient knowledge and understanding Assessment of congruence with pre-specified values and preferences	Measurement of: Weight loss Patient satisfaction Quality of life

Figure 1.5. Conceptual model for novel bariatric surgery decision support tool

To learn more about the Michigan Bariatric Surgery Collaborative initiative, please visit umchop.org/programs/mbsc.html.

and potential for success. Given this complexity, patients can easily become overwhelmed with information. As a result, decision support tools are ideally suited for patients considering bariatric surgery. Previous evaluations of decision aids in this population have reported significant improvements in knowledge, value concordance, decisional conflict, decisional self-efficacy, and treatment choice.[16] Decision aids typically provide a broad range of information to patients, including discussion of potential treatment options (diet-based, medical therapies, and surgical treatments), and offer shared decision-making as a tool to improve decision quality.

The Michigan Bariatric Surgery Collaborative (MBSC) is also developing a new decision support tool for the treatment of morbid obesity. The tool will be continuously updated by registry data to ensure that information about procedures, as well as patient-specific data regarding risks and benefits, are accurate and current (Figure 1.5). This will allow patients to make personalized treatment decisions that are better informed by the latest evidence and more congruent with their individual preferences. The tool will be disseminated throughout the state and will be rigorously studied to evaluate both clinical effectiveness and subjective patient experience. If proven effective, it will be made available nationally so that organizations may use this experience as a blueprint to develop similar decision support tools for other preference-sensitive conditions.

Patients who are considering bariatric surgery may want to visit the following web sites for more information:

American Society for Metabolic and Bariatric Surgery (ASMBS) Patient Learning Center: asmbs.org/patients

Weight-control Information Network from the National Institute of Diabetes and Digestive and Kidney Diseases: www.win.niddk.nih.gov/publications/gastric.htm

Laparoscopic Surgery for Severe (Morbid) Obesity Patient Information from the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES): www.sages.org/publications/patient-information/patient-information-for-laparoscopic-surgery-for-severe-morbid-obesity-from-sages

The Strategies to Overcome and Prevent (STOP) Obesity Alliance: www.stopobesityalliance.org

Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP): www.facs.org/quality-programs/mbsaqip

Ethicon: images and animations of bariatric procedures: www.ethicon.com/healthcare-professionals/specialties/bariatric/patient-education

During surgery

Choosing surgical care, and the type of surgical care

The patient and his or her physician must choose not only whether or not to proceed with surgery, but also the specific procedure that is best for the patient. Procedure choice is influenced by several factors: the patient's preferences, procedure availability, insurance coverage, the surgeon's preference, and the current evidence regarding a procedure's clinical effectiveness. The risk of complications and potential for weight loss also differ with each procedure and change over time. As outcomes research has developed, information about surgical outcomes has become essential to inform patient and provider preferences. Historic and current trends in bariatric procedure utilization reflect the evolution of these factors.

Trends in utilization

The rise in rates of obesity, along with increasing interest in surgical options, has resulted in a dramatic increase in utilization of bariatric surgery in recent years. Figure 1.6 illustrates the increasing utilization of bariatric surgery from 2001 to 2011. The national average rate of bariatric surgery increased nearly sixfold between 1990 and 2000, and this rise has continued through 2011.[17,18] Moreover, the shift in surgical approach from more invasive open procedures (more than 85% of all bariatric surgery in 2000) to a less invasive laparoscopic approach (more than 90% of all bariatric surgery in 2008) over the decade led to a further striking increase in utilization. Rates of overall procedure use reached a high of nearly 40 per 100,000 Medicare patients in 2009.[19]

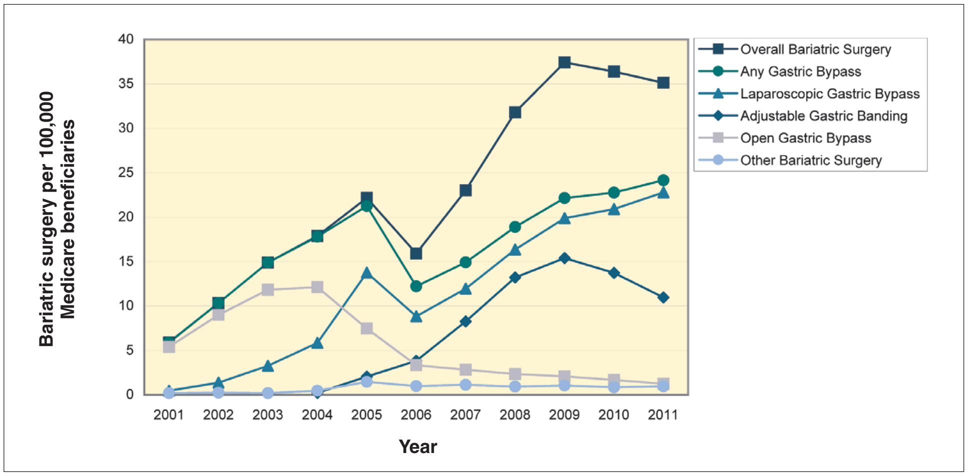


Figure 1.6. Bariatric surgery utilization trends among Medicare beneficiaries (2001-11)

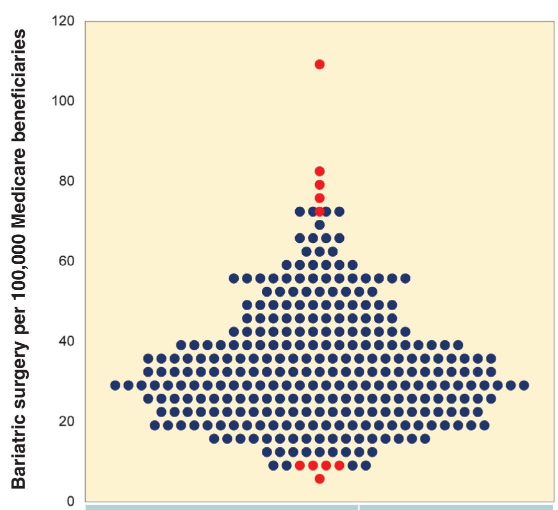
The choice of procedure also shifted during this 20-year period. As gastric bypass gained popularity, increasing from 55% of all bariatric procedures in 1990 to 99% in 2003, vertical banded gastroplasty fell out of favor, decreasing from more than 40% to 7% during the same period.[18-20]

Additional changes in utilization during this decade reflected emerging research in support of novel procedures and the policy changes that followed. The Food and Drug Administration approved adjustable gastric banding for use in the United States in 2001 following multiple reports of successful outcomes in Europe and Australia.[21,22] In the ensuing years, utilization of adjustable gastric banding grew substantially due to its ease of reversibility, adjustability, and overall safety profile.[23-25]

Policy influence on procedure utilization

Based on the growing body of literature supporting bariatric surgery as a treatment for morbidly obese patients, the Centers for Medicare & Medicaid Services (CMS) announced in 2006 that gastric bypass, laparoscopic adjustable gastric banding, and biliopancreatic diversion with duodenal switch would be covered for Medicare patients meeting certain criteria.[26] Though overall rates of bariatric surgery had started to decline after 2004, this expansion of coverage increased the availability and use of these procedures. Between 2005 and 2010, as the popularity of adjustable gastric banding grew, the relative utilization of gastric bypass slowly decreased. In 2008, laparoscopic gastric bypass accounted for 69% of all bariatric procedures, while laparoscopic adjustable gastric banding accounted for 29%.[19]

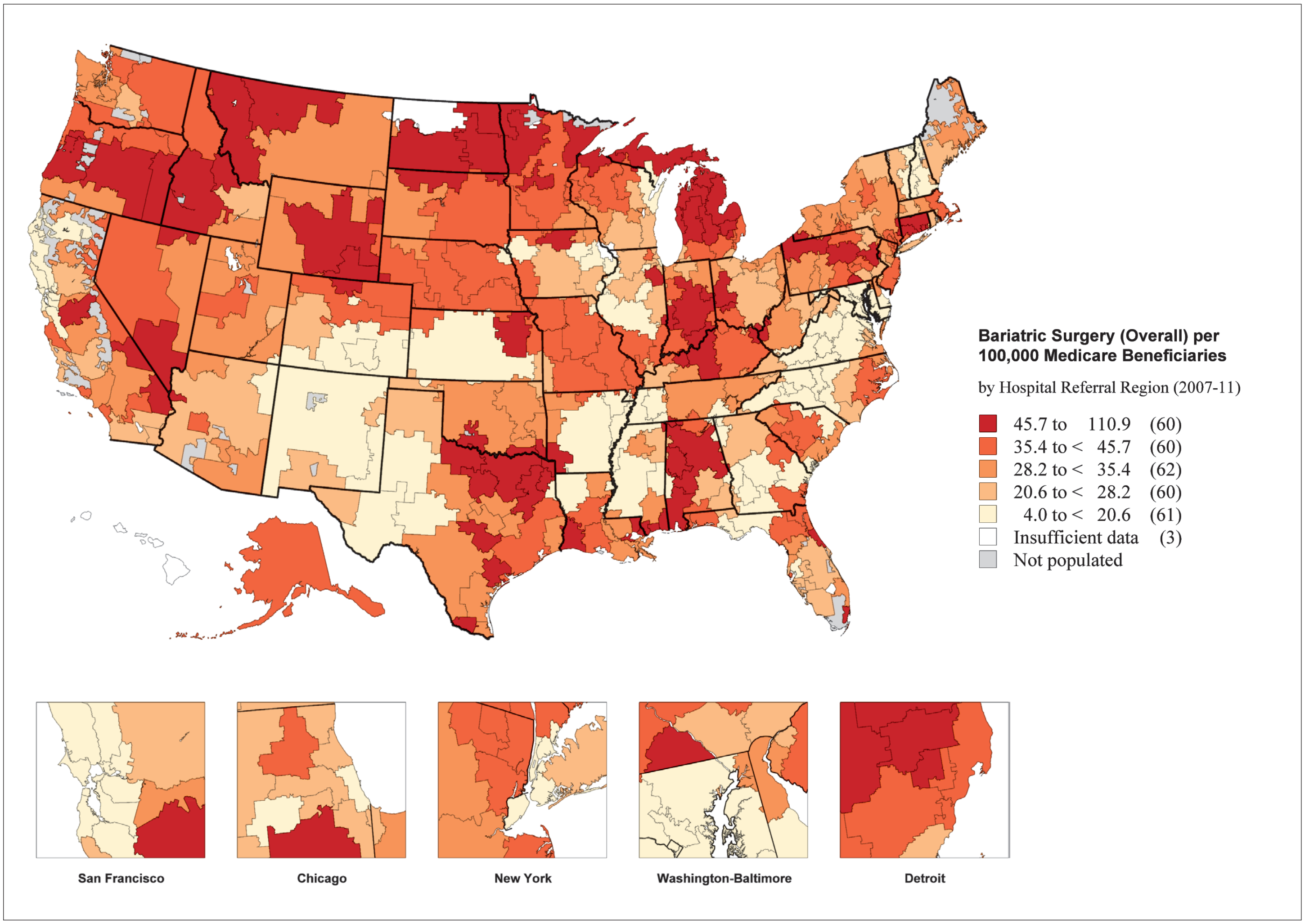
Laparoscopic sleeve gastrectomy was introduced to the field in 2003. Select private insurers began to cover the procedure in the years following, although CMS chose not to cover the procedure until 2006. This increased insurance coverage was followed by the rise in utilization observed in Figure 1.6. During this same period, new research on adjustable gastric banding reported increased late complications and high long-term failure rates (poor weight loss and band removal),[27,28] and consequently, utilization of adjustable gastric banding decreased.



Muskegon, MI	110.9
Kettering, OH	83.7
Marquette, MI	77.7
Great Falls, MT	75.3
Bend, OR	73.9
Alameda County, CA	9.3
Cedar Rapids, IA	9.3
Santa Rosa, CA	8.4
San Mateo County, CA	7.9
San Francisco, CA	4.0

Figure 1.7. Bariatric surgery among 100,000 Medicare beneficiaries among hospital referral regions (2007-11)

Each blue dot represents the rate of bariatric surgery in one of 306 hospital referral regions in the U.S. Red dots indicate the regions with the 5 lowest and 5 highest rates.



Map 1.3. Bariatric surgery among 100,000 Medicare beneficiaries (2007-11)

Rates are adjusted for age, sex, and race.

Geographic variation in bariatric procedure utilization is indicative of the complexity of the decision faced by morbidly obese patients. Rates of bariatric surgery varied by a factor of more than twenty during the period from 2007 to 2011, from fewer than 9 procedures per 100,000 Medicare beneficiaries in San Francisco (4.0), San Mateo County (7.9), and Santa Rosa, California (8.4) to more than 80 per 100,000 in Muskegon, Michigan (110.9) and Kettering, Ohio (83.7) (Figure 1.7). In general, rates of bariatric surgery were higher in the Midwest and northwestern regions than in the southern states (Map 1.3). The national average rate of bariatric surgery during the period from 2007 to 2011 was 32.8 per 100,000 enrollees.

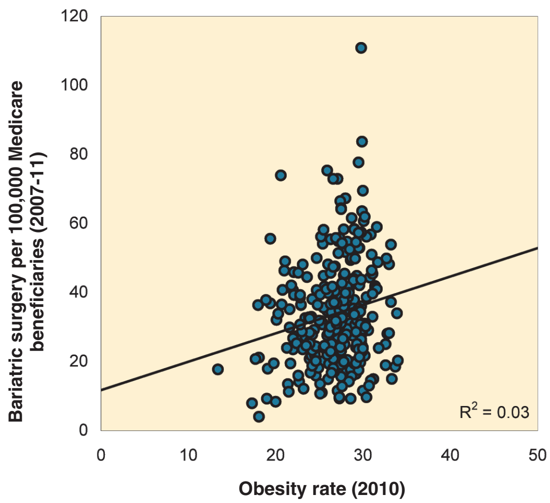


Figure 1.8A. Relationship between obesity rates and bariatric surgery among hospital referral regions

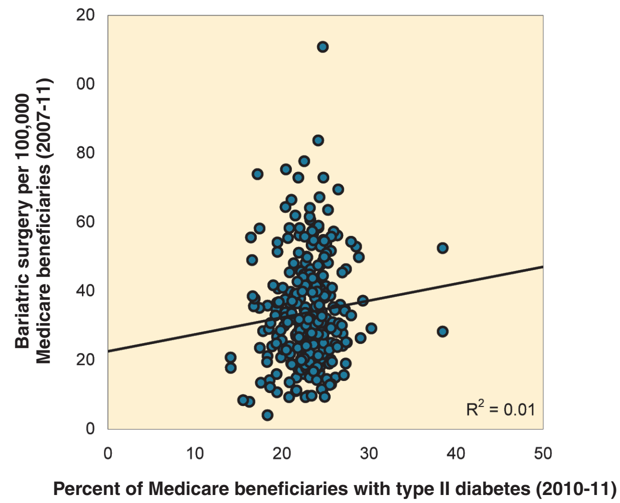


Figure 1.8B. Relationship between type II diabetes and bariatric surgery among hospital referral regions

Each dot represents one of the 306 hospital referral regions across the United States. Regional rates of obesity and diabetes were unrelated to rates of bariatric surgery. Obesity rates were estimated using data from the Centers for Disease Control and Prevention.

Figure 1.8 shows a hospital referral region's rates of obesity (Figure 1.8A) or diabetes (Figure 1.8B) on the horizontal axis, while the vertical axis shows the same region's rate of bariatric surgical procedures. Regional rates of obesity and diabetes have virtually no relationship to the rates of bariatric surgery (R^2 = 0.03 and 0.01, respectively). Rather, differences in procedure characteristics, safety profiles, and the evidence supporting clinical effectiveness each contribute to these variations. Provider preferences, reflecting their training and experiences, are also a major contributor. Given the lack of shared decision-making in most health systems, it is hard to argue that patient preferences are a dominant cause of regional variation in utilization.

The notion that surgery might be an effective population-based solution for obesity should be met with some skepticism. Given the Centers for Disease Control and Prevention (CDC) estimates for 2010, more than 10 million Americans are extremely obese, to the extent that their obesity would exceed body mass index (BMI) criteria for bariatric surgery (BMI > 40). However, in 2010, fewer than 150,000 bariatric surgical procedures were performed in the United States, suggesting that an eighty-fold increase in the number of bariatric procedures would be needed to "treat" obesity surgically in the U.S., at a cost that would exceed $17 billion (based on an average Medicare payment of $1,700 for a single bariatric procedure). These estimates are decidedly conservative, as they only include the payments made to surgeons for the procedure. Even under a conservative assumption wherein only 10% of eligible obese Americans—about 1 million people—were ultimately treated with bariatric surgery, payments to hospitals, surgical centers, and physicians could potentially exceed $15 billion.

Using regional collaboratives to study comparative effectiveness

Our knowledge about the relative effectiveness of different bariatric procedures is incomplete. For example, randomized trials comparing gastric bypass to sleeve gastrectomy are limited to small, single-center studies with short follow-up intervals, and the results may not apply to the general obese population.[29-36] Most large observational studies utilize administrative data limited to perioperative periods, examine nonspecific surgical outcomes, and often lag behind current practice. Observational studies with longer follow-up periods—that report detailed bariatric surgery-specific clinical risk factors and outcomes—are usually single-center studies. As a result, uncertainty remains regarding the outcomes associated with certain patients. Within the state of Michigan, however, a unique environment exists to allow for more detailed evaluation of these issues.

The Michigan Bariatric Surgery Collaborative (MBSC), formed in 2006, is a voluntary regional consortium of all surgeons who perform bariatric surgery and the hospitals where it is performed within the state. The timely collection and distribution of MBSC data—along with detailed bariatric-specific risk factors and outcomes—allows for a more accurate understanding of current trends in the utilization, safety, and effectiveness of bariatric procedures. For example, trends in procedure utilization in Michigan over time parallel those seen nationally. Figure 1.9 illustrates the utilization of gastric bypass, adjustable gastric banding, and sleeve gastrectomy in Michigan during the period from 2006 to 2012. In 2006, gastric bypass accounted for 61% of all bariatric surgery in the state, and adjustable gastric banding accounted for 37%. Utilization of sleeve gastrectomy began in 2007 and increased rapidly in the ensuing years, while rates of gastric bypass decreased moderately and rates of adjustable gastric banding decreased substantially. In 2012, 45% of bariatric procedures performed in Michigan were sleeve gastrectomies, while 43% were gastric bypasses, and only 11% were adjustable gastric banding procedures.

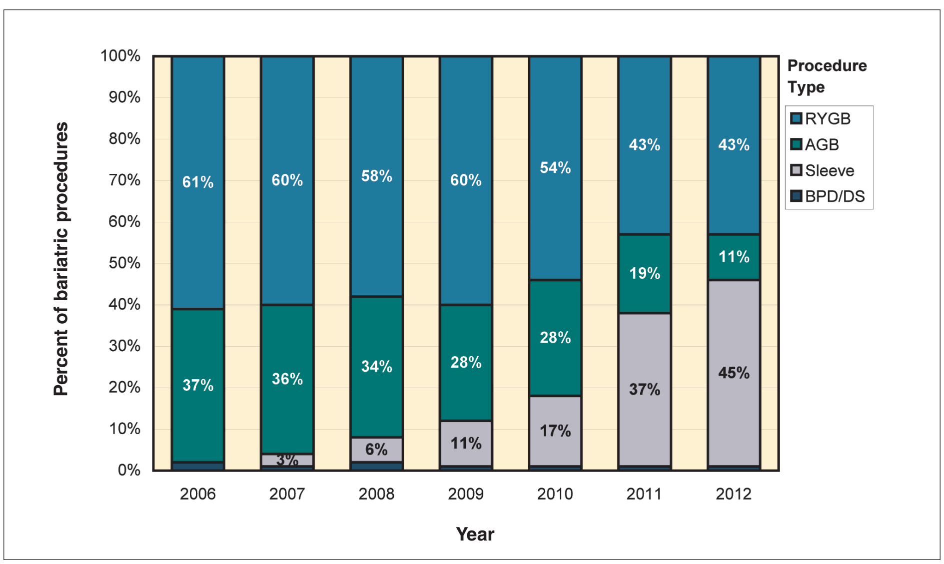


Figure 1.9. Trends in utilization of gastric bypass, adjustable gastric banding, and sleeve gastrectomy in Michigan (2006-12)

BPD/DS = biliopancreatic diversion with duodenal switch. AGB = adjustable gastric banding. RYBG = Roux-en-Y gastric bypass.

Source: Michigan Bariatric Surgery Collaborative.

Technical quality: the role of centers of excellence in bariatric surgery

Ensuring safe, high-quality bariatric surgical care became a public health priority as utilization increased dramatically during the 2000s. Initial studies of the modern bariatric surgical experience reported varying mortality rates across hospitals and surgeons. A meta-analysis of case series and early population-based analyses of administrative data reported 30-day mortality rates between 0.2 and 1.9%,[10,20,37,38] while examination of Medicare patients revealed mortality rates of 2.0% at 30 days and 4.6% at 1 year.[39] Many of these studies linked surgeon and hospital volume to surgical outcomes: "low-volume" centers exhibited two to threefold increased odds of mortality, and this effect was most pronounced in older, high-risk patients.[40,41]

Consequently, the American Society for Bariatric Surgery established a "centers of excellence" program in 2003 to implement national standards for institutions performing bariatric surgery.[42,43] A similar program was developed by the American College of Surgeons.[44] When CMS issued its national coverage decision in 2006, the criteria limited coverage to certified centers of excellence only.[26] However, subsequent research evaluating the effect of the CMS policy on bariatric surgical outcomes revealed mixed results. Several studies evaluating centers of excellence compared to other hospitals failed to identify improvements in outcomes, despite increased hospital volumes at centers of excellence.[45,46] One such study found that rates of serious complications varied widely regardless of the "center of excellence" designation. In contrast, multiple studies examining outcomes in Medicare patients before and after the CMS policy revealed beneficial effects: 90-day mortality, complications, readmissions, and length of stay were all reported to decrease following the restriction of coverage.[47,48] However, these studies could not distinguish the effect of the policy from general trends toward improved outcomes during the study period.

To clarify these conflicting studies, Dimick and colleagues used hospital discharge data to evaluate the effect of the CMS policy on Medicare patients undergoing bariatric surgery compared to a control group of non-Medicare patients. To isolate improvements in outcomes after the coverage decision from coincident temporal trends, the authors applied an econometric technique—difference-in-differences—commonly used to evaluate the effect of policy changes. This evaluation determined that, after controlling for temporal trends, there was no benefit to the coverage restriction.[49] Following the CMS policy, rates of any complication, serious complications, and reoperation decreased substantially in both Medicare and non-Medicare patients, but trends toward improved outcomes were present in both groups well before the policy was implemented (Figure 1.10). Difference-in-differences analysis failed to reveal an independent effect of the CMS policy.

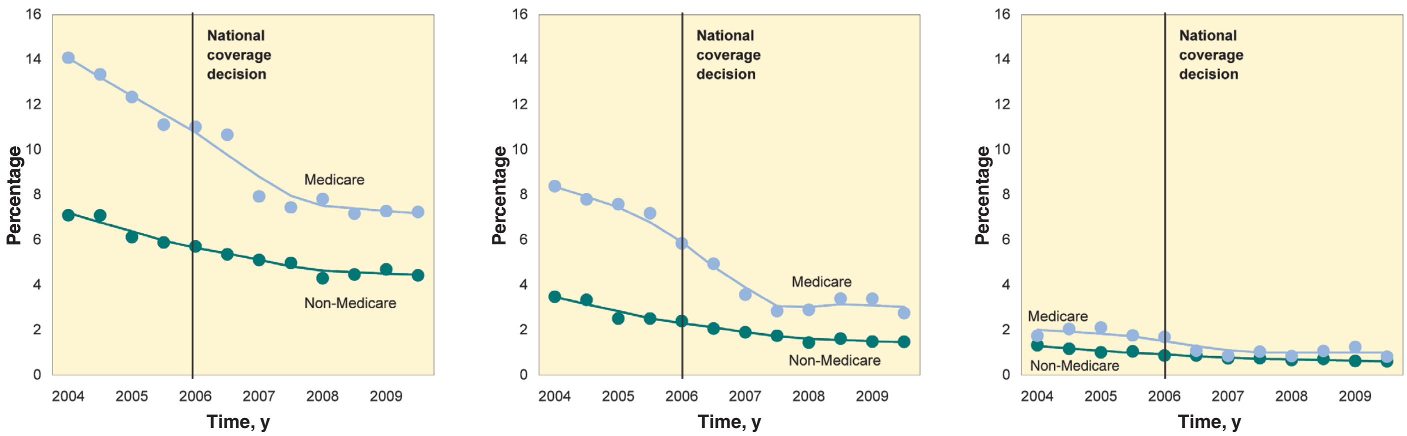


Figure 1.10A. Any complication **Figure 1.10B. Serious complications** **Figure 1.10C. Reoperation**

Figure 1.10. Trends in adverse outcomes before and after the implementation of the Centers for Medicare & Medicaid Services bariatric surgery national coverage decision

Each data marker represents two quarters within each year. The national policy restricting coverage to centers of excellence was implemented starting in the first quarter of 2006.

Though this evaluation failed to identify a benefit of the CMS policy, subsequent analyses demonstrated restrictions to access, particularly among minority beneficiaries.[50] While rates of bariatric surgery remained stable among non-Medicare minorities, rates in Medicare minority patients declined by 17% after the February 2006 national coverage decision. Publication of these findings had a substantial impact on CMS policy. In September of 2013, CMS decided to eliminate the "facility certification requirement," allowing beneficiaries fulfilling appropriate criteria to pursue bariatric surgery at the institution of their choice.[51,52]

These examples of policy change clearly illustrate the importance of outcomes research to the field of bariatric surgery. Patients and providers have all benefited from the ongoing evaluation of bariatric surgical quality and access to care. Future health services research must build on these successes through continued evaluation of current techniques, surgical outcomes, systems of care, and health policy.

After surgery

New attention has been focused on the events that follow surgery, especially among patients undergoing surgical care for obesity. Hospital readmission rates are carefully scrutinized, as are events that occur after discharge, such as close follow-up with primary care physicians or the surgical team itself. Tables 1.1 and 1.2 show the variations in readmission risk and in follow-up with a primary care physician for Medicare patients treated with surgical therapy for obesity. The national average 30-day readmission rate following bariatric surgery was 8.3% during 2007-11; during that same period, on average, 39.5% of patients had a follow-up visit with a primary care physician within 30 days of bariatric surgery.

However, several pertinent outcomes of bariatric surgery in Medicare patients remain undefined: how much weight they lose, their functional health status, and their satisfaction with their care and outcomes. Nearly every randomized trial has studied weight loss as an outcome, yet this outcome is not routinely available at long-term follow-up in large studies of aged Medicare patients using claims data. Patient-centered outcomes, such as satisfaction with the procedure and the level of functional improvement after the operation, remain incompletely described. Studying these important outcomes remains a target for physicians and policymakers across the United States.

Table 1.1. Percent of Medicare beneficiaries readmitted within 30 days following bariatric surgery by hospital referral region (2007-11)

HRR	State	Percent readmitted within 30 days following bariatric surgery (2007-11)
10 highest HRRs		
Cleveland	OH	13.3%
Orlando	FL	13.0%
Oklahoma City	OK	10.8%
Boston	MA	10.7%
Nashville	TN	10.2%
Fort Lauderdale	FL	10.0%
Minneapolis	MN	9.9%
Knoxville	TN	9.8%
St. Louis	MO	9.5%
New Haven	CT	9.5%
10 lowest HRRs		
Manhattan	NY	7.2%
Columbus	OH	7.2%
East Long Island	NY	7.1%
Los Angeles	CA	6.9%
Grand Rapids	MI	6.9%
Allentown	PA	6.9%
Jacksonville	FL	6.6%
Hartford	CT	6.1%
Birmingham	AL	4.8%
San Antonio	TX	4.3%

Table 1.2. Percent of Medicare beneficiaries having a primary care visit within 30 days following bariatric surgery by hospital referral region (2007-11)

HRR	State	Percent having primary care visit within 30 days following bariatric surgery (2007-11)
10 highest HRRs		
Danville	PA	78.6%
Muskegon	MI	70.9%
Flint	MI	70.1%
McAllen	TX	63.5%
Omaha	NE	62.8%
Royal Oak	MI	60.9%
Saginaw	MI	59.9%
Dearborn	MI	59.2%
Sarasota	FL	57.6%
Marshfield	WI	57.0%
10 lowest HRRs		
Rochester	MN	27.3%
Greeley	CO	27.2%
Manchester	NH	27.1%
Bronx	NY	27.0%
Elmira	NY	26.3%
Shreveport	LA	25.8%
Oklahoma City	OK	24.8%
Lafayette	LA	23.4%
Wichita Falls	TX	20.1%
Fort Smith	AR	19.5%

The tables show the hospital referral regions with the 10 highest and 10 lowest rates for clinical events following discharge after bariatric surgery.

Beyond surgery

Spending on surgery – or spending on prevention?

Nationally, health care costs related to bariatric surgery were estimated at just under a billion dollars in 2002 and had grown to nearly $3 billion by 2011. While the surgical treatment of obesity is efficacious, this clinical effectiveness comes at a relatively steep price, and extrapolation of this treatment to the true “epidemic” of obesity would come at an impractical and implausible cost.

Should we spend our efforts—and financial resources—on alternatives to surgery for patients with obesity? Progress has been made in preventing childhood obesity; a recent CDC report showed that childhood obesity rates declined in 19 of the 43 states where obesity prevention programs were introduced.[53] Many might argue that directing some of the resources currently allocated to surgical care toward preventing childhood obesity might have more impact. How resources are—or should be—allocated between preventive measures aimed at younger obese Americans and surgical treatment of older patients remains an open question.

Using quality improvement to limit variation

While the examples above illustrate improved outcomes for patients undergoing bariatric surgery—and the vital role health services research has played—opportunities for continued improvement exist. Wide variations persist in hospital processes, surgical outcomes, and procedure utilization despite these improvements. Patients considering bariatric surgery are faced with complex decisions and can become overloaded with information. In addition to these issues, current health care reform efforts require providers at all levels to increase quality of care while simultaneously decreasing costs. Going forward, there is no doubt that health services research will be essential to continued improvements in outcomes and quality.

Within the Michigan Bariatric Surgery Collaborative (MBSC), research is currently under way to better understand these challenges and develop novel strategies for quality improvement. Numerous publications have highlighted the benefits of regional quality collaboratives.[46,54-57] Collaboratives have been shown to lead to decreased complications, mortality, resource utilization, and costs. For bariatric surgery, the MBSC provides an example of the success that can be achieved through regional quality collaboratives: the standardization of venous thromboembolism (VTE) prophylaxis in MBSC hospitals.[58] After evaluation of VTE prophylaxis regimens revealed wide variations across MBSC hospitals in 2008, the collaborative used registry data to develop a VTE risk-prediction tool and identify optimal prophylaxis strategies for each risk cohort. This and other examples illustrate how further improvements for bariatric surgery patients can be achieved on a national scale.

Decision aids and shared decision-making

As described previously, decision support tools can be valuable aids for patients considering bariatric surgery. The MBSC's work developing a new decision support tool for the treatment of morbid obesity (Figure 1.5) will allow patients to make personalized treatment decisions that are better informed by the current evidence and more congruent with their individual preferences.

Conclusions

Despite many achievements in treating obesity, future work is needed to determine the outcomes of treatment choices in terms that are meaningful to patients. These efforts, which will likely emanate from regional quality improvement initiatives, will focus on weight loss, functional status, cost effectiveness, and other patient-centered outcomes to ensure that the significant expenditures on surgical care for obese patients in the United States provide the most return on this investment.

Health services research is playing a critical role in advancing the field of treatment for obesity and bariatric surgery. Publications reporting on new techniques, surgical outcomes, and the impact of policy decisions have influenced procedure utilization over time, improved insurance coverage, and resulted in better access to surgical care for obese patients. Better evaluation of these treatments remains a priority, along with the incorporation of the findings into shared decision-making.

Chapter 1 Table. Rates of obesity, type II diabetes, bariatric surgery, and events occurring following surgical discharge among hospital referral regions

HRR Name	State	Percent of population that is obese (BMI of 30 or more) (2010)	Percent of Medicare beneficiaries with type II diabetes (2010-11)	Bariatric surgery per 100,000 Medicare beneficiaries (2007-11)	Percent having primary care visit within 30 days following bariatric surgery (2007-11)	Percent readmitted within 30 days following bariatric surgery (2007-11)
Birmingham	AL	31.7	24.7	48.8	34.3	4.8
Dothan	AL	32.6	25.6	25.1	41.1	
Huntsville	AL	30.8	24.5	44.4	49.2	
Mobile	AL	30.1	23.3	60.7	35.0	8.9
Montgomery	AL	32.8	23.2	28.1	39.7	
Tuscaloosa	AL	33.2	25.1	53.9	36.0	
Anchorage	AK	27.8	18.4	35.8	46.8	
Mesa	AZ	23.4	21.0	32.6	35.9	
Phoenix	AZ	23.4	19.5	27.2	37.6	
Sun City	AZ	22.9	19.5	36.4		
Tucson	AZ	21.6	17.4	35.2	38.5	
Fort Smith	AR	29.2	24.1	33.0	19.5	
Jonesboro	AR	30.0	24.7	11.6		
Little Rock	AR	29.3	21.1	19.1	39.0	
Springdale	AR	26.6	20.5	32.8	45.4	
Texarkana	AR	30.9	23.6	56.8	30.3	
Orange County	CA	19.4	22.0	36.9	35.6	
Bakersfield	CA	28.6	27.0	27.8	48.6	
Chico	CA	25.2	21.4	31.8	40.8	
Contra Costa County	CA	22.7	18.6	14.2		
Fresno	CA	25.9	27.2	34.7	45.3	
Los Angeles	CA	20.1	25.1	32.1	39.0	6.9
Modesto	CA	28.0	25.6	51.7	45.7	
Napa	CA	21.4	17.6	13.5		
Alameda County	CA	19.0	20.8	9.3		
Palm Springs/Rancho Mirage	CA	25.5	16.8	35.6	42.5	
Redding	CA	24.6	19.4	16.0		
Sacramento	CA	23.9	19.9	20.8	51.3	
Salinas	CA	22.0	23.6	40.7	28.4	
San Bernardino	CA	26.4	24.4	34.3	36.5	
San Diego	CA	22.4	21.6	27.4	35.1	
San Francisco	CA	18.1	18.3	4.0		
San Jose	CA	19.1	23.5	18.0	39.4	
San Luis Obispo	CA	22.0	17.5	23.6		
San Mateo County	CA	17.3	16.3	7.9		
Santa Barbara	CA	22.0	19.4	26.8		
Santa Cruz	CA	18.1	18.4	21.2		
Santa Rosa	CA	20.0	15.6	8.4		
Stockton	CA	28.6	23.8	31.1	39.3	
Ventura	CA	22.9	21.5	36.4	33.9	
Boulder	CO	13.4	14.1	17.8		
Colorado Springs	CO	19.8	18.3	19.5	38.3	
Denver	CO	18.9	16.9	37.8	50.2	
Fort Collins	CO	19.4	16.4	55.6	40.7	

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period. Obesity rates were estimated using county-level rates from the Centers for Disease Control and Prevention.

Chapter 1 Table. Rates of obesity, type II diabetes, bariatric surgery, and events occurring following surgical discharge among hospital referral regions

HRR Name	State	Percent of population that is obese (BMI of 30 or more) (2010)	Percent of Medicare beneficiaries with type II diabetes (2010-11)	Bariatric surgery per 100,000 Medicare beneficiaries (2007-11)	Percent having primary care visit within 30 days following bariatric surgery (2007-11)	Percent readmitted within 30 days following bariatric surgery (2007-11)
Grand Junction	CO	17.7	14.1	20.8		
Greeley	CO	20.8	19.6	40.8	27.2	
Pueblo	CO	22.6	22.6	16.0		
Bridgeport	CT	18.0	19.7	36.4	44.2	
Hartford	CT	22.1	22.1	45.9	31.3	6.1
New Haven	CT	22.6	22.2	45.7	32.2	9.5
Wilmington	DE	27.8	23.4	34.0	34.0	
Washington	DC	26.0	21.7	14.9	41.6	
Bradenton	FL	23.0	20.9	24.0		
Clearwater	FL	26.0	20.6	23.6		
Fort Lauderdale	FL	20.3	20.4	33.9	41.0	10.0
Fort Myers	FL	23.9	20.0	25.8	40.4	
Gainesville	FL	27.8	23.2	45.0	34.8	
Hudson	FL	24.4	25.6	29.2	42.2	
Jacksonville	FL	27.5	24.2	39.0	37.8	6.6
Lakeland	FL	29.2	27.0	24.2		
Miami	FL	21.0	27.4	46.4	38.2	9.5
Ocala	FL	25.4	23.7	31.1	40.1	
Orlando	FL	24.3	24.7	24.7	37.1	13.0
Ormond Beach	FL	24.7	22.8	50.0	43.0	
Panama City	FL	25.5	24.7	20.2		
Pensacola	FL	26.8	25.2	40.4	29.7	
Sarasota	FL	21.3	18.9	24.0	57.6	
St. Petersburg	FL	26.0	21.0	39.8	49.7	
Tallahassee	FL	29.2	24.3	16.5	38.7	
Tampa	FL	24.9	24.4	18.2	52.7	
Albany	GA	30.4	23.0	9.7		
Atlanta	GA	26.3	22.3	21.5	42.0	7.5
Augusta	GA	31.4	22.7	41.9	35.6	
Columbus	GA	31.2	26.1	15.0		
Macon	GA	30.9	25.1	14.6	42.9	
Rome	GA	29.2	27.3	19.0		
Savannah	GA	28.0	21.9	17.4	31.3	
Honolulu	HI	21.2	23.7			
Boise	ID	25.4	19.5	54.1	48.6	
Idaho Falls	ID	26.4	23.7	25.1		
Aurora	IL	26.1	24.0	19.3		
Blue Island	IL	24.1	22.9	21.7	35.8	
Chicago	IL	24.0	23.4	16.8	34.7	
Elgin	IL	25.5	22.5	44.9	42.5	
Evanston	IL	24.0	19.4	24.9	35.6	
Hinsdale	IL	24.5	20.9	21.8		
Joliet	IL	26.8	24.4	47.6	31.9	
Melrose Park	IL	24.2	22.5	23.2	43.0	

Chapter 1 Table. Rates of obesity, type II diabetes, bariatric surgery, and events occurring following surgical discharge among hospital referral regions

HRR Name	State	Percent of population that is obese (BMI of 30 or more) (2010)	Percent of Medicare beneficiaries with type II diabetes (2010-11)	Bariatric surgery per 100,000 Medicare beneficiaries (2007-11)	Percent having primary care visit within 30 days following bariatric surgery (2007-11)	Percent readmitted within 30 days following bariatric surgery (2007-11)
Peoria	IL	27.3	22.1	25.5	38.5	
Rockford	IL	26.4	23.3	25.2	33.5	
Springfield	IL	27.7	23.7	17.1	45.3	
Urbana	IL	27.7	22.9	25.8	39.3	
Bloomington	IL	27.0	22.2	20.1		
Evansville	IN	28.2	24.9	38.1	34.2	
Fort Wayne	IN	29.2	24.6	33.3	35.1	
Gary	IN	30.6	24.2	29.1	45.1	
Indianapolis	IN	28.6	24.9	49.4	36.1	9.4
Lafayette	IN	28.1	25.6	38.7		
Muncie	IN	30.4	26.4	56.2	37.1	
Munster	IN	29.9	26.2	24.6		
South Bend	IN	29.2	23.8	27.0	29.4	
Terre Haute	IN	30.0	26.5	69.5	41.0	
Cedar Rapids	IA	28.6	22.7	9.3		
Davenport	IA	27.1	22.2	17.1		
Des Moines	IA	27.2	21.6	27.0	38.4	
Dubuque	IA	27.3	20.8			
Iowa City	IA	25.9	22.2	27.6		
Mason City	IA	27.1	21.9	72.9	39.9	
Sioux City	IA	28.6	22.8	17.7		
Waterloo	IA	27.2	23.7	20.1		
Topeka	KS	28.8	21.9	51.2	28.4	
Wichita	KS	29.0	22.5	19.5	39.1	
Covington	KY	28.4	25.2	40.8	42.7	
Lexington	KY	31.1	26.9	45.4	39.3	8.5
Louisville	KY	29.0	24.2	58.4	34.6	9.0
Owensboro	KY	29.6	28.5	52.9	39.8	
Paducah	KY	30.0	24.9	24.1	43.9	
Alexandria	LA	30.4	24.4	38.7	32.2	
Baton Rouge	LA	29.4	23.6	33.7	30.4	
Houma	LA	30.2	25.8	31.0		
Lafayette	LA	28.7	24.4	37.0	23.4	
Lake Charles	LA	31.6	24.2	59.0	33.7	
Metairie	LA	29.0	23.4	53.4	37.6	
Monroe	LA	30.0	23.5	31.0		
New Orleans	LA	28.3	22.6	34.8	27.7	
Shreveport	LA	29.0	22.1	19.9	25.8	
Slidell	LA	28.0	24.3	67.3	40.9	
Bangor	ME	27.9	24.4	34.7	31.1	
Portland	ME	24.2	21.7	27.8	39.7	
Baltimore	MD	27.5	22.4	19.1	38.2	
Salisbury	MD	29.7	24.7	19.7	36.6	
Takoma Park	MD	25.3	21.6	11.0		

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period. Obesity rates were estimated using county-level rates from the Centers for Disease Control and Prevention.

Chapter 1 Table. Rates of obesity, type II diabetes, bariatric surgery, and events occurring following surgical discharge among hospital referral regions

HRR Name	State	Percent of population that is obese (BMI of 30 or more) (2010)	Percent of Medicare beneficiaries with type II diabetes (2010-11)	Bariatric surgery per 100,000 Medicare beneficiaries (2007-11)	Percent having primary care visit within 30 days following bariatric surgery (2007-11)	Percent readmitted within 30 days following bariatric surgery (2007-11)
Boston	MA	22.1	21.5	39.3	37.7	10.7
Springfield	MA	24.6	23.1	24.4	42.9	
Worcester	MA	23.8	22.5	32.8	39.1	
Ann Arbor	MI	29.6	23.3	42.1	55.0	7.8
Dearborn	MI	33.2	29.3	37.2	59.2	
Detroit	MI	31.4	25.1	41.5	54.2	7.3
Flint	MI	33.0	25.3	48.2	70.1	
Grand Rapids	MI	28.2	23.6	54.7	43.4	6.9
Kalamazoo	MI	28.9	23.9	35.5	41.5	
Lansing	MI	29.5	24.4	52.9	43.6	
Marquette	MI	29.5	22.6	77.7	54.9	
Muskegon	MI	29.8	24.7	110.9	70.9	
Petoskey	MI	29.8	23.5	57.4	45.8	
Pontiac	MI	26.0	22.7	48.1	48.8	
Royal Oak	MI	26.3	23.2	45.7	60.9	
Saginaw	MI	31.0	25.1	51.0	59.9	
St. Joseph	MI	28.9	23.6	28.1		
Traverse City	MI	28.7	23.2	61.6	41.1	
Duluth	MN	26.3	20.7	55.4	35.5	
Minneapolis	MN	25.6	19.0	41.7	39.3	9.9
Rochester	MN	27.3	19.3	34.9	27.3	
St. Cloud	MN	27.2	19.5	51.4		
St. Paul	MN	26.3	19.4	36.7	45.3	
Gulfport	MS	31.0	23.3	46.4	33.8	
Hattiesburg	MS	33.9	24.6	34.0	34.9	
Jackson	MS	33.7	22.7	18.6	37.6	
Meridian	MS	34.0	24.5	20.3		
Oxford	MS	33.0	23.5	28.2		
Tupelo	MS	31.8	24.9	23.9	33.8	
Cape Girardeau	MO	29.8	26.7	36.1	51.1	
Columbia	MO	29.3	23.2	44.9	42.3	
Joplin	MO	30.2	24.7	21.7	46.9	
Kansas City	MO	28.9	22.4	44.0	41.0	7.5
Springfield	MO	29.0	22.1	37.9	37.9	
St. Louis	MO	28.9	23.8	43.5	39.9	9.5
Billings	MT	23.9	17.8	28.4	44.3	
Great Falls	MT	25.9	20.5	75.3	27.5	
Missoula	MT	21.1	16.6	49.0	43.0	
Lincoln	NE	27.9	20.9	45.5	54.4	
Omaha	NE	28.1	21.4	38.4	62.8	
Las Vegas	NV	25.2	22.0	56.2	32.8	7.8
Reno	NV	22.8	16.6	38.6	38.4	
Lebanon	NH	25.1	19.4	10.7		
Manchester	NH	24.2	21.1	18.8	27.1	

Chapter 1 Table. Rates of obesity, type II diabetes, bariatric surgery, and events occurring following surgical discharge among hospital referral regions

HRR Name	State	Percent of population that is obese (BMI of 30 or more) (2010)	Percent of Medicare beneficiaries with type II diabetes (2010-11)	Bariatric surgery per 100,000 Medicare beneficiaries (2007-11)	Percent having primary care visit within 30 days following bariatric surgery (2007-11)	Percent readmitted within 30 days following bariatric surgery (2007-11)
Camden	NJ	24.7	24.4	40.7	34.8	8.2
Hackensack	NJ	21.8	24.1	42.0	36.2	
Morristown	NJ	21.6	20.3	29.9	31.5	
New Brunswick	NJ	23.0	24.4	28.7	35.4	
Newark	NJ	23.6	24.7	44.5	36.9	
Paterson	NJ	24.2	23.8	38.1	32.5	
Ridgewood	NJ	22.8	21.7	39.3	29.3	
Albuquerque	NM	21.5	21.7	11.3	46.5	
Albany	NY	25.4	22.0	30.8	43.8	9.2
Binghamton	NY	26.6	22.6	20.8		
Bronx	NY	24.6	25.6	20.2	27.0	
Buffalo	NY	27.1	22.5	29.7	29.5	
Elmira	NY	25.1	25.0	39.4	26.3	
East Long Island	NY	22.4	22.6	25.3	36.1	7.1
Manhattan	NY	21.7	23.2	19.5	32.9	7.2
Rochester	NY	26.1	23.2	29.1	37.4	
Syracuse	NY	27.0	23.6	29.6	33.3	
White Plains	NY	20.7	20.9	36.5	39.1	
Asheville	NC	25.1	20.9	13.6	31.2	
Charlotte	NC	27.1	24.6	11.6	46.2	
Durham	NC	29.5	23.8	17.5	32.1	
Greensboro	NC	28.7	23.2	15.7		
Greenville	NC	31.6	25.8	41.0	41.5	
Hickory	NC	27.5	27.1	15.7		
Raleigh	NC	29.8	24.6	26.0	41.3	8.6
Wilmington	NC	27.2	24.8	23.2	28.3	
Winston-Salem	NC	27.3	24.9	9.4		
Bismarck	ND	27.8	22.0	58.3	33.5	
Fargo/Moorhead MN	ND	27.4	21.1	66.5	34.8	
Grand Forks	ND	29.0	20.9	58.3		
Minot	ND	27.2	23.2			
Akron	OH	27.9	24.8	25.0	39.3	
Canton	OH	29.9	25.4	23.0	39.6	
Cincinnati	OH	28.2	23.9	41.6	34.0	9.3
Cleveland	OH	28.2	23.1	29.5	37.3	13.3
Columbus	OH	29.9	26.3	28.2	50.5	7.2
Dayton	OH	29.9	25.3	63.6	43.6	9.1
Elyria	OH	29.1	26.5	30.7		
Kettering	OH	29.9	24.2	83.7	41.7	
Toledo	OH	29.8	29.0	26.4	46.3	
Youngstown	OH	28.5	26.1	34.9	42.9	
Lawton	OK	29.5	25.9	57.3	29.8	
Oklahoma City	OK	28.9	22.7	35.4	24.8	10.8
Tulsa	OK	29.3	23.3	32.0	31.2	

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period. Obesity rates were estimated using county-level rates from the Centers for Disease Control and Prevention.

Chapter 1 Table. Rates of obesity, type II diabetes, bariatric surgery, and events occurring following surgical discharge among hospital referral regions

HRR Name	State	Percent of population that is obese (BMI of 30 or more) (2010)	Percent of Medicare beneficiaries with type II diabetes (2010-11)	Bariatric surgery per 100,000 Medicare beneficiaries (2007-11)	Percent having primary care visit within 30 days following bariatric surgery (2007-11)	Percent readmitted within 30 days following bariatric surgery (2007-11)
Bend	OR	20.6	17.2	73.9	37.7	
Eugene	OR	27.5	20.4	64.4	43.7	
Medford	OR	24.1	19.3	33.0	39.9	
Portland	OR	25.8	20.1	41.0	36.0	7.5
Salem	OR	30.2	21.5	62.0		
Allentown	PA	27.2	24.8	54.9	45.2	6.9
Altoona	PA	29.4	27.2	34.3		
Danville	PA	27.3	25.7	55.9	78.6	
Erie	PA	29.2	24.9	54.6	54.0	
Harrisburg	PA	28.3	24.9	38.6	44.7	
Johnstown	PA	30.0	25.6	29.4		
Lancaster	PA	25.9	23.2	22.0		
Philadelphia	PA	25.5	20.9	24.0	42.3	8.2
Pittsburgh	PA	27.4	23.2	30.7	39.7	9.4
Reading	PA	27.8	24.3	36.0	42.9	
Sayre	PA	28.4	24.1	39.9		
Scranton	PA	25.6	23.7	24.6		
Wilkes-Barre	PA	27.1	24.8	27.4		
York	PA	28.7	24.9	49.9	55.0	
Providence	RI	23.1	22.3	23.6	39.3	
Charleston	SC	28.9	22.7	33.7	35.6	
Columbia	SC	31.1	23.5	39.7	37.2	7.3
Florence	SC	32.6	25.4	19.0		
Greenville	SC	26.2	23.8	30.3	29.2	
Spartanburg	SC	29.8	23.5	43.8	30.7	
Rapid City	SD	26.7	18.5	29.0		
Sioux Falls	SD	27.8	20.4	37.7	43.7	
Chattanooga	TN	29.2	25.8	19.5	43.1	
Jackson	TN	30.7	25.7	13.0		
Johnson City	TN	28.8	24.2	27.5		
Kingsport	TN	29.3	27.5	25.1	42.6	
Knoxville	TN	29.5	25.9	35.4	45.2	9.8
Memphis	TN	33.3	23.2	15.0	37.5	
Nashville	TN	29.7	24.5	30.8	48.6	10.2
Abilene	TX	26.6	22.0	29.1		
Amarillo	TX	27.5	20.2	23.1		
Austin	TX	23.1	21.4	48.1	34.7	
Beaumont	TX	29.7	26.1	34.5	41.8	
Bryan	TX	26.6	22.1	28.8		
Corpus Christi	TX	26.9	30.3	29.2	41.8	
Dallas	TX	26.9	22.6	55.8	36.8	8.4
El Paso	TX	23.9	27.4	25.2	33.3	
Fort Worth	TX	26.6	24.2	47.5	36.6	8.2
Harlingen	TX	26.1	38.5	28.3		

Chapter 1 Table. Rates of obesity, type II diabetes, bariatric surgery, and events occurring following surgical discharge among hospital referral regions

HRR Name	State	Percent of population that is obese (BMI of 30 or more) (2010)	Percent of Medicare beneficiaries with type II diabetes (2010-11)	Bariatric surgery per 100,000 Medicare beneficiaries (2007-11)	Percent having primary care visit within 30 days following bariatric surgery (2007-11)	Percent readmitted within 30 days following bariatric surgery (2007-11)
Houston	TX	26.5	22.7	41.7	28.9	7.3
Longview	TX	29.1	22.9	49.8	36.8	
Lubbock	TX	26.7	23.8	17.0	36.0	
McAllen	TX	28.5	38.5	52.5	63.5	
Odessa	TX	27.3	23.4	9.7		
San Angelo	TX	26.6	24.1	18.1		
San Antonio	TX	26.3	26.9	30.1	36.3	4.3
Temple	TX	27.5	24.2	31.1	40.4	
Tyler	TX	27.5	23.2	64.2	32.5	
Victoria	TX	27.6	28.0	54.3		
Waco	TX	30.3	22.8	30.1		
Wichita Falls	TX	26.6	24.8	72.9	20.1	
Ogden	UT	25.0	23.1	31.9		
Provo	UT	24.8	21.7	36.5		
Salt Lake City	UT	23.9	20.4	32.5	38.5	
Burlington	VT	23.5	22.6	24.7	28.8	
Arlington	VA	23.2	18.6	12.2	42.7	
Charlottesville	VA	26.4	23.6	16.7		
Lynchburg	VA	28.4	24.0	14.2		
Newport News	VA	29.5	21.8	23.6	35.5	
Norfolk	VA	27.6	24.6	32.7	40.3	
Richmond	VA	28.2	22.6	20.5	42.1	
Roanoke	VA	27.6	25.5	12.8	41.6	
Winchester	VA	29.6	24.2	21.3		
Everett	WA	27.0	19.7	36.8	46.5	
Olympia	WA	29.2	19.9	28.6	30.8	
Seattle	WA	22.8	18.7	30.7	43.8	9.5
Spokane	WA	26.7	21.2	37.1	36.3	9.4
Tacoma	WA	29.0	21.1	33.6	41.3	
Yakima	WA	28.1	23.4	27.9		
Charleston	WV	31.1	28.0	33.0	32.6	
Huntington	WV	32.7	28.8	49.9	36.4	
Morgantown	WV	30.0	26.4	23.8	56.6	
Appleton	WI	27.4	22.8	24.2		
Green Bay	WI	27.8	22.2	19.9		
La Crosse	WI	27.0	20.7	31.0		
Madison	WI	26.3	20.5	22.9	30.7	
Marshfield	WI	28.0	22.3	39.9	57.0	
Milwaukee	WI	27.7	21.9	26.7	33.4	8.2
Neenah	WI	26.9	22.0	31.8		
Wausau	WI	27.6	21.8	42.7		
Casper	WY	25.5	17.4	58.2	50.1	
United States average		25.9	23.0	32.8	39.5	8.3

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period. Obesity rates were estimated using county-level rates from the Centers for Disease Control and Prevention.

THE Dartmouth INSTITUTE FOR HEALTH POLICY & CLINICAL PRACTICE

Variation in the Care of Surgical Conditions: Cerebral Aneurysms

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Cerebral aneurysms: frequency and variation

Cerebral aneurysms are a common and potentially serious problem.[1] Cerebral aneurysms (Figure 2.1) are disorders in which a weakness of the wall of the arteries in the brain causes a localized dilatation or ballooning of the blood vessel. The overall frequency in the general adult population ranges from 0.2% to 9.9%,[2,3] suggesting that 10 to 15 million people in the United States have a cerebral aneurysm. Due to the widespread availability and increasing use of imaging techniques, including computed tomography (CT) scanning, magnetic resonance imaging (MRI), CT angiography, and MR angiography, a rising number of unruptured cerebral aneurysms are being diagnosed.[4]

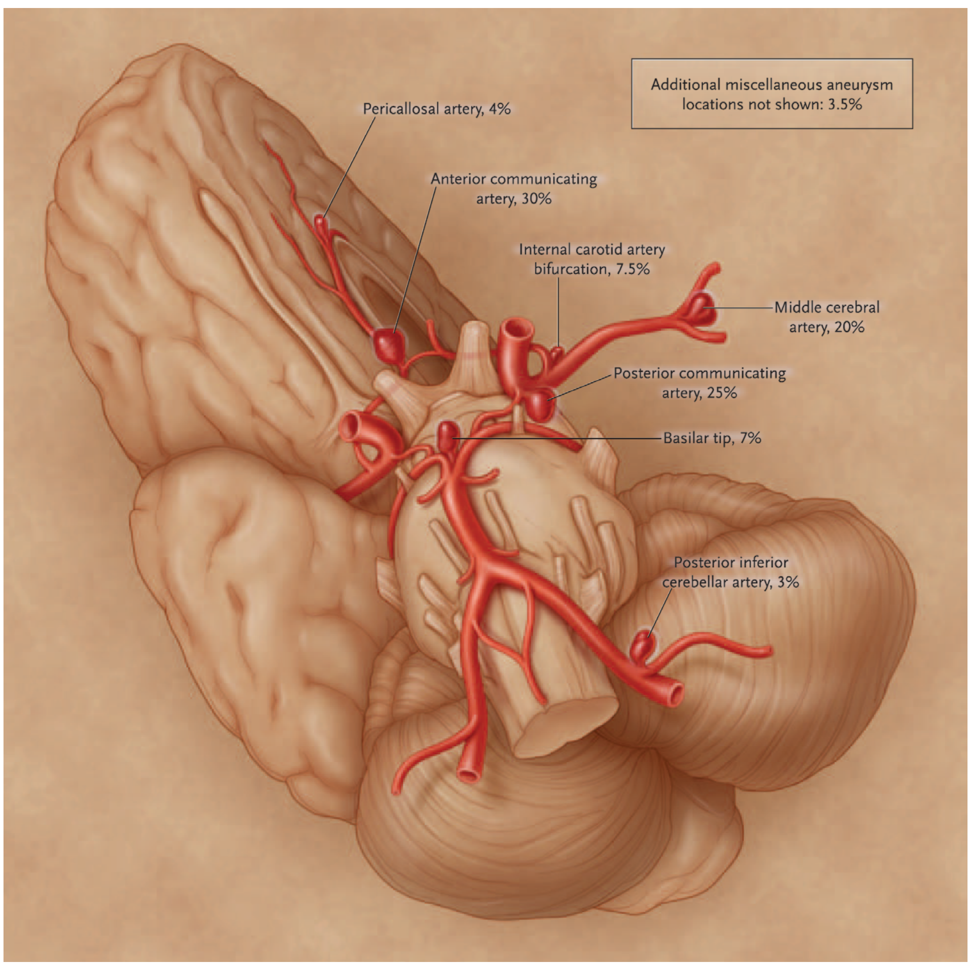
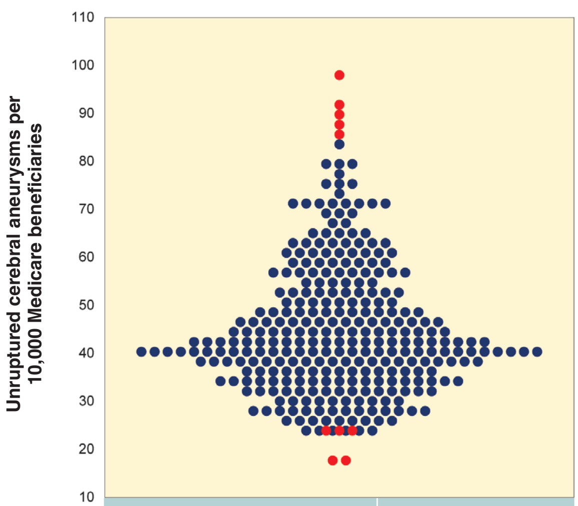


Figure 2.1. Most frequent locations of cerebral aneurysms

Percentages indicate the incidence of intracranial aneurysms.

Source: Brisman JL, Song JK, Newell DW. Cerebral aneurysms. *N Engl J Med* 2006;355:928-39.

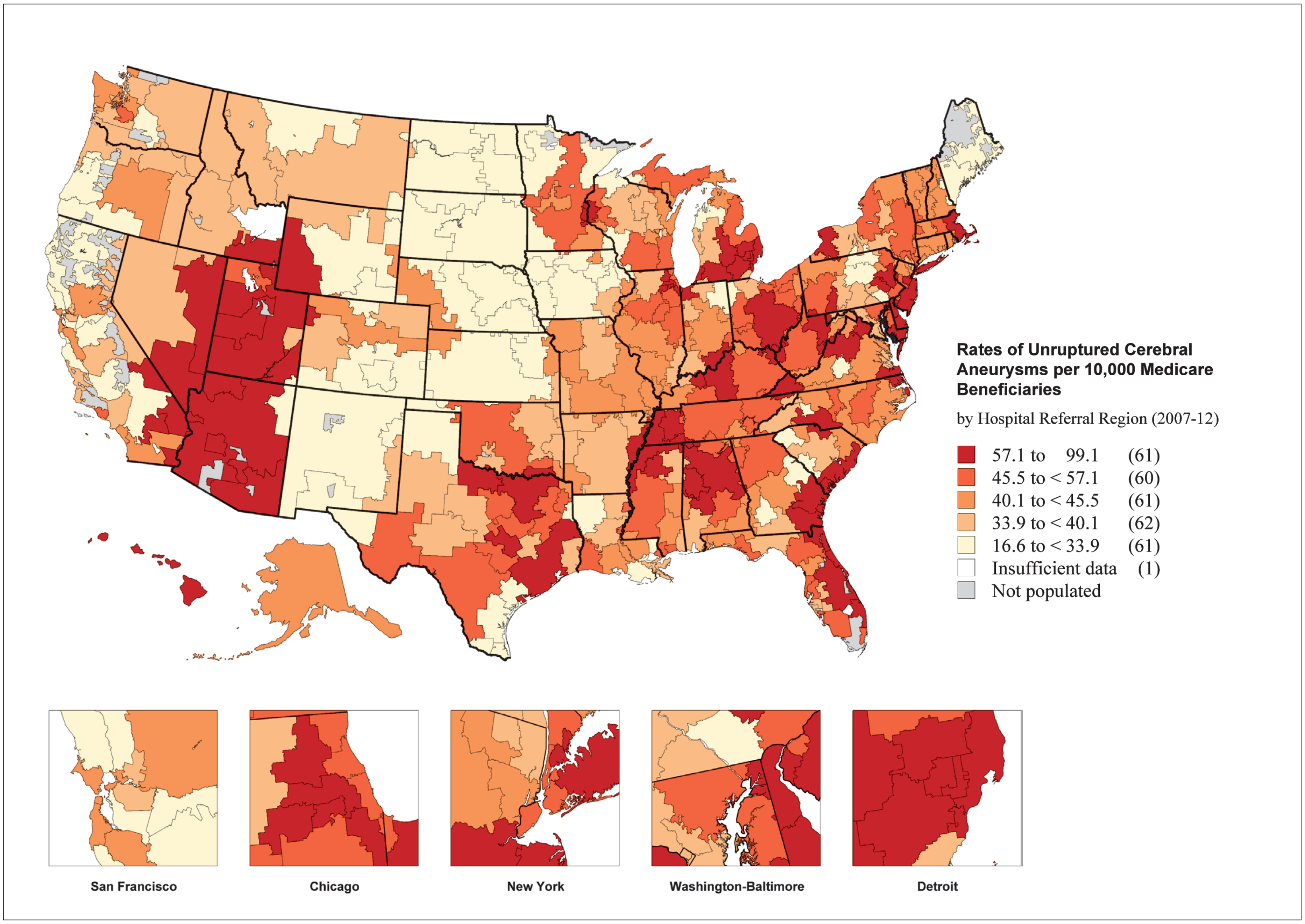
There was considerable variation in the incidence of cerebral aneurysms detected in elderly Medicare patients in the United States during the period from 2007 to 2012 (Figure 2.2). Rates of unruptured cerebral aneurysms varied more than fivefold among hospital referral regions, from 16.7 per 10,000 Medicare beneficiaries in Sioux City, Iowa to 99.0 per 10,000 in Tuscaloosa, Alabama. The national average rate was 48.7 per 10,000. Rates of unruptured cerebral aneurysms were relatively low among regions in the Midwest and Great Plains states, including Rapid City, South Dakota (23.1), Dubuque, Iowa (23.3), and Great Falls, Montana (23.4). The rates were nearly four times higher in Wilmington, Delaware (91.5), Royal Oak, Michigan (90.6), and the Bronx, New York (87.3) (Map 2.1). The reasons behind the observed variation are unclear. However, differences in the aggressiveness of aneurysm detection through imaging studies could explain this phenomenon.



Tuscaloosa, AL	99.0
Wilmington, DE	91.5
Royal Oak, MI	90.6
Bronx, NY	87.3
Salt Lake City, UT	85.5
Great Falls, MT	23.4
Dubuque, IA	23.3
Rapid City, SD	23.1
McAllen, TX	18.7
Sioux City, IA	16.7

Figure 2.2. Rates of unruptured cerebral aneurysms per 10,000 Medicare beneficiaries among hospital referral regions (2007-12)

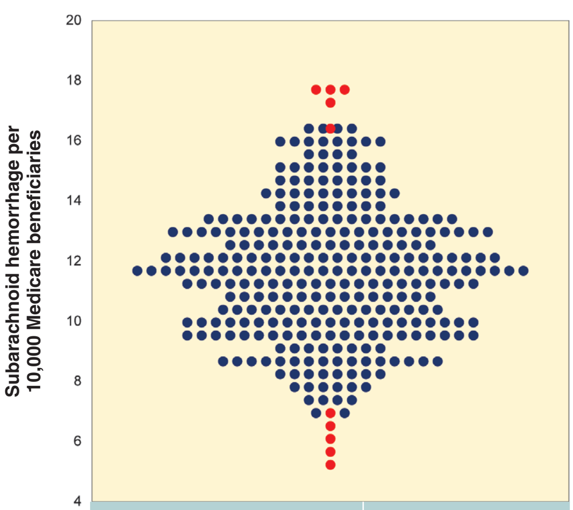
Each blue dot represents the rate of unruptured cerebral aneurysms in one of 306 hospital referral regions in the U.S. Red dots indicate the regions with the 5 lowest and 5 highest rates.



Map 2.1. Rates of unruptured cerebral aneurysms per 10,000 Medicare beneficiaries (2007-12)

Rates are adjusted for age, sex, and race.

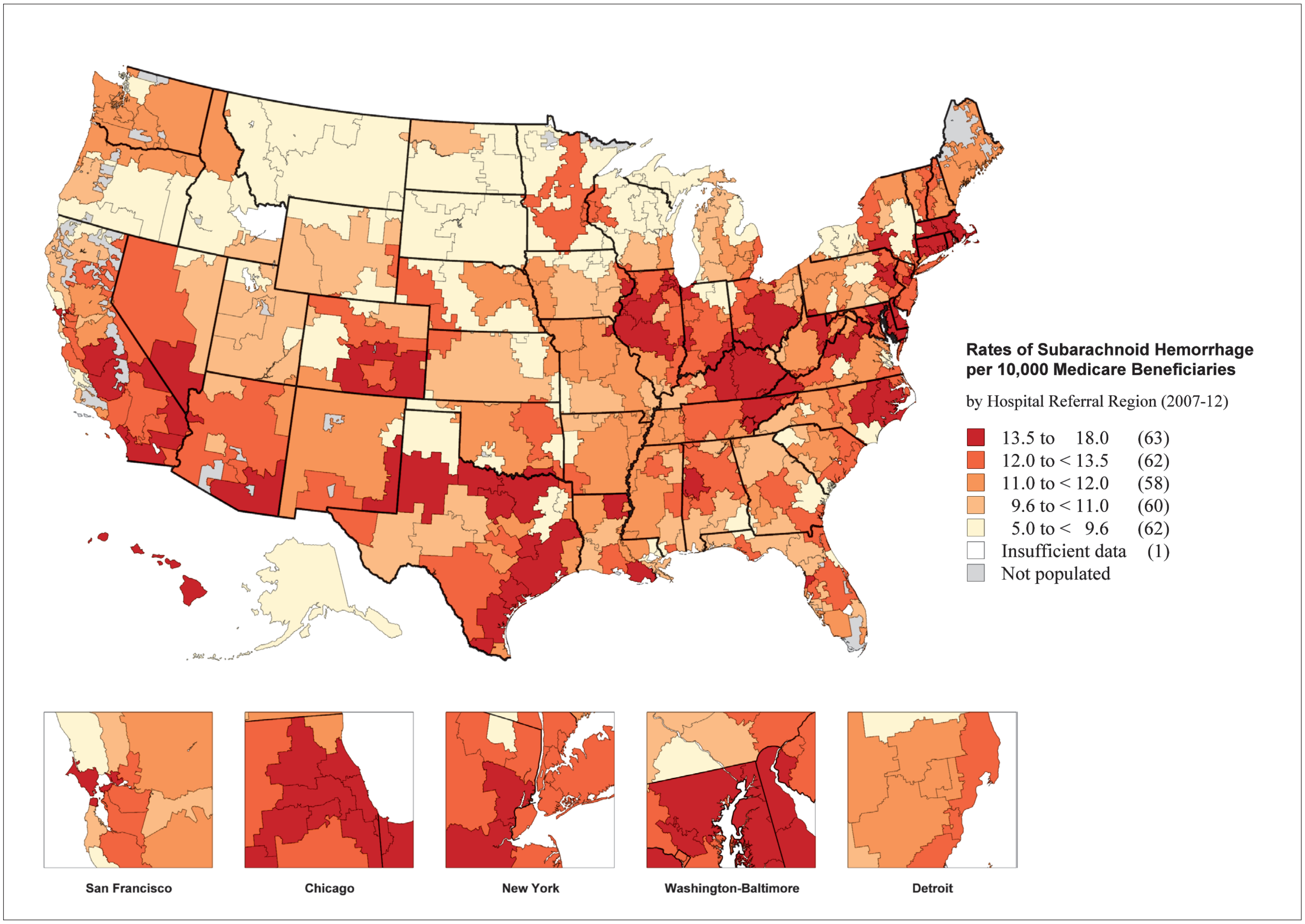
Most aneurysms cause no symptoms until they rupture (burst), causing subarachnoid hemorrhage, or bleeding in the brain.[5-7] Roughly one in one hundred patients with cerebral aneurysms will experience a rupture every year.[1,8,9] In population-based studies in Western countries, subarachnoid hemorrhage comprises 0.8% to 7% of all strokes.[10] The annual incidence of rupture is 8 to 10 per 100,000 in the overall population.[4] Among elderly Medicare beneficiaries, the rate of aneurysmal subarachnoid hemorrhage during 2007-12 averaged 12.2 per 10,000. The rate varied more than threefold, from less than 6 per 10,000 in Rapid City, South Dakota (5.0) and York, Pennsylvania (5.5) to more than 17 per 10,000 in the Illinois regions of Hinsdale (17.9), Aurora (17.5), and Elgin (17.5) (Figure 2.3). Rates were generally lower in the northern Great Plains and Mountain states than in other parts of the country (Map 2.2).



Hinsdale, IL	17.9
Aurora, IL	17.5
Elgin, IL	17.5
Morgantown, WV	17.3
Wilmington, DE	16.5
Marshfield, WI	6.9
Hickory, NC	6.6
Mason City, IA	6.1
York, PA	5.5
Rapid City, SD	5.0

Figure 2.3. Rates of subarachnoid hemorrhage per 10,000 Medicare beneficiaries among hospital referral regions (2007-12)

Each blue dot represents the rate of subarachnoid hemorrhage in one of 306 hospital referral regions in the U.S. Red dots indicate the regions with the 5 lowest and 5 highest rates.



Map 2.2. Rates of subarachnoid hemorrhage per 10,000 Medicare beneficiaries (2007-12)

Rates are adjusted for age, sex, and race.

Subarachnoid hemorrhage is a devastating event associated with significant morbidity and mortality.[7,11,12] The blood from subarachnoid hemorrhage on the brain disturbs its ability to perform its vital functions. Symptoms of rupture include a severe headache with a very rapid onset, often characterized by patients as "the worst headache of their lives." Vomiting, confusion, and sometimes seizures quickly follow. About 10-15% of these patients will collapse and die before reaching the hospital.[5-7] Patients who survive are subject to long hospitalizations (sometimes months) that start with treatment of the aneurysm to prevent further bleeding.[5,6] Frequently, patients spend long periods in the intensive care unit and their breathing is supported with a breathing tube. Some undergo additional procedures to have drains placed temporarily inside their brains (external ventricular drain) to relieve the increased pressure caused by build-up of fluid (hydrocephalus), a common complication of subarachnoid hemorrhage.[5,6] Patients are often dependent on these drains and need to have a permanent shunt placed in the operating room. A significant portion of the hospitalization is spent monitoring the patient for secondary strokes (through a phenomenon called vasospasm), which might require additional procedures to reverse them.[5,6] Overall, even despite optimal care in the hospital, about one-third of the patients die and more than one-third of those who survive have major neurological deficits.[7]

The cause of cerebral aneurysm rupture remains poorly understood. Larger aneurysms and those in certain locations—such as the back part of the brain—are more likely to rupture,[1,8,9] but it remains difficult to predict the possibility of rupture for an individual aneurysm. Smoking has been associated with subarachnoid hemorrhage in some studies.[1,9] However, the exact relationship between smoking status and the risk of rupture of cerebral aneurysms remains unclear. The role of high blood pressure is also unclear, given the inconclusive evidence so far.[8,9,13-18] Aneurysmal subarachnoid hemorrhage in younger patients is often the result of cocaine use.[19] Physical activity or other behaviors have not been associated with a higher risk of rupture.

Before surgery

Competing treatment options

Cerebral aneurysms are common and potentially very dangerous. However, there are important treatment choices that may prevent bleeding and stroke before aneurysm rupture. After aneurysm rupture, the same treatments can be used to secure the aneurysm and prevent further catastrophic bleeding.

Current procedural options are clipping and endovascular coiling. Clipping (Figure 2.4) involves removal of part of the skull through a craniotomy and obstruction of the blood flow to the aneurysm externally with a clip. This procedure, even when performed electively, requires a hospitalization that typically lasts 2 to 5 days.[5] The recovery period after clipping is often lengthy, and patients typically require 4 to 6 weeks to return to their pre-operative quality of life.[5]

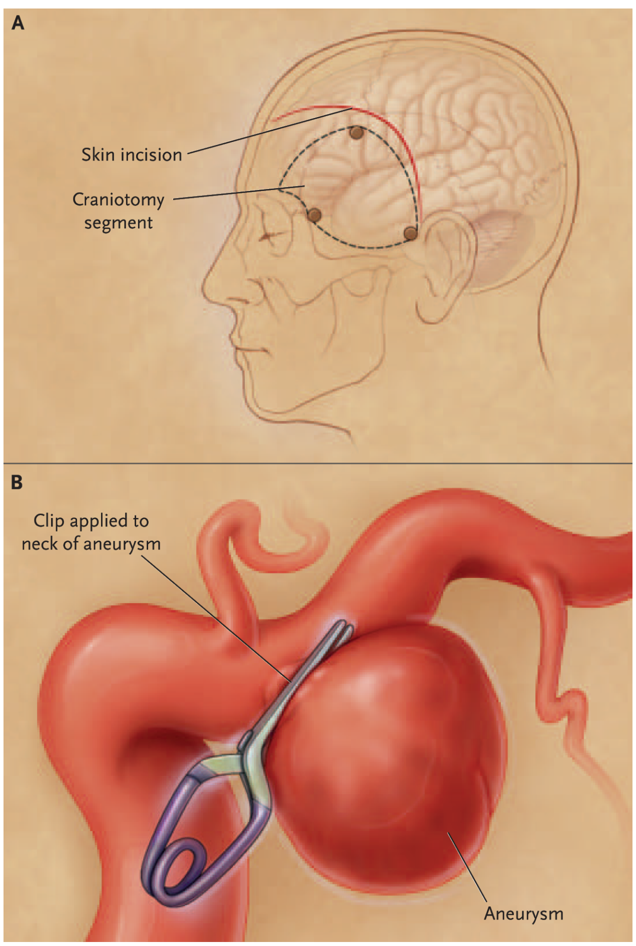


Figure 2.4. Clipping of an aneurysm

Figure A shows the typical skin incision and craniotomy needed to access the aneurysm. Figure B shows the application of the clip blade to the neck of the aneurysm.

Source: Brisman JL, Song JK, Newell DW. Cerebral aneurysms. *N Engl J Med* 2006;355:928-39.

Advances in endovascular techniques, which use catheters, wires, and devices placed within the blood vessels themselves, have allowed a less invasive treatment option to be offered to patients. Called endovascular coiling (Figure 2.5), this treatment involves access to the femoral artery through a puncture wound in the patient's groin. Subsequently, the surgeon, under X-ray guidance, directs a catheter into the sac of the aneurysm and fills it with coils.[5] These coils form a clot inside the aneurysm, excluding it from the circulation and preventing the possibility of a subarachnoid hemorrhage. The anatomy of most aneurysms is amenable to either treatment. However, a small number of patients can only be treated with one technique. Some asymptomatic patients elect to have their aneurysms managed non-operatively through serial imaging and symptom monitoring.

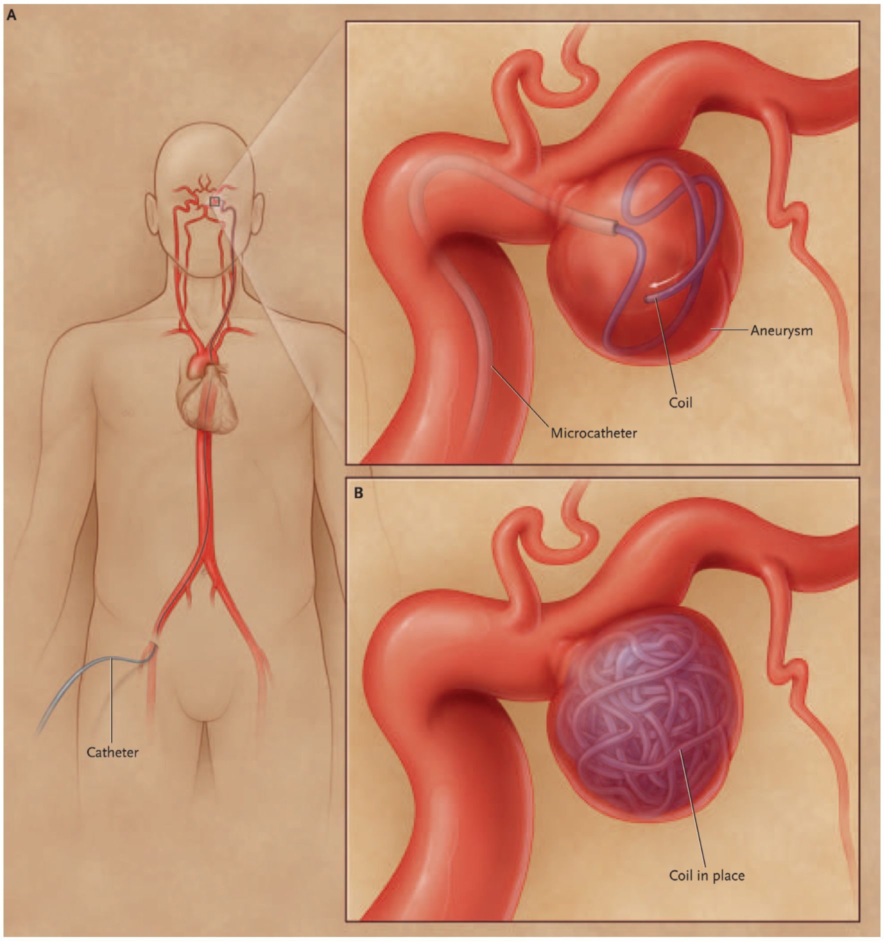


Figure 2.5. Occlusion of an aneurysm with detachable coils

Figure A and the inset show the route of the microcatheter into the aneurysm through the right femoral artery, aorta, and left carotid artery and the beginning of the coil deployment. Figure B shows the final occlusion of the aneurysm with coils.

Source: Brisman JL, Song JK, Newell DW. Cerebral aneurysms. *N Engl J Med* 2006;355:928-39.

The different options for treatment of cerebral aneurysms, coupled with an exponential increase in the use of radiologic imaging—leading to the discovery of small, asymptomatic cerebral aneurysms—have introduced significant uncertainty in determining the best treatments for this condition. This is further complicated by the development of promising (but less well-studied) endovascular devices, such as several types of stents[20] (metal sheaths that act as braces inside a blood vessel), which are constantly changing the way endovascular therapy is delivered. Patients and physicians alike have found it difficult to know when and how to best treat cerebral aneurysms, especially small ones where the risks of treatment might outweigh the risks of aneurysm rupture. This report examines the trends and developments that have affected how physicians, patients, and policymakers have studied variation in the care of this potentially devastating disease. Further, it outlines why, where, and how efforts to improve the care of patients with cerebral aneurysms are under way.

During surgery

Impact of randomized trials and database studies on practice patterns

In 2002, investigators from multiple European centers published the International Study for Aneurysm Treatment (ISAT),[11] which compared clipping and coiling in the treatment of ruptured cerebral aneurysms. They found that treatment with endovascular coiling provided patients with longer survival and less disability one year after rupture when compared with open surgical clipping. However, critics[21] of this study have expressed concerns about the generalizability of its findings, as the majority of the patients selected for this trial had small aneurysms, mainly at one location in the brain. Despite the uncertainty regarding the procedure's benefits, these findings resulted in a change in the treatment of ruptured cerebral aneurysms in the United States, with greater use of coiling.[22]

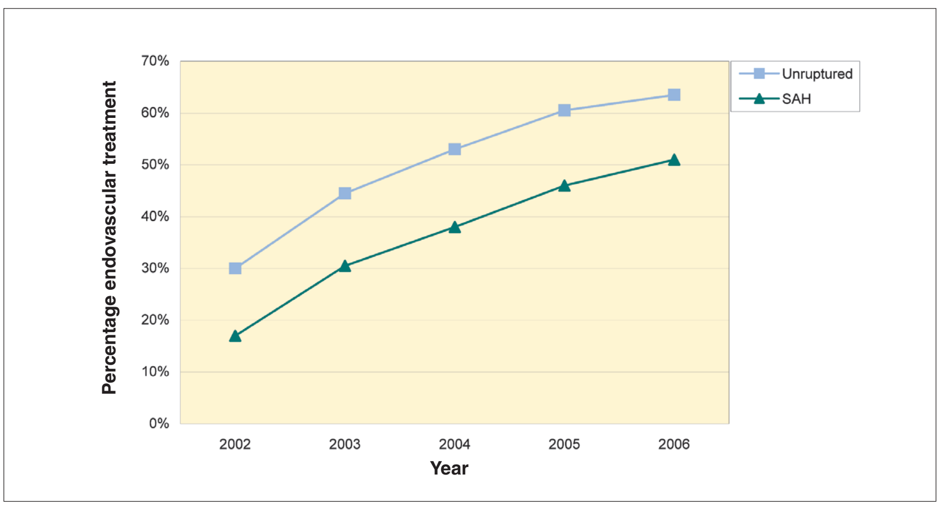


Figure 2.6. Increase in use of endovascular therapies for ruptured and unruptured cerebral aneurysms, 2002 to 2006

Based on assessment of the AHRQ NIS database. SAH=subarachnoid hemorrhage.

Source: Adapted from Smith GA, Dagostino P, Maltenfort MG, Dumont AS, Ratliff JK. Geographic variation and regional trends in adoption of endovascular techniques for cerebral aneurysms. *J Neurosurg*. 2011;114(6):1768-1777.

In 2009, the publication of the long-term follow-up data from the ISAT study[12] demonstrated no difference in mortality between the two treatment options, while coiling was associated with a slightly higher risk of rebleeding. These findings curbed the initial enthusiasm for coiling, and resulted in a renewed interest in clipping for patients with ruptured cerebral aneurysms. This study led to a decline in the use of coiling for Medicare beneficiaries (Figure 2.7), evident by 2010, and then a stabilization of the rate to approximately 60% of the total procedures in recent years.

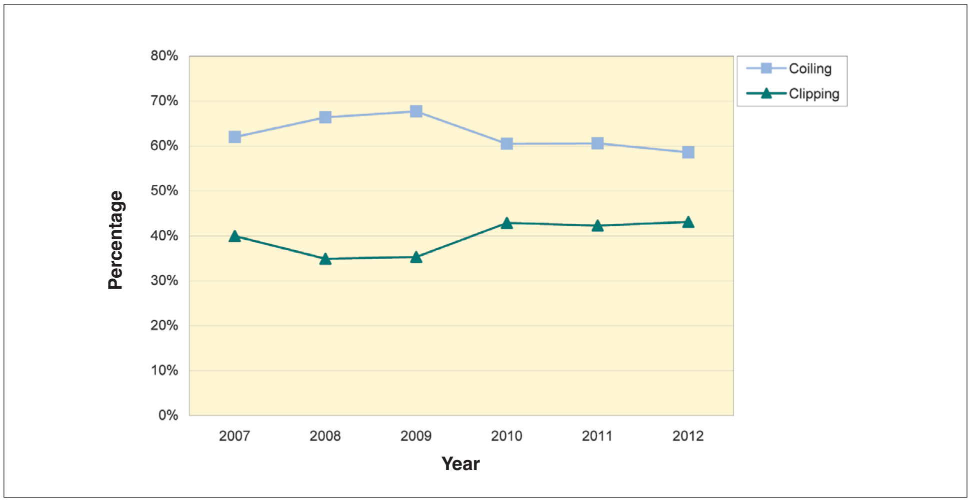


Figure 2.7. Trends in annual rates of coiling and clipping for ruptured aneurysms among Medicare beneficiaries, 2007 to 2012

These trends in the treatment of ruptured cerebral aneurysms have been paralleled by similar practices for unruptured cerebral aneurysms (Figure 2.8), despite the lack of randomized studies comparing the results of clipping and coiling in this population. Following the initial enthusiasm for coiling, there was a decrease in the rate of the procedure to below 70% around 2009. The reduced invasiveness of coiling (especially for patients that have no symptoms from bleeding) and the need for minimal hospitalization (most often just an overnight stay) could explain the new surge in coiling observed in recent years among the Medicare population. Current rates of coiling now exceed 70% of all treatments for unruptured cerebral aneurysms.

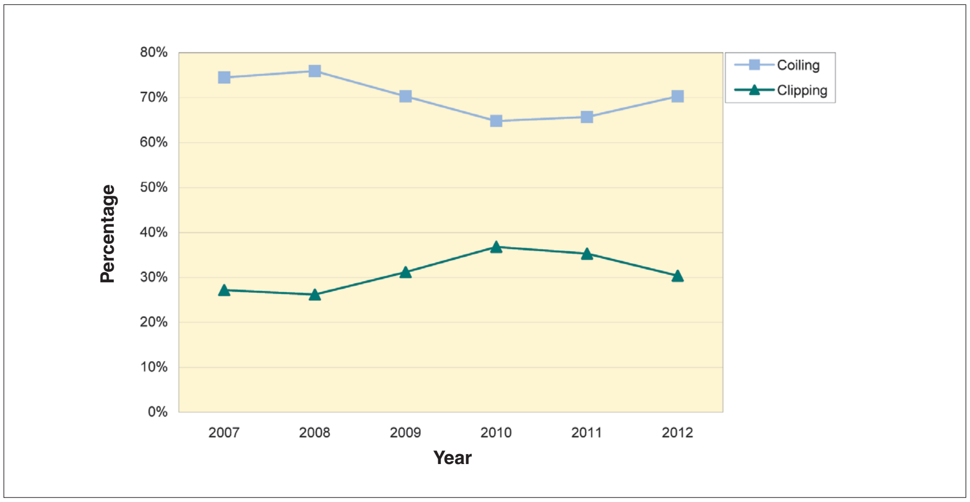


Figure 2.8. Trends in annual rates of coiling and clipping for unruptured aneurysms among Medicare beneficiaries, 2007 to 2012

While large database studies[23-26] have provided some evidence in favor of coiling for patients with unruptured aneurysms, uncertainty remains as to which approach is optimal. Table 2.1 demonstrates the relative advantages of each technique. The potential durability of clipping has been used as an argument in favor of using this technique for younger patients. On the other hand, the less invasive nature of coiling (which does not require a craniotomy) is attractive for a lot of patients. For aneurysms amenable to treatment with either option (the majority of cases), the patient should be fully informed of the relative benefits and drawbacks of each technique in order to reach a decision, ideally guided by the process of shared decision-making.

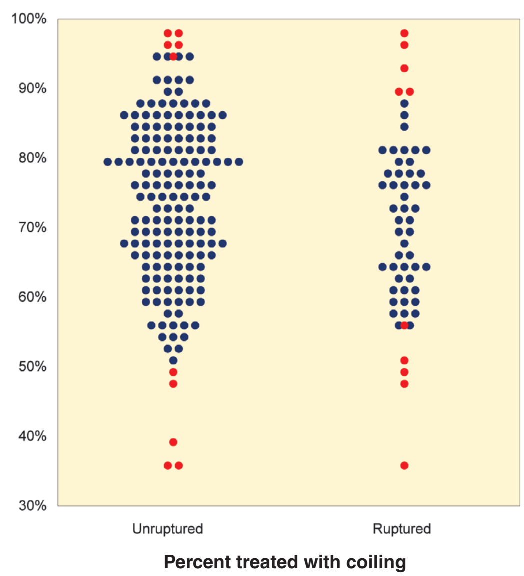
Table 2.1. Relative advantages and disadvantages of endovascular coiling and surgical clipping for cerebral aneurysm treatment

Surgical clipping	Endovascular coiling
Well-established procedure	Newer technique
Minor improvements in currently used instruments; long experience with their use and safety profile	New devices are developed constantly; while some hold promise, there is limited experience with their use and safety profile
No invasive follow-up required	Requires follow-up angiograms, which carry additional risk of stroke
More durable	May require retreatment in case of recurrence
Requires a craniotomy	Less invasive; performed with a groin puncture
Higher infection risk	Infection is extremely rare
Longer postoperative stay in the hospital	Typically a single-night postoperative stay
More postoperative pain	Minimal, if any, postoperative pain
Similar rate of procedural complications	Similar rate of procedural complications

Regional variation in treatment decisions

Despite an increasing number of studies, there is still significant controversy regarding the best ways to treat patients with cerebral aneurysms. As such, regional variation in the predominant treatment modality for unruptured and ruptured cerebral aneurysms is common and expected. For example, there was wide variation in rates of coiling among a cohort of Medicare patients with cerebral aneurysms who underwent treatment (Figure 2.9), ranging from regions where clipping was performed almost exclusively to regions where coiling was the predominant treatment modality. Nationally, an average of 71% of patients with unruptured aneurysms and 63% of patients with ruptured aneurysms were treated with coiling during 2007-12. Less than 40% of patients treated for unruptured aneurysms received coiling in Modesto, California (35.0%), Madison, Wisconsin (36.0%), and Manchester, New Hampshire (39.0%), while nearly all of these patients were treated with coiling in Tacoma, Washington (98.6%), Evansville, Indiana (97.4%), Des Moines, Iowa (96.8%), and Duluth, Minnesota (96.2%). Among those treated for ruptured aneurysms, rates of coiling ranged from less than half of patients in Atlanta, Georgia (36.3%), Phoenix, Arizona (48.3%), and San Antonio, Texas (48.7%) to more than 90% of patients in Fort Lauderdale, Florida (98.8%), Nashville, Tennessee (96.6%), and Providence, Rhode Island (93.2%).

Unruptured	
Tacoma, WA	98.6%
Evansville, IN	97.4%
Des Moines, IA	96.8%
Duluth, MN	96.2%
Newport News, VA	94.9%
Anchorage, AK	49.8%
San Diego, CA	47.5%
Manchester, NH	39.0%
Madison, WI	36.0%
Modesto, CA	35.0%



Ruptured	
Fort Lauderdale, FL	98.8%
Nashville, TN	96.6%
Providence, RI	93.2%
Camden, NJ	88.9%
Honolulu, HI	88.8%
Chicago, IL	55.3%
Dallas, TX	51.4%
San Antonio, TX	48.7%
Phoenix, AZ	48.3%
Atlanta, GA	36.3%

Figure 2.9. Percent of Medicare beneficiaries treated for ruptured and unruptured cerebral aneurysms using coiling (2007-12)

Each blue dot represents the percent of Medicare beneficiaries who were treated for cerebral aneurysms with coiling in one of 306 hospital referral regions in the U.S. Red dots indicate the regions with the 5 lowest and 5 highest rates.

Although socioeconomic disparities[27] and patient preferences could factor into this variation, such wide disparities can more likely be attributed to physician training—not all surgeons are trained in both techniques—and preferences based on the personal experience of the treating physician. For example, some surgeons promote coiling for frail patients that would be too sick to undergo a craniotomy. Others are concerned that coiling has inferior durability in comparison to clipping. Although such an effect has not been clearly demonstrated,[11,28] with only one study[12] supporting it, the short follow-up time in the published literature prevents definitive conclusions.

Whether clipping or coiling is associated with the best outcome is an important gap in knowledge, for both patients and physicians, and would be an ideal question to answer through further research (i.e., a registry investigation). However, the available databases lack the necessary clinical information, since they focus mainly on crude outcomes such as mortality. An ideal prospective registry would include anatomic details of the aneurysms, the initial neurologic condition of the patient, the number and type of coils, clips, or new devices used, and long-term angiographic follow-up results. Additionally, while it would be helpful for the details of procedures and outcomes to be recorded in a registry, the data would still leave a gap in understanding how patients—especially those with unruptured, intact cerebral aneurysms—feel about their treatment options. Patients are faced with complex decisions revolving around whether treatment is needed and what approach should be taken, particularly as they age and develop other illnesses. The current decision-making process can generate significant frustration and, to some degree, mistrust toward the consulting physician. The need for decision aids that will assist in shared decision-making is paramount.

After surgery

Use of data to improve practice patterns is associated with benefits in patient mortality and wellbeing and can also lower costs. Especially with the development of accountable care organizations,[29] several regulatory bodies are monitoring outcome metrics and penalizing inferior performance. Benchmarks are being developed for mortality, rate of discharge to rehabilitation facilities, length of stay, rate of 30-day readmission, and cost in all areas of medicine. However, there are currently no discrete efforts to pursue these measures for the treatment of patients with cerebral aneurysms, an obvious opportunity for practice improvement in the immediate future.

Mortality

The ISAT study[11] demonstrated that 30.6% of subarachnoid hemorrhage patients allocated to clipping were dead or care-dependent at the end of one year. By comparison, 22.6% of the patients allocated to coiling had similar outcomes (Figure 2.10). Among elderly Medicare patients treated for ruptured aneurysms, the one-year mortality rates after coiling or clipping for subarachnoid hemorrhage were 37.5% and 33.2%, respectively. The one-year mortality rates for unruptured aneurysms (3.9% and 4.0%, respectively) were much lower. The higher mortality rate associated with coiling in this cohort is most likely related to the selection of patients for coiling—those who are too sick to undergo a craniotomy. A large database study of unruptured aneurysms demonstrated that coiled patients had lower in-hospital mortality (0.6%) compared to clipped patients (1.2%).[24] In-hospital mortality rates would be expected to be lower than one-year mortality rates, since the latter capture complications that occur after discharge following surgery (both coiling and clipping).

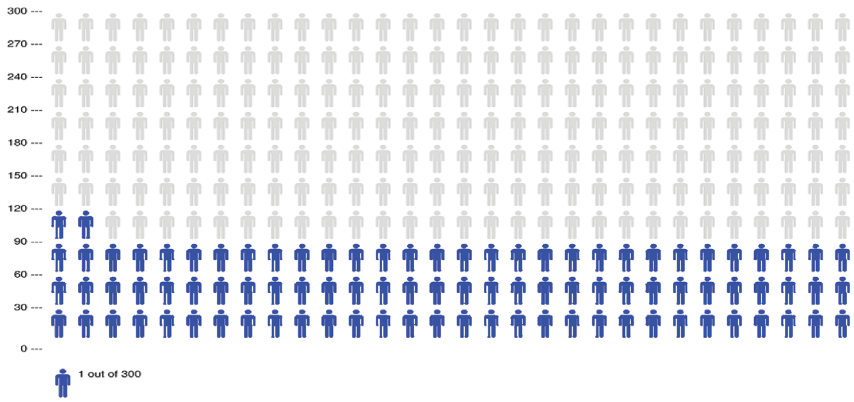


Figure 2.10A. Clipping
92 out of 300 (30.6%).

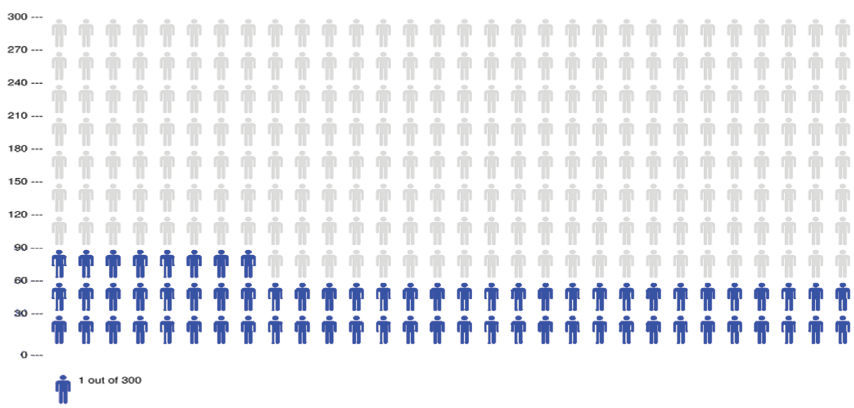


Figure 2.10B. Coiling
68 out of 300 (22.6%).

Figure 2.10. One-year mortality or dependence after coiling and clipping for subarachnoid hemorrhage patients

Length of stay

The median lengths of stay after admission for coiling or clipping of an aneurysm in a subarachnoid hemorrhage patient were 15 days and 20.2 days, respectively, in recent large database studies.[30,31] As expected, this metric was significantly lower for patients with unruptured aneurysms (1 day and 6.6 days, respectively).[30,31] Subarachnoid hemorrhage patients are hospitalized for long periods postoperatively (usually more than 2 weeks) in order to be monitored for the development of complications such as vasospasm: a subarachnoid hemorrhage-related problem characterized by constriction of the brain arteries, which increases the risk of stroke.[6] The observed difference in length of stay in favor of coiling reflects its less invasive nature, allowing fast postoperative recovery and early discharge home.

Discharge to rehabilitation facility

Discharge to a rehabilitation facility was used as an indicator of disability for patients undergoing treatment for their aneurysms. The average rates of discharge to rehabilitation after coiling or clipping for subarachnoid hemorrhage among elderly Medicare patients during 2007-12 were 26.1% and 30.0%, respectively. A relatively high rate (in comparison to unruptured aneurysms) would be expected in this population because subarachnoid hemorrhage patients have long hospitalizations and often suffer neurologic deficits from aneurysm rupture, increasing the need for rehabilitation services.[6] The average rates of discharge to rehabilitation facilities after coiling or clipping of unruptured cerebral aneurysms were 5.1% and 19.4%, respectively.

30-day readmission

The goal of minimizing readmissions has been at the forefront of recent changes in health care policy. Average 30-day readmission rates after coiling and clipping for subarachnoid hemorrhage among elderly Medicare patients during 2007-12 were 2.4% and 1.3%, respectively. The respective rates for unruptured aneurysms were 4.2% and 1.4%. The higher number of all-cause readmissions associated with coiling is more likely related to the fact that coiling patients tend to have more competing illnesses—and, therefore, are more susceptible to developing medical complications after discharge—than to the procedure itself.

Cost

Several regulatory bodies are taking measures to moderate costs in all areas of medicine. Expenditures for new and evolving technology, such as coiling, compare favorably to already established options (clipping). Table 2.2 demonstrates the hospitalization cost for patients undergoing clipping and coiling for ruptured and unruptured cerebral aneurysms in a cohort of patients from the Nationwide Inpatient Sample.[30,31] The table shows a lower hospitalization cost for coiling in comparison to clipping. The high costs of the technology involved in this new procedure may be offset by shorter hospital stays.

Table 2.2. Inflation-adjusted hospitalization cost of patients with cerebral aneurysms undergoing endovascular coiling or surgical clipping

Technique	Ruptured cerebral aneurysms				Unruptured cerebral aneurysms			
	Mean	95% CI	Median	IQR	Mean	95% CI	Median	IQR
Coiling	$87,001	$85,071-88,931	$69,304	$36,750-101,858	$31,264	$30,673-31,856	$25,594	$15,679-35,509
Clipping	$93,180	$90,701-95,660	$73,694	$46,270-115,128	$32,872	$32,068-33,677	$24,398	$17,079-38,249

The mean value represents the average cost per hospitalization for each technique. The 95% confidence interval (CI) indicates that the probability of the mean value falling outside of this range is less than 5%. The median indicates the middle value; half of all hospitalizations were more costly and half were less costly than the median value. The interquartile range (IQR) indicates the difference between the lowest and highest hospitalization cost in the middle 50% of the data range (25th to 75th percentile).

Beyond surgery

The present

The impact of randomized trials and large database studies has been profound in swinging the pendulum toward more coiling procedures for patients with both intact and ruptured cerebral aneurysms. However, significant uncertainty still exists regarding the best treatment option, or even whether intervention is always the best option for some patients with unruptured aneurysms. This uncertainty in how best to treat patients with cerebral aneurysms has important implications. It has resulted in significant regional variation in the way in which cerebral aneurysms are treated throughout the United States. These wide differences, especially in the rates of coiling for patients with intact aneurysms, are not justified.

How should we move forward? The treatment decisions are not simple, as not all aneurysms are amenable to either clipping or coiling, and each choice has its own trade-offs. How the benefits and trade-offs are valued varies across different patients, and, therefore, the right treatment decision needs to include greater patient participation. This starts with better communication of the probabilities associated with the outcomes of each option in terms that can be understood by patients. Equally important is helping the patients clarify their own treatment goals, as well as legitimizing patients' partnership in the decision-making process. Tools (e.g., decision aids) to achieve shared decision-making, are needed to assist patients and their clinicians (Figure 2.11). In addition, new trials and studies are needed to assess how these tools can be most effectively used to guide patients through these complex decisions.

Treatment Options	Decision Support Tool Components			Patient Outcomes
	Patient Needs	Decision Support	Decision Quality	
Observation Surgical clipping Endovascular coiling	Clarification of individual values and preferences Knowledge of procedure risks, benefits, and other considerations	**Continuously updated, patient-specific data regarding risks and benefits** Guidance for the patient/surgeon interaction Other considerations	Assessment of patient knowledge and understanding Assessment of congruence with pre-specified values and preferences	Measurement of: Mortality Neurologic compromise Durability Patient satisfaction Quality of life

Figure 2.11. Conceptual model for decision support process

The future for physicians

Variation in the treatment of cerebral aneurysm is a sign of local practice styles that may not always provide the care that patients need or want. An effort to benchmark neurosurgical procedures and limit the associated variation is ongoing. The National Neurosurgery Quality and Outcomes Database (N^2QOD),[32] by the NeuroPoint Alliance (NPA),[33] is intended to track quality of care and practice patterns. The recently launched "cerebrovascular module" is starting to be adopted by several institutions and will track factors that are not reflected in the existing national registries. These will include neurological status, development of vasospasm, durability of coiling, and the use of new endovascular devices. These parameters can further assist practitioners in helping patients make decisions, while allowing focused research that will address questions that current databases and randomized trials have not been able to answer.

N^2QOD will also be a reliable clinical outcomes platform that, through accurate risk-adjustment (to account for the sicker patients treated in some centers of excellence, or the tendency to treat patients with more comorbidities with less invasive options such as coiling), will allow head-to-head comparison of practices and treatment techniques (such as coiling and clipping). This will supplement the national effort to minimize disparities and reward excellence. It will also facilitate targeted quality improvement, practice-based learning, shared decision-making, and effective resource utilization.

This initiative will provide a reliable tool for patients, physicians, hospitals, and payers in an effort to define value in the treatment of cerebral aneurysms. Patients will have current, real-time data on which to base their treatment decisions. Physicians will be able to monitor their practice and alter their performance to align with centers of excellence. Hospitals and payers will be able to design cost-effective policies and promote best practices based on the real-time data provided.

The future for patients

Improving patients' understanding of the treatment options and incorporating their preferences should be a priority in improving patient care. Patients receiving a new diagnosis of cerebral aneurysm are faced with several hurdles that can be difficult to overcome without appropriate support. They are introduced to new concepts and complex medical terminology, which can be difficult to comprehend and interpret even for the most sophisticated individuals outside the medical profession. Additional obstacles to comprehension are created by patients' frustration and fear over the cause of the disease and the possibility of death. If watchful waiting is elected, some patients restrict their daily activities, despite what they are told by clinicians, for fear of causing their aneurysms to rupture. Their follow-up visits can produce anxiety in anticipation of imaging results. If a decision is made to treat the aneurysm, the next decision is the choice between clipping and coiling. All of this can be further complicated when these procedures are offered by different specialists.

Neurosurgeons should encourage patients to play an active role in decision-making. Audiovisual and written decision aids should have a prominent role, and should include the experiences of similar patients. Ideally, patients should have access to reliable web sites that provide interactive feedback regarding the available options. N^2QOD can have a major impact in this phase by providing real-time simplified data that can be easily interpreted by the patient. The data would need to be tailored toward the patients' needs and common questions, as mapped by prior surveys. Regional centers should also develop support groups, comprising patients who have undergone both treatment options as well as those who are following a conservative approach, as well as physicians and nurses actively involved in the treatment of this population. These groups should meet regularly, and new patients should be offered the option to participate and be actively engaged. To minimize despair and feelings of helplessness while dealing with this diagnosis, patients should be provided with a contact person, like a nurse practitioner or physician assistant, with whom they can communicate for additional questions or concerns.

Patients who are considering brain aneurysm surgery may want to visit the following web sites for more information:

The American Association of Neurological Surgeons: www.aans.org/Patient%20Information/Conditions%20and%20Treatments/Treatment%20Options%20for%20Cerebral%20Aneurysms.aspx

The Brain Aneurysm Foundation: www.bafound.org/patient-resources

The American Stroke Association: www.strokeassociation.org/STROKEORG/AboutStroke/TypesofStroke/Hemor-rhagicBleeds/What-You-Should-Know-About-Cerebral-Aneurysms_UCM_310103_Article.jsp

Conclusion

There is considerable regional variation in the United States in the treatment of ruptured and unruptured cerebral aneurysms. These wide differences suggest that patients do not always receive the most optimal treatment, which has implications for both quality and cost. Patients who receive a new diagnosis of cerebral aneurysm (especially unruptured) face a difficult road to informed decision-making. Understanding their needs, addressing their concerns, and creating new quality-promoting registries will be central to the process of minimizing variability and orchestrating a patient-centered approach to cerebral aneurysm treatment.

Chapter 2 Table. Rates of unruptured cerebral aneurysm, subarachnoid hemorrhage, and coiling among patients with unruptured and ruptured cerebral aneurysms (2007-12)						
HRR Name	State	Number of Medicare beneficiaries	Unruptured cerebral aneurysms per 10,000 Medicare beneficiaries	Subarachnoid hemorrhage per 10,000 Medicare beneficiaries	Percent of Medicare beneficiaries treated for unruptured cerebral aneurysms using coiling	Percent of Medicare beneficiaries treated for subarachnoid hemorrhage using coiling
Birmingham	AL	309,770	57.4	12.1	68.0%	
Dothan	AL	64,901	40.7	8.3		
Huntsville	AL	90,635	46.3	10.5	70.9%	
Mobile	AL	104,462	35.4	10.1		
Montgomery	AL	57,649	45.5	10.0		
Tuscaloosa	AL	37,568	99.0	13.6		
Anchorage	AK	63,054	45.1	9.5	49.8%	
Mesa	AZ	96,007	76.6	13.3	52.8%	
Phoenix	AZ	310,545	62.9	12.8	60.5%	48.3%
Sun City	AZ	58,148	57.8	10.8	64.5%	
Tucson	AZ	127,346	58.3	15.1	68.2%	
Fort Smith	AR	56,578	34.1	8.6		
Jonesboro	AR	38,738	37.1	11.4		
Little Rock	AR	252,938	38.1	11.1	53.7%	72.7%
Springdale	AR	62,893	38.1	10.3	56.6%	
Texarkana	AR	42,984	44.1	13.2		
Orange County	CA	235,738	43.3	14.4	75.6%	63.6%
Bakersfield	CA	87,131	32.6	14.1	53.8%	
Chico	CA	55,389	26.6	12.3		
Contra Costa County	CA	73,963	33.9	13.1	69.6%	
Fresno	CA	103,103	36.8	14.4		
Los Angeles	CA	670,889	39.6	13.4	70.9%	61.7%
Modesto	CA	84,584	33.3	11.3	35.0%	
Napa	CA	42,539	25.1	9.7		
Alameda County	CA	98,169	29.3	12.7		59.1%
Palm Springs/Rancho Mirage	CA	51,236	67.1	12.2		
Redding	CA	64,546	26.5	10.4	56.5%	
Sacramento	CA	216,069	40.6	11.4	58.5%	62.6%
Salinas	CA	48,126	26.4	12.9		
San Bernardino	CA	147,595	31.2	12.5	57.9%	
San Diego	CA	262,164	44.0	13.6	47.5%	
San Francisco	CA	123,402	42.7	16.2		
San Jose	CA	125,965	42.4	13.0	77.1%	86.4%
San Luis Obispo	CA	40,766	38.5	9.2	71.9%	
San Mateo County	CA	65,879	40.2	9.9		
Santa Barbara	CA	55,071	37.2	10.7	79.4%	
Santa Cruz	CA	32,051	28.4	7.1		
Santa Rosa	CA	48,780	28.5	9.0		
Stockton	CA	49,835	29.2	10.2		
Ventura	CA	82,554	50.7	11.8	83.5%	

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Chapter 2 Table. Rates of unruptured cerebral aneurysm, subarachnoid hemorrhage, and coiling among patients with unruptured and ruptured cerebral aneurysms (2007-12)

HRR Name	State	Number of Medicare beneficiaries	Unruptured cerebral aneurysms per 10,000 Medicare beneficiaries	Subarachnoid hemorrhage per 10,000 Medicare beneficiaries	Percent of Medicare beneficiaries treated for unruptured cerebral aneurysms using coiling	Percent of Medicare beneficiaries treated for subarachnoid hemorrhage using coiling
Boulder	CO	23,240	32.8	11.3		
Colorado Springs	CO	89,295	29.5	14.0	51.8%	
Denver	CO	188,307	45.5	13.4	59.5%	
Fort Collins	CO	38,473	31.4	9.4		
Grand Junction	CO	38,633	34.0	8.2		
Greeley	CO	41,906	35.1	10.2		
Pueblo	CO	23,736	32.8	13.1		
Bridgeport	CT	84,676	40.8	12.0		
Hartford	CT	214,262	41.9	14.5	88.7%	68.6%
New Haven	CT	201,077	44.8	14.9	62.1%	
Wilmington	DE	113,579	91.5	16.5	76.1%	75.5%
Washington	DC	303,962	39.7	13.3	51.8%	57.9%
Bradenton	FL	54,307	39.3	9.9		
Clearwater	FL	79,808	48.5	11.5		
Fort Lauderdale	FL	367,948	62.5	11.0	87.9%	98.8%
Fort Myers	FL	238,007	49.0	11.1	75.6%	67.9%
Gainesville	FL	86,233	49.8	10.8		
Hudson	FL	71,438	47.1	13.9	77.4%	
Jacksonville	FL	203,502	70.7	12.8	85.6%	65.8%
Lakeland	FL	46,521	37.0	9.8		
Miami	FL	248,690	56.7	11.7	82.8%	84.1%
Ocala	FL	147,301	40.6	10.2	66.8%	
Orlando	FL	489,891	58.3	12.0	80.0%	77.5%
Ormond Beach	FL	68,795	71.0	9.6	87.0%	
Panama City	FL	36,044	50.5	13.1		
Pensacola	FL	120,750	43.4	9.8	63.9%	
Sarasota	FL	115,349	35.1	10.2	62.5%	
St. Petersburg	FL	57,209	41.3	10.4	84.5%	
Tallahassee	FL	94,150	35.4	10.7		
Tampa	FL	123,739	48.7	13.2	82.3%	
Albany	GA	28,116	32.9	12.0		
Atlanta	GA	582,514	46.9	10.8	62.9%	36.3%
Augusta	GA	89,046	30.1	9.7		
Columbus	GA	42,651	41.2	11.5		
Macon	GA	96,902	41.3	12.4	91.1%	
Rome	GA	43,392	48.1	11.0		
Savannah	GA	113,647	60.0	8.5	66.5%	
Honolulu	HI	121,712	71.6	14.5	82.2%	88.8%
Boise	ID	89,364	36.8	7.3	68.4%	
Idaho Falls	ID	24,481				
Aurora	IL	27,339	63.6	17.5	73.6%	

Chapter 2 Table. Rates of unruptured cerebral aneurysm, subarachnoid hemorrhage, and coiling among patients with unruptured and ruptured cerebral aneurysms (2007-12)

HRR Name	State	Number of Medicare beneficiaries	Unruptured cerebral aneurysms per 10,000 Medicare beneficiaries	Subarachnoid hemorrhage per 10,000 Medicare beneficiaries	Percent of Medicare beneficiaries treated for unruptured cerebral aneurysms using coiling	Percent of Medicare beneficiaries treated for subarachnoid hemorrhage using coiling
Blue Island	IL	125,424	60.2	13.9	86.1%	70.6%
Chicago	IL	246,594	56.5	14.7	84.5%	55.3%
Elgin	IL	86,944	57.6	17.5	65.0%	
Evanston	IL	153,969	55.5	15.9	66.2%	
Hinsdale	IL	57,330	70.6	17.9	62.1%	
Joliet	IL	86,811	50.5	12.3	78.5%	
Melrose Park	IL	166,408	59.0	14.2	84.1%	64.8%
Peoria	IL	105,259	49.4	14.4	55.5%	
Rockford	IL	109,219	35.5	12.5		
Springfield	IL	155,562	42.2	15.0	67.9%	
Urbana	IL	61,985	55.5	12.0		
Bloomington	IL	23,802	51.2	10.9	94.5%	
Evansville	IN	112,983	34.4	12.2	97.4%	
Fort Wayne	IN	104,136	33.0	9.3	88.5%	
Gary	IN	80,700	64.1	14.9	60.0%	
Indianapolis	IN	381,175	42.1	12.1	67.9%	61.8%
Lafayette	IN	27,953	39.0	13.3		
Muncie	IN	29,325	42.0	11.8		
Munster	IN	47,380	54.6	15.5		
South Bend	IN	95,419	34.2	9.4		
Terre Haute	IN	30,633	41.4	15.4		
Cedar Rapids	IA	42,079	28.5	9.8		
Davenport	IA	83,543	41.0	13.7	94.6%	
Des Moines	IA	165,135	25.7	9.6	96.8%	
Dubuque	IA	19,773	23.3	12.3		
Iowa City	IA	49,964	39.0	9.8	86.9%	
Mason City	IA	30,205	26.5	6.1		
Sioux City	IA	41,286	16.7	11.9		
Waterloo	IA	36,853	33.7	7.2		
Topeka	KS	69,373	32.0	9.6		
Wichita	KS	202,643	26.3	9.6	67.5%	70.1%
Covington	KY	43,791	43.9	15.0		
Lexington	KY	204,613	46.5	14.2	81.1%	63.1%
Louisville	KY	242,765	64.5	15.6	90.6%	77.8%
Owensboro	KY	24,019	61.6	10.9		
Paducah	KY	72,003	42.9	9.8	87.9%	
Alexandria	LA	45,416	39.5	10.3		
Baton Rouge	LA	84,980	42.7	11.9	70.8%	
Houma	LA	34,470	28.6	14.7		
Lafayette	LA	86,101	41.1	12.4	82.7%	
Lake Charles	LA	37,296	53.0	10.1		

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Chapter 2 Table. Rates of unruptured cerebral aneurysm, subarachnoid hemorrhage, and coiling among patients with unruptured and ruptured cerebral aneurysms (2007-12)

HRR Name	State	Number of Medicare beneficiaries	Unruptured cerebral aneurysms per 10,000 Medicare beneficiaries	Subarachnoid hemorrhage per 10,000 Medicare beneficiaries	Percent of Medicare beneficiaries treated for unruptured cerebral aneurysms using coiling	Percent of Medicare beneficiaries treated for subarachnoid hemorrhage using coiling
Metairie	LA	45,566	31.9	9.1		
Monroe	LA	42,660	40.1	13.9		
New Orleans	LA	41,920	40.0	11.0		
Shreveport	LA	104,472	27.9	11.6		
Slidell	LA	22,001	50.1	8.0		
Bangor	ME	76,763	32.1	11.9		
Portland	ME	177,326	33.3	11.5	68.3%	
Baltimore	MD	342,591	48.7	14.2	60.5%	57.5%
Salisbury	MD	92,689	59.5	13.5	56.5%	
Takoma Park	MD	90,420	39.3	15.2	76.5%	
Boston	MA	630,906	71.4	16.2	59.3%	58.1%
Springfield	MA	100,593	40.9	13.5	78.9%	
Worcester	MA	69,392	56.2	14.2	81.0%	
Ann Arbor	MI	182,766	58.2	11.4	70.3%	
Dearborn	MI	75,354	68.2	13.1		
Detroit	MI	243,876	83.7	12.8	75.0%	81.0%
Flint	MI	82,997	60.2	11.1	54.0%	
Grand Rapids	MI	124,753	35.1	9.7	71.8%	
Kalamazoo	MI	98,344	76.1	10.4	69.3%	
Lansing	MI	94,657	79.7	11.8	91.8%	
Marquette	MI	39,544	45.7	9.2		
Muskegon	MI	38,760	33.9	9.5		
Petoskey	MI	36,537	41.0	9.9		
Pontiac	MI	59,298	78.6	11.0	86.9%	
Royal Oak	MI	103,415	90.6	11.2	81.5%	
Saginaw	MI	129,251	51.7	8.7	61.6%	
St. Joseph	MI	24,347	65.3	8.7	79.7%	
Traverse City	MI	49,137	31.8	10.0		
Duluth	MN	51,383	29.3	8.5	96.2%	
Minneapolis	MN	278,470	52.7	12.2	85.5%	
Rochester	MN	59,246	41.1	9.4		
St. Cloud	MN	23,726	42.0	8.5		
St. Paul	MN	80,367	74.7	12.7	67.5%	
Gulfport	MS	25,987	49.0	13.2		
Hattiesburg	MS	46,397	43.8	10.5		
Jackson	MS	150,069	47.5	11.5	76.3%	
Meridian	MS	33,996	41.3	12.8		
Oxford	MS	22,465	63.4	12.1		
Tupelo	MS	62,914	38.9	10.6		
Cape Girardeau	MO	48,131	43.4	9.9		
Columbia	MO	114,291	39.3	11.6	57.2%	

Chapter 2 Table. Rates of unruptured cerebral aneurysm, subarachnoid hemorrhage, and coiling among patients with unruptured and ruptured cerebral aneurysms (2007-12)

HRR Name	State	Number of Medicare beneficiaries	Unruptured cerebral aneurysms per 10,000 Medicare beneficiaries	Subarachnoid hemorrhage per 10,000 Medicare beneficiaries	Percent of Medicare beneficiaries treated for unruptured cerebral aneurysms using coiling	Percent of Medicare beneficiaries treated for subarachnoid hemorrhage using coiling
Joplin	MO	64,526	34.3	8.5	86.5%	
Kansas City	MO	296,526	43.5	11.9	78.1%	81.0%
Springfield	MO	130,285	45.4	9.8	61.8%	
St. Louis	MO	439,656	43.9	11.7	85.0%	76.9%
Billings	MT	87,728	38.0	7.6	66.0%	
Great Falls	MT	23,493	23.4	8.4		
Missoula	MT	63,709	38.1	9.4		
Lincoln	NE	93,289	25.2	7.5	91.9%	
Omaha	NE	181,668	31.4	11.4	88.3%	
Las Vegas	NV	170,438	69.4	16.1	82.2%	
Reno	NV	99,497	38.9	13.4	75.9%	
Lebanon	NH	76,181	41.5	12.1		
Manchester	NH	131,701	44.6	11.3	39.0%	
Camden	NJ	446,088	63.1	12.7	73.4%	88.9%
Hackensack	NJ	173,852	38.3	12.9	79.9%	
Morristown	NJ	143,057	42.5	12.8	87.4%	73.4%
New Brunswick	NJ	130,872	79.4	15.8	73.8%	
Newark	NJ	167,202	41.0	13.9	73.8%	64.7%
Paterson	NJ	51,055	40.2	13.2		
Ridgewood	NJ	58,562	40.0	8.7		
Albuquerque	NM	176,166	28.0	11.8		
Albany	NY	258,987	46.3	9.4	84.3%	
Binghamton	NY	61,375	35.0	13.6		
Bronx	NY	86,385	87.3	12.4		
Buffalo	NY	125,732	73.4	8.5	67.7%	
Elmira	NY	50,864	37.6	10.4		
East Long Island	NY	539,197	58.0	12.7	65.1%	55.3%
Manhattan	NY	450,471	56.6	13.0	79.2%	72.0%
Rochester	NY	98,051	35.2	9.5		
Syracuse	NY	147,797	48.5	12.3	74.3%	81.3%
White Plains	NY	149,409	47.2	12.4	70.1%	
Asheville	NC	129,637	37.8	9.7	76.3%	
Charlotte	NC	298,021	67.3	11.3	79.9%	
Durham	NC	189,171	41.5	11.7	70.1%	78.9%
Greensboro	NC	67,024	57.0	12.3	64.5%	
Greenville	NC	131,290	43.5	14.1	64.3%	64.4%
Hickory	NC	47,045	29.8	6.6		
Raleigh	NC	225,210	48.4	15.2	62.6%	58.6%
Wilmington	NC	76,691	41.6	7.7		
Winston-Salem	NC	135,653	45.5	11.5	74.6%	76.9%
Bismarck	ND	39,077	28.9	7.8		

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Chapter 2 Table. Rates of unruptured cerebral aneurysm, subarachnoid hemorrhage, and coiling among patients with unruptured and ruptured cerebral aneurysms (2007-12)

HRR Name	State	Number of Medicare beneficiaries	Unruptured cerebral aneurysms per 10,000 Medicare beneficiaries	Subarachnoid hemorrhage per 10,000 Medicare beneficiaries	Percent of Medicare beneficiaries treated for unruptured cerebral aneurysms using coiling	Percent of Medicare beneficiaries treated for subarachnoid hemorrhage using coiling
Fargo/Moorhead MN	ND	72,899	29.3	8.9		
Grand Forks	ND	24,133	28.8	7.0		
Minot	ND	21,707	27.4	10.0		
Akron	OH	80,878	50.3	9.7	58.8%	
Canton	OH	81,025	52.9	10.6		
Cincinnati	OH	190,191	49.4	13.5	72.9%	
Cleveland	OH	286,216	53.6	11.2	69.1%	81.8%
Columbus	OH	362,249	57.2	15.3	80.1%	76.3%
Dayton	OH	150,832	51.5	12.5	80.4%	
Elyria	OH	37,236	50.4	15.9		
Kettering	OH	55,772	52.7	11.1	66.7%	
Toledo	OH	137,567	37.3	12.8	78.4%	
Youngstown	OH	94,905	40.3	10.6	55.8%	
Lawton	OK	30,599	34.2	8.8		
Oklahoma City	OK	259,993	57.1	11.4	84.0%	65.9%
Tulsa	OK	180,109	39.7	12.3	70.8%	
Bend	OR	32,102	43.2	8.8		
Eugene	OR	90,548	28.6	10.0	69.0%	
Medford	OR	75,699	23.6	8.9		
Portland	OR	199,303	37.0	11.5	66.6%	
Salem	OR	21,326	24.6	8.8		
Allentown	PA	182,451	60.0	15.9	61.5%	
Altoona	PA	37,817	35.9	11.3		
Danville	PA	74,508	33.4	9.2	79.7%	
Erie	PA	106,034	44.2	11.9	89.0%	
Harrisburg	PA	144,526	40.1	10.6	85.9%	
Johnstown	PA	22,340	64.9	8.1		
Lancaster	PA	89,905	31.2	10.1		
Philadelphia	PA	440,460	56.2	12.1	85.7%	81.8%
Pittsburgh	PA	282,079	48.2	11.6	63.5%	71.9%
Reading	PA	82,007	69.9	13.0	86.2%	
Sayre	PA	33,391	29.5	10.3		
Scranton	PA	57,441	53.6	13.1		
Wilkes-Barre	PA	44,333	43.5	14.7		
York	PA	60,951	36.2	5.5		
Providence	RI	126,546	44.6	14.3	79.6%	93.2%
Charleston	SC	157,108	61.6	12.9	76.9%	75.7%
Columbia	SC	165,820	38.4	11.8	85.3%	
Florence	SC	57,482	43.3	13.3		
Greenville	SC	127,431	33.5	8.8	87.3%	
Spartanburg	SC	54,237	42.1	10.6		

Chapter 2 Table. Rates of unruptured cerebral aneurysm, subarachnoid hemorrhage, and coiling among patients with unruptured and ruptured cerebral aneurysms (2007-12)

HRR Name	State	Number of Medicare beneficiaries	Unruptured cerebral aneurysms per 10,000 Medicare beneficiaries	Subarachnoid hemorrhage per 10,000 Medicare beneficiaries	Percent of Medicare beneficiaries treated for unruptured cerebral aneurysms using coiling	Percent of Medicare beneficiaries treated for subarachnoid hemorrhage using coiling
Rapid City	SD	33,116	23.1	5.0		
Sioux Falls	SD	136,534	27.2	9.1		
Chattanooga	TN	101,778	42.3	11.8	66.2%	
Jackson	TN	60,953	57.9	11.5		
Johnson City	TN	38,106	37.4	13.3		
Kingsport	TN	68,578	63.1	15.5	79.3%	
Knoxville	TN	187,268	53.9	13.5	89.1%	87.5%
Memphis	TN	226,526	61.2	11.5	81.2%	65.1%
Nashville	TN	329,552	52.0	12.9	81.9%	96.6%
Abilene	TX	53,238	39.2	10.9		
Amarillo	TX	64,106	30.6	8.5		
Austin	TX	152,041	54.2	11.6	67.7%	
Beaumont	TX	65,348	39.6	11.9	84.8%	
Bryan	TX	27,274	35.3	16.3		
Corpus Christi	TX	60,453	30.7	14.7		
Dallas	TX	446,407	60.8	14.6	66.4%	51.4%
El Paso	TX	112,930	32.8	12.7		
Fort Worth	TX	190,444	52.1	15.8	74.0%	58.5%
Harlingen	TX	59,200	27.1	11.5		
Houston	TX	544,283	62.9	14.6	73.2%	61.7%
Longview	TX	31,783	46.9	8.3		
Lubbock	TX	95,214	39.3	13.6		
McAllen	TX	60,506	18.7	16.0		
Odessa	TX	44,338	47.6	10.2		
San Angelo	TX	27,666	37.3	10.7		
San Antonio	TX	276,930	45.6	12.6	60.5%	48.7%
Temple	TX	39,094	63.1	12.8		
Tyler	TX	97,977	45.9	8.8	67.0%	
Victoria	TX	26,178	31.9	14.0		
Waco	TX	46,689	46.1	12.0		
Wichita Falls	TX	35,383	60.8	13.5		
Ogden	UT	36,534	48.3	7.9		
Provo	UT	33,676	76.0	9.7		
Salt Lake City	UT	173,441	85.5	10.0	60.0%	
Burlington	VT	100,314	43.7	11.3	70.3%	
Arlington	VA	187,334	71.4	13.6	80.7%	78.8%
Charlottesville	VA	88,687	59.0	16.2	83.5%	
Lynchburg	VA	43,517	23.9	8.3		
Newport News	VA	79,768	39.2	8.4	94.9%	
Norfolk	VA	157,474	71.8	12.3	74.4%	
Richmond	VA	223,342	43.2	11.9	79.5%	75.0%

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Chapter 2 Table. Rates of unruptured cerebral aneurysm, subarachnoid hemorrhage, and coiling among patients with unruptured and ruptured cerebral aneurysms (2007-12)

HRR Name	State	Number of Medicare beneficiaries	Unruptured cerebral aneurysms per 10,000 Medicare beneficiaries	Subarachnoid hemorrhage per 10,000 Medicare beneficiaries	Percent of Medicare beneficiaries treated for unruptured cerebral aneurysms using coiling	Percent of Medicare beneficiaries treated for subarachnoid hemorrhage using coiling
Roanoke	VA	120,639	41.0	13.2	80.4%	
Winchester	VA	63,081	40.6	11.9	94.1%	
Everett	WA	67,390	36.8	9.6		
Olympia	WA	50,715	38.7	12.0		
Seattle	WA	297,820	43.4	11.0	69.8%	
Spokane	WA	213,757	39.2	11.4	69.2%	77.7%
Tacoma	WA	83,171	53.6	11.8	98.6%	
Yakima	WA	37,116	27.1	11.9		
Charleston	WV	129,320	54.8	11.7	77.8%	
Huntington	WV	56,719	71.8	10.0	80.1%	
Morgantown	WV	57,420	64.4	17.3		
Appleton	WI	33,451	38.6	8.0		
Green Bay	WI	69,790	41.7	8.4	83.0%	
La Crosse	WI	43,597	26.0	7.2		
Madison	WI	140,742	46.0	9.8	36.0%	
Marshfield	WI	55,125	34.0	6.9		
Milwaukee	WI	318,624	46.5	11.3	80.3%	77.4%
Neenah	WI	26,621	40.4	9.4		
Wausau	WI	29,848	35.6	8.5		
Casper	WY	32,487	28.3	9.8		
United States	US	36,169,055	48.7	12.2	71.0%	63.3%

Variation in the Care of Surgical Conditions: Diabetes and Peripheral Arterial Disease

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Diabetes and peripheral arterial disease: Putting patients at high risk for amputation

Patients with diabetes (high blood sugar) and peripheral arterial disease (PAD, or blockages in the arteries of the legs and other locations) are at high risk for major limb amputation at rates several times the national average for patients without diabetes.[1,2] Nearly 100,000 major leg amputations are performed annually in Medicare patients, and more than half of them occur as a result of diabetes.[3-5] Co-occurrence of these two illnesses—diabetes and peripheral arterial disease—has a negative synergistic effect, leaving patients at a higher risk for amputation than either of the two diseases alone.

In the context of these two diseases, a seemingly simple event, such as a small ulcer or break in the integrity of the skin of the foot, can result in a life or limb-threatening infection. When infection manages to breach the barrier of the skin of the lower limb, it often finds its way into the soft tissue, and occasionally into the bony structures of the foot. Given the poor ability of patients with diabetes to heal, the poor blood supply caused by arterial insufficiency known to occur in PAD, and the inability of antibiotic therapy to be delivered effectively through narrowed blood vessels, a "perfect storm" for uncontrolled infection results.

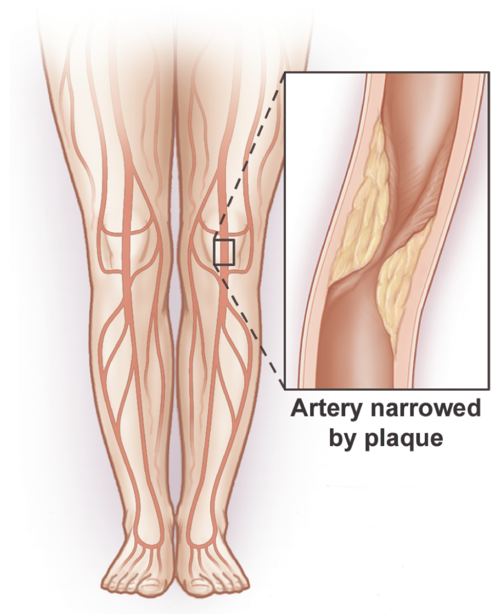


Figure 3.1. Arterial outline showing atherosclerosis

Source: The Society for Vascular Surgery, 2005.

Once infection has spread into the foot, it can be exceedingly difficult to eradicate.[6] The patient's blood sugar must be well controlled, which can be very difficult for many patients with diabetes. Measures to keep the patient's foot wounds clean and to keep the patient from bearing weight directly on the wounds are absolutely essential, but this is not easy when the wound is on the bottom of the foot. Patients with diabetes and PAD also need the best preventive medical treatments, such as statin therapy and smoking cessation counseling, to ensure the best outcomes. Therefore, for patients with diabetes and PAD, strategies for prevention and revascularization are of the utmost importance.[7-9]

Coordinating this complex care for diabetes and PAD can be challenging for patients and physicians. While plausible for patients with good financial and social resources, the task is daunting for the many patients with limited resources. This report examines how Medicare patients with diabetes and PAD are treated across the United States. It describes how, when, and why they may (or may not) be treated with preventive measures, as well as invasive treatments aimed at limiting amputation. By examining these treatment patterns, and outlining the ways in which physicians have attempted to study and improve the care of these complex patients, we hope to highlight opportunities to reduce amputations for patients at the highest risk for limb loss.

Before surgery

Regional variation in the risk of amputation

While the processes of care for patients with diabetes and PAD are complex, one outcome that matters is easily measurable: major leg amputation, or loss of the leg above or below the knee. In many regions of the United States, amputation rates are quite low, especially in parts of the country where diabetes is uncommon, and among patients who are unlikely to be poor or black (Figure 3.2).[10-12] However, in other regions—for example, rural areas of the southeastern United States—amputation rates, especially among black patients with diabetes, are high (Map 3.1). In these regions, the risks of major amputation are often three to four times the national average.

During the period from 2007 to 2011, the national average rate of leg amputation was 2.4 per 1,000 Medicare beneficiaries with diabetes and PAD. This rate varied more than fivefold across hospital referral regions, from 1.2 per 1,000 patients in Royal Oak, Michigan and Sarasota, Florida, to more than 6 per 1,000 patients in Tupelo, Mississippi (6.2) and Appleton, Wisconsin (6.1). Nationally, the amputation rate among black patients—5.6 per 1,000—was nearly three times higher than the rate among other beneficiaries (2.0). The amputation rate varied by a factor of more than seven among black patients, from about 2 per 1,000 in San Diego (2.1) and Las Vegas (2.2) to 14 or more per 1,000 in Lynchburg, Virginia (14.0), Meridian, Mississippi (14.2), and Tupelo (16.1). Among non-black patients (including white, Hispanic, Asian, and others), the amputation rate was less than 1 per 1,000 in Takoma Park, Maryland (0.9) and Royal Oak (0.9) and more than 4 per 1,000 in Lynchburg (4.1) and Tupelo (4.7).

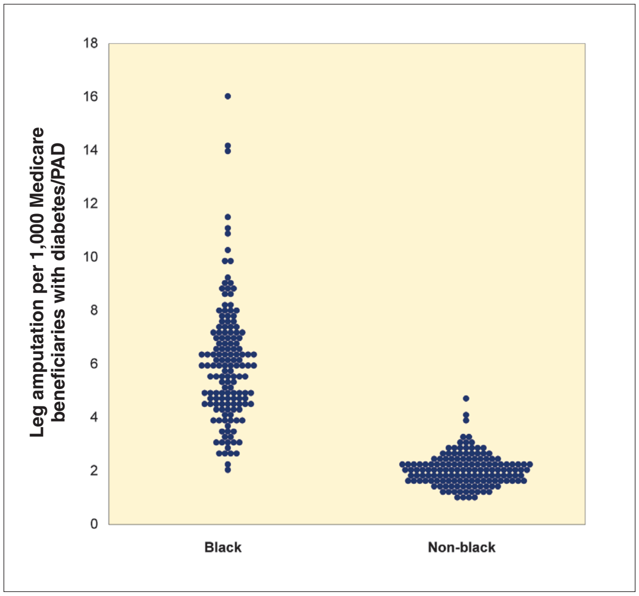
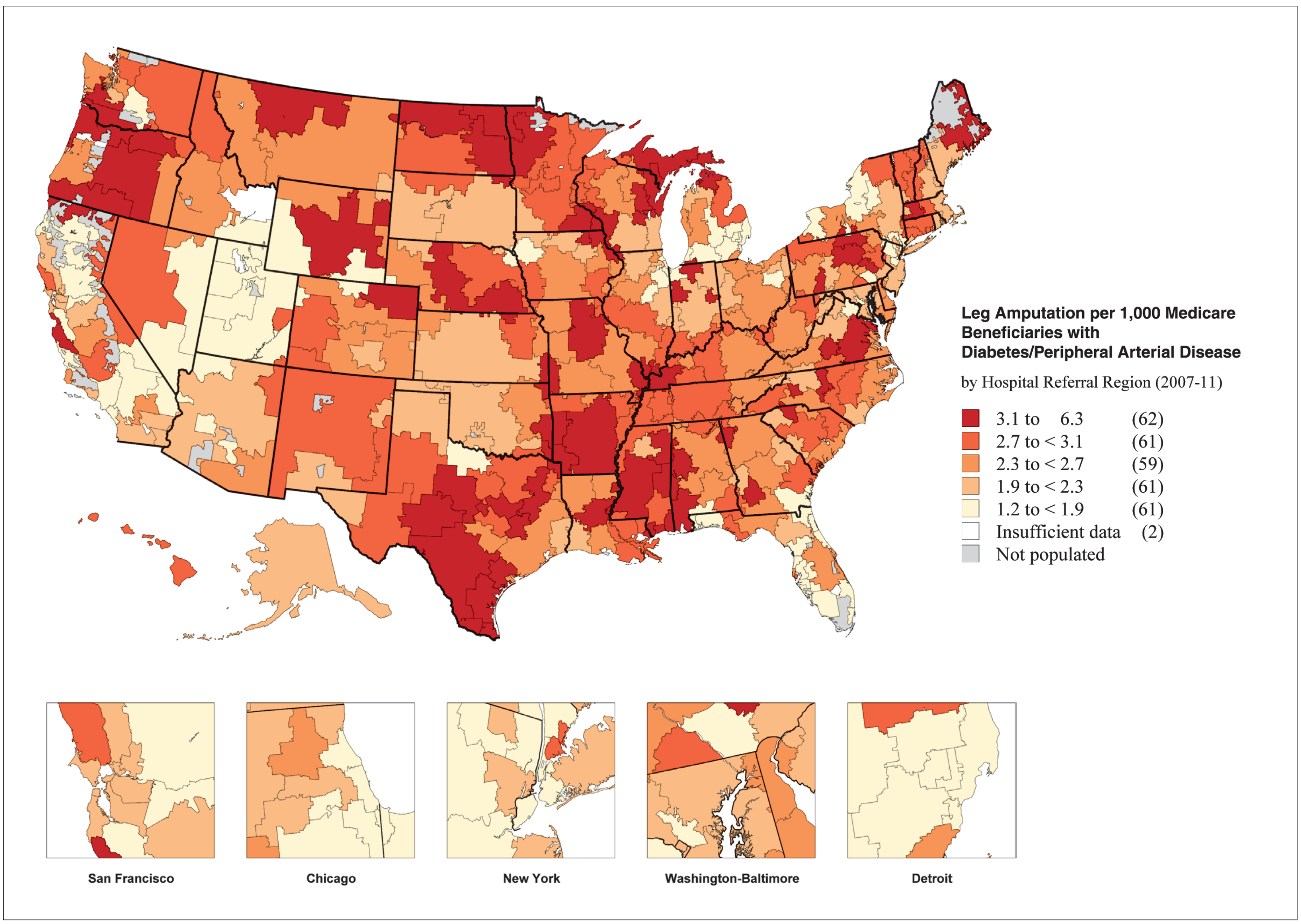


Figure 3.2. Leg amputation per 1,000 Medicare beneficiaries with diabetes and PAD by race among hospital referral regions (2007-11)

Each blue dot represents the rate of leg amputation among patients with diabetes and PAD in one of 306 hospital referral regions in the U.S. Rates are adjusted for age and sex.

While amputation rates among black patients were higher than others in each of the 306 hospital referral regions, the differences in some were small. For example, in San Antonio, Texas, amputation rates among black and non-black patients were nearly identical during 2007-11 (3.2 and 3.0 per 1,000, respectively). This was a result of the San Antonio region having relatively high amputation rates for non-black patients and below average rates for black patients. By contrast, in Monroe, Louisiana, amputation rates among black patients (7.9) were more than five times higher than among non-black patients (1.5). Tupelo had the highest amputation rates for both black and non-black patients, but the rate among black patients was more than three times higher (16.1 versus 4.7 per 1,000).

The results shown highlight one of the major persistent findings in the care of patients at risk for amputation. Across the United States, the risk of amputation averages between 2 and 3 per 1,000 patients with diabetes and peripheral arterial disease. However, this rate can be up to eight times higher in some places, especially among black patients. In fact, when comparing black and non-black patients, the lowest-risk black patients have higher risk of amputation than nearly all non-black patients. Further, the extent of variation—the distance from the bottom dots, indicative of the regions with the lowest amputation risk, to the top dots, indicative of the regions with the highest amputation risk—is much more dramatic among black patients when compared to other patients (Figure 3.2). These data leave little doubt where the focus on amputation prevention needs to be directed.



Map 3.1. Leg amputation per 1,000 Medicare beneficiaries with diabetes and PAD (2007-11)

Rates are adjusted for age, sex, and race.

Treatment options: Effectiveness, trade-offs, and knowledge gaps about preventive and invasive approaches

Several approaches are available to limit the risk of amputation for patients with severe diabetes and PAD. Wounds on the feet and poor circulation carry a sizeable potential risk of amputation for these patients and require interventions focused on improving blood flow to the legs to allow wounds the best possible chance to heal. At the same time, patients are in need of preventive treatments aimed at treating the complications of diabetes and PAD. First and foremost, preventive measures, such as those outlined in the Healthcare Effectiveness Data and Information Set (HEDIS), can help to prevent problems such as foot ulceration or cellulitis that may lead to amputation.[13-15] These preventive treatments are simple, inexpensive, and vital to the care of patients with diabetes, not just with respect to their legs, but in terms of their overall lives.[15,16] These measures focus on four key goals: tests to examine the quality of blood sugar control; foot care aimed at limiting the presence of ulcerations; testing and treatment of high cholesterol; and smoking cessation. All have been shown to limit the risk of limb loss. However, the use of these preventive measures by patients faced with limb amputation varies widely.

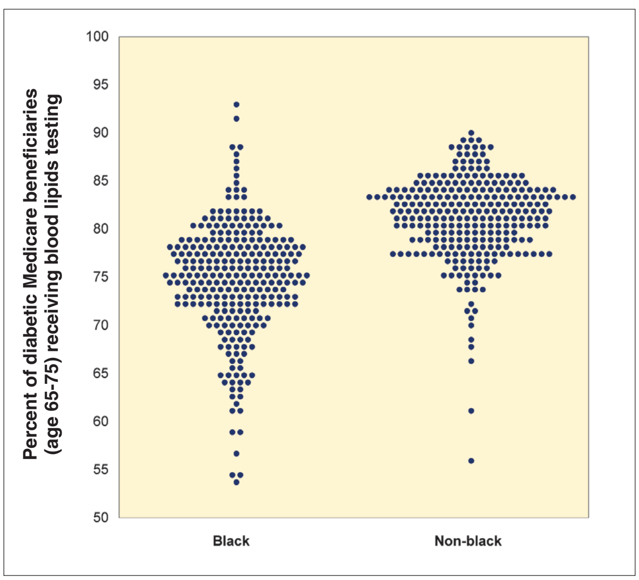
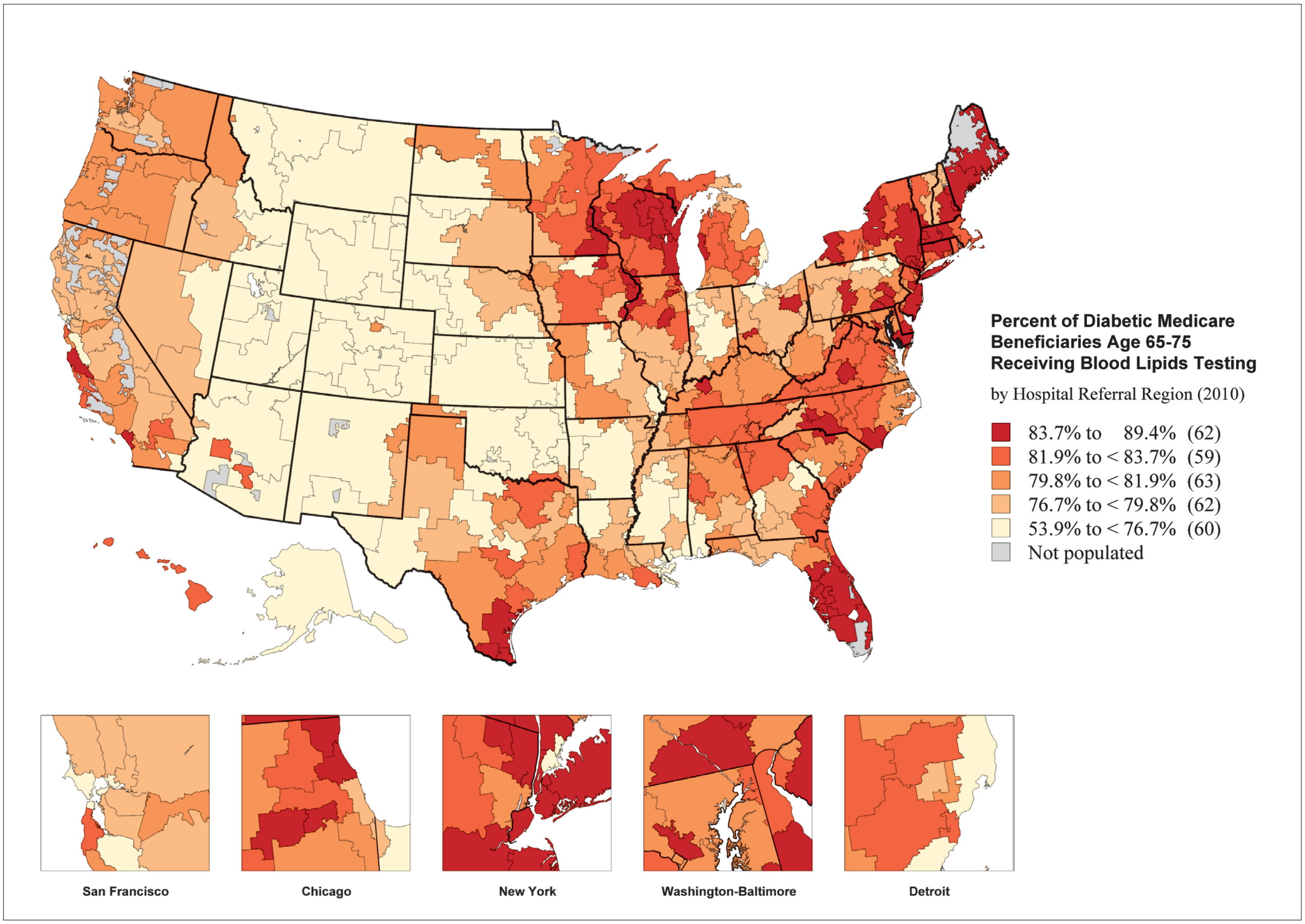


Figure 3.3. Percent of diabetic Medicare beneficiaries receiving cholesterol testing by race among hospital referral regions (2010)

Each blue dot represents the rate of blood lipids testing among patients age 65-75 with diabetes in one of 306 hospital referral regions in the U.S. Rates are unadjusted.

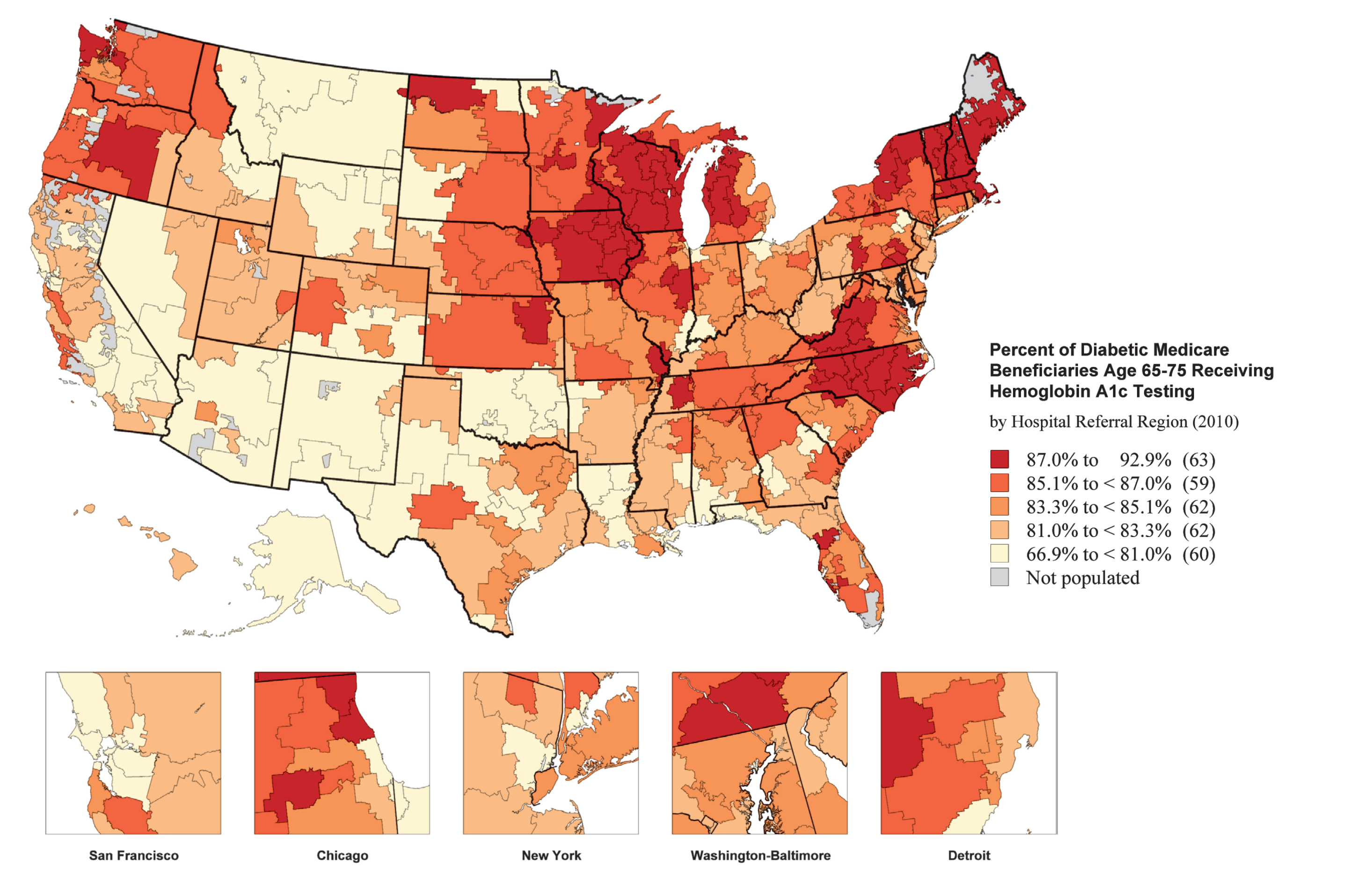
Given that preventive treatments are evidence-based, nearly universally available, and inexpensive, one might expect that their use would be high. However, as shown in Maps 3.2 and 3.3, there are marked differences in the use of these basic services in different regions of the United States. For example, while an average 80.7% of diabetic patients had at least one blood lipids test to check their cholesterol in 2010, testing levels were much lower in hospital referral regions in the central and mountain states—including Casper, Wyoming (53.9%) and Albuquerque, New Mexico (60.9%)—than in the Northeast and in Florida regions such as Ocala (89.4%) and Clearwater (88.7%) (Map 3.2). Rates of hemoglobin A1c testing, a measure of the quality of blood glucose control, averaged 83.8% during 2010. Testing rates were relatively low in southern and western regions, including Albuquerque (66.9%), Anchorage, Alaska (69.8%), and Lawton, Oklahoma (73.8%), compared to regions in the upper Midwest, including Dubuque, Iowa (92.8%), Rochester, Minnesota (92.7%), and Marshfield, Wisconsin (92.3%) (Map 3.3).



Map 3.2. Percent of diabetic Medicare beneficiaries receiving cholesterol testing (2010)

Rates are unadjusted.

Two major findings are evident in these maps and Figures 3.3 and 3.4. First, there are broad differences in the best and worst performing regions, in terms of the provision of preventive measures for patients with diabetes. Second, while there is variation by region, there are also differences by race; black patients are less likely to be treated with preventive measures, on average, across the country. While 81.5% of non-black diabetic patients received a blood lipids test in 2010, only 75.2% of black diabetic patients had this test. Similarly, 84.2% of non-black patients had hemoglobin A1c tests in 2010, while 80.9% of black patients had them.



Map 3.3. Percent of diabetic Medicare beneficiaries receiving hemoglobin A1c testing (2010)

Rates are unadjusted.

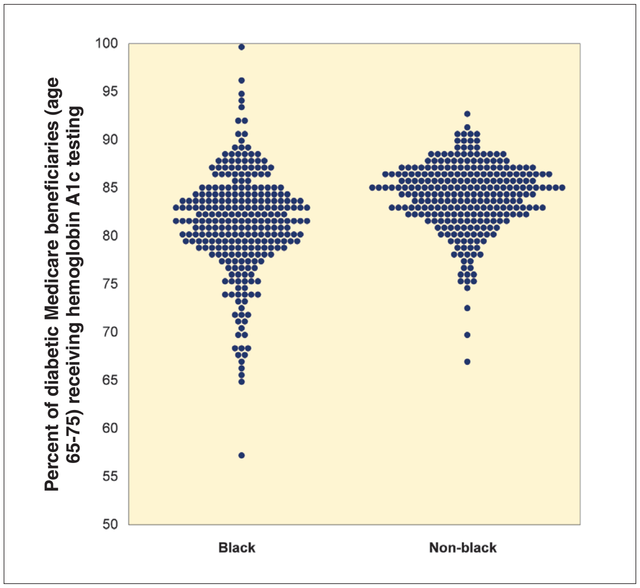


Figure 3.4. Percent of diabetic Medicare beneficiaries receiving hemoglobin A1c testing by race among hospital referral regions (2010)

Each blue dot represents the rate of hemoglobin A1c testing among patients age 65-75 with diabetes in one of 306 hospital referral regions in the U.S. Rates are unadjusted.

Preventive measures are not the only beneficial services available for patients with diabetes and PAD. After the preventive strategies have been optimized, patients with diabetes, PAD, and wounds or ulcerations generally improve most rapidly if blood flow to their feet is improved. The strategies that are available for increasing blood flow vary, but can be combined into two basic categories: endovascular treatments such as balloons or stents, or open surgical procedures such as bypass surgery (Figure 3.5).

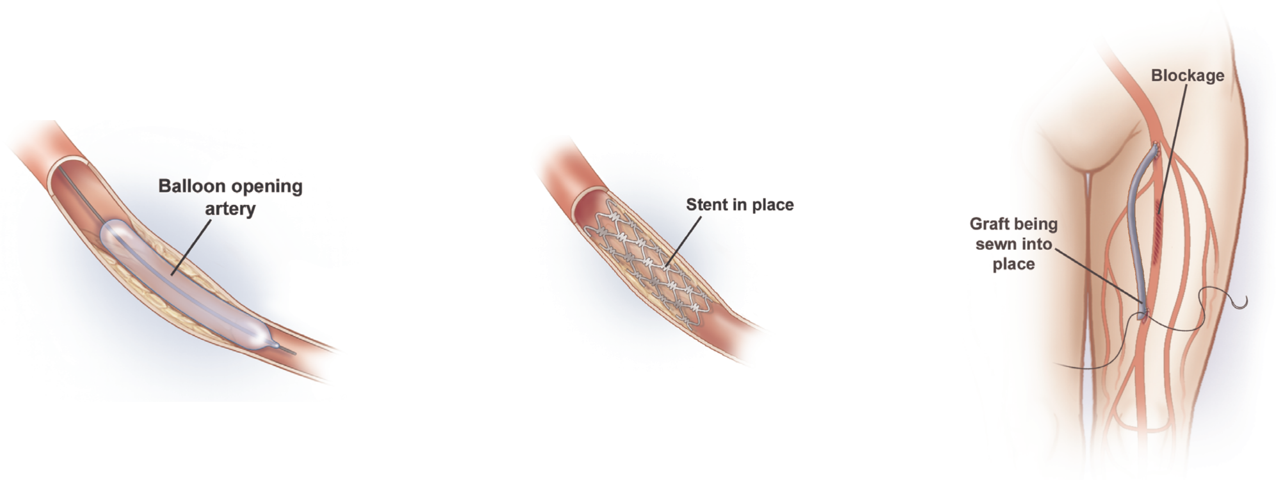


Figure 3.5. Types of revascularization

Source: The Society for Vascular Surgery, 2004-05.

Which of the treatment strategies is the most effective? Do the different treatments complement one another, or is there a synergy effect? These questions are still debated, and patients, providers, and payers remain uncertain as to which strategy—or combination of strategies—is the most effective at limiting the risk of amputation.[17,18] Each of these strategies brings trade-offs for patients, physicians, and society. While preventive measures are inexpensive and non-invasive, they may not arrest the most severe disease in an advanced state. Conversely, if invasive procedures are overused in low-risk patients, the risks may outweigh the potential benefits and result in increased costs that society must bear in the care of these chronically ill patients. Invasive vascular treatments are expensive. Balloons, stents, and catheter-based treatments, especially atherectomy devices, range in cost from a few hundred to several thousand dollars for each treatment, and some procedures can involve several treatments per artery. Similarly, surgical procedures, such as lower extremity bypass surgery, can involve a long hospital stay and complex recovery, resulting in costs that can extend above tens of thousands of dollars.

Decision quality and shared decision-making

Which of these treatment strategies is the best and how should physicians and caregivers advise patients and families who are faced with potential limb loss from diabetes and PAD? Significant gaps in knowledge exist in terms of which of these strategies will offer patients the best outcomes at the lowest risk.[11,19] The variation in the treatment of these conditions indicates that many physicians and patients choose vastly different treatment strategies, introducing potentially wasteful, and at times even potentially harmful, variation in treatment.

Patients with diabetes and peripheral arterial disease are faced with difficult decisions regarding their health care. "How should I care for my diabetes? Is my blood sugar well controlled? Do I need an invasive procedure to keep me from losing my leg?" When important questions such as these are faced by patients and their health care providers, decision aids can offer guidance and consistency, and often improve the quality of a patient's decision.

Treatment Options	Decision Support Tool Components			Patient Outcomes
	Patient Needs	Decision Support	Decision Quality	
Preventive care a. Blood sugar monitoring b. Diabetic foot care c. Smoking cessation d. Cholesterol monitoring Surgical and diagnostic interventions a. Diagnostic endovascular procedure b. Endovascular procedure c. Open bypass surgery	Clarification of individual values and preferences Knowledge of procedure risks, benefits, and other considerations	**Continuously updated, patient-specific data regarding risks and benefits** Guidance for the patient/surgeon interaction Other considerations	Assessment of patient knowledge and understanding Assessment of congruence with pre-specified values and preferences	Measurement of: Adherence to preventive care Patient satisfaction Quality of life

Figure 3.6. Conceptual model for decision support process

Many groups and societies have established web sites and resources aimed at helping patients make the best decisions about their care, especially care related to diabetes and peripheral arterial disease. For example, the American Diabetes Association has created patient information sites aimed at improving understanding about the care of foot wounds among patients with diabetes (www.americandiabetesassociation.org). Similarly, the Society for Vascular Surgery has web-based information available for patients who need treatments for vascular disease (www.vascularweb.org). But while educational tools improve patients' understanding of their disease and its treatments, work is still needed to help patients better understand what treatments will offer them the best results.

As outlined in this report, patients with diabetes and peripheral arterial disease are at risk for foot problems that may lead to amputation. While successfully navigating these health problems is difficult, resources are available at:

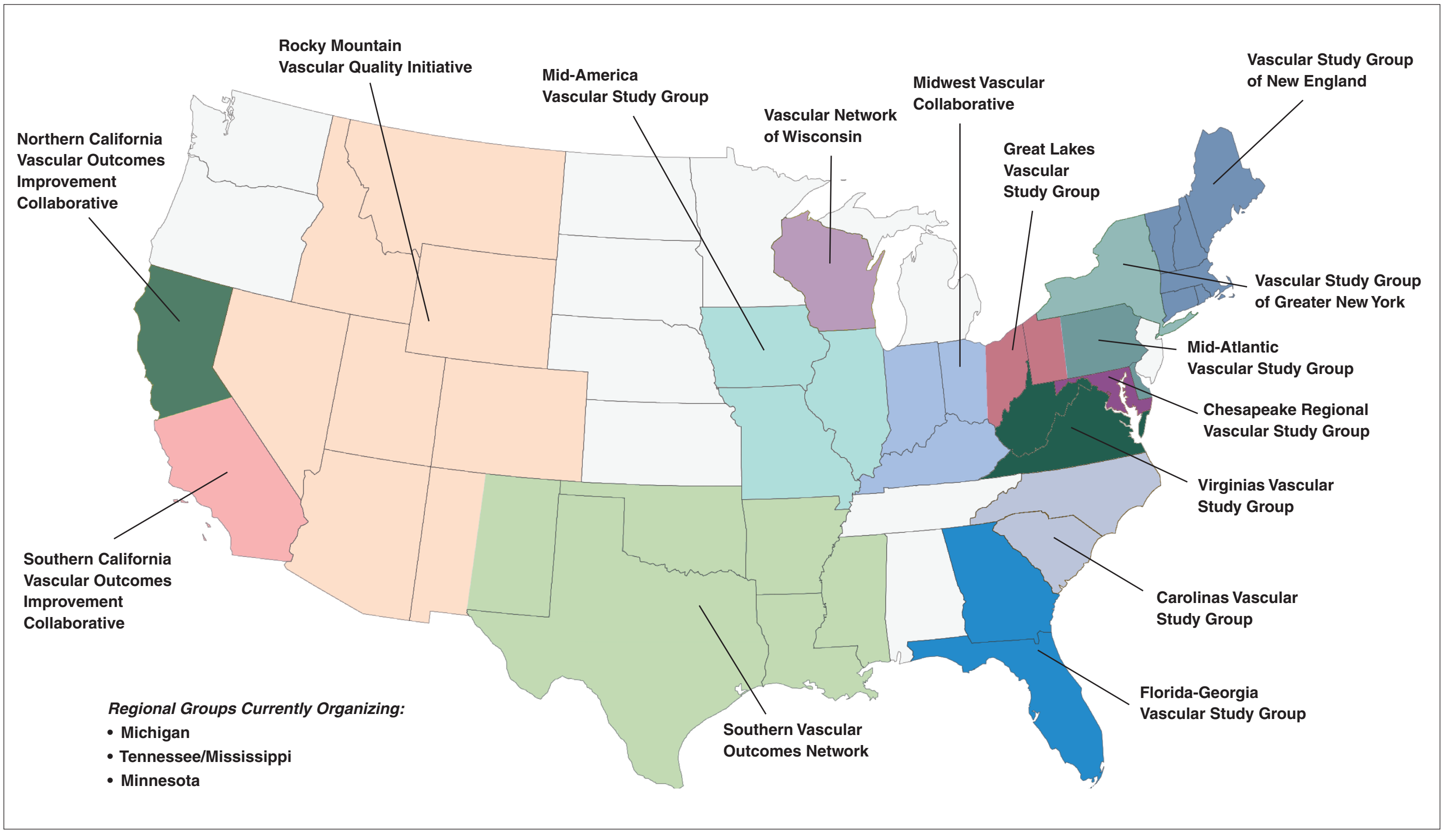
The Society for Vascular Surgery: www.vascularweb.org/vascularhealth/Pages/diabetic-vascular-disease.aspx

The American Diabetes Organization: www.diabetes.org/living-with-diabetes/complications/foot-complications/

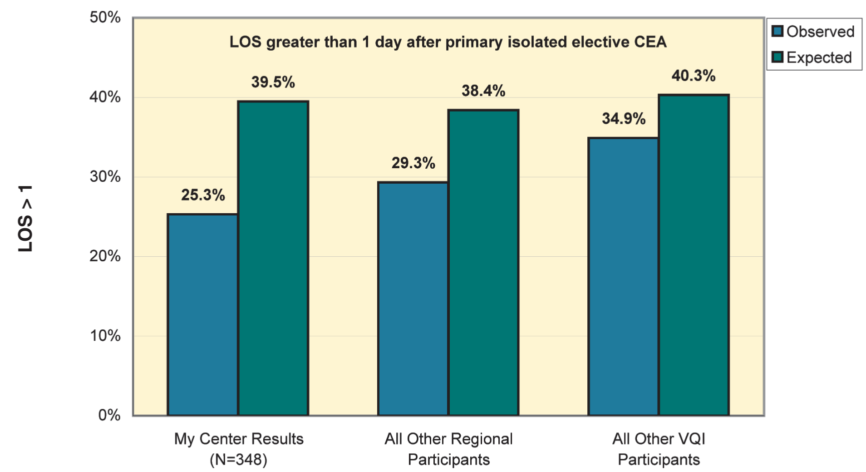
The Diabetic Foot Blog, from the Southern Arizona Limb Salvage Alliance (SALSA): diabeticfootonline.blogspot.com/

The Society for Vascular Surgery's Vascular Quality Initiative (VQI)

Determining the outcomes of treatments is complex when the illnesses are as broad and complex as diabetes and PAD. Few resources exist to provide the most current information to patients. To address this gap, in 2002, vascular surgeons in New England began a regional vascular quality improvement initiative called the Vascular Study Group of New England, modeled after similar regional quality improvement initiatives started by the Northern New England Cardiovascular Study Group. This regional effort in New England has expanded to become the National Vascular Quality Initiative (www.vascularqualityinitiative.org), or VQI. The VQI records outcomes across the country for hundreds of thousands of patients with vascular disease. While many questions still remain, these efforts have made important contributions toward a better understanding of vascular care. Early efforts have seen the VQI achieve success in limiting length of stay after vascular operations and helping to standardize approaches to post-operative care after surgery.



Map 3.4. The Society for Vascular Surgery's fifteen regional quality groups participating in Vascular Quality Initiative (VQI)



Adjusted for: Age, gender, race, hypertension, diabetes, pre-op beta blockers, CAD symptoms, prior CHF, COPD, stress test, prior PVI, pre-op ASA / pre-op P2Y12 antagonist, ipsilateral cortical symptoms, contralateral cortical symptoms, vertebrobasilar symptoms, previous radiation, pre-op MRA

Figure 3.7. Example of a VQI benchmarking graph

The VQI benchmarking graph allows a center to compare its results to other participants across several criteria, including pre-operative risk factors, intra-procedural variables, post-procedural outcomes, and one-year follow-up data.

During surgery

Cross sectional rates of competing treatments

For patients with diabetes and PAD, preventive measures are underused, especially for black patients, and their use varies nationwide. Similarly, the use of revascularization treatments also varies dramatically for patients with diabetes and PAD. An examination of cohorts of patients at high risk for limb loss—patients with diabetes, PAD, and severe wounds on their feet requiring hospitalization—revealed that, in some regions of the United States, invasive vascular care was rarely provided, while in other regions, vascular interventions, including interventional procedures and surgical bypass operations, were common.[10,11] The use of these procedures also varied markedly by patient race. Further, while the rates of revascularization were higher among black patients in many regions, the extent of variation for both endovascular procedures and open bypass surgery was much more dramatic among black patients, indicative of a poorer understanding of what works best to limit amputation risk for these high-risk patients.

The average rate of therapeutic endovascular interventions for Medicare patients with diabetes and PAD in the United States during the period from 2007 to 2011 was 14.1 per 1,000 beneficiaries. The rate varied more than sixfold across hospital referral regions, from fewer than 6 procedures per 1,000 patients in Columbus, Georgia (4.8), Boulder, Colorado (5.4), and Honolulu (5.5) to more than 30 in Petoskey, Michigan (33.5) and Munster, Indiana (32.0) (Map 3.5). The national average rate among black patients (19.7) was nearly 50% higher than the rate among non-black patients (13.3). Rates among black patients also varied dramatically, from fewer than 5 procedures per 1,000 in Columbus, Georgia (4.8) to more than 40 in Lafayette, Louisiana (42.9), Amarillo, Texas (41.7), and Hattiesburg, Mississippi (41.7). Among non-black patients, the rate varied less—but still more than fivefold—from fewer than 6 per 1,000 in Columbus (5.6) and Rochester, New York (5.9) to more than 30 in Munster (33.0) (Figure 3.8).

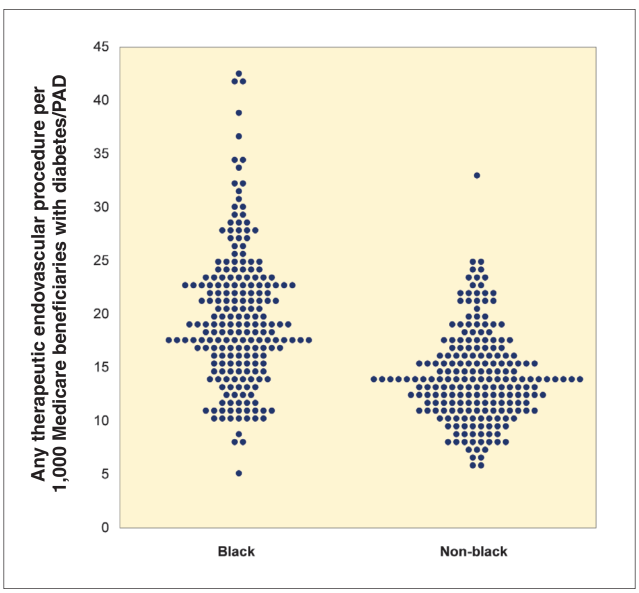
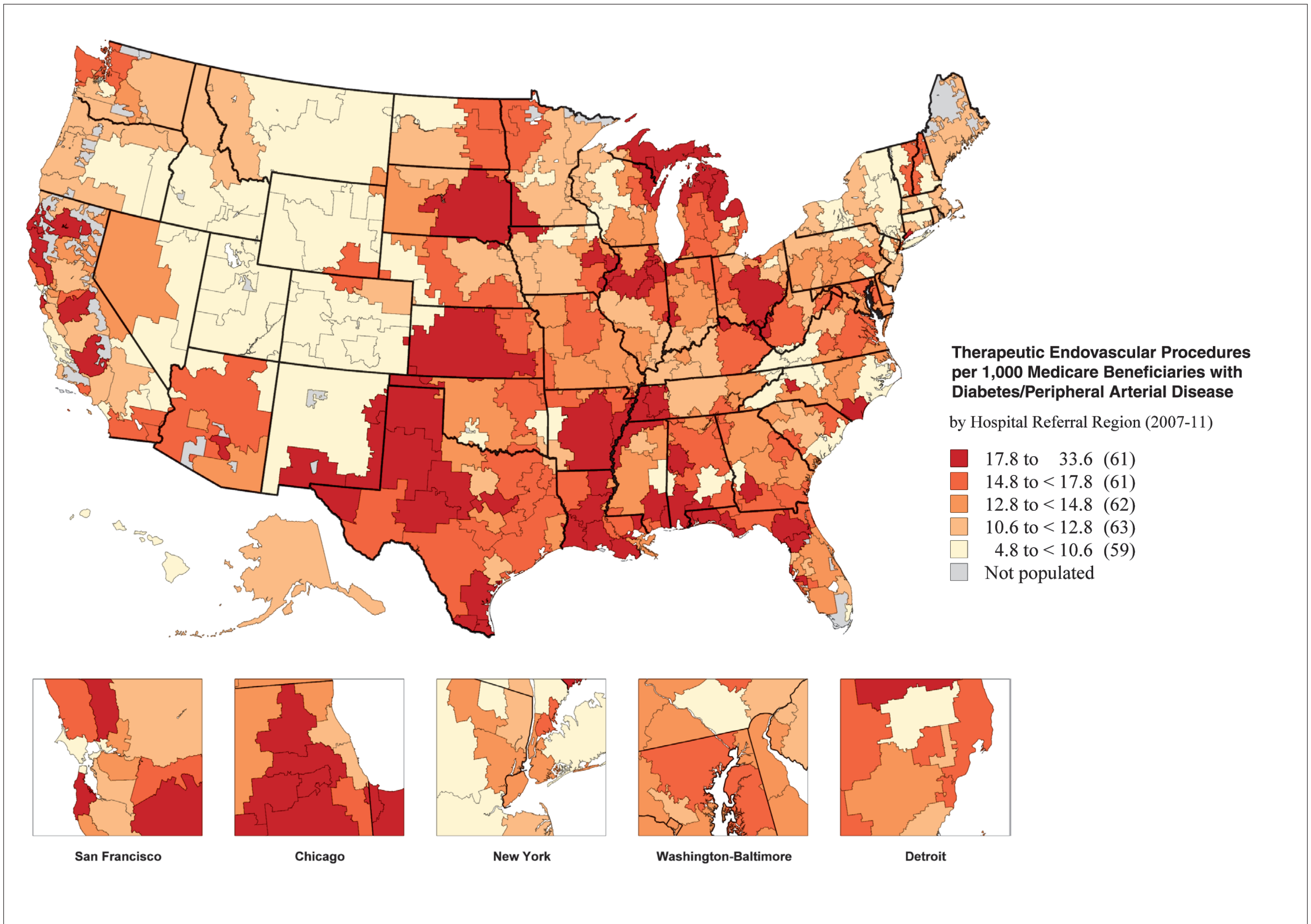


Figure 3.8. Therapeutic endovascular interventions per 1,000 Medicare beneficiaries with diabetes and PAD by race among hospital referral regions (2007-11)

Each blue dot represents the rate of therapeutic endovascular procedures among patients with diabetes and PAD in one of 306 hospital referral regions in the U.S. Rates are adjusted for age and sex.



Map 3.5. Therapeutic endovascular interventions per 1,000 Medicare beneficiaries with diabetes and PAD (2007-11)

Rates are adjusted for age, sex, and race.

During 2007-11, the average rate of open leg bypass surgery was 4.1 per 1,000 Medicare beneficiaries with diabetes and PAD. This rate varied from fewer than 2 to more than 9 procedures per 1,000 among hospital referral regions. Open leg procedures occurred relatively infrequently in the Ogden, Utah (1.4), Houma, Louisiana (1.5), and Provo, Utah (1.6) hospital referral regions. These procedures were much more common in the Medford, Oregon (9.4), Corpus Christi, Texas (8.6), and Wausau, Wisconsin (8.2) regions (Map 3.6). Rates of open leg bypass were about 30% higher among black patients than other patients (5.2 versus 4.0 procedures per 1,000). Among black patients, the rate varied from fewer than 3 procedures per 1,000 in several regions—including Winston-Salem, North Carolina (2.1), Tupelo, Mississippi (2.5), Jackson, Tennessee (2.6), and Lexington, Kentucky (2.7)—to more than 10 per 1,000 in Mobile, Alabama (13.5), Portland, Oregon (11.2), Corpus Christi (10.4), and Bridgeport, Connecticut (10.4). There was less variation among non-black patients, but the rate still varied more than fourfold, from 1.8 procedures per 1,000 in Meridian, Mississippi to 8.3 per 1,000 in Corpus Christi (Figure 3.9).

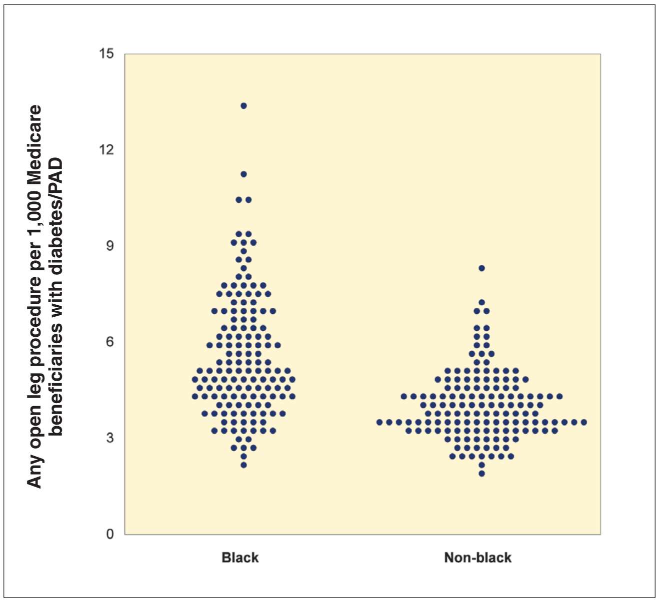
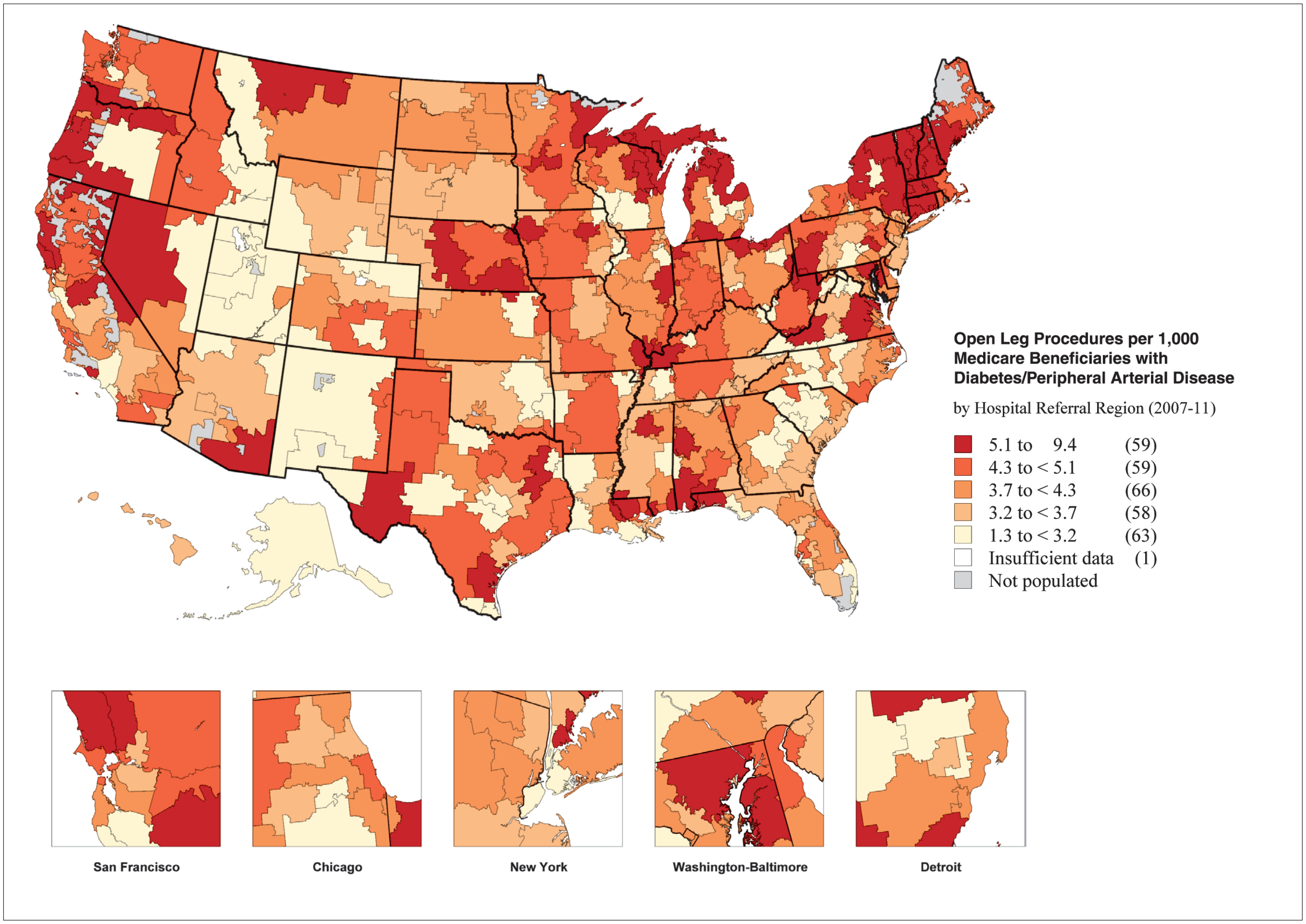


Figure 3.9. Open leg procedures per 1,000 Medicare beneficiaries with diabetes and PAD by race among hospital referral regions (2007-11)

Each blue dot represents the rate of open leg procedures among patients with diabetes and PAD in one of 306 hospital referral regions in the U.S. Rates are adjusted for age and sex.



Map 3.6. Open leg procedures per 1,000 Medicare beneficiaries with diabetes and PAD (2007-11)

Rates are adjusted for age, sex, and race.

Risk factors associated with poor outcomes after surgical revascularization

Within the Vascular Quality Initiative, vascular surgeons have worked to improve the information available to physicians and patients about outcomes, as well as the processes of care that occur during surgery. For example, for patients faced with lower extremity bypass surgery, the risks of amputation or death may seem hard to quantify. Recent research in the Vascular Quality Initiative has identified specific patient characteristics, such as lack of an available conduit to construct a new artery, that are important determinants of success. But the relationships are exceedingly complex, and many clinical factors interact with other factors such as race to determine outcomes. Research to identify the benefits and risks of revascularization is complicated but promising.

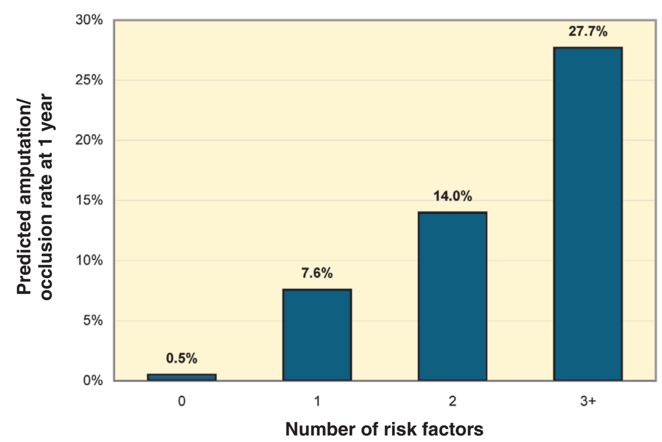


Figure 3.10. Risk factors associated with poor outcomes after surgical revascularization

After surgery

Readmission or re-intervention following treatment for peripheral arterial disease

Hospital readmission is a common complication among patients with complex illnesses, and patients undergoing vascular procedures have among the highest rates of hospital readmission within 30 days of discharge. The national rate of readmission following revascularization procedures was 17.9% during 2007-11. In some regions, such as Sioux City, Iowa, hospital readmission after revascularization was common, happening to nearly one out of three patients who underwent a revascularization procedure. In other regions, such as Redding, California, readmission was much less common; about one in ten patients who underwent a revascularization procedure were readmitted within 30 days.

Table 3.1. Thirty-day readmission rates after any revascularization procedure among patients with diabetes and PAD (2007-11)

HRR	State	Percent of patients with diabetes/PAD readmitted within 30 days following any procedure (2007-11)
10 highest HRRs		
Sioux City	IA	30.7%
Sioux Falls	SD	29.4%
Paducah	KY	28.8%
Roanoke	VA	27.6%
Neenah	WI	27.3%
Johnson City	TN	26.3%
Worcester	MA	25.9%
St. Cloud	MN	25.8%
Montgomery	AL	25.4%
Appleton	WI	24.9%
10 lowest HRRs		
Fort Collins	CO	12.6%
Owensboro	KY	12.3%
Winchester	VA	12.3%
Kettering	OH	12.1%
Tupelo	MS	12.1%
Ogden	UT	11.8%
St. Joseph	MI	11.5%
Ocala	FL	10.9%
Rapid City	SD	10.5%
Redding	CA	10.4%

Quality and results: outcomes that matter to patients

The most important outcomes after revascularization procedures to patients with peripheral arterial disease and diabetes are simple and clear. "Have I had to suffer amputation? Can I live independently? Can I walk?" These are the questions that are central to patients' health goals. Procedure rates and the amount of preventive care received by patients are important to measure, for physicians and policymakers alike. However, what matters most to patients is to keep their legs and to walk. The ability to walk—even if it is only for short distances, such as from the bed to the restroom or the bed to the kitchen table to eat—is vital for independent living. Therefore, a key outcome of surgery to improve blood supply to the limbs of diabetic patients is ambulatory status. A patient who retains the ability to walk when faced with foot wounds, diabetes, and peripheral arterial disease is a success story.[20,21]

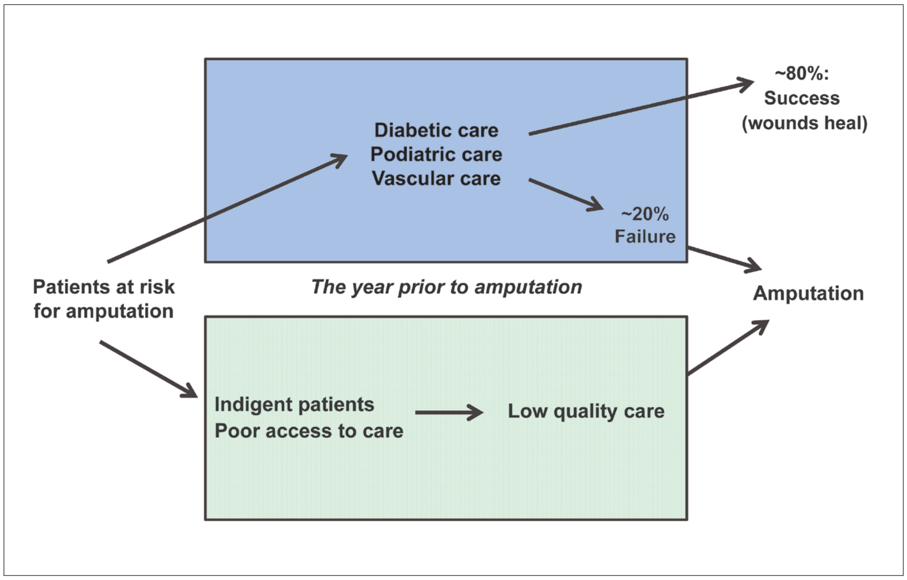


Figure 3.11. Conceptual model for amputation as a quality measure

Vascular care in the year prior to amputation can provide insight about the overall quality of vascular care.

The ability to walk, however, cannot be measured easily using Medicare billing data. For this reason, members of the Vascular Quality Initiative studied how common it was for patients faced with limb-threatening situations to be able to continue walking. The study found that, if they survived the challenges associated with their diabetes and PAD, most patients retained their ability to walk and live independently within the first year after lower extremity revascularization.[22] However, the analysis also found that patients who were unable to walk before surgery—such as those who were bedridden, often living in nursing homes—were almost always unable to walk after surgery. The importance of acting to provide revascularization while there is still a chance to keep the person walking was an important lesson for both surgeons and patients. In combination with preventive measures, the treatment of these patients with revascularization offers an excellent likelihood of a good outcome; the patient has the chance to retain the ability to walk and live independently, as long as he or she begins the process in reasonably good health.

Even if patients with diabetes and PAD are treated with revascularization, they remain at risk for amputation. Sometimes the increased blood flow after revascularization is not sustained. Despite revascularization, preventive care, and other treatments, factors like continued smoking and poor medical compliance might lead patients to lose their legs. Unfortunately, because these risks remain, the failure of "limb salvage"—the goal of preventing the patient from losing their limb—among patients with diabetes and PAD is common.[23]

Long-term effects of treatment on patients with diabetes and peripheral arterial disease

Patients face complex treatment choices that involve the likelihood that they will survive after revascularization with an intact limb, as well as whether or not they are likely to need repeated interventions if their revascularization treatment does not prove durable. Because many of these events may happen at a distant time in the future, it can often be difficult for patients to understand the chances of these events occurring. A better understanding of these risks will help patients and surgeons make the best treatment choices—both before surgery (e.g., whether to have a blood vessel operation at all) and after surgery (e.g., whether to undergo revisions, repairs, and surveillance of existing bypass operations).

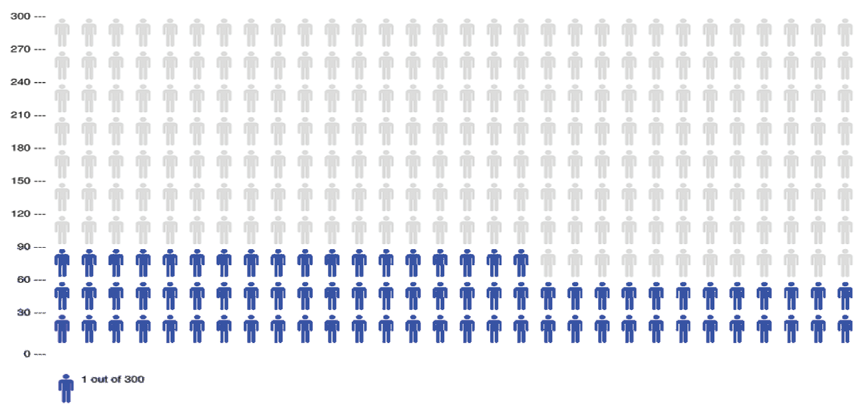


Figure 3.12A. Risk of amputation or death

78 out of 300 (26%).

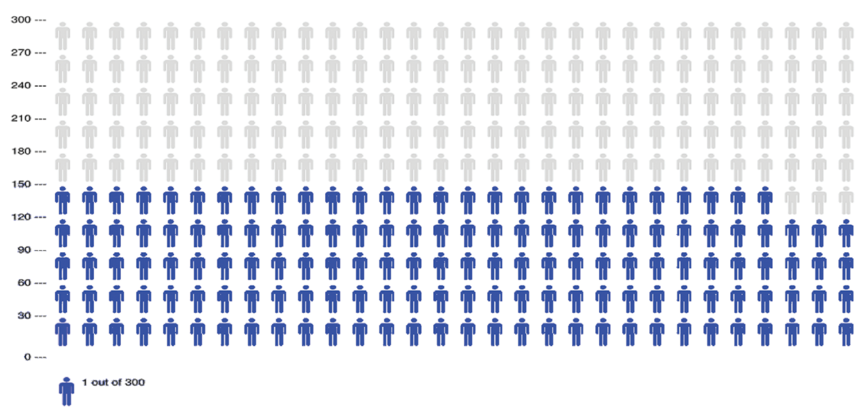


Figure 3.12B. Risk of re-intervention or death

147 out of 300 (49%).

Figure 3.12. Risks of complications two years following a vascular procedure

Figures 3.13A and 3.13B show the likelihood of amputation within the first two years after revascularization. These figures provide an illustration of the long-term effectiveness of revascularization procedures—both open surgical bypass, as well as endovascular interventions—in helping patients avoid amputation. Four out of five patients will still be alive and avoid amputation two years after their initial treatment for wounds that threaten them with limb loss. The results are worse for black patients when compared to non-black patients. Table 3.2 lists the hospital referral regions with the 10 highest and 10 lowest rates of amputation-free survival following revascularization for both black and non-black patients.

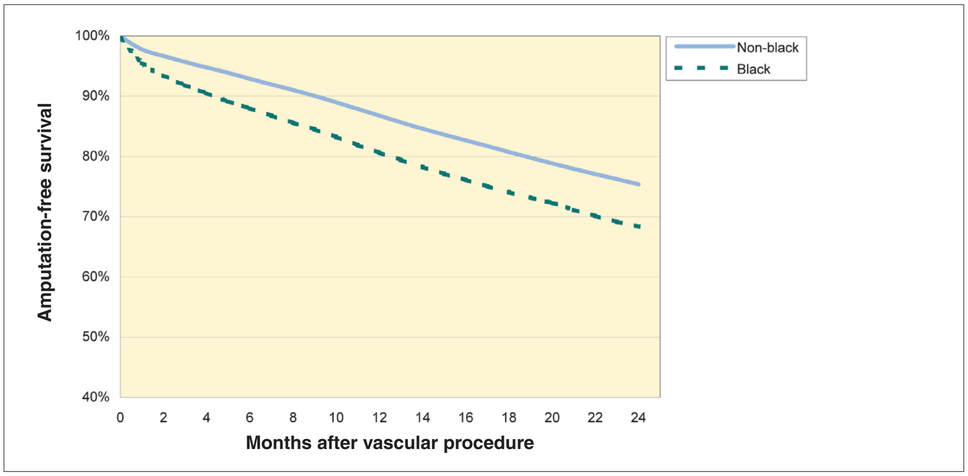


Figure 3.13A. Amputation-free survival after any vascular procedure among black and non-black patients with diabetes and PAD (2007-11)

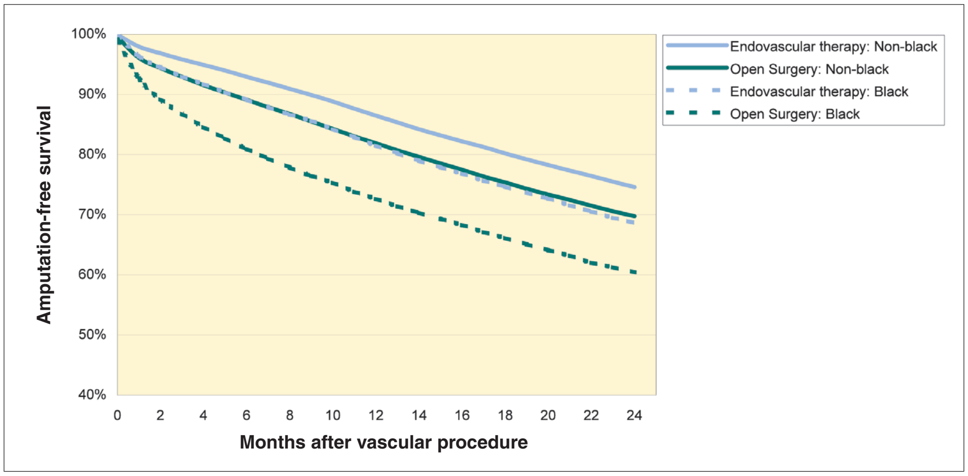


Figure 3.13B. Amputation-free survival after endovascular therapeutic or open surgery procedures among black and non-black patients with diabetes and PAD (2007-11)

Table 3.2. Amputation-free survival after any vascular procedure among black and non-black patients with diabetes and PAD (2007-11)

Black patients			Non-black patients		
10 highest HRRs			10 highest HRRs		
Gary	IN	76.2%	Yakima	WA	83.4%
Boston	MA	73.7%	Owensboro	KY	83.2%
Washington	DC	73.6%	Sarasota	FL	82.9%
Wilmington	NC	73.4%	Ocala	FL	82.8%
Detroit	MI	72.4%	St. Joseph	MI	82.6%
Beaumont	TX	71.9%	Davenport	IA	82.6%
Birmingham	AL	71.8%	Tupelo	MS	82.0%
Pensacola	FL	71.6%	Texarkana	AR	81.9%
Wilmington	DE	71.1%	Traverse City	MI	81.9%
Little Rock	AR	70.7%	Wichita Falls	TX	81.9%
10 lowest HRRs			10 lowest HRRs		
Philadelphia	PA	64.4%	Ridgewood	NJ	68.2%
Louisville	KY	63.6%	Lynchburg	VA	68.1%
Manhattan	NY	63.6%	Honolulu	HI	67.9%
St. Louis	MO	63.1%	Akron	OH	67.8%
Charleston	SC	62.2%	Roanoke	VA	67.7%
Arlington	VA	62.2%	Canton	OH	67.5%
Dallas	TX	61.0%	Olympia	WA	67.2%
Jackson	MS	60.6%	Bronx	NY	67.0%
Macon	GA	60.5%	Salinas	CA	66.7%
Savannah	GA	53.7%	Appleton	WI	64.9%

Once patients undergo revascularization, there is a risk that improved blood flow will not continue. Patients may need a second procedure to reestablish adequate blood flow to the legs, called a "re-intervention." Figures 3.14A and 3.14B demonstrate that this is a fairly common occurrence. The likelihood of this complication occurring is higher among black patients than others.

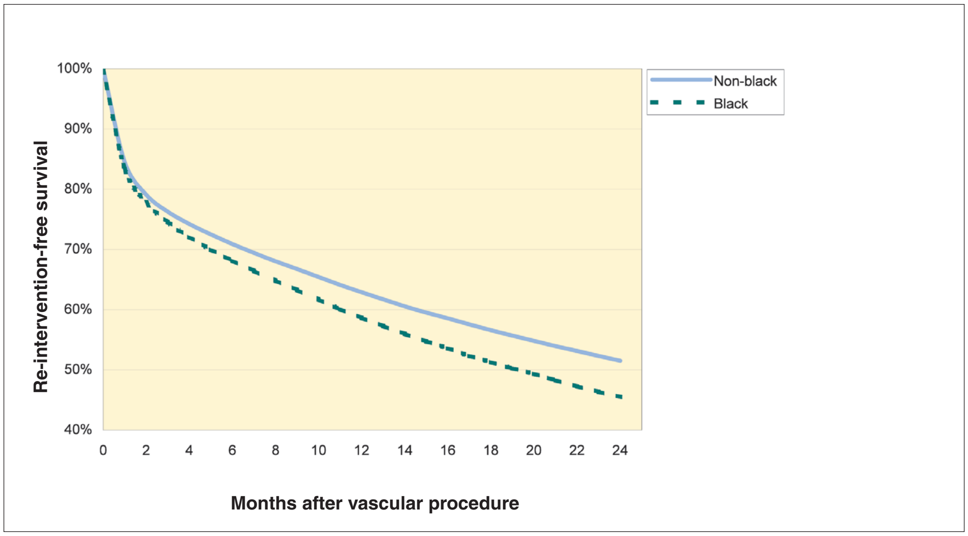


Figure 3.14A. Re-intervention-free survival after any vascular procedure among black and non-black patients with diabetes and PAD (2007-11)

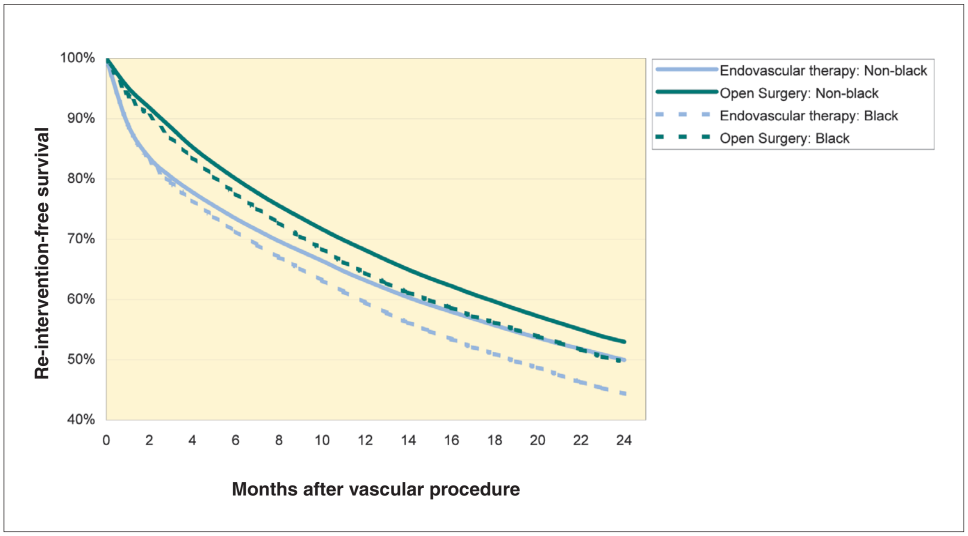


Figure 3.14B. Re-intervention-free survival after endovascular therapeutic or open surgery procedures among black and non-black patients with diabetes and PAD (2007-11)

Table 3.3. Re-intervention-free survival after any vascular procedure among black and non-black patients with diabetes and PAD (2007-11)

Black patients			Non-black patients		
10 highest HRRs			10 highest HRRs		
Florence	SC	55.0%	Owensboro	KY	68.5%
Orlando	FL	53.1%	Kingsport	TN	65.2%
Charlotte	NC	52.8%	Texarkana	AR	65.0%
Charleston	SC	52.5%	Santa Cruz	CA	65.0%
Columbia	SC	52.1%	Tupelo	MS	62.4%
Wilmington	NC	51.6%	Billings	MT	61.3%
Milwaukee	WI	51.2%	Abilene	TX	61.3%
Boston	MA	51.2%	Yakima	WA	61.2%
Birmingham	AL	51.0%	Wichita Falls	TX	60.5%
Greenville	NC	50.2%	Winston-Salem	NC	60.4%
10 lowest HRRs			10 lowest HRRs		
Cleveland	OH	40.3%	Corpus Christi	TX	43.6%
Lafayette	LA	40.0%	Sioux City	IA	43.0%
Takoma Park	MD	39.7%	Muskegon	MI	42.8%
Baton Rouge	LA	39.7%	Olympia	WA	42.1%
Dallas	TX	39.1%	El Paso	TX	41.0%
East Long Island	NY	38.3%	Bronx	NY	41.0%
Augusta	GA	38.1%	Appleton	WI	40.7%
Indianapolis	IN	36.0%	Terre Haute	IN	40.5%
Bronx	NY	36.0%	Munster	IN	40.1%
Manhattan	NY	34.8%	Medford	OR	37.9%

Beyond surgery

How variation in treatments for diabetes and PAD reflects opportunities for improvement

This report reveals significant variation in the approaches to the treatment of diabetes and PAD chosen by patients and physicians. These differences are striking, not only for preventive treatments, but also in the use of invasive treatments designed to limit the devastating effects of these diseases. Depending on a variety of influential factors—race, the part of the country in which they live, as well as the choices made by the physicians caring for them—patients may or may not receive important preventive care.

The findings of this report suggest that there are areas of "low-hanging fruit" that reflect opportunities for improvement, especially in poorer regions of the United States and among black patients, where increases in the use of preventive care and vascular treatments are likely to have an immediate impact. Further, while most of these procedures are effective when utilized for patients whom they are likely to help, more work is necessary to identify precisely which patients are most likely to benefit from invasive and non-invasive strategies. Finally, improving prevention, focusing on variation in procedure rates, and limiting the need for re-intervention are three areas where improving the care of patients with diabetes and vascular disease can make a real difference in the lives of these high-risk patients.

These efforts are needed most, and will have the greatest impact, in the regions of the United States where the amputation risk is the highest. There are many regions where amputation is common, such as the rural southeastern states. In these regions, especially among black patients, the risk of amputation is several times higher than in nearly all other regions of the country. This report suggests that, while a comprehensive approach is necessary, focusing on black patients in poor, rural regions of the United States is likely to be the best place to start. This approach will have the most impact—and likely the greatest challenge towards implementation—as high limb loss rates have been a part of life for many years in rural portions of the southern United States.

An integrated, multifaceted approach will be the most effective tool in improving care and limiting amputation risk for high-risk patients. Primary care physicians must engage patients with preventive measures and educate them about risk factor modification. Surgeons and interventionalists should aim to limit invasive treatment to patients who have received proper medical management in order to achieve the best possible outcomes. Finally, continued attention to the measurement and improvement of the quality of vascular care, especially to measuring patient-centered outcomes that demonstrate the long-term value of vascular care, will be a major focus for regional registries, physicians, and payers in the years to come.

Chapter 3 Table A. Rates of preventive services among patients with diabetes (2010), leg amputation, and revascularization procedures among patients with diabetes and PAD (2007-11), overall and by race, among hospital referral regions

HRR Name	State	Number of Medicare beneficiaries with diabetes and PAD			Leg amputation per 1,000 Medicare beneficiaries with diabetes and PAD			Therapeutic endovascular interventions per 1,000 Medicare beneficiaries with diabetes and PAD		
		Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
Birmingham	AL	141,039	26,044	114,995	2.7	5.9	2.3	16.2	22.7	15.3
Dothan	AL	30,100	5,886	24,214	3.1	8.6	2.2	15.9	24.4	14.6
Huntsville	AL	41,051	5,222	35,829	2.9	7.5	2.3	14.7	18.6	14.2
Mobile	AL	43,842	9,806	34,036	3.4	8.8	2.6	21.4	27.2	21.0
Montgomery	AL	25,361	8,657	16,704	2.6	7.0	1.7	8.6	13.3	7.5
Tuscaloosa	AL	16,920	5,267	11,653	3.9	9.8	2.9	22.1	23.7	24.1
Anchorage	AK	18,541	734	17,807	2.3			11.5		
Mesa	AZ	39,750	1,266	38,484	1.5			18.3	22.4	17.5
Phoenix	AZ	111,852	3,393	108,459	2.0	3.3	1.7	17.0	29.3	15.9
Sun City	AZ	24,450	575	23,875	1.9			14.3		
Tucson	AZ	40,429	1,258	39,171	2.7			13.1	14.5	12.5
Fort Smith	AR	21,493	505	20,988	4.9			9.9		
Jonesboro	AR	14,541	306	14,235	2.9			15.3		
Little Rock	AR	90,541	13,395	77,146	3.5	8.7	2.7	19.8	28.1	18.7
Springdale	AR	21,498	95	21,403	3.0			15.2		
Texarkana	AR	17,819	3,168	14,651	3.9	11.6	2.7	11.6	13.9	11.5
Orange County	CA	107,926	1,732	106,194	1.4			7.5	14.6	7.1
Bakersfield	CA	44,038	1,537	42,501	3.1			20.4	30.0	19.3
Chico	CA	21,337	304	21,033	1.6			13.9		
Contra Costa County	CA	25,035	1,937	23,098	1.9			14.2	19.4	13.5
Fresno	CA	51,920	2,829	49,091	2.5	6.3	2.0	12.1	15.2	11.6
Los Angeles	CA	381,344	37,056	344,288	1.7	4.5	1.3	10.8	21.0	9.6
Modesto	CA	39,114	1,489	37,625	2.0			20.2	20.3	19.5
Napa	CA	11,797	187	11,610	2.1			24.1		
Alameda County	CA	38,909	6,491	32,418	2.3	6.1	1.7	11.7	10.6	12.2
Palm Spa/Rancho Mirage	CA	16,976	400	16,576	2.5			10.6		
Redding	CA	20,728	163	20,565	1.3			20.9		
Sacramento	CA	81,816	4,875	76,941	1.8	4.7	1.5	11.0	16.1	10.4
Salinas	CA	22,073	1,206	20,867	3.8			10.2	15.5	9.6
San Bernardino	CA	68,378	6,989	61,389	1.9	3.0	1.7	11.1	12.1	10.9
San Diego	CA	113,518	5,648	107,870	2.0	2.1	1.8	16.3	23.1	15.4
San Francisco	CA	42,399	5,070	37,329	2.2	5.9	1.7	8.8	11.0	8.5
San Jose	CA	53,107	1,186	51,921	1.8			11.7	15.2	11.1
San Luis Obispo	CA	12,532	113	12,419	1.4			7.4		
San Mateo County	CA	19,700	895	18,805	2.1			18.9	22.1	18.1
Santa Barbara	CA	19,362	626	18,736	2.6			10.6		
Santa Cruz	CA	10,270	125	10,145	3.4			14.0		
Santa Rosa	CA	13,687	194	13,493	2.9			15.2		
Stockton	CA	20,751	1,862	18,889	1.5			17.0	22.5	16.3
Ventura	CA	35,102	880	34,222	1.9			16.5	18.7	15.7
Boulder	CO	5,764	56	5,708	2.7			5.4		
Colorado Springs	CO	28,373	1,541	26,832	2.5			8.2	11.6	7.7

Procedure rates are adjusted for age, sex, and race. Race-specific rates are adjusted for age and sex. Rates of preventive services are unadjusted. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Open leg bypass procedures per 1,000 Medicare beneficiaries with diabetes and PAD			Percent of diabetic Medicare beneficiaries (age 65-75) receiving blood lipids testing			Percent of diabetic Medicare beneficiaries (age 65-75) receiving hemoglobin A1c testing		
Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
4.3	6.3	3.9	80.2	74.9	81.5	83.8	81.5	84.4
3.4	3.6	3.4	79.7	76.6	80.5	84.4	84.4	84.5
3.3	3.6	3.3	79.9	72.8	81.2	85.1	80.2	86.0
7.7	13.5	6.3	76.1	71.0	77.7	80.3	79.5	80.6
4.7	6.3	4.3	78.0	73.8	80.3	82.8	81.6	83.5
5.8	6.8	5.9	82.9	80.9	83.9	84.3	84.8	84.0
2.8			66.0	58.7	66.3	69.8	64.6	70.0
3.9			82.4	79.7	82.5	83.1	83.5	83.1
3.5	4.6	3.4	73.9	78.8	73.8	76.3	78.7	76.2
3.3			82.9	82.2	83.0	84.4	86.1	84.4
5.1			75.5	61.4	76.1	78.7	68.7	79.1
3.2			67.5	61.2	67.6	75.4	82.8	75.2
3.1			76.7	64.3	77.0	83.9	79.8	84.0
4.5	6.9	4.1	75.6	68.7	76.8	82.5	81.4	82.7
3.4			75.7			80.8	81.3	80.8
4.9	5.9	4.7	78.1	72.9	79.2	81.9	81.6	81.9
2.5			84.9	76.1	85.0	82.8	78.7	82.9
4.0	7.5	3.8	80.2	76.9	80.3	79.0	73.9	79.2
5.0			78.3	71.4	78.4	77.9	78.6	77.9
3.5			77.8	66.3	79.0	79.6	67.6	80.9
3.5	4.6	3.4	78.9	76.1	79.0	81.3	76.6	81.6
2.9	5.4	2.7	80.3	72.1	81.2	79.0	71.8	79.8
5.2	7.7	5.0	79.5	74.9	79.6	82.6	83.8	82.5
5.5			77.8	86.8	77.6	81.9	86.8	81.8
3.9	8.1	3.2	77.8	66.8	80.3	78.0	70.0	79.7
4.0			82.4	68.2	82.8	79.6	71.6	79.8
4.6			78.1	76.5	78.1	82.7	88.2	82.7
4.4	6.7	4.2	79.6	73.0	80.0	81.0	76.3	81.3
4.2			83.8	72.9	84.3	82.3	74.9	82.7
3.3	3.6	3.3	78.3	74.6	78.7	76.9	73.8	77.2
4.5	6.8	4.3	81.0	72.7	81.5	82.3	75.5	82.7
4.4	7.6	3.9	75.7	64.2	77.5	79.9	74.1	80.8
3.0			75.6	64.6	75.9	85.3	85.0	85.3
4.7			82.1	88.5	82.0	85.4	84.6	85.4
4.3			82.1	75.7	82.4	83.7	82.9	83.8
3.8			83.4	80.6	83.5	86.7	84.3	86.7
2.4			80.7	84.4	80.6	82.9	87.5	82.8
5.3			77.4	65.0	77.6	80.0	75.0	80.1
4.6			81.9	78.4	82.2	82.0	79.7	82.2
5.2			79.8	71.1	80.1	82.4	77.4	82.6
			80.6	81.3	80.6	83.7	81.3	83.7
4.3			70.7	59.2	71.4	77.0	68.2	77.6

Chapter 3 Table A. Rates of preventive services among patients with diabetes (2010), leg amputation, and revascularization procedures among patients with diabetes and PAD (2007-11), overall and by race, among hospital referral regions

HRR Name	State	Number of Medicare beneficiaries with diabetes and PAD			Leg amputation per 1,000 Medicare beneficiaries with diabetes and PAD			Therapeutic endovascular interventions per 1,000 Medicare beneficiaries with diabetes and PAD		
		Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
Denver	CO	55,321	3,507	51,814	2.5	4.7	2.1	9.7	14.5	9.1
Fort Collins	CO	10,859	126	10,733	1.3			15.4		
Grand Junction	CO	7,540	12	7,528	2.9			8.4		
Greeley	CO	13,204	27	13,177	3.2			11.6		
Pueblo	CO	9,354	157	9,197	2.0			7.0		
Bridgeport	CT	33,657	4,616	29,041	2.3	6.8	1.6	18.5	31.5	16.6
Hartford	CT	90,626	6,631	83,995	2.7	6.1	2.3	8.6	11.3	8.2
New Haven	CT	92,616	6,846	85,770	2.8	6.9	2.3	11.8	18.5	11.0
Wilmington	DE	59,663	11,786	47,877	2.5	5.3	2.1	13.2	15.8	13.2
Washington	DC	150,419	53,229	97,190	2.2	4.6	2.1	14.0	21.2	12.4
Bradenton	FL	25,024	1,147	23,877	1.3			26.5	36.6	25.1
Clearwater	FL	34,540	1,000	33,540	2.3			18.6	23.2	17.7
Fort Lauderdale	FL	180,908	13,822	167,086	1.4	5.1	1.1	11.7	20.3	10.7
Fort Myers	FL	103,603	4,310	99,293	1.7	5.0	1.4	14.1	16.7	13.5
Gainesville	FL	40,436	6,263	34,173	2.3	7.4	1.5	18.7	22.3	18.5
Hudson	FL	40,030	935	39,095	1.8			12.8		
Jacksonville	FL	104,844	19,630	85,214	1.7	4.7	1.3	16.3	22.5	15.5
Lakeland	FL	24,661	2,152	22,509	1.3			12.6	14.1	12.3
Miami	FL	160,910	15,710	145,200	1.8	4.4	1.4	9.0	16.7	8.1
Ocala	FL	71,290	3,442	67,848	1.5	3.7	1.2	24.0	22.3	23.2
Orlando	FL	256,687	23,878	232,809	2.3	6.4	1.8	14.7	17.6	14.3
Ormond Beach	FL	33,451	2,930	30,521	1.7	3.6	1.5	14.6	17.7	14.1
Panama City	FL	16,549	1,846	14,703	2.7	6.0	2.3	20.0	19.1	20.0
Pensacola	FL	61,571	7,681	53,890	1.8	5.6	1.3	18.5	24.3	17.8
Sarasota	FL	45,670	1,674	43,996	1.2			16.3	25.2	15.4
St. Petersburg	FL	24,875	2,561	22,314	2.9	9.0	2.1	15.1	19.4	14.5
Tallahassee	FL	42,556	11,349	31,207	2.4	6.0	1.9	15.0	23.2	13.5
Tampa	FL	61,247	6,166	55,081	1.6	2.9	1.4	13.9	18.8	13.2
Albany	GA	12,395	4,446	7,949	3.3	7.2	3.0	19.1	34.2	14.1
Atlanta	GA	244,088	49,793	194,295	2.3	6.3	1.7	13.4	18.2	12.8
Augusta	GA	38,957	11,531	27,426	2.2	6.1	1.4	15.2	23.4	13.6
Columbus	GA	24,733	8,585	16,148	2.0	3.9	2.1	4.8	4.8	5.6
Macon	GA	50,418	14,386	36,032	2.6	6.6	2.0	13.8	22.5	11.8
Rome	GA	19,441	1,433	18,008	3.8	11.2	2.9	15.1	18.9	14.4
Savannah	GA	48,196	13,107	35,089	3.0	7.9	2.1	14.8	21.8	13.6
Honolulu	HI	53,722	354	53,368	2.8			5.5		
Boise	ID	24,945	88	24,857	2.5			8.6		
Idaho Falls	ID	9,314						8.1		
Aurora	IL	11,776	953	10,823	2.0			21.3	27.2	20.4
Blue Island	IL	62,029	15,946	46,083	1.5	2.6	1.5	15.4	17.9	15.8
Chicago	IL	128,243	57,095	71,148	1.7	3.4	2.0	11.9	14.1	13.4
Elgin	IL	36,097	677	35,420	2.4			18.9	32.4	17.8

Procedure rates are adjusted for age, sex, and race. Race-specific rates are adjusted for age and sex. Rates of preventive services are unadjusted. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Open leg bypass procedures per 1,000 Medicare beneficiaries with diabetes and PAD			Percent of diabetic Medicare beneficiaries (age 65-75) receiving blood lipids testing			Percent of diabetic Medicare beneficiaries (age 65-75) receiving hemoglobin A1c testing		
Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
3.3	4.6	3.2	76.5	68.1	77.1	81.8	75.4	82.3
3.2			75.4	63.0	75.5	82.3	81.5	82.4
4.3			71.2			85.4		
3.1			74.1			83.7		
2.6			74.2	75.7	74.1	83.4	86.5	83.3
7.0	10.4	6.5	81.8	73.8	83.7	81.4	78.2	82.2
5.9	7.7	5.6	84.0	77.7	84.7	86.9	84.8	87.1
5.2	5.9	5.1	82.3	71.7	83.5	84.6	80.7	85.0
5.1	5.7	5.1	82.1	76.9	83.7	82.4	80.4	83.0
4.1	6.3	3.2	81.8	77.5	84.4	82.9	79.6	84.7
2.2			84.4	72.6	85.2	83.8	73.8	84.4
3.6			88.7	80.9	89.1	87.1	79.8	87.3
3.1	4.8	2.9	87.2	80.6	88.2	85.2	81.9	85.7
3.4	3.4	3.4	87.8	80.3	88.3	86.4	81.5	86.6
3.8	4.7	3.6	80.6	74.6	81.7	83.0	82.7	83.1
3.1			88.3	87.4	88.3	85.3	81.4	85.4
3.5	3.8	3.5	83.5	79.5	84.4	82.7	80.9	83.2
3.6			87.0	80.9	87.6	85.1	80.4	85.6
2.8	3.2	2.7	88.2	80.0	89.5	84.3	79.8	85.0
3.6			89.4	83.9	89.6	87.7	86.6	87.7
4.0	4.3	4.0	86.5	82.1	87.0	84.6	82.6	84.8
4.6	6.2	4.4	88.2	84.7	88.6	85.1	84.0	85.3
3.2			77.0	74.1	77.4	77.0	76.9	77.0
6.1	9.3	5.7	80.7	76.0	81.3	79.8	78.8	80.0
4.2			86.7	77.1	87.1	87.4	83.3	87.6
5.0	8.9	4.5	84.0	80.7	84.6	83.2	83.4	83.1
3.5	5.0	3.2	79.6	75.1	81.2	82.5	80.2	83.4
4.5	4.2	4.5	84.6	76.1	85.7	83.5	80.6	83.9
4.0	5.1	3.8	78.0	72.7	81.3	77.1	73.8	79.2
3.9	4.8	3.8	82.7	78.3	83.9	85.7	84.6	86.1
2.9	4.3	2.5	76.4	72.0	78.4	80.6	78.7	81.4
4.2	4.0	4.8	76.4	72.7	78.6	80.6	78.9	81.6
3.0	3.5	3.1	76.8	72.3	78.6	81.4	80.8	81.6
4.3			82.3	78.0	82.7	86.0	84.6	86.2
3.3	3.1	3.5	82.8	78.4	84.4	85.3	83.6	85.9
3.7			83.2	64.4	83.3	83.3	65.5	83.4
4.6			77.3	78.3	77.3	83.1	78.3	83.1
2.5			72.5			79.3		
3.2			85.7	79.2	86.4	87.9	88.3	87.8
3.8	3.2	4.2	80.3	76.6	82.0	81.6	80.1	82.3
4.7	5.2	5.1	76.7	73.1	79.9	76.6	73.0	79.7
3.4			83.1	82.0	83.1	85.3	80.4	85.4

Chapter 3 Table A. Rates of preventive services among patients with diabetes (2010), leg amputation, and revascularization procedures among patients with diabetes and PAD (2007-11), overall and by race, among hospital referral regions

HRR Name	State	Number of Medicare beneficiaries with diabetes and PAD			Leg amputation per 1,000 Medicare beneficiaries with diabetes and PAD			Therapeutic endovascular interventions per 1,000 Medicare beneficiaries with diabetes and PAD		
		Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
Evanston	IL	61,876	1,766	60,110	1.6			11.1	10.3	10.7
Hinsdale	IL	23,466	1,105	22,361	1.8			22.7	20.3	22.1
Joliet	IL	42,804	3,457	39,347	1.7			19.5	18.4	19.3
Melrose Park	IL	73,355	6,001	67,354	2.1	3.9	1.8	22.1	19.5	22.0
Peoria	IL	41,802	1,874	39,928	2.6	7.5	2.1	25.7	34.4	24.4
Rockford	IL	44,561	2,055	42,506	2.0			14.5	17.2	13.9
Springfield	IL	60,369	2,384	57,985	2.9	8.3	2.3	11.9	16.9	11.3
Urbana	IL	24,289	1,531	22,758	2.0			16.2	11.1	16.2
Bloomington	IL	9,216	246	8,970	1.4			19.9		
Evansville	IN	47,338	1,328	46,010	2.9			11.9	17.3	11.2
Fort Wayne	IN	41,984	1,696	40,288	2.0			15.0	29.6	13.8
Gary	IN	41,785	9,411	32,374	1.8	4.0	1.5	22.2	30.2	21.2
Indianapolis	IN	166,889	14,337	152,552	2.0	5.0	1.6	13.1	18.3	12.5
Lafayette	IN	11,938	114	11,824	3.5			13.1		
Muncie	IN	13,495	584	12,911	3.7			14.1		
Munster	IN	27,666	3,843	23,823	1.5	3.5	1.3	32.0	28.3	33.0
South Bend	IN	40,195	2,262	37,933	3.2	6.0	2.7	14.0	22.6	13.1
Terre Haute	IN	15,076	474	14,602	1.9			23.4		
Cedar Rapids	IA	15,996	235	15,761	2.4			21.2		
Davenport	IA	33,706	1,367	32,339	2.6			25.9	25.3	25.0
Des Moines	IA	60,623	1,098	59,525	2.4			12.7	10.8	12.2
Dubuque	IA	6,315			3.6			13.7		
Iowa City	IA	17,304	152	17,152	3.0			17.7		
Mason City	IA	11,158	18	11,140	2.3			9.6		
Sioux City	IA	14,812	81	14,731	1.4			12.0		
Waterloo	IA	14,568	678	13,890	2.1			14.6	19.1	13.9
Topeka	KS	26,160	1,464	24,696	2.9			16.8	27.1	15.7
Wichita	KS	76,209	2,905	73,304	2.1			24.1	28.9	23.0
Covington	KY	18,732	321	18,411	2.8			18.7		
Lexington	KY	95,377	4,192	91,185	2.5	4.3	2.1	15.9	15.9	15.4
Louisville	KY	107,798	9,824	97,974	3.0	7.3	2.4	12.8	18.6	12.0
Owensboro	KY	13,872	452	13,420	2.4			13.8		
Paducah	KY	32,872	1,650	31,222	3.6			11.0	12.7	10.6
Alexandria	LA	21,256	5,072	16,184	3.7	9.2	2.9	20.0	28.1	18.9
Baton Rouge	LA	39,637	14,603	25,034	3.0	7.3	2.3	17.6	23.2	17.5
Houma	LA	17,660	2,803	14,857	3.0	6.2	2.7	23.1	26.5	23.0
Lafayette	LA	44,911	13,328	31,583	2.6	6.7	1.8	26.2	42.9	22.3
Lake Charles	LA	17,044	3,541	13,503	2.1	4.6	1.8	18.5	24.7	17.8
Metairie	LA	21,664	3,727	17,937	2.9	8.0	2.2	23.7	39.1	21.2
Monroe	LA	19,678	5,679	13,999	2.7	7.9	1.5	19.4	26.3	18.8
New Orleans	LA	21,539	10,499	11,040	3.0	6.8	2.6	14.6	21.5	12.9
Shreveport	LA	46,189	15,204	30,985	2.6	7.0	1.7	16.1	22.8	15.1

Procedure rates are adjusted for age, sex, and race. Race-specific rates are adjusted for age and sex. Rates of preventive services are unadjusted. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

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Open leg bypass procedures per 1,000 Medicare beneficiaries with diabetes and PAD			Percent of diabetic Medicare beneficiaries (age 65-75) receiving blood lipids testing			Percent of diabetic Medicare beneficiaries (age 65-75) receiving hemoglobin A1c testing		
Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
3.6	8.6	3.3	84.5	75.9	84.8	87.1	82.9	87.3
2.3			84.8	78.4	85.3	85.9	83.4	86.0
3.0			81.4	76.7	81.8	84.0	80.6	84.3
3.7	4.1	3.7	82.6	76.0	83.4	84.1	77.8	84.9
3.8			83.4	77.2	83.7	86.6	84.3	86.7
4.7			81.6	75.3	82.0	86.4	83.1	86.6
3.9			79.8	73.5	80.1	86.5	84.6	86.6
5.2	7.1	5.0	82.2	74.6	82.8	87.0	82.6	87.3
3.5			86.5	83.9	86.6	88.9	90.3	88.9
4.7			79.3	62.3	79.8	80.7	78.5	80.7
4.1			78.8	70.0	79.2	85.1	81.6	85.2
5.3	7.0	5.1	74.1	70.6	75.1	80.0	75.3	81.4
5.0	7.0	4.8	76.0	63.4	77.2	84.0	82.7	84.1
4.8			55.7	54.3	55.8	86.2	82.9	86.2
4.4			80.1	74.5	80.4	86.9	83.2	87.1
4.2	7.1	3.8	78.6	73.5	79.7	80.4	75.9	81.3
4.4			79.7	74.8	80.0	85.1	81.6	85.3
4.0			78.4	66.7	78.8	83.4	80.2	83.5
4.2			83.5	62.7	83.8	90.7	78.4	90.9
2.4			84.3	75.6	84.7	88.4	87.1	88.4
4.5			82.4	75.5	82.5	89.6	85.2	89.7
3.7			84.9			92.8		
3.3			77.2	65.0	77.3	88.3	95.0	88.3
4.6			73.3			87.1		
7.2			80.0	86.4	80.0	87.4	90.9	87.4
5.9			82.8	78.0	83.1	91.4	93.1	91.2
2.0			76.6	73.4	76.8	88.0	85.2	88.2
4.0	3.7	4.0	73.2	69.1	73.4	86.4	85.1	86.5
4.1			81.8	72.0	82.0	82.1	84.9	82.1
3.8	2.7	3.8	79.8	74.6	80.1	83.9	87.1	83.8
4.5	6.0	4.4	81.2	76.7	81.6	84.2	83.2	84.3
2.8			86.9	81.4	87.0	84.7	83.7	84.8
5.4	9.0	5.1	80.0	72.2	80.3	83.3	82.4	83.3
3.3	4.3	3.1	76.9	74.3	77.7	79.9	79.8	79.9
5.9	7.8	5.4	79.2	76.7	80.7	81.8	81.4	82.1
1.5			83.1	78.4	84.1	84.6	80.7	85.4
4.1	5.0	4.0	80.2	77.3	81.4	78.8	78.3	79.1
2.9	5.3	2.3	81.5	76.7	82.8	83.2	81.4	83.7
4.3	6.0	4.1	79.3	74.7	80.6	81.0	81.8	80.8
4.0	3.3	4.6	78.8	77.8	79.2	80.5	82.0	79.9
3.5	4.7	3.1	75.5	73.3	78.2	78.9	77.9	80.0
2.4	2.7	2.4	75.7	72.0	77.6	80.6	79.3	81.3

Chapter 3 Table A. Rates of preventive services among patients with diabetes (2010), leg amputation, and revascularization procedures among patients with diabetes and PAD (2007-11), overall and by race, among hospital referral regions

HRR Name	State	Number of Medicare beneficiaries with diabetes and PAD			Leg amputation per 1,000 Medicare beneficiaries with diabetes and PAD			Therapeutic endovascular interventions per 1,000 Medicare beneficiaries with diabetes and PAD		
		Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
Slidell	LA	9,610	1,127	8,483	3.6	9.8	2.8	17.4	23.8	16.6
Bangor	ME	26,822	71	26,751	4.0			10.7		
Portland	ME	63,045	223	62,822	2.2			11.2		
Baltimore	MD	173,846	47,304	126,542	2.2	4.8	2.0	15.3	21.3	14.6
Salisbury	MD	46,480	7,740	38,740	2.4	6.4	1.8	13.6	16.6	13.4
Takoma Park	MD	45,513	15,344	30,169	1.6	4.6	0.9	12.6	20.4	10.4
Boston	MA	258,931	14,465	244,466	2.1	4.0	1.8	12.0	14.8	11.5
Springfield	MA	44,936	2,830	42,106	3.5	6.6	3.0	11.0	10.9	10.8
Worcester	MA	27,782	634	27,148	2.8			8.5		
Ann Arbor	MI	74,955	8,264	66,691	1.7	2.6	1.5	14.3	17.4	13.9
Dearborn	MI	44,312	2,390	41,922	1.8			16.8	23.3	15.9
Detroit	MI	146,699	59,883	86,816	1.6	3.1	1.7	16.9	24.6	15.4
Flint	MI	43,292	8,201	35,091	1.8	3.1	1.7	9.1	10.8	9.1
Grand Rapids	MI	45,608	2,398	43,210	2.6	5.3	2.2	16.5	13.6	16.1
Kalamazoo	MI	38,601	2,789	35,812	1.7			15.1	24.1	14.0
Lansing	MI	37,354	1,753	35,601	1.8			16.6	16.5	16.1
Marquette	MI	12,678	25	12,653	3.7			20.4		
Muskegon	MI	14,943	1,192	13,751	2.5			13.2	14.3	12.9
Petoskey	MI	13,168	11	13,157	3.7			33.5		
Pontiac	MI	26,013	3,413	22,600	1.5			15.5	22.9	14.5
Royal Oak	MI	51,078	8,012	43,066	1.2	3.1	0.9	11.0	16.1	10.3
Saginaw	MI	57,165	3,495	53,670	3.0	3.9	2.7	18.5	14.9	18.2
St. Joseph	MI	10,764	1,989	8,775	1.9			18.5	20.3	18.8
Traverse City	MI	17,577	29	17,548	1.9			27.1		
Duluth	MN	16,233	62	16,171	2.9			10.7		
Minneapolis	MN	82,566	1,672	80,894	2.8			11.6	19.9	10.9
Rochester	MN	18,200	48	18,152	3.3			12.2		
St. Cloud	MN	6,658	18	6,640	3.1			9.3		
St. Paul	MN	24,862	748	24,114	2.8			10.8		
Gulfport	MS	11,563	2,166	9,397	4.2	10.3	3.3	15.6	16.8	15.9
Hattiesburg	MS	20,098	4,557	15,541	3.0	7.8	2.3	26.1	41.7	23.2
Jackson	MS	62,582	25,474	37,108	3.5	8.9	2.5	13.2	17.7	12.9
Meridian	MS	14,988	5,168	9,820	5.5	14.2	3.8	9.7	13.5	9.2
Oxford	MS	9,739	2,915	6,824	2.1			12.8	16.6	12.6
Tupelo	MS	24,996	5,259	19,737	6.2	16.1	4.7	13.5	11.0	14.9
Cape Girardeau	MO	21,198	1,444	19,754	3.6	9.0	2.9	14.3	17.8	13.7
Columbia	MO	47,372	1,633	45,739	3.1			17.5	18.4	16.8
Joplin	MO	27,389	222	27,167	3.3			17.7		
Kansas City	MO	115,769	10,989	104,780	2.3	6.3	1.8	14.4	19.6	13.7
Springfield	MO	45,084	253	44,831	2.7			13.8		
St. Louis	MO	203,732	26,272	177,460	2.6	6.7	2.1	14.5	17.3	14.1
Billings	MT	24,146	49	24,097	2.6			9.9		

Procedure rates are adjusted for age, sex, and race. Race-specific rates are adjusted for age and sex. Rates of preventive services are unadjusted. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Open leg bypass procedures per 1,000 Medicare beneficiaries with diabetes and PAD			Percent of diabetic Medicare beneficiaries (age 65-75) receiving blood lipids testing			Percent of diabetic Medicare beneficiaries (age 65-75) receiving hemoglobin A1c testing		
Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
5.2			76.6	71.9	77.2	82.1	79.7	82.5
4.9			83.7	83.3	83.7	87.7	83.3	87.7
6.2			84.0	78.8	84.0	88.1	92.3	88.1
6.0	6.9	6.0	81.1	76.2	83.3	83.7	81.1	84.8
4.2	4.7	4.2	83.9	77.5	85.1	84.8	83.3	85.1
3.4	5.9	2.4	83.7	80.2	86.0	84.1	81.5	85.7
4.8	4.4	4.8	83.4	77.5	83.8	89.1	88.0	89.2
5.2	7.6	4.9	85.1	82.1	85.4	88.1	87.4	88.2
6.2			84.5	75.2	84.8	87.3	83.4	87.4
4.3	4.9	4.2	81.9	75.1	82.8	86.5	82.5	87.1
4.0			82.6	72.4	83.3	83.6	76.6	84.0
3.8	5.0	3.4	75.0	64.0	82.3	83.2	78.0	86.6
2.9	2.9	3.0	83.0	80.1	83.6	85.7	84.6	85.9
3.8			82.8	72.9	83.4	88.1	83.5	88.4
7.3	9.1	7.0	81.8	72.4	82.5	86.3	80.7	86.7
2.5			83.6	78.8	83.9	88.3	86.4	88.4
7.8			82.4			87.0		
6.5			85.4	81.4	85.8	90.3	87.6	90.6
7.7			79.8			87.9		
3.6	4.6	3.5	76.7	70.3	77.7	84.7	82.2	85.1
2.9	3.6	2.8	81.9	74.3	83.6	83.9	82.8	84.1
5.4			81.7	74.8	82.1	85.1	75.7	85.7
4.3			80.8	76.0	81.9	86.1	83.4	86.7
6.9			83.3			88.9		
5.8			82.0	80.0	82.0	87.8		
4.6			82.7	72.1	83.0	86.9	84.0	87.0
3.7			86.7	88.2	86.6	92.7	94.1	92.7
6.7			81.8			88.6		
4.2			85.5	72.4	86.0	90.1	89.0	90.1
5.0			69.9	64.8	71.1	75.6	77.3	75.2
3.8	4.9	3.6	76.9	75.1	77.5	82.4	81.3	82.7
3.5	4.9	3.0	72.1	67.1	75.7	81.7	79.2	83.6
2.3	3.8	1.8	70.0	69.6	70.3	79.4	84.0	76.6
5.4	7.6	4.8	74.6	74.1	74.8	83.1	86.1	81.8
3.8	2.5	4.3	79.2	77.7	79.7	86.8	87.9	86.4
5.3			74.9	70.6	75.2	87.0	84.8	87.2
3.4			76.3	67.7	76.7	84.6	83.6	84.6
3.6			75.3	73.9	75.3	81.3	87.0	81.2
4.9	7.3	4.6	80.1	74.8	80.7	85.1	80.6	85.6
5.1			81.2	78.2	81.2	86.1	87.3	86.1
3.8	4.9	3.6	79.2	71.9	80.3	84.4	82.6	84.7
4.1			68.3			79.4		

Chapter 3 Table A. Rates of preventive services among patients with diabetes (2010), leg amputation, and revascularization procedures among patients with diabetes and PAD (2007-11), overall and by race, among hospital referral regions

HRR Name	State	Number of Medicare beneficiaries with diabetes and PAD			Leg amputation per 1,000 Medicare beneficiaries with diabetes and PAD			Therapeutic endovascular interventions per 1,000 Medicare beneficiaries with diabetes and PAD		
		Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
Great Falls	MT	7,459	40	7,419	3.3			10.3		
Missoula	MT	15,559	25	15,534	2.5			11.2		
Lincoln	NE	31,064	259	30,805	4.1			17.3		
Omaha	NE	63,427	2,520	60,907	2.8	4.8	2.4	12.7	16.7	12.1
Las Vegas	NV	77,317	8,512	68,805	1.3	2.2	1.2	9.9	13.7	9.4
Reno	NV	26,089	380	25,709	2.8			14.4		
Lebanon	NH	22,188	64	22,124	2.9			17.2		
Manchester	NH	46,624	303	46,321	2.1			10.0		
Camden	NJ	257,693	27,657	230,036	2.1	4.0	1.9	12.1	18.4	11.3
Hackensack	NJ	97,862	6,616	91,246	1.9	2.7	1.7	11.2	11.8	10.9
Morristown	NJ	63,664	5,435	58,229	1.6	4.2	1.3	9.8	10.0	9.6
New Brunswick	NJ	73,185	6,164	67,021	1.9	3.8	1.6	10.3	12.7	9.9
Newark	NJ	102,065	31,276	70,789	2.1	4.5	1.8	12.9	19.8	11.4
Paterson	NJ	28,000	3,515	24,485	1.5	4.4	1.1	13.7	28.9	11.5
Ridgewood	NJ	28,907	1,703	27,204	2.1			10.2	8.7	10.0
Albuquerque	NM	62,692	1,005	61,687	2.9			9.1	14.6	8.6
Albany	NY	112,185	5,131	107,054	2.1	4.9	1.8	8.6	10.7	8.2
Binghamton	NY	24,840	385	24,455	2.5			12.7		
Bronx	NY	52,117	17,243	34,874	2.7	4.9	3.0	15.6	22.3	14.6
Buffalo	NY	54,131	6,441	47,690	1.9	2.6	1.8	12.3	17.1	11.7
Elmira	NY	25,753	783	24,970	1.7			9.7		
East Long Island	NY	302,921	33,330	269,591	2.0	4.5	1.6	10.4	16.9	9.6
Manhattan	NY	266,610	48,551	218,059	1.9	5.4	1.3	14.1	22.9	12.6
Rochester	NY	39,043	3,642	35,401	2.6	8.2	1.9	6.1	7.9	5.9
Syracuse	NY	66,813	2,471	64,342	1.8			12.7	17.3	12.0
White Plains	NY	70,622	9,963	60,659	1.9	5.0	1.4	9.7	15.7	8.8
Asheville	NC	42,561	1,632	40,929	2.8			7.3	10.5	6.9
Charlotte	NC	134,069	24,994	109,075	2.6	6.1	2.1	14.3	18.3	13.9
Durham	NC	77,030	22,388	54,642	2.9	7.2	2.3	13.3	19.6	12.2
Greensboro	NC	27,065	5,630	21,435	3.8	10.9	2.5	8.6	11.2	8.4
Greenville	NC	64,352	21,619	42,733	2.5	4.9	2.5	9.7	10.2	10.9
Hickory	NC	19,985	1,239	18,746	3.3			18.5	19.6	17.9
Raleigh	NC	105,005	32,329	72,676	2.8	6.4	2.3	14.3	19.3	13.9
Wilmington	NC	36,688	8,827	27,861	2.2	5.5	1.6	17.9	21.6	18.0
Winston-Salem	NC	55,031	7,038	47,993	2.1	4.5	1.8	8.3	12.5	7.7
Bismarck	ND	13,872	22	13,850	2.7			11.6		
Fargo/Moorhead MN	ND	26,311	44	26,267	3.8			16.1		
Grand Forks	ND	7,595	44	7,551	4.5			15.2		
Minot	ND	8,143	23	8,120	4.0			10.1		
Akron	OH	36,706	4,330	32,376	2.3	5.8	1.8	6.6	8.0	6.4
Canton	OH	35,608	1,824	33,784	1.6			10.7	10.3	10.3
Cincinnati	OH	78,179	10,168	68,011	2.6	6.9	2.0	14.8	22.6	13.7

Procedure rates are adjusted for age, sex, and race. Race-specific rates are adjusted for age and sex. Rates of preventive services are unadjusted. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Open leg bypass procedures per 1,000 Medicare beneficiaries with diabetes and PAD			Percent of diabetic Medicare beneficiaries (age 65-75) receiving blood lipids testing			Percent of diabetic Medicare beneficiaries (age 65-75) receiving hemoglobin A1c testing		
Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
7.9			67.7			76.4		
3.0			73.7			80.5		
6.0			75.3	64.5	75.4	86.3	81.6	86.3
4.7	4.2	4.7	77.0	67.9	77.4	85.5	85.1	85.5
3.7	5.3	3.5	77.7	72.4	78.4	77.3	72.8	77.8
5.9			76.9	73.8	77.0	78.4	80.4	78.3
6.8			79.2	93.3	79.2	88.4	100.0	88.4
6.1			85.5	79.8	85.6	89.0	79.8	89.0
3.6	3.9	3.5	84.5	75.1	85.8	82.6	76.8	83.4
3.6	3.2	3.6	86.2	80.4	86.7	82.9	80.2	83.2
3.8	5.6	3.5	82.7	77.9	83.2	81.8	79.1	82.1
3.6	4.0	3.5	83.8	77.6	84.5	82.6	77.7	83.1
3.9	5.4	3.6	80.4	73.4	84.2	78.7	74.3	81.1
4.1	6.5	3.8	82.3	75.2	83.6	82.1	80.0	82.5
3.8	8.1	3.5	88.1	85.9	88.3	86.6	84.3	86.8
2.1			60.9	71.1	60.8	66.9	81.6	66.7
7.6	9.3	7.3	85.0	79.3	85.3	86.4	81.0	86.8
5.1			80.7	73.4	80.8	85.6	81.9	85.6
5.5	7.7	4.9	75.8	73.3	77.2	78.4	78.0	78.6
4.2	5.2	4.1	83.7	76.7	84.9	85.6	80.3	86.5
2.8			82.0	69.5	82.5	87.0	80.9	87.3
4.0	4.0	4.0	87.2	80.9	88.2	84.7	81.4	85.2
2.8	4.2	2.6	84.7	77.6	86.8	83.4	78.8	84.8
4.5	5.9	4.3	81.9	75.3	82.9	86.6	84.8	86.9
6.5	6.9	6.3	84.9	79.9	85.2	87.7	88.8	87.6
3.5	4.2	3.4	86.5	82.2	87.4	85.4	83.0	85.9
3.8			77.2	69.3	77.4	86.4	88.1	86.3
3.0	3.7	2.9	84.4	80.5	85.4	87.5	86.2	87.8
3.1	3.8	3.0	82.4	79.1	83.8	87.4	86.2	87.9
4.0	6.5	3.4	82.0	79.0	83.0	87.7	84.3	88.8
3.9	3.9	4.3	80.1	77.5	81.5	87.5	87.8	87.4
3.8			85.2	80.7	85.5	89.5	92.3	89.4
3.7	4.7	3.5	82.5	78.8	84.3	87.8	86.3	88.5
4.4	4.3	4.6	87.6	83.1	89.0	90.2	88.6	90.7
2.6	2.1	2.6	83.3	80.4	83.7	88.9	88.1	89.0
3.9			75.1			83.7		
4.2			80.2			86.8		
4.3			72.7			80.8		
3.5			80.2			87.2		
3.4	3.8	3.4	79.0	74.8	79.7	83.0	82.8	83.0
3.0			84.9	75.7	85.4	86.3	78.5	86.7
4.4	6.3	4.2	80.8	73.9	82.0	85.0	82.4	85.4

Chapter 3 Table A. Rates of preventive services among patients with diabetes (2010), leg amputation, and revascularization procedures among patients with diabetes and PAD (2007-11), overall and by race, among hospital referral regions

HRR Name	State	Number of Medicare beneficiaries with diabetes and PAD			Leg amputation per 1,000 Medicare beneficiaries with diabetes and PAD			Therapeutic endovascular interventions per 1,000 Medicare beneficiaries with diabetes and PAD		
		Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
Cleveland	OH	127,532	21,954	105,578	2.7	5.6	2.3	14.6	18.8	14.1
Columbus	OH	155,927	11,998	143,929	2.4	5.9	2.0	18.8	25.2	17.9
Dayton	OH	68,323	8,440	59,883	2.2	4.9	1.8	15.6	17.4	15.5
Elyria	OH	18,725	1,401	17,324	1.9			19.3	21.0	18.7
Kettering	OH	23,109	1,043	22,066	2.5			13.4	19.0	12.7
Toledo	OH	70,903	6,028	64,875	2.5	6.4	2.0	11.9	13.6	11.6
Youngstown	OH	47,596	4,516	43,080	2.1	5.6	1.7	11.2	18.9	10.2
Lawton	OK	15,805	1,413	14,392	2.0			10.5	17.1	9.7
Oklahoma City	OK	98,638	6,376	92,262	2.2	4.4	1.9	14.5	21.2	13.6
Tulsa	OK	67,448	4,032	63,416	2.4	3.5	2.1	16.2	17.6	15.7
Bend	OR	8,138	32	8,106	4.1			7.2		
Eugene	OR	26,735	112	26,623	2.6			10.7		
Medford	OR	22,877	105	22,772	3.6			10.8		
Portland	OR	57,742	1,135	56,607	3.2			10.9		
Salem	OR	6,366	24	6,342				10.7		
Allentown	PA	98,634	2,333	96,301	2.8	7.2	2.3	13.2	13.9	12.6
Altoona	PA	20,723	171	20,552	2.1			13.6		
Danville	PA	36,250	231	36,019	3.7			14.0		
Erie	PA	51,690	922	50,768	2.8			12.3	22.0	11.6
Harrisburg	PA	67,230	2,489	64,741	2.7	4.6	2.3	13.5	25.7	12.5
Johnstown	PA	11,109	177	10,932	3.4			11.3		
Lancaster	PA	44,800	1,506	43,294	1.8			8.5	14.5	8.0
Philadelphia	PA	206,281	39,805	166,476	2.2	5.5	1.7	11.6	17.2	10.8
Pittsburgh	PA	122,201	7,206	114,995	2.5	4.1	2.2	13.7	15.6	13.2
Reading	PA	39,896	752	39,144	4.2			16.4	31.9	15.3
Sayre	PA	14,944	111	14,833	3.3			9.7		
Scranton	PA	29,073	229	28,844	2.4			11.0		
Wilkes-Barre	PA	24,973	183	24,790	3.0			10.2		
York	PA	29,831	869	28,962	2.8			13.3	15.7	12.7
Providence	RI	52,356	1,716	50,640	2.2			11.8	16.5	11.2
Charleston	SC	69,956	17,728	52,228	2.5	7.4	1.6	8.5	12.8	7.8
Columbia	SC	75,718	24,821	50,897	2.9	7.5	2.1	11.7	16.2	11.1
Florence	SC	30,112	11,771	18,341	2.7	6.5	2.2	14.9	21.3	13.9
Greenville	SC	54,384	6,592	47,792	2.1	6.3	1.5	14.3	21.4	13.4
Spartanburg	SC	21,266	2,922	18,344	3.1	6.7	2.7	11.3	21.9	9.7
Rapid City	SD	9,756	25	9,731	2.2			14.1		
Sioux Falls	SD	42,337	83	42,254	2.0			17.9		
Chattanooga	TN	46,846	4,645	42,201	2.9	5.9	2.5	17.6	24.5	16.6
Jackson	TN	29,148	4,898	24,250	2.9	5.9	2.5	18.0	27.9	16.5
Johnson City	TN	14,767	282	14,485	2.0			7.5		
Kingsport	TN	30,765	453	30,312	2.4			9.6		
Knoxville	TN	85,029	3,486	81,543	2.5	4.2	2.2	13.3	17.8	12.6

Procedure rates are adjusted for age, sex, and race. Race-specific rates are adjusted for age and sex. Rates of preventive services are unadjusted. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Open leg bypass procedures per 1,000 Medicare beneficiaries with diabetes and PAD			Percent of diabetic Medicare beneficiaries (age 65-75) receiving blood lipids testing			Percent of diabetic Medicare beneficiaries (age 65-75) receiving hemoglobin A1c testing		
Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
5.2	7.4	4.8	78.2	70.4	80.0	82.9	79.5	83.6
4.2	5.5	4.1	79.6	74.9	79.9	84.6	82.7	84.8
3.4	4.6	3.2	77.7	70.2	78.7	82.2	77.7	82.7
5.5			81.6	80.3	81.7	82.9	80.3	83.1
3.2			84.6	78.1	84.9	86.1	83.6	86.2
5.3	5.2	5.2	75.8	66.0	76.8	74.8	67.8	75.4
4.1	7.8	3.7	81.0	71.9	82.0	83.7	79.5	84.2
4.1			70.5	68.9	70.7	73.8	69.5	74.3
3.4	4.7	3.2	75.3	74.5	75.4	79.5	82.2	79.3
3.2			72.0	72.9	72.0	78.0	81.0	77.9
2.9			81.0			87.7		
5.5			80.4	83.3	80.4	86.5	88.9	86.5
9.4			80.6	71.4	80.6	85.8	71.4	85.9
6.5	11.2	6.2	80.7	75.4	80.8	86.6	87.7	86.6
3.9			81.1			79.8		
5.0	5.8	4.8	81.8	78.4	82.0	83.6	79.7	83.7
3.3			83.7	75.0	83.8	87.8	81.3	87.9
3.3			77.3	54.4	77.5	83.5	70.2	83.6
4.9			79.4	74.8	79.5	84.1	82.3	84.1
2.9			80.8	72.8	81.1	86.9	79.7	87.2
3.6			78.2	75.0	78.3	81.8	71.4	81.9
4.0			84.9	76.6	85.3	87.7	80.2	88.1
3.6	4.5	3.4	81.4	73.0	83.9	83.5	78.7	84.9
5.5	5.1	5.4	77.6	65.8	78.5	81.1	74.3	81.6
6.6			84.6	70.3	85.0	87.2	75.1	87.6
3.8			75.9			86.0	68.2	86.2
3.7			73.7	78.6	73.7	76.2	83.9	76.1
5.1			68.3	53.3	68.5	72.6	66.7	72.6
4.1			87.6	82.0	87.9	90.2	85.7	90.4
4.6	9.0	4.3	83.1	74.2	83.5	85.0	83.1	85.1
3.3	3.9	3.3	82.7	78.1	84.3	85.8	85.2	86.0
2.8	3.1	2.9	80.2	77.1	81.8	83.4	82.3	84.0
4.0	5.0	3.9	80.0	78.2	81.2	84.5	84.5	84.5
2.7	4.6	2.5	82.0	77.0	82.7	84.5	80.1	85.1
4.5	5.9	4.3	80.5	77.1	81.1	84.6	84.2	84.7
3.3			66.3			76.4		
3.5			78.4	70.8	78.5	87.0	95.8	87.0
3.5	2.8	3.5	81.9	75.6	82.6	85.6	85.0	85.6
2.3	2.6	2.2	81.5	77.9	82.1	87.3	87.5	87.2
3.5			79.1	81.0	79.1	84.9	75.9	85.1
2.1			83.0	80.9	83.0	86.5	88.3	86.5
3.4			83.5	80.3	83.6	86.9	89.1	86.8

Chapter 3 Table A. Rates of preventive services among patients with diabetes (2010), leg amputation, and revascularization procedures among patients with diabetes and PAD (2007-11), overall and by race, among hospital referral regions

HRR Name	State	Number of Medicare beneficiaries with diabetes and PAD			Leg amputation per 1,000 Medicare beneficiaries with diabetes and PAD			Therapeutic endovascular interventions per 1,000 Medicare beneficiaries with diabetes and PAD		
		Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
Memphis	TN	100,612	35,294	65,318	2.8	6.8	2.2	18.2	24.3	17.8
Nashville	TN	145,892	14,095	131,797	3.0	7.6	2.4	12.4	17.6	11.7
Abilene	TX	21,181	888	20,293	3.9			22.2	30.7	21.1
Amarillo	TX	21,387	664	20,723	2.0			21.3	41.7	19.8
Austin	TX	62,995	6,086	56,909	2.5	4.7	2.2	15.2	16.3	14.9
Beaumont	TX	37,641	8,035	29,606	2.2	5.6	1.8	13.0	24.5	10.6
Bryan	TX	10,765	2,029	8,736	3.1	8.1	2.4	16.3	23.7	15.3
Corpus Christi	TX	37,882	1,163	36,719	3.5			22.4	13.0	21.8
Dallas	TX	194,759	30,793	163,966	3.0	6.9	2.4	16.3	22.5	15.5
El Paso	TX	62,684	1,604	61,080	1.9			22.6	27.8	21.5
Fort Worth	TX	87,283	9,481	77,802	2.9	6.3	2.5	12.6	17.5	12.0
Harlingen	TX	50,153	198	49,955	3.7			18.9		
Houston	TX	244,810	43,523	201,287	2.6	6.5	2.1	17.0	24.7	15.9
Longview	TX	12,968	2,340	10,628	3.0	7.9	2.3	16.2	27.5	14.3
Lubbock	TX	36,724	1,752	34,972	2.7			23.0	33.6	21.7
McAllen	TX	53,269	180	53,089	3.7			23.3		
Odessa	TX	15,254	800	14,454	3.0			15.8		
San Angelo	TX	11,333	399	10,934	3.3			18.2		
San Antonio	TX	149,072	7,745	141,327	3.3	3.2	3.0	17.3	20.4	16.6
Temple	TX	17,022	2,681	14,341	2.9	4.6	2.8	14.8	11.4	15.7
Tyler	TX	42,843	6,387	36,456	3.9	8.6	3.2	16.7	22.8	15.9
Victoria	TX	13,811	1,052	12,759	4.7			11.1		
Waco	TX	17,405	2,483	14,922	3.1	7.9	2.4	23.4	26.0	23.3
Wichita Falls	TX	16,456	1,063	15,393	1.6			13.0	17.7	12.4
Ogden	UT	14,864	188	14,676	1.6			10.2		
Provo	UT	12,660	11	12,649	1.5			6.4		
Salt Lake City	UT	56,700	289	56,411	1.9			8.2		
Burlington	VT	38,210	174	38,036	2.9			10.3		
Arlington	VA	69,277	8,599	60,678	1.7	5.5	1.1	13.8	23.1	12.5
Charlottesville	VA	36,431	4,155	32,276	2.0	5.1	1.6	11.3	18.8	10.3
Lynchburg	VA	17,801	3,493	14,308	5.4	14.0	4.1	15.3	20.0	14.8
Newport News	VA	35,060	10,456	24,604	2.7	7.4	1.7	14.8	20.9	13.9
Norfolk	VA	83,755	26,213	57,542	2.3	5.7	1.8	13.7	17.6	13.6
Richmond	VA	93,994	29,058	64,936	3.1	7.1	2.6	15.3	22.4	14.1
Roanoke	VA	53,077	4,113	48,964	2.5	4.5	2.1	7.8	10.3	7.5
Winchester	VA	27,622	1,235	26,387	1.9			17.0	12.0	16.7
Everett	WA	21,836	222	21,614	2.9			15.7		
Olympia	WA	15,677	147	15,530	3.4			11.4		
Seattle	WA	94,933	3,596	91,337	2.6	6.1	2.2	14.8	22.3	14.0
Spokane	WA	74,537	598	73,939	2.9			10.9		
Tacoma	WA	33,240	1,817	31,423	1.9			9.3	12.5	8.9
Yakima	WA	13,069	144	12,925	1.4			14.3		

Procedure rates are adjusted for age, sex, and race. Race-specific rates are adjusted for age and sex. Rates of preventive services are unadjusted. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Open leg bypass procedures per 1,000 Medicare beneficiaries with diabetes and PAD			Percent of diabetic Medicare beneficiaries (age 65-75) receiving blood lipids testing			Percent of diabetic Medicare beneficiaries (age 65-75) receiving hemoglobin A1c testing		
Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
3.7	5.0	3.3	78.2	72.9	81.0	83.1	82.2	83.6
4.8	7.3	4.5	82.1	76.1	82.7	85.6	83.8	85.7
3.8			74.1	67.6	74.4	79.5	78.7	79.6
4.9			80.0	79.2	80.0	82.3	79.9	82.4
2.7	3.7	2.6	82.5	74.5	83.4	84.3	78.5	84.9
4.4	6.1	4.1	81.9	79.1	82.7	82.4	83.0	82.2
3.3	5.7	2.8	80.7	77.2	81.4	80.8	78.1	81.4
8.6	10.4	8.3	84.6	78.7	84.8	84.8	83.6	84.9
4.4	5.3	4.2	82.2	77.3	83.1	83.8	80.7	84.4
2.4			75.5	69.9	75.7	76.0	66.3	76.3
4.4	4.9	4.3	80.3	74.7	81.0	82.8	79.6	83.2
2.6			85.4	91.4	85.3	82.6	82.9	82.6
4.6	6.6	4.3	80.0	75.5	81.0	81.4	79.0	81.9
3.1			81.7	78.8	82.4	85.0	86.0	84.8
4.6	6.3	4.4	76.9	71.4	77.1	80.4	77.0	80.5
3.1			87.5	71.4	87.6	80.0	77.1	80.1
6.7			74.7	67.8	75.1	79.0	77.4	79.1
3.1			77.2	70.9	77.5	86.2	88.4	86.1
4.6	4.3	4.6	80.9	73.5	81.3	81.2	77.2	81.4
3.1			76.5	68.9	77.8	80.3	79.6	80.5
5.8	7.5	5.6	78.8	76.7	79.2	83.5	84.0	83.5
3.2			82.9	78.6	83.3	85.0	85.2	85.0
3.5			78.4	76.6	78.7	80.2	78.1	80.6
1.9			76.1	74.4	76.3	78.2	78.6	78.2
1.4			76.3	70.2	76.4	85.0	87.2	85.0
1.6			72.1			82.1		
2.5			73.4	72.9	73.4	83.2	89.8	83.2
5.7			82.4	70.7	82.5	88.8	80.5	88.8
2.7	5.2	2.4	82.5	76.7	83.3	83.7	79.7	84.3
3.3	6.2	3.0	82.4	77.6	83.0	88.2	86.4	88.4
3.3	4.0	3.3	84.3	81.6	85.0	87.1	86.2	87.4
3.8	4.4	3.8	79.6	73.4	82.5	85.0	80.5	87.1
4.4	5.4	4.3	80.3	76.4	82.0	83.9	82.6	84.5
5.8	8.3	5.1	83.1	78.3	85.4	85.9	84.4	86.7
7.2	8.6	7.0	83.3	77.6	83.7	87.1	84.3	87.3
2.7			83.2	79.0	83.4	85.3	87.2	85.2
4.8			81.2	72.6	81.3	86.9	80.6	87.0
4.7			77.3	56.9	77.6	83.5	56.9	83.9
4.3	7.4	4.1	81.1	70.2	81.6	87.4	82.3	87.6
4.9			79.9	75.2	79.9	86.6	83.5	86.7
2.1			79.1	65.7	79.9	84.1	71.8	84.8
3.6			78.7	61.5	78.9	85.8	73.1	85.9

Chapter 3 Table A. Rates of preventive services among patients with diabetes (2010), leg amputation, and revascularization procedures among patients with diabetes and PAD (2007-11), overall and by race, among hospital referral regions

HRR Name	State	Number of Medicare beneficiaries with diabetes and PAD			Leg amputation per 1,000 Medicare beneficiaries with diabetes and PAD			Therapeutic endovascular interventions per 1,000 Medicare beneficiaries with diabetes and PAD		
		Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
Charleston	WV	65,383	2,017	63,366	2.5			15.4	19.3	14.7
Huntington	WV	28,753	495	28,258	3.1			23.7		
Morgantown	WV	25,078	417	24,661	3.1			10.8		
Appleton	WI	12,082	13	12,069	6.1			16.4		
Green Bay	WI	25,181	65	25,116	4.0			19.8		
La Crosse	WI	16,026	62	15,964	3.5			7.7		
Madison	WI	46,285	912	45,373	2.3			14.1	12.9	13.5
Marshfield	WI	22,141	25	22,116	2.6			8.8		
Milwaukee	WI	132,717	12,471	120,246	2.2	4.9	1.8	14.5	15.2	14.3
Neenah	WI	9,991	27	9,964	4.2			10.7		
Wausau	WI	12,500			2.6			13.4		
Casper	WY	8,534	24	8,510	4.1			10.5		
United States	US	15,937,763	1,861,061	14,076,702	2.4	5.6	2.0	14.1	19.7	13.3

Procedure rates are adjusted for age, sex, and race. Race-specific rates are adjusted for age and sex. Rates of preventive services are unadjusted. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Open leg bypass procedures per 1,000 Medicare beneficiaries with diabetes and PAD			Percent of diabetic Medicare beneficiaries (age 65-75) receiving blood lipids testing			Percent of diabetic Medicare beneficiaries (age 65-75) receiving hemoglobin A1c testing		
Overall	Black	Non-black	Overall	Black	Non-black	Overall	Black	Non-black
4.7			81.0	77.9	81.0	82.8	81.1	82.9
3.1			78.3	71.6	78.4	83.0	82.1	83.0
5.8			78.6	68.9	78.7	82.6	80.0	82.6
7.4			87.6			89.4		
6.3			84.3	70.0	84.4	89.5	75.0	89.6
3.2			83.4			90.8		
3.1			82.7	72.7	83.0	89.7	82.4	89.8
4.3			86.5			92.3		
4.0	4.7	3.9	83.9	78.8	84.5	88.4	87.0	88.6
5.7			87.2			92.1		
8.2			85.0			90.3		
3.6			53.9			73.6		
4.1	5.2	4.0	80.7	75.2	81.5	83.8	80.9	84.2

Chapter 3 Table B. Thirty-day readmission rates, amputation-free survival, and re-intervention-free survival following surgical discharge among hospital referral regions (2007-11)

HRR Name	State	Percent of Medicare beneficiaries with diabetes and PAD readmitted within 30 days following revascularization procedure	Amputation-free survival after any vascular procedure among patients with diabetes and PAD		Re-intervention-free survival after any vascular procedure among patients with diabetes and PAD	
			Black	Non-black	Black	Non-black
Birmingham	AL	15.0	71.8	77.9	51.0	58.9
Dothan	AL	19.4		76.2		50.3
Huntsville	AL	14.0		78.6		56.9
Mobile	AL	19.8	69.3	77.6	46.4	53.9
Montgomery	AL	25.4				
Tuscaloosa	AL	18.2		74.0		47.3
Anchorage	AK	14.9		72.3		50.2
Mesa	AZ	15.8		76.3		52.2
Phoenix	AZ	18.2		78.2		53.0
Sun City	AZ	18.5		73.6		48.4
Tucson	AZ	20.8		69.2		46.9
Fort Smith	AR	16.6		74.2		58.2
Jonesboro	AR	16.9		79.0		53.5
Little Rock	AR	17.0	70.7	77.9	44.7	53.1
Springdale	AR	17.5		74.8		53.3
Texarkana	AR	18.4		81.9		65.0
Orange County	CA	18.3		73.0		51.6
Bakersfield	CA	18.1		71.8		44.3
Chico	CA	13.8		79.5		51.6
Contra Costa County	CA	15.5		69.9		46.2
Fresno	CA	18.1		74.1		52.0
Los Angeles	CA	19.1	69.4	74.3	42.0	48.8
Modesto	CA	14.3		79.6		49.0
Napa	CA	15.3		74.6		45.9
Alameda County	CA	16.7		73.4		48.6
Palm Springs/Rancho Mirage	CA	16.3		70.3		56.0
Redding	CA	10.4		79.3		54.1
Sacramento	CA	16.6		73.6		50.2
Salinas	CA	15.3		66.7		48.8
San Bernardino	CA	15.6		74.2		49.9
San Diego	CA	17.0		74.0		50.9
San Francisco	CA	18.7		75.4		51.2
San Jose	CA	14.1		74.8		49.1
San Luis Obispo	CA	17.3				
San Mateo County	CA	19.2		72.4		44.7
Santa Barbara	CA	15.5		74.3		55.1
Santa Cruz	CA	12.6		76.3		65.0
Santa Rosa	CA	15.0		76.4		54.6
Stockton	CA	15.9		80.1		46.2
Ventura	CA	16.2		77.5		48.7
Colorado Springs	CO	15.1		74.2		56.6
Denver	CO	18.0		70.3		51.7
Fort Collins	CO	12.6				
Greeley	CO	15.9				

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Chapter 3 Table B. Thirty-day readmission rates, amputation-free survival, and re-intervention-free survival following surgical discharge among hospital referral regions (2007-11)

HRR Name	State	Percent of Medicare beneficiaries with diabetes and PAD readmitted within 30 days following revascularization procedure	Amputation-free survival after any vascular procedure among patients with diabetes and PAD		Re-intervention-free survival after any vascular procedure among patients with diabetes and PAD	
			Black	Non-black	Black	Non-black
Pueblo	CO	20.7				
Bridgeport	CT	16.0		70.1		46.2
Hartford	CT	20.1		70.8		47.6
New Haven	CT	19.9		68.2		46.7
Wilmington	DE	18.1	71.1	73.9	46.5	47.1
Washington	DC	16.7	73.6	73.4	41.8	51.1
Bradenton	FL	16.1		79.7		44.5
Clearwater	FL	14.1		79.5		52.1
Fort Lauderdale	FL	17.6	66.5	75.9	44.6	52.5
Fort Myers	FL	14.9		78.4		57.7
Gainesville	FL	15.2		80.9		51.5
Hudson	FL	17.8		75.5		56.0
Jacksonville	FL	15.7	70.1	75.3	46.5	52.3
Lakeland	FL	15.7		73.7		51.4
Miami	FL	19.1	67.4	70.5	42.7	48.2
Ocala	FL	10.9		82.8		56.3
Orlando	FL	15.6	67.3	77.2	53.1	54.4
Ormond Beach	FL	14.5		76.7		53.4
Panama City	FL	13.4		77.2		46.1
Pensacola	FL	18.0	71.6	80.1	42.4	45.7
Sarasota	FL	15.1		82.9		56.6
St. Petersburg	FL	16.0		78.8		57.9
Tallahassee	FL	16.3	67.9	78.0	46.0	54.7
Tampa	FL	19.2		79.6		59.2
Albany	GA	18.6				
Atlanta	GA	17.7	67.6	76.4	43.5	52.3
Augusta	GA	19.3	65.7	75.6	38.1	48.7
Columbus	GA	20.4		70.2		46.0
Macon	GA	15.0	60.5	75.8	41.2	55.4
Rome	GA	17.0		71.5		50.7
Savannah	GA	14.3	53.7	74.2	41.8	52.1
Honolulu	HI	24.2		67.9		48.0
Boise	ID	17.8		71.7		53.9
Idaho Falls	ID	13.9				
Aurora	IL	16.3		75.9		44.9
Blue Island	IL	23.6	67.6	77.2	48.2	48.7
Chicago	IL	23.6	67.9	76.5	47.4	50.4
Elgin	IL	24.3		74.6		46.8
Evanston	IL	23.0		72.4		51.4
Hinsdale	IL	16.0		76.8		48.8
Joliet	IL	20.9		76.5		49.1
Melrose Park	IL	19.1		75.2		47.0
Peoria	IL	14.0		76.2		49.0
Rockford	IL	18.0		81.8		57.8

Chapter 3 Table B. Thirty-day readmission rates, amputation-free survival, and re-intervention-free survival following surgical discharge among hospital referral regions (2007-11)

HRR Name	State	Percent of Medicare beneficiaries with diabetes and PAD readmitted within 30 days following revascularization procedure	Amputation-free survival after any vascular procedure among patients with diabetes and PAD		Re-intervention-free survival after any vascular procedure among patients with diabetes and PAD	
			Black	Non-black	Black	Non-black
Springfield	IL	16.8		78.9		54.6
Urbana	IL	17.3		76.7		48.6
Bloomington	IL	13.8		73.5		50.5
Evansville	IN	20.7		69.9		50.0
Fort Wayne	IN	16.4		72.1		48.8
Gary	IN	20.3	76.2	75.2	41.6	43.7
Indianapolis	IN	21.6	65.1	76.8	36.0	46.6
Lafayette	IN	20.0		76.3		51.8
Muncie	IN	24.0		74.3		52.7
Munster	IN	24.3		78.4		40.1
South Bend	IN	17.7		71.9		48.7
Terre Haute	IN	19.0		81.5		40.5
Cedar Rapids	IA	12.7		73.5		51.7
Davenport	IA	14.4		82.6		51.4
Des Moines	IA	18.4		75.8		54.5
Dubuque	IA	13.9				
Iowa City	IA	14.2		78.2		56.9
Mason City	IA	17.1				
Sioux City	IA	30.7		69.7		43.0
Waterloo	IA	16.2				
Topeka	KS	15.8		76.8		55.1
Wichita	KS	15.3		79.6		50.3
Covington	KY	19.7		72.0		55.5
Lexington	KY	16.0		77.6		56.6
Louisville	KY	20.4	63.6	74.4	43.4	53.4
Owensboro	KY	12.3		83.2		68.5
Paducah	KY	28.8		74.5		48.6
Alexandria	LA	15.8		75.1		49.4
Baton Rouge	LA	17.1	64.4	73.8	39.7	50.9
Houma	LA	12.9		77.4		56.5
Lafayette	LA	18.5	70.6	76.9	40.0	46.3
Lake Charles	LA	19.7		80.5		48.5
Metairie	LA	18.2		73.6		50.9
Monroe	LA	16.9		77.5		53.3
New Orleans	LA	13.9	70.5	70.1	49.0	48.5
Shreveport	LA	19.8	68.4	75.0	46.5	47.2
Slidell	LA	20.4				
Bangor	ME	16.7		71.3		52.2
Portland	ME	21.5		76.9		49.5
Baltimore	MD	23.6	66.3	73.6	42.0	47.2
Salisbury	MD	15.9		78.0		53.1
Takoma Park	MD	19.1	68.5	76.2	39.7	51.7
Boston	MA	20.7	73.7	74.5	51.2	50.1
Springfield	MA	20.4		70.1		51.2

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Chapter 3 Table B. Thirty-day readmission rates, amputation-free survival, and re-intervention-free survival following surgical discharge among hospital referral regions (2007-11)

HRR Name	State	Percent of Medicare beneficiaries with diabetes and PAD readmitted within 30 days following revascularization procedure	Amputation-free survival after any vascular procedure among patients with diabetes and PAD		Re-intervention-free survival after any vascular procedure among patients with diabetes and PAD	
			Black	Non-black	Black	Non-black
Worcester	MA	25.9		70.0		46.8
Ann Arbor	MI	14.3		77.9		50.6
Dearborn	MI	17.4		77.8		48.6
Detroit	MI	19.6	72.4	73.6	40.6	49.3
Flint	MI	16.0		72.9		52.1
Grand Rapids	MI	15.5		74.4		47.7
Kalamazoo	MI	17.6		75.4		49.9
Lansing	MI	15.5		76.8		52.3
Marquette	MI	14.4		75.6		52.2
Muskegon	MI	19.8		75.0		42.8
Petoskey	MI	13.8		77.0		46.6
Pontiac	MI	17.6		77.7		53.4
Royal Oak	MI	19.0		75.3		50.0
Saginaw	MI	15.7		77.1		49.1
St. Joseph	MI	11.5		82.6		57.8
Traverse City	MI	17.3		81.9		50.6
Duluth	MN	16.4		73.7		55.4
Minneapolis	MN	22.0		73.8		54.1
Rochester	MN	15.1		71.8		56.4
St. Cloud	MN	25.8				
St. Paul	MN	20.2		72.6		52.5
Gulfport	MS	20.6		75.6		56.6
Hattiesburg	MS	13.8		76.5		56.4
Jackson	MS	16.6	60.6	75.2	48.1	54.3
Meridian	MS	13.8				
Oxford	MS	21.3				
Tupelo	MS	12.1		82.0		62.4
Cape Girardeau	MO	17.6		75.6		57.5
Columbia	MO	20.1		77.3		53.7
Joplin	MO	20.7		72.4		51.4
Kansas City	MO	18.1	68.6	75.2	47.7	52.6
Springfield	MO	17.6		79.0		51.6
St. Louis	MO	18.7	63.1	75.2	45.7	53.4
Billings	MT	19.1		75.8		61.3
Great Falls	MT	22.6				
Missoula	MT	12.8		76.7		60.2
Lincoln	NE	19.9		71.5		48.0
Omaha	NE	19.4		75.2		56.5
Las Vegas	NV	15.3		79.2		56.4
Reno	NV	12.9		77.5		49.5
Lebanon	NH	18.0		72.5		53.2
Manchester	NH	17.9		77.9		54.2
Camden	NJ	18.4	69.3	73.4	47.5	50.7
Hackensack	NJ	17.9		70.8		47.9

Chapter 3 Table B. Thirty-day readmission rates, amputation-free survival, and re-intervention-free survival following surgical discharge among hospital referral regions (2007-11)

HRR Name	State	Percent of Medicare beneficiaries with diabetes and PAD readmitted within 30 days following revascularization procedure	Amputation-free survival after any vascular procedure among patients with diabetes and PAD		Re-intervention-free survival after any vascular procedure among patients with diabetes and PAD	
			Black	Non-black	Black	Non-black
Morristown	NJ	19.1		71.4		50.1
New Brunswick	NJ	18.6		73.2		54.1
Newark	NJ	19.2	67.2	69.2	44.9	49.2
Paterson	NJ	15.1		73.7		46.5
Ridgewood	NJ	20.1		68.2		46.3
Albuquerque	NM	17.0		70.9		53.1
Albany	NY	23.1		73.4		44.7
Binghamton	NY	15.7		72.6		51.2
Bronx	NY	22.4	64.9	67.0	36.0	41.0
Buffalo	NY	16.8		70.2		49.1
Elmira	NY	19.9		71.6		49.7
East Long Island	NY	18.7	67.1	72.6	38.3	46.5
Manhattan	NY	20.6	63.6	73.9	34.8	43.6
Rochester	NY	18.1		69.6		54.5
Syracuse	NY	16.9		76.4		47.7
White Plains	NY	19.3		69.5		46.1
Asheville	NC	21.1		75.0		59.1
Charlotte	NC	16.0	69.4	78.5	52.8	57.1
Durham	NC	16.1	64.7	74.4	46.4	53.9
Greensboro	NC	17.8		72.1		53.0
Greenville	NC	16.2	65.7	73.2	50.2	53.8
Hickory	NC	15.8		72.9		51.0
Raleigh	NC	16.2	67.8	77.0	44.1	53.6
Wilmington	NC	14.7	73.4	78.5	51.6	55.2
Winston-Salem	NC	21.3		76.0		60.4
Bismarck	ND	18.1		77.3		59.8
Fargo/Moorhead MN	ND	22.8		70.8		48.0
Grand Forks	ND	23.1				
Minot	ND	20.1				
Akron	OH	19.0		67.8		49.1
Canton	OH	21.7		67.5		49.1
Cincinnati	OH	18.6	67.4	73.3	41.4	47.0
Cleveland	OH	21.2	67.0	69.4	40.3	44.8
Columbus	OH	20.0	68.6	74.8	43.7	48.6
Dayton	OH	17.4		76.7		52.9
Elyria	OH	23.9		77.8		49.5
Kettering	OH	12.1		75.7		54.0
Toledo	OH	20.0		75.4		50.0
Youngstown	OH	19.0		70.9		51.1
Lawton	OK	15.8		74.4		51.0
Oklahoma City	OK	16.8		75.2		56.2
Tulsa	OK	17.7		72.2		51.9
Bend	OR	19.7				
Eugene	OR	19.7		75.0		52.7

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Chapter 3 Table B. Thirty-day readmission rates, amputation-free survival, and re-intervention-free survival following surgical discharge among hospital referral regions (2007-11)

HRR Name	State	Percent of Medicare beneficiaries with diabetes and PAD readmitted within 30 days following revascularization procedure	Amputation-free survival after any vascular procedure among patients with diabetes and PAD		Re-intervention-free survival after any vascular procedure among patients with diabetes and PAD	
			Black	Non-black	Black	Non-black
Medford	OR	23.1		74.8		37.9
Portland	OR	20.4		73.4		48.1
Salem	OR	18.6				
Allentown	PA	19.3		70.4		47.3
Altoona	PA	12.8		73.7		53.8
Danville	PA	21.5		70.2		49.4
Erie	PA	15.0		73.3		53.6
Harrisburg	PA	16.0		72.2		52.0
Johnstown	PA	17.4				
Lancaster	PA	16.1		76.1		53.3
Philadelphia	PA	20.1	64.4	73.4	43.1	50.3
Pittsburgh	PA	20.5		70.1		46.4
Reading	PA	18.9		73.1		47.0
Sayre	PA	19.9		80.9		58.7
Scranton	PA	18.8		77.4		53.0
Wilkes-Barre	PA	18.1		73.5		50.4
York	PA	12.8		74.9		54.4
Providence	RI	18.9		69.4		49.8
Charleston	SC	17.6	62.2	78.7	52.5	58.5
Columbia	SC	14.1	66.6	79.8	52.1	59.7
Florence	SC	14.5	68.9	70.5	55.0	50.1
Greenville	SC	14.8		79.8		59.8
Spartanburg	SC	16.7		71.8		55.3
Rapid City	SD	10.5				
Sioux Falls	SD	29.4		73.2		47.4
Chattanooga	TN	15.8		74.7		50.9
Jackson	TN	14.1		73.9		53.8
Johnson City	TN	26.3		79.4		58.0
Kingsport	TN	16.2		75.3		65.2
Knoxville	TN	17.0		73.5		52.8
Memphis	TN	15.1	70.1	78.1	42.8	53.8
Nashville	TN	19.8	67.9	75.9	48.9	51.7
Abilene	TX	12.8		77.8		61.3
Amarillo	TX	17.5		79.7		52.2
Austin	TX	14.5		77.6		59.1
Beaumont	TX	13.3	71.9	77.7	47.6	52.4
Bryan	TX	16.2				
Corpus Christi	TX	16.4		75.4		43.6
Dallas	TX	17.1	61.0	73.6	39.1	49.7
El Paso	TX	17.9		72.6		41.0
Fort Worth	TX	16.8	68.3	74.4	49.4	51.2
Harlingen	TX	13.6		73.1		49.5
Houston	TX	16.8	65.3	74.7	45.5	52.3
Longview	TX	15.3				

Chapter 3 Table B. Thirty-day readmission rates, amputation-free survival, and re-intervention-free survival following surgical discharge among hospital referral regions (2007-11)						
HRR Name	State	Percent of Medicare beneficiaries with diabetes and PAD readmitted within 30 days following revascularization procedure	Amputation-free survival after any vascular procedure among patients with diabetes and PAD		Re-intervention-free survival after any vascular procedure among patients with diabetes and PAD	
			Black	Non-black	Black	Non-black
Lubbock	TX	17.8		77.5		53.9
McAllen	TX	14.6		79.8		52.5
Odessa	TX	17.8		73.2		52.6
San Angelo	TX	19.0		77.3		52.3
San Antonio	TX	20.5		70.5		46.2
Temple	TX	16.4		77.7		53.8
Tyler	TX	19.1		75.6		45.8
Victoria	TX	19.8		74.1		59.0
Waco	TX	14.3		78.8		58.0
Wichita Falls	TX	14.3		81.9		60.5
Ogden	UT	11.8				
Provo	UT	17.2				
Salt Lake City	UT	15.1		73.4		53.9
Burlington	VT	20.7		75.0		54.3
Arlington	VA	16.1	62.2	72.6	41.0	51.5
Charlottesville	VA	23.7		79.1		54.9
Lynchburg	VA	19.0		68.1		53.6
Newport News	VA	13.6	67.1	75.2	45.4	52.9
Norfolk	VA	15.3	65.9	75.6	49.5	52.8
Richmond	VA	17.6	65.7	74.8	40.5	55.2
Roanoke	VA	27.6		67.7		44.2
Winchester	VA	12.3		80.0		59.2
Everett	WA	19.3		71.6		46.6
Olympia	WA	21.1		67.2		42.1
Seattle	WA	17.1		76.1		46.9
Spokane	WA	20.4		72.8		47.7
Tacoma	WA	15.8		72.1		55.1
Yakima	WA	16.2		83.4		61.2
Charleston	WV	17.9		74.4		53.1
Huntington	WV	16.1		76.9		53.9
Morgantown	WV	22.0		75.9		51.8
Appleton	WI	24.9		64.9		40.7
Green Bay	WI	20.1		73.1		46.8
La Crosse	WI	20.3				
Madison	WI	17.0		74.1		54.3
Marshfield	WI	22.9		76.7		53.7
Milwaukee	WI	18.8	67.2	73.5	51.2	50.1
Neenah	WI	27.3				
Wausau	WI	20.0		77.7		52.2
Casper	WY	20.4				

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Variation in the Care of Surgical Conditions: Spinal Stenosis

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Back pain in the United States

Back pain is a leading cause of morbidity and disability in the United States.[1] It is estimated that up to 80% of people will experience low back pain at some point during their lifetimes.[2,3] At any given point in time, about 26% of U.S. adults have low back pain, and 14% have neck pain.[4,5] Back pain that lasts at least two weeks occurs in 13.8% of the U.S. population annually, accounting for 2-3% of all physician visits, and is the second most common reason for hospitalizations.[4,6-8]

About 30 million people in the United States receive professional medical care for a spine problem each year.[9] The prevalence of back pain under treatment remained stable from 1997 to 2005 and then declined slightly between 2006 and 2008, possibly due to a decrease in the use of elective procedures during the economic recession.[9,10] However, while the prevalence of back pain has remained fairly stable over time, the percentage of patients who describe their back pain as "chronic" has increased, from less than 5% in 1992 to more than 10% of all patients with back pain in 2006.[11,12]

Economic burden of low back pain

Low back pain is a leading cause of both lost productivity and medical expenditures. In 2004, over $100 billion was spent in the United States on medical care associated with spine problems—approximately the same amount spent treating cancer, diabetes, or arthritis.[9] On average, patients with back pain have 73% higher health care expenses than patients without back pain (Figure 4.1).

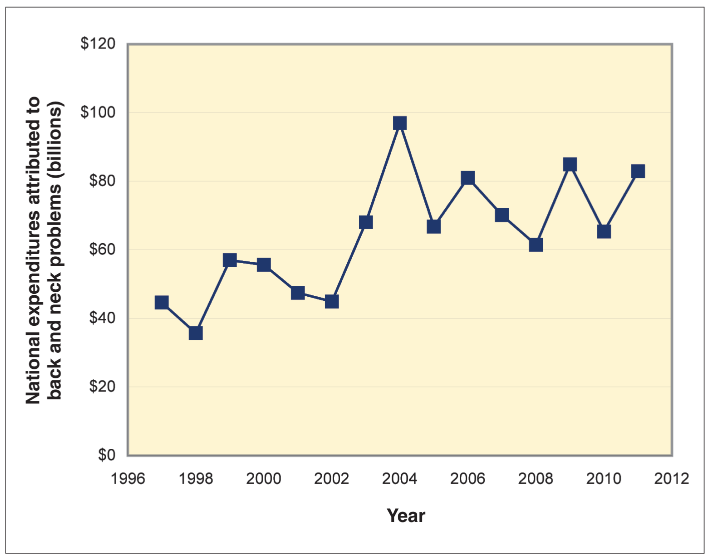


Figure 4.1. National expenditures attributed to back and neck problems, 1997-2011

Source: Medical Expenditure Panel Survey (MEPS).

Wide regional variation in back surgery rates has been reported previously by the Dartmouth Atlas Project.[13] More recently, marked variation in Medicare costs for an average episode of care (a series of health care encounters related to an occurrence of back pain) has been reported across the United States. Much of the variation was explained by the type of operation chosen; for example, admissions involving a spinal fusion operation were more expensive than those involving a decompression alone. Decisions about how to treat patients in the short period of time after they were discharged were also highly variable. Whether patients were discharged to skilled nursing facilities, referred to home health agencies, sent home with instructions for self-care, or used rehabilitation services was an important factor in explaining differences in costs.[14]

A focus on lumbar spinal stenosis

Back pain is a complex problem, but a specific type of back pain, lumbar spinal stenosis, provides a good example that helps to summarize the treatment options, epidemiology, and evidence of effectiveness of treatment. Simply defined, lumbar spinal stenosis is a narrowing of the space within the vertebrae (backbone) where spinal nerves pass. This is caused by an abnormal thickening of the tissues surrounding the spinal cord and vertebral bodies (Figure 4.2). The hallmark of this condition is neurogenic claudication—pain in the leg that occurs while walking—which is relieved by sitting down or bending forward. Symptoms due to stenosis typically progress slowly. However, unlike pain from a disc herniation, symptoms from stenosis rarely resolve, but typically wax and wane over time.[15] Among older adults, spinal stenosis is common, thought to affect about 30% of people age 60 and over.[16]

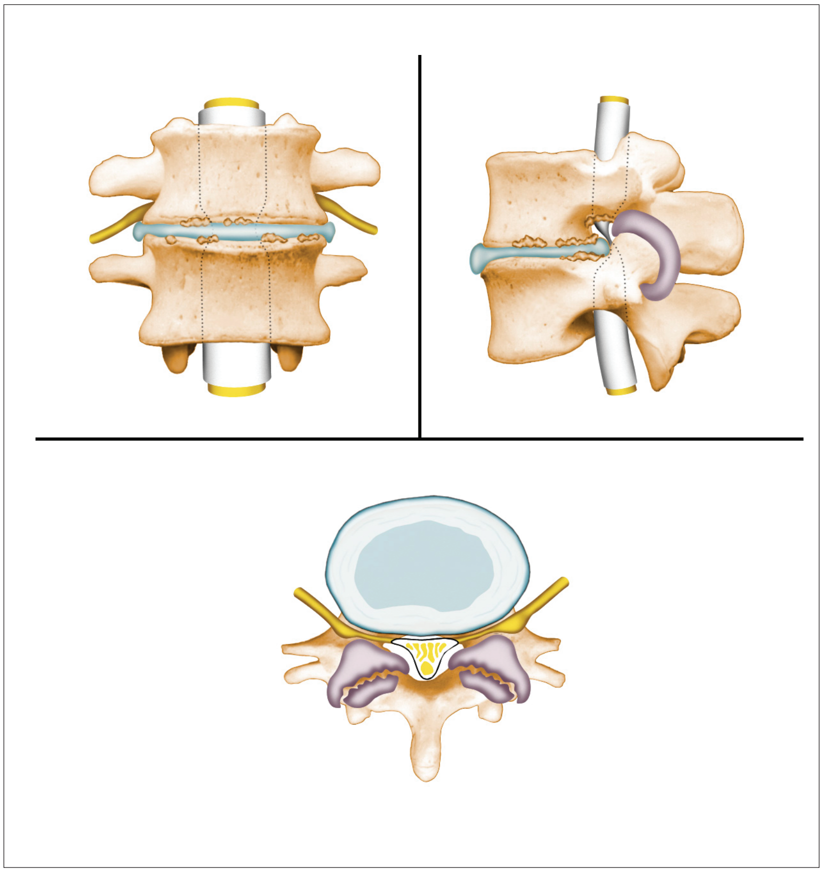


Figure 4.2. Spinal stenosis

Thickening of the tissue surrounding the spinal cord is shown in purple.

The role of imaging: too much or too little?

Spinal stenosis can be difficult to diagnose definitively, in part because there is no reliable test. The diagnosis requires consideration of clinical symptoms, as well as imaging that shows a narrow spinal canal. However, in some patients, a narrow spinal canal causes no symptoms. When combined with a clinical evaluation, imaging studies, such as magnetic resonance imaging (MRI), may help diagnose spinal stenosis. However, radiographic and clinical definitions of stenosis lack consensus,[17-19] and these classifications often correlate poorly with patient reports of pain and disability.[20-22] In fact, spinal abnormalities revealed by imaging are surprisingly common even among asymptomatic people; studies have shown that, among patients without symptoms of back pain, 21% had spinal stenosis, 17% had spine joint problems, and 19% had other abnormalities of the bones and tissues of the spinal canal.[23,24] Although the narrowing of the spinal canal can be measured with imaging, the degree of constriction predicts poorly which patients will benefit from surgery.

Before surgery

Patient decisions about back pain: challenges in treatment choices

There are multiple treatment options for people with lumbar spinal stenosis, including medication and physical therapy, steroid injections, and surgery. While the use of tests and treatments for spinal stenosis has grown in recent years, this increase does not appear to be caused by higher prevalence of the disease;[25] rather, patients are receiving higher intensity care.

Given the many different treatment options for spinal stenosis, many patients would benefit from shared decision-making, a formal process of educating patients about the risks and benefits of treatment options and engaging them in decisions that promote care consistent with their values and preferences. The Spine Center at Dartmouth-Hitchcock Medical Center and Dr. James Weinstein led a National Institutes of Health-funded trial, the Spine Patient Outcomes Research Trial (SPORT), that studied ways to give patients the best information possible about the different treatments for back pain and which decisions were associated with the best outcomes (www.dartmouth-hitchcock.org/spine/sport.html). Similar efforts to help patients make the best, most informed decisions—even in the context of a brief clinic visit—have been undertaken by The Decision Laboratory, led by Dr. Glyn Elwyn (www.optiongrid.org). These decision support tools aim to help patients and providers compare alternative treatment options, even with complex conditions such as back pain and spinal stenosis (Figure 4.3).

As outlined in this report, patients with spinal stenosis often suffer from chronic pain and disability. While successfully navigating these health problems is difficult, resources are available at:

The American Academy of Orthopaedic Surgeons: orthoinfo.aaos.org/topic.cfm?topic=A00575

National Institute of Arthritis and Musculoskeletal and Skin Diseases: www.niams.nih.gov/Health_Info/Back_Pain/

Anthem BlueCross BlueShield: www.anthem.com/wps/portal/ahpprovider?content_path=provider/noapplication/f1/s0/t0/pw_b156442.htm&state=in&rootLevel=1&label=Low%20Back%20Pain%20Tools%20for%20Patients%20and%20Providers

Dartmouth-Hitchcock Medical Center: www.dartmouth-hitchcock.org/medical-information/health_encyclopedia/aa121240#zx3768 option grid®

Spinal stenosis

Use this grid to help you and your healthcare professional talk about how best to treat spinal stenosis. It is for people diagnosed with spinal stenosis who have experienced leg weakness, numbness, or pain that worsens with standing and walking and improves with sitting. It is not for people with loss of bowel and urine control due to pinched nerves in their lower back.

Frequently asked questions	**Managing without injections or surgery**	**Injections (epidural steroids)**	**Surgery**
What does the treatment involve?	Being as active as possible to improve blood flow and taking medicine to relieve pain and swelling around the nerves.	Injection of a local anesthetic and steroid where the nerves are under pressure. This takes around 20 minutes.	A small piece of bone is removed to make a larger space for the nerve(s) in your back. This takes about 2 hours and most people spend 1-2 days in the hospital afterwards.
How soon will I feel better?	6 weeks after the problem starts, about 20 in every 100 people (20%) say they are better.	Studies have had mixed findings. At best, between 15 to 30 in every 100 people (15 to 30%) experience relief. Of those, most feel better in a week or so.	6 weeks after surgery, about 75 in every 100 people (75%) say they feel better.
Which treatment works best in the long-term??	4 years after treatment, about 48 in every 100 people (48%) who manage without surgery say they are better.	It is hard to say. Some studies have shown benefits from steroid injections but others have not.	4 years after surgery, around 59 in every 100 people (59%) say they are better.
What are the main risks/side effects?	The side effects will depend on which pain reliever you use.	Fewer than 1 in every 100 people (>1%) have problems, such as bleeding, headache, and infection.	2 in every 100 people (2%) will get an infection. 1 in every 100 people (1%) will get blood clots. Less than 1 in every 100 people (>1%) will get nerve damage.
How will this treatment impact my ability to care for myself?	You should go about your normal daily activities as much as you are able to.	You will need someone to drive you home after the injection. Most people resume regular activities the day after the injection.	Most people need some help from family and/or friends for 1-2 months following a simple operation. More complex operations require longer healing.
Will I need any other treatment?	No, but you may be asked to see a physical therapist to start an exercise program.	You should take pain relievers as needed and keep active. The injection may be repeated in the future, but usually no more than 2 or 3 times in total.	Most people use pain relievers after the operation. Some need physical therapy after their operation and 15 in every 100 people (15%) need a short stay in a nursing home. Longer term, 6 in every 100 people (6%) need more back operations within 1 year of surgery, 13 in every 100 (13%) within 4 years; and 25 in every 100 (25%) within 10 years.

Editors: Thom Walsh, Ben Dropkin, Sohail Mirza, Michael Lewis, Glyn Elwyn.
Evidence document: http://www.optiongrid.org/resources/spinalstenosis_evidence.pdf
Last update: 7 October 2014 **Next update:** 1 November 2015 **ISBN:** 978-0-9926733-1-4 **License:** CC BY-NC-ND 4.0 (International)
Download the most current version from: http://www.optiongrid.org

Figure 4.3. Option grid for spinal stenosis

Source: The Option Grid Collaborative (www.optiongrid.org).

Non-surgical options for the treatment of spinal stenosis

Medical management: Medications are commonly used as initial therapy for common spinal problems, including spinal stenosis. Typical medications include non-steroidal anti-inflammatory drugs (NSAIDs), analgesics, COX-2 inhibitors, muscle relaxants, certain anticonvulsants (e.g., Neurontin), and certain anti-depression medications (e.g., Cymbalta). Systematic reviews highlight a moderate short-term benefit of most of these drugs to relieve pain, but, like nearly all medications, they also have risks.[26-28]

Although the use of opioids (also referred to as narcotics) in the treatment of back pain has been discouraged in clinical guidelines, there was a 423% increase in opioid use among people with back problems from 1997 to 2005.[25] The availability of more potent opioid analgesics since 1997 has been accompanied by higher rates of opioid-related complications, leading to emergency department visits, psychiatric conditions, and death.[26,29-31] It is unclear why these treatment patterns have occurred, as the wide geographic variation in opioid use does not appear to reflect disease prevalence, injury, or surgical procedures.[32] Opioid use for the long-term management of chronic spinal problems is not supported by scientific evidence of safety and effectiveness.[33,34] While more than half of "regular" prescription opioid users have back pain,[35] a report from the Cochrane collaboration states that "… opioids for long-term management of chronic [low back pain] remains questionable" and guidelines from the American College of Physicians and the American Pain Society have called for reassessing patients who fail to respond to a time-limited course of opioids.[26,33,36]

Non-operative therapy: The benefits of medical care, chiropractic care, physical therapy, and other non-surgical interventions to treat spinal stenosis have not been demonstrated.[16,37,38] There is some evidence that exercise improves leg pain and functioning compared to no treatment, but these measures do not alter the natural progression of stenosis.[39] Nevertheless, one-third of the patients in the Spine Patient Outcomes Research Trial (SPORT) study's unstructured non-operative treatment group reported significant improvements in symptoms at four years.[40] This may be as due to "tincture of time" as any treatment offered.

Epidural steroid injections: Wide geographic variation in epidural steroid injections has also been reported in the United States. Their use does not correlate to evidence-based indications of sciatica or radiculopathy;[41,42] does not reduce the rate of subsequent surgery;[43-48] and does not appear to obviate the need for opioids, surgery, or medical visits among the elderly U.S. population.[42,49] One recent large randomized trial found no short-term benefit of epidural steroid injection relative to injection with lidocaine, a short-term anesthetic, in treating patients with lumbar spinal stenosis.[50]

During surgery

Older treatments or newer methods? Trends and geographic variation in surgical treatments for spinal stenosis

Surgical interventions have evolved from traditional decompression—where the tissue compressing the spinal nerves is removed—to include both more invasive types of operations such as spinal fusion, where the spine bones are fixed together, and less invasive procedures such as minimally invasive or percutaneous (through the skin) decompression. Over 94,000 inpatient operations for lumbar stenosis were performed in the United States in 2011, with national hospital costs exceeding $2.3 billion (according to unpublished data from the Healthcare Cost and Utilization Project). There are no recent studies documenting the rate of ambulatory or outpatient decompression operations for spinal stenosis in the United States.

Figure 4.4 shows the rates of initial (incident) inpatient decompression and fusion operations for lumbar spinal stenosis among Medicare fee-for-service beneficiaries age 65 and over. These estimates exclude patients who had other spine problems, such as spinal fractures, or a diagnosis of cancer. The rate of spinal fusion operations for stenosis increased 67%, from 31.6 per 100,000 Medicare beneficiaries in 2001 to 52.7 per 100,000 Medicare beneficiaries in 2011.

Surgical decompression of the spinal canal, such as laminectomy (removing the rear piece of the vertebrae), eliminates pressure on the spinal nerve roots. A variety of surgical techniques is used, with recent advances toward minimally invasive and microscopic techniques.[51,52] The rates of inpatient decompression among older adults have declined as fusion operations have increased and as decompression is increasingly performed as an outpatient procedure (Figure 4.4).

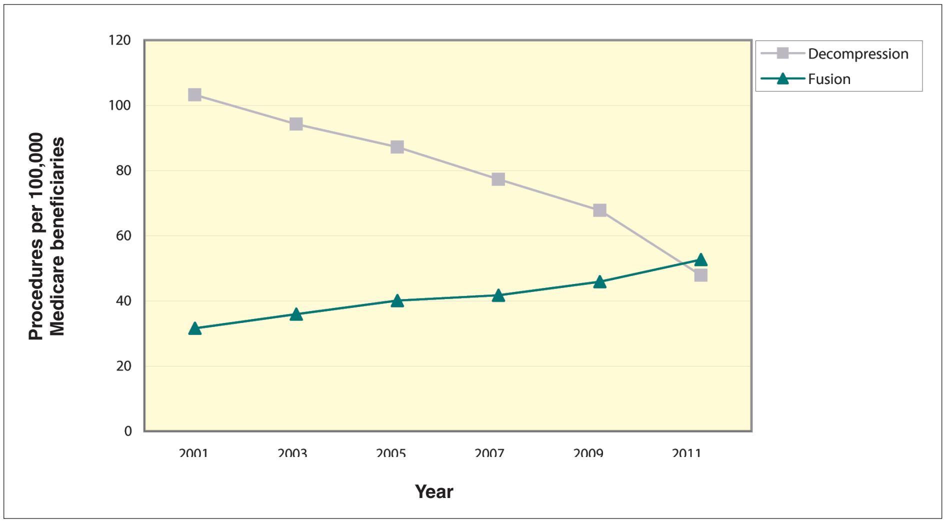
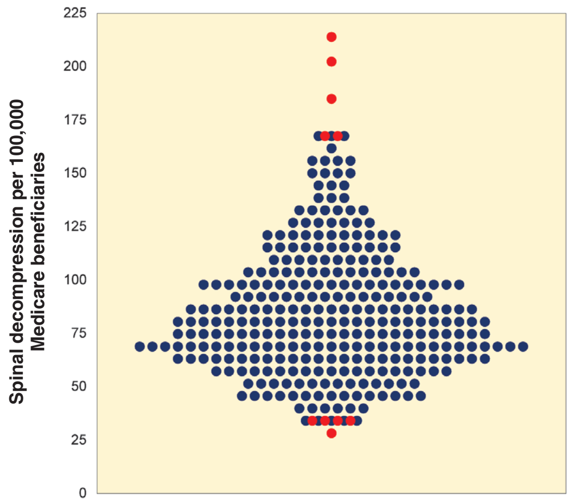


Figure 4.4. Trends in rates of spinal decompression and fusion, 2001 to 2011

The rates shown in the figure represent decompression and fusion procedures for patients with a diagnosis of lumbar spinal stenosis among all Medicare fee-for-service beneficiaries.

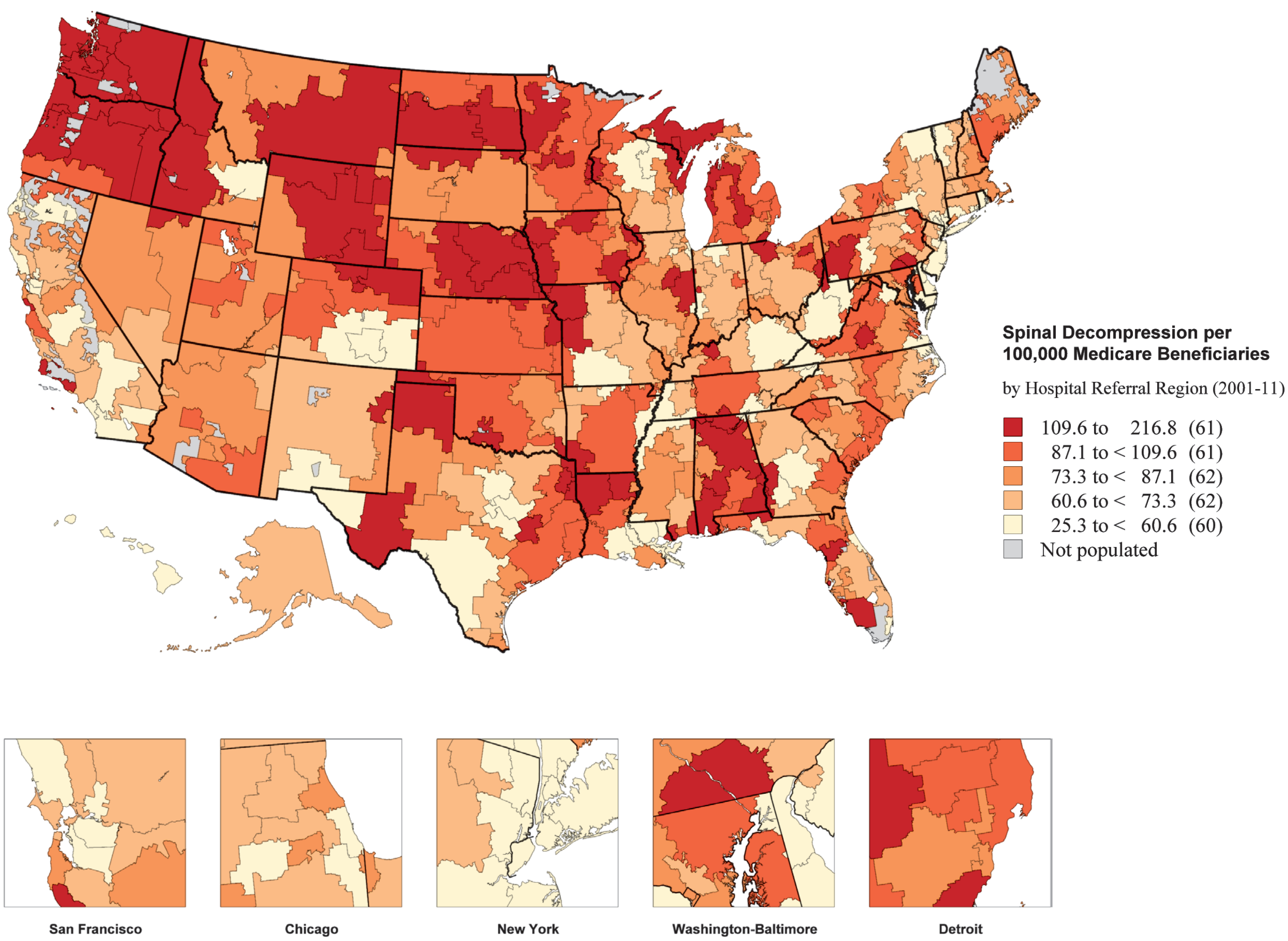
During the period comprising 2001 through 2011, inpatient spinal decompressions for lumbar spinal stenosis were performed at a rate of 80.0 per 100,000 Medicare beneficiaries across the United States. The rate varied more than eightfold among hospital referral regions, from fewer than 35 procedures per 100,000 in the Bronx, New York (25.3), Miami, Florida (31.8), and South Bend, Indiana (34.8) to more than 180 per 100,000 in Mason City, Iowa (216.7), Tacoma, Washington (200.7), and Bloomington, Illinois (186.6) (Figure 4.5). Rates of spinal decompression were generally higher in the Pacific Northwest and northern Mountain states than in other parts of the country (Map 4.1).



Mason City, IA	216.7
Tacoma, WA	200.7
Bloomington, IL	186.6
Slidell, LA	167.3
Monroe, LA	166.8
Newark, NJ	35.8
Manhattan, NY	35.6
South Bend, IN	34.8
Miami, FL	31.8
Bronx, NY	25.3

Figure 4.5. Inpatient spinal decompression per 100,000 Medicare beneficiaries among hospital referral regions (2001-11)

Each blue dot represents the rate of spinal decompression for lumbar spinal stenosis in one of 306 hospital referral regions in the U.S. Red dots indicate the regions with the 5 lowest and 5 highest rates.

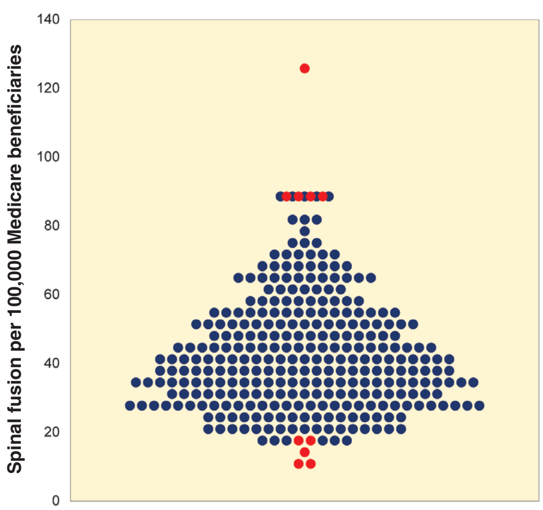


Map 4.1. Inpatient spinal decompression per 100,000 Medicare beneficiaries (2001-11)

Rates are adjusted for age, sex, and race. The average was created based on odd-numbered years from 2001 to 2011.

While decompression procedures are well established for treating stenosis, fusion operations are an increasingly popular, but controversial, treatment option (Figure 4.4).[53] Spinal fusion is intended to eliminate back pain by joining together two or more adjacent vertebrae under the theory that stabilization will reduce symptoms. The procedure frequently involves implanting cages, rods, or other instrumentation to join vertebrae together. The evidence of the effectiveness of lumbar fusion surgery for treating spinal stenosis (in the absence of significant curvature, called scoliosis, or slipping of a vertebra, called spondylolisthesis) has not been fully established.[54] A meta-analysis by Turner et al was among the first to find little evidence supporting fusion surgery for spinal stenosis, reporting large variation in satisfactory results.[55] On the other hand, a European cohort study found that fusion operations led to better patient-reported outcomes compared to decompression alone, although fusion increased the risk for surgical complications and repeat operations.[56]

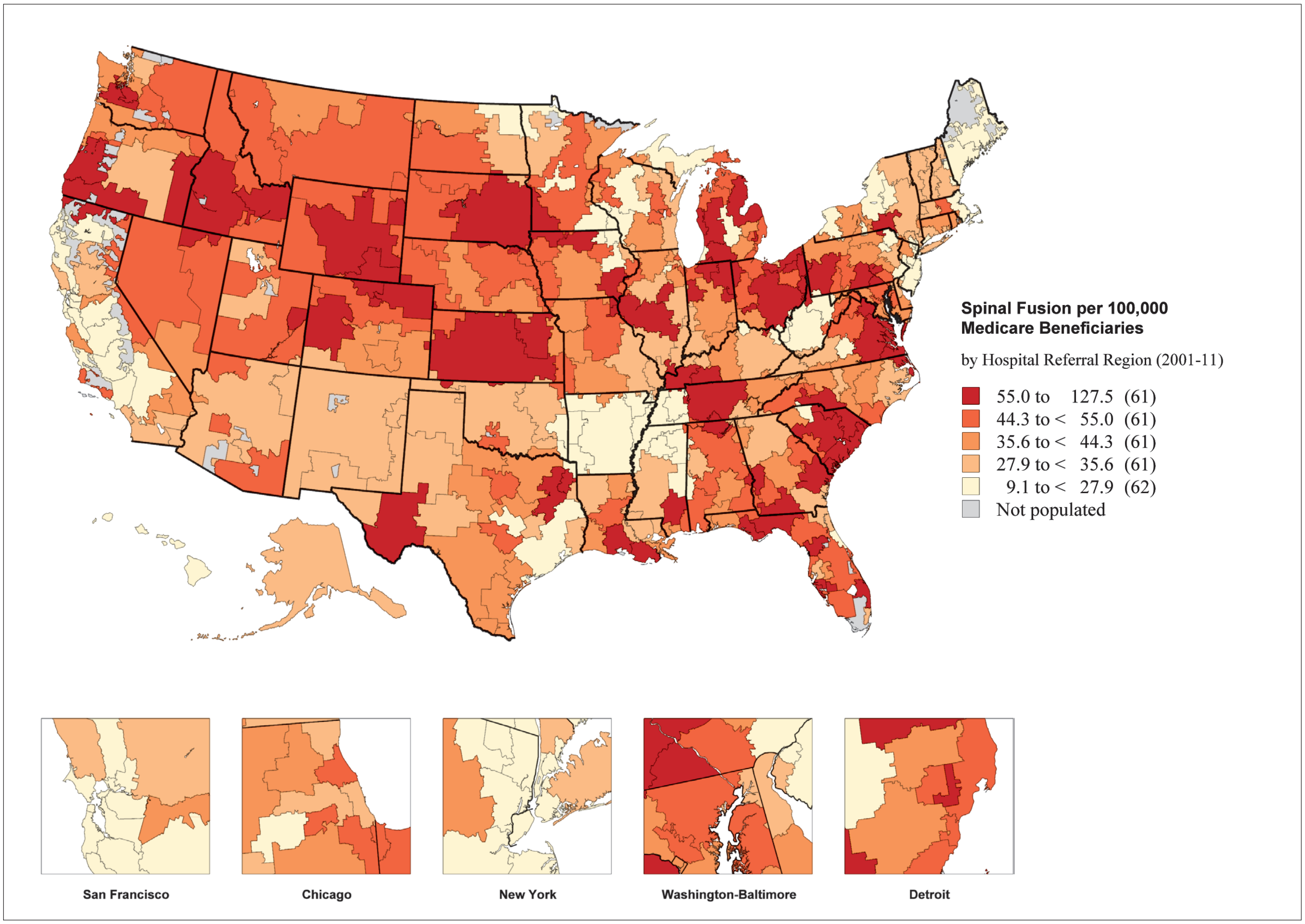
The average rate of inpatient spinal fusion for lumbar spinal stenosis during the period from 2001 to 2011 in the United States was 41.1 per 100,000 Medicare beneficiaries. The fusion rate varied by a factor of more than fourteen across hospital referral regions, from 9.2 procedures per 100,000 in Bangor, Maine to 127.5 per 100,000 in Bradenton, Florida (Figure 4.6). Regions with relatively low fusion rates included Fresno, California (12.5), Alameda County, California (14.9), and Scranton, Pennsylvania (17.1). More than 80 procedures per 100,000 were performed in Grand Rapids, Michigan (89.9), Mason City, Iowa (89.2), and Tyler, Texas (88.5) (Map 4.2).



Bradenton, FL	127.5
Grand Rapids, MI	89.9
Mason City, IA	89.2
Tyler, TX	88.5
Newport News, VA	87.4
Bronx, NY	17.5
Scranton, PA	17.1
Alameda County, CA	14.9
Fresno, CA	12.5
Bangor, ME	9.2

Figure 4.6. Inpatient spinal fusion per 100,000 Medicare beneficiaries among hospital referral regions (2001-11)

Each blue dot represents the rate of spinal fusion for lumbar spinal stenosis in one of 306 hospital referral regions in the U.S. Red dots indicate the regions with the 5 lowest and 5 highest rates.



Map 4.2. Inpatient spinal fusion per 100,000 Medicare beneficiaries (2001-11)

Rates are adjusted for age, sex, and race. The average was created based on odd-numbered years from 2001 to 2011.

After surgery

Two small randomized trials have demonstrated that, on average, surgical decompression improves patient-reported measures of pain, disability, and quality of life compared to non-operative treatments.[57,58] Other comparative effectiveness studies examining the potential benefits and harms of surgery for spinal stenosis have helped to provide further guidance. Surgical patients with spinal stenosis in the Maine Lumbar Spine Study (MLSS) had greater improvements in patient-reported measures of pain and function through a ten-year follow-up compared to non-surgical patients; however, the surgical advantage narrowed over time.[59] The SPORT study reported better pain relief and functional recovery with surgical treatment than with non-surgical treatment for patients with spinal stenosis.[40] Overall, decompression procedures appear to have moderate efficacy for stenosis, but these results lessen with time,[53] and many patients still have significant problems. At a median four years of follow-up in one cohort study, 17% of patients had undergone a repeat operation, and 30% reported severe pain.[14]

Complications

Compared to decompression procedures alone, complex fusion operations (defined as those involving combined surgical approaches or multiple vertebral levels) are associated with greater risks of life-threatening complications, mortality, and increased health care utilization.[60] After adjustment for age, comorbidity, previous spine surgery, and other features in a Medicare population, the likelihood of a life-threatening complication with complex fusions compared to decompressions was almost three times higher. Rehospitalizations within 30 days occurred for 7.8% of patients undergoing decompression compared to 13.0% having a complex fusion. Among Medicare patients undergoing any type of spine surgery for lumbar stenosis, with or without spondylolisthesis, the two-year reoperation rate was 17%. In addition, 25% were readmitted to the hospital due to a surgery-related complication.[61]

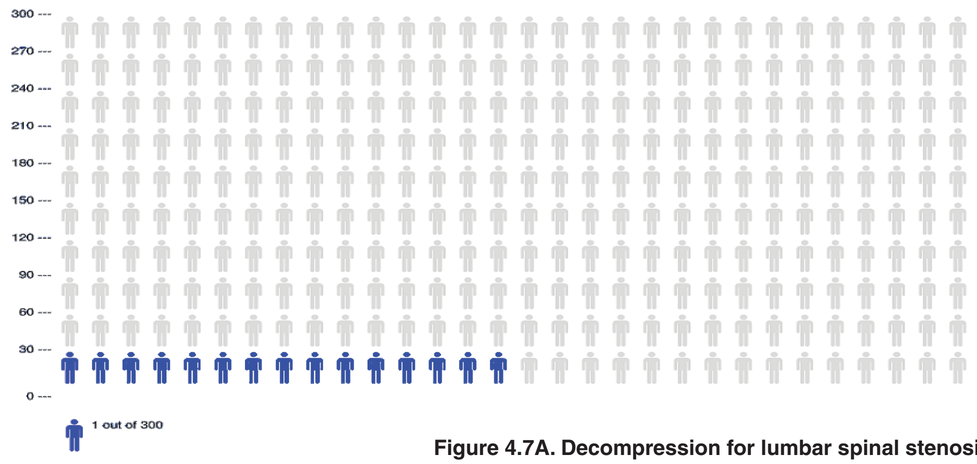


Figure 4.7A. Decompression for lumbar spinal stenosis
15 out of 300 (5.1%).

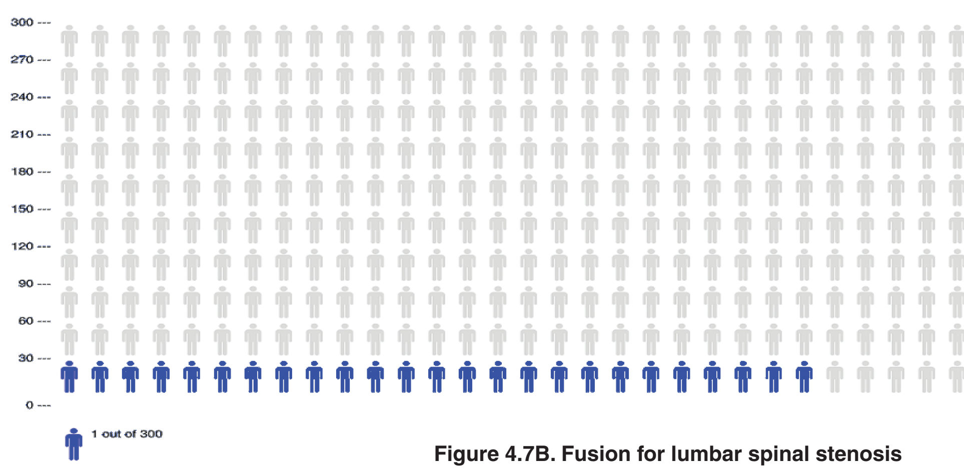


Figure 4.7B. Fusion for lumbar spinal stenosis
25 out of 300 (8.4%).

Figure 4.7. Risk of death after inpatient surgical procedure for lumbar spinal stenosis

Table 4.1. Surgical safety outcomes following inpatient operation for lumbar spinal stenosis among Medicare beneficiaries

Outcome	Decompression	Fusion
Life-threatening complications	1.7%	2.8%
Wound problems	1.9%	3.4%
All-cause readmission	6.8%	8.8%
Reoperation (1 year)	5.2%	4.7%
Reoperation (5 year)	14.0%	16.0%
Reoperation (10 year)	17.9%	20.7%

Adjusted for age group, sex, comorbidity, and previous hospitalization. Analysis based on approach reported in: Deyo RA et al. Trends, major medical complications, and charges associated with surgery for lumbar spinal stenosis in older adults. *JAMA.* 20:303(13);1259-65. Updated with additional years of combined data.

Table 4.1 and Figure 4.8 show the rates of postoperative surgical complications and repeat spine surgeries among Medicare beneficiaries undergoing an initial inpatient lumbar spine operation for spinal stenosis (without spondylolisthesis or scoliosis). On average, during the five-year period after surgery, 16% of patients required a second operation among those with fusion and 14% among those with decompression, even after adjusting for differences in patient age, sex, comorbidity, and hospitalizations in the previous year. Fusion operations were associated with greater risk of wound problems and life-threatening complications within 30 days, as well as a significantly higher rate of all-cause repeat hospitalizations.

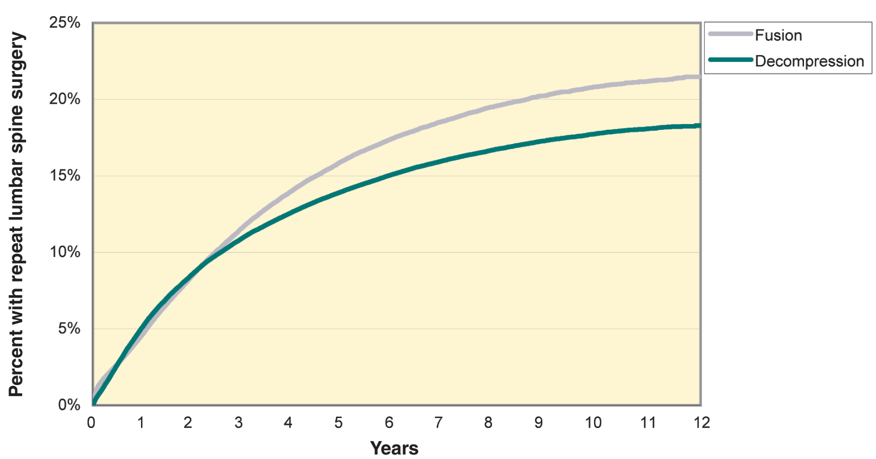


Figure 4.8. Cumulative incidence of repeat lumbar spine operations following initial inpatient decompression or fusion for lumbar spinal stenosis among Medicare fee-for-service beneficiaries, 2000-11

Source: CMS MedPAR. Estimates based on Kaplan-Meier Failure, following methods reported in: Deyo RA et al. Revision surgery following operations for lumbar stenosis. *J Bone Joint Surg Am.* 2011 Nov 2;93(21):1979-86. Updated with additional years of data.

Can less invasive alternatives help? New technology, but what evidence?

Interspinious process devices (such as the X-Stop© device, approved by the FDA in late 2005) have recently emerged as a less invasive alternative to decompression procedures. These devices are inserted between the spinous processes of adjacent vertebrae and spread the vertebrae apart to prevent the nerve canals from pressing on the nerves. While industry-sponsored randomized trials suggest an advantage over non-surgical treatments, there are only a few clinical trials comparing them to decompression.[62-64] While these devices can be placed using only local anesthetics, their use is associated with a higher incidence of reoperation. Interspinous distraction procedures appear to have fewer life-threatening complications at the time of the operation, but lead to more subsequent revision operations.[65,66] Other minimally invasive decompression techniques are under development, but the evidence necessary to support their use remains limited.

Beyond surgery

Trends and variation in treatments for lumbar spinal stenosis likely reflect an aging population, a lack of consensus about the best treatment options, and changes in surgical technologies. While decompression may remain the gold standard for patients for whom non-operative treatments have failed, it is increasingly performed on an outpatient basis, using minimally invasive techniques, and incorporating spinal spacers. Additionally, some patients may seek to undergo lumbar fusion operations. Some have viewed fusion as obviating the need for additional treatments. Sadly, this does not bear out in observation of readmissions, complications, and repeat spine surgery rates.

The need for shared decision-making

The complex and changing treatment options highlight the need for the development of better tools to help patients to make the best, most informed treatment choices. Prior work by the Dartmouth Atlas Project has shown that the marked regional variation in surgery for back pain reflects the local practice styles of spine surgeons. For the individual patient, there is often not a single "right" treatment choice. Each has the potential to benefit the patient, but benefit is not certain. Each also entails the possibility of harm or the need for further surgery. In ideal settings, patients should be informed about these options and given the opportunity to participate in shared decision-making, allowing their values and preferences to guide them to the best decision for them.

Treatment Options	Decision Support Tool Components			Patient Outcomes
	Patient Needs	Decision Support	Decision Quality	
Medication Physical therapy Steroid injections Surgery - Decompression - Fusion	Clarification of individual values and preferences Knowledge of procedure risks, benefits, and other considerations	**Continuously updated, patient-specific data regarding risks and benefits** Guidance for the patient/surgeon interaction Other considerations	Assessment of patient knowledge and understanding Assessment of congruence with pre-specified values and preferences	Measurement of: Pain reduction Quality of life Surgical complications 30-day readmission Need for repeat surgery

Figure 4.9. Conceptual model for decision support process

Procedures such as spinal fusion have become increasingly common in recent years. These operations, unfortunately, can result in complications, some requiring readmission to the hospital. These findings point to significant opportunities to improve safety and effectiveness in treating back pain. Long-term surveillance of safety measures and patient-reported outcomes are rare in spine surgery but are critically important for informing patients and other stakeholders about the value of spinal procedures.

Conclusions

Surgery for back pain, especially for patients with spinal stenosis, has changed dramatically in recent years but continues to vary from one region to the next. While surgical outcomes research has provided information about when and how these changes have occurred over time, patients are still subject to the accident of geography. In one region, patients are more likely to be offered decompression; in another, fusion; and in a third, medical management may be more common. We know very little about how the variation in care patterns has affected patients and their lives. While more needs to be done to improve the treatments for spinal stenosis and back pain, there is a more immediate opportunity to improve care by implementing shared decision-making. A higher quality decision-making process would help patients find the choice best aligned with their values and preferences.

Chapter 4 Table. Rates of inpatient lumbar decompression and fusion for lumbar spinal stenosis among hospital referral regions (2001-11)

HRR Name	State	Number of Medicare beneficiaries	Lumbar decompression per 100,000 Medicare beneficiaries	Lumbar fusion per 100,000 Medicare beneficiaries
Birmingham	AL	1,398,742	124.6	44.7
Dothan	AL	282,577	121.3	50.0
Huntsville	AL	402,264	118.5	65.4
Mobile	AL	464,724	119.6	44.8
Montgomery	AL	272,362	96.2	37.2
Tuscaloosa	AL	167,593	82.2	28.0
Anchorage	AK	254,882	63.5	35.5
Mesa	AZ	398,308	74.9	34.2
Phoenix	AZ	1,324,677	76.6	31.9
Sun City	AZ	267,810	93.1	50.0
Tucson	AZ	572,030	97.6	49.7
Fort Smith	AR	250,102	62.8	24.1
Jonesboro	AR	174,688	100.3	24.6
Little Rock	AR	1,130,527	109.5	27.6
Springdale	AR	292,036	61.0	22.5
Texarkana	AR	194,169	128.0	27.4
Orange County	CA	1,061,288	46.7	30.8
Bakersfield	CA	372,840	63.1	18.4
Chico	CA	237,544	80.5	29.7
Contra Costa County	CA	332,781	52.5	25.0
Fresno	CA	465,467	37.0	12.5
Los Angeles	CA	3,308,910	61.7	22.8
Modesto	CA	366,226	74.3	26.1
Napa	CA	183,811	67.6	25.4
Alameda County	CA	480,509	48.3	14.9
Palm Springs/Rancho Mirage	CA	220,793	66.1	36.9
Redding	CA	275,138	54.1	18.9
Sacramento	CA	978,357	67.9	28.9
Salinas	CA	219,866	108.5	39.3
San Bernardino	CA	664,846	54.2	23.0
San Diego	CA	1,205,041	57.7	29.2
San Francisco	CA	611,589	62.2	19.9
San Jose	CA	577,960	60.8	17.6
San Luis Obispo	CA	170,941	63.9	21.2
San Mateo County	CA	327,617	82.8	26.1
Santa Barbara	CA	234,230	153.9	45.0
Santa Cruz	CA	127,842	140.4	21.6
Santa Rosa	CA	214,000	47.6	28.5
Stockton	CA	224,961	63.1	40.2
Ventura	CA	361,823	121.1	45.9
Boulder	CO	101,347	110.6	68.4
Colorado Springs	CO	381,179	47.9	41.1
Denver	CO	848,970	89.6	46.1
Fort Collins	CO	168,987	120.5	59.8

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period. The averages were created based on odd-numbered years from 2001 to 2011.

Chapter 4 Table. Rates of inpatient lumbar decompression and fusion for lumbar spinal stenosis among hospital referral regions (2001-11)

HRR Name	State	Number of Medicare beneficiaries	Lumbar decompression per 100,000 Medicare beneficiaries	Lumbar fusion per 100,000 Medicare beneficiaries
Grand Junction	CO	159,589	91.0	64.3
Greeley	CO	185,433	146.8	64.0
Pueblo	CO	103,911	44.0	42.5
Bridgeport	CT	419,634	82.7	24.0
Hartford	CT	1,039,959	70.0	39.5
New Haven	CT	965,608	54.7	34.8
Wilmington	DE	500,184	40.6	30.7
Washington	DC	1,441,278	81.3	39.6
Bradenton	FL	261,124	85.5	127.5
Clearwater	FL	385,591	84.7	48.6
Fort Lauderdale	FL	1,715,571	68.2	65.9
Fort Myers	FL	1,053,852	112.7	47.7
Gainesville	FL	373,306	104.7	49.5
Hudson	FL	349,227	100.8	45.1
Jacksonville	FL	854,278	84.6	35.6
Lakeland	FL	229,025	79.4	43.2
Miami	FL	1,068,243	31.8	31.5
Ocala	FL	637,897	134.9	60.0
Orlando	FL	2,222,114	65.6	54.2
Ormond Beach	FL	301,636	53.9	27.7
Panama City	FL	157,359	46.8	64.6
Pensacola	FL	527,166	102.0	41.5
Sarasota	FL	547,740	77.2	80.5
St. Petersburg	FL	278,090	118.1	36.4
Tallahassee	FL	420,477	69.0	61.2
Tampa	FL	542,844	67.1	30.5
Albany	GA	125,218	53.0	52.9
Atlanta	GA	2,441,602	65.7	32.8
Augusta	GA	396,573	66.7	47.9
Columbus	GA	195,141	125.0	81.7
Macon	GA	435,234	58.7	39.6
Rome	GA	188,040	87.1	35.6
Savannah	GA	488,566	97.3	58.7
Honolulu	HI	576,993	40.3	26.8
Boise	ID	401,406	120.2	86.9
Idaho Falls	ID	110,210	59.6	70.9
Aurora	IL	111,932	43.7	21.5
Blue Island	IL	572,392	59.9	51.9
Chicago	IL	1,238,208	46.4	28.4
Elgin	IL	364,742	68.5	39.1
Evanston	IL	756,091	86.9	51.9
Hinsdale	IL	249,779	73.5	48.0
Joliet	IL	372,502	65.4	36.9
Melrose Park	IL	777,643	69.6	35.0

Chapter 4 Table. Rates of inpatient lumbar decompression and fusion for lumbar spinal stenosis among hospital referral regions (2001-11)

HRR Name	State	Number of Medicare beneficiaries	Lumbar decompression per 100,000 Medicare beneficiaries	Lumbar fusion per 100,000 Medicare beneficiaries
Peoria	IL	500,641	73.3	33.7
Rockford	IL	503,483	60.6	42.0
Springfield	IL	725,016	77.7	79.9
Urbana	IL	293,657	147.7	33.7
Bloomington	IL	106,732	186.6	72.5
Evansville	IN	523,772	83.3	32.0
Fort Wayne	IN	521,594	67.8	83.5
Gary	IN	357,341	64.4	53.1
Indianapolis	IN	1,729,082	69.9	36.2
Lafayette	IN	120,404	71.7	68.1
Muncie	IN	133,807	98.4	71.7
Munster	IN	221,961	82.2	53.9
South Bend	IN	463,173	34.8	74.3
Terre Haute	IN	141,641	49.9	32.9
Cedar Rapids	IA	199,297	74.4	20.4
Davenport	IA	379,339	107.5	54.3
Des Moines	IA	785,272	101.8	40.6
Dubuque	IA	87,363	139.2	32.9
Iowa City	IA	232,634	118.3	56.8
Mason City	IA	149,020	216.7	89.2
Sioux City	IA	206,199	112.6	48.3
Waterloo	IA	159,472	88.0	44.8
Topeka	KS	321,952	98.3	66.6
Wichita	KS	974,015	92.7	58.4
Covington	KY	200,691	83.3	18.0
Lexington	KY	915,667	50.0	27.9
Louisville	KY	1,098,043	68.9	39.8
Owensboro	KY	107,837	116.0	32.0
Paducah	KY	324,320	63.7	60.4
Alexandria	LA	204,932	106.4	49.7
Baton Rouge	LA	370,119	38.0	30.6
Houma	LA	145,992	73.8	56.4
Lafayette	LA	378,712	48.9	60.4
Lake Charles	LA	165,315	94.8	43.1
Metairie	LA	207,018	53.7	29.3
Monroe	LA	201,108	166.8	38.5
New Orleans	LA	235,393	48.6	37.2
Shreveport	LA	486,473	124.0	35.0
Slidell	LA	92,030	167.3	42.1
Bangor	ME	343,868	83.6	9.2
Portland	ME	813,159	91.6	27.0
Baltimore	MD	1,598,239	91.3	48.9
Salisbury	MD	393,863	54.0	38.8
Takoma Park	MD	440,271	70.0	50.4

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period. The averages were created based on odd-numbered years from 2001 to 2011.

Chapter 4 Table. Rates of inpatient lumbar decompression and fusion for lumbar spinal stenosis among hospital referral regions (2001-11)

HRR Name	State	Number of Medicare beneficiaries	Lumbar decompression per 100,000 Medicare beneficiaries	Lumbar fusion per 100,000 Medicare beneficiaries
Boston	MA	2,905,066	85.4	26.8
Springfield	MA	469,764	72.0	33.7
Worcester	MA	307,221	77.4	50.2
Ann Arbor	MI	771,202	83.7	41.1
Dearborn	MI	342,156	73.3	52.1
Detroit	MI	1,108,678	95.1	54.3
Flint	MI	339,333	88.1	39.9
Grand Rapids	MI	605,380	106.3	89.9
Kalamazoo	MI	432,238	96.4	55.4
Lansing	MI	388,435	134.8	27.1
Marquette	MI	171,068	116.6	19.6
Muskegon	MI	178,442	131.9	57.9
Petoskey	MI	153,544	74.0	52.3
Pontiac	MI	239,421	102.5	53.8
Royal Oak	MI	459,439	84.0	69.4
Saginaw	MI	555,906	100.3	68.1
St. Joseph	MI	109,088	100.3	22.4
Traverse City	MI	206,670	117.3	54.6
Duluth	MN	257,760	96.9	36.8
Minneapolis	MN	1,434,362	102.2	45.9
Rochester	MN	298,010	104.1	21.1
St. Cloud	MN	130,611	166.7	20.4
St. Paul	MN	400,552	123.4	41.9
Gulfport	MS	114,522	104.0	41.6
Hattiesburg	MS	195,547	60.6	69.4
Jackson	MS	666,746	75.4	33.3
Meridian	MS	149,597	79.0	20.5
Oxford	MS	97,154	79.6	23.0
Tupelo	MS	269,844	66.5	17.9
Cape Girardeau	MO	218,620	85.5	34.4
Columbia	MO	520,521	70.2	54.2
Joplin	MO	292,890	89.7	50.3
Kansas City	MO	1,338,356	112.7	40.2
Springfield	MO	594,758	56.1	41.7
St. Louis	MO	1,977,157	68.5	32.6
Billings	MT	394,864	125.9	54.7
Great Falls	MT	113,357	79.8	40.5
Missoula	MT	274,625	78.6	48.7
Lincoln	NE	445,555	123.5	43.5
Omaha	NE	847,677	119.1	45.3
Las Vegas	NV	694,803	68.3	40.6
Reno	NV	419,773	81.8	44.9
Lebanon	NH	346,236	71.0	32.3
Manchester	NH	576,524	81.2	35.1

Chapter 4 Table. Rates of inpatient lumbar decompression and fusion for lumbar spinal stenosis among hospital referral regions (2001-11)

HRR Name	State	Number of Medicare beneficiaries	Lumbar decompression per 100,000 Medicare beneficiaries	Lumbar fusion per 100,000 Medicare beneficiaries
Camden	NJ	2,018,098	48.4	24.7
Hackensack	NJ	855,222	43.5	27.2
Morristown	NJ	657,767	64.8	35.7
New Brunswick	NJ	609,813	48.5	23.7
Newark	NJ	828,334	35.8	18.6
Paterson	NJ	242,770	63.4	20.0
Ridgewood	NJ	276,298	60.0	21.6
Albuquerque	NM	798,793	72.0	33.5
Albany	NY	1,232,672	65.9	33.8
Binghamton	NY	297,971	55.2	55.1
Bronx	NY	447,503	25.3	17.5
Buffalo	NY	692,313	71.0	26.9
Elmira	NY	266,299	61.9	20.4
East Long Island	NY	2,629,006	38.5	30.9
Manhattan	NY	2,320,335	35.6	23.2
Rochester	NY	499,889	100.2	37.5
Syracuse	NY	729,887	83.0	27.7
White Plains	NY	712,135	57.6	31.5
Asheville	NC	578,469	74.7	47.2
Charlotte	NC	1,270,661	72.4	65.2
Durham	NC	845,359	91.7	37.1
Greensboro	NC	315,613	84.0	28.3
Greenville	NC	560,227	69.9	31.9
Hickory	NC	203,696	88.7	51.9
Raleigh	NC	938,652	83.1	36.4
Wilmington	NC	306,199	82.7	50.2
Winston-Salem	NC	610,810	66.0	39.2
Bismarck	ND	184,179	130.2	44.4
Fargo/Moorhead MN	ND	375,347	110.3	33.7
Grand Forks	ND	123,966	95.8	25.0
Minot	ND	104,868	88.9	37.3
Akron	OH	376,023	142.0	76.4
Canton	OH	385,753	108.1	54.7
Cincinnati	OH	879,493	73.4	41.9
Cleveland	OH	1,340,774	76.0	57.2
Columbus	OH	1,636,441	64.6	55.5
Dayton	OH	711,358	72.9	51.4
Elyria	OH	163,416	95.1	31.7
Kettering	OH	255,125	64.4	65.1
Toledo	OH	607,040	131.7	51.0
Youngstown	OH	448,648	78.9	55.4
Lawton	OK	138,559	112.7	47.6
Oklahoma City	OK	1,176,503	95.7	29.3
Tulsa	OK	788,484	76.9	29.3

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period. The averages were created based on odd-numbered years from 2001 to 2011.

Chapter 4 Table. Rates of inpatient lumbar decompression and fusion for lumbar spinal stenosis among hospital referral regions (2001-11)

HRR Name	State	Number of Medicare beneficiaries	Lumbar decompression per 100,000 Medicare beneficiaries	Lumbar fusion per 100,000 Medicare beneficiaries
Bend	OR	121,059	154.2	33.1
Eugene	OR	391,361	149.8	57.2
Medford	OR	323,665	107.2	60.1
Portland	OR	898,954	149.0	42.3
Salem	OR	100,701	127.5	47.3
Allentown	PA	824,563	89.5	33.5
Altoona	PA	179,896	54.3	50.4
Danville	PA	360,304	70.1	41.6
Erie	PA	512,378	93.6	37.5
Harrisburg	PA	696,969	85.8	64.6
Johnstown	PA	113,991	93.3	44.8
Lancaster	PA	423,965	159.3	54.4
Philadelphia	PA	1,955,482	64.7	27.1
Pittsburgh	PA	1,504,518	111.1	59.1
Reading	PA	394,268	61.5	40.6
Sayre	PA	155,201	67.7	37.5
Scranton	PA	270,765	89.8	17.1
Wilkes-Barre	PA	219,944	47.4	25.2
York	PA	297,112	136.1	62.4
Providence	RI	615,563	55.2	43.1
Charleston	SC	651,793	98.6	71.9
Columbia	SC	726,297	85.9	58.5
Florence	SC	241,915	103.3	74.7
Greenville	SC	564,871	98.0	36.4
Spartanburg	SC	246,860	100.2	26.0
Rapid City	SD	151,118	77.4	51.8
Sioux Falls	SD	652,940	86.3	73.0
Chattanooga	TN	451,315	50.7	31.8
Jackson	TN	267,675	67.5	24.0
Johnson City	TN	174,303	48.5	37.5
Kingsport	TN	307,496	57.8	29.9
Knoxville	TN	846,740	70.6	35.8
Memphis	TN	1,021,060	59.4	23.5
Nashville	TN	1,446,374	88.1	67.9
Abilene	TX	246,124	71.2	39.3
Amarillo	TX	302,164	132.0	32.8
Austin	TX	635,194	79.8	50.0
Beaumont	TX	298,469	96.8	32.7
Bryan	TX	121,785	155.7	35.1
Corpus Christi	TX	278,392	70.5	44.2
Dallas	TX	1,913,948	70.3	40.3
El Paso	TX	543,167	57.5	35.1
Fort Worth	TX	812,985	55.8	47.5
Harlingen	TX	266,872	85.5	40.8

Chapter 4 Table. Rates of inpatient lumbar decompression and fusion for lumbar spinal stenosis among hospital referral regions (2001-11)

HRR Name	State	Number of Medicare beneficiaries	Lumbar decompression per 100,000 Medicare beneficiaries	Lumbar fusion per 100,000 Medicare beneficiaries
Houston	TX	2,405,919	103.3	27.7
Longview	TX	144,511	118.0	67.9
Lubbock	TX	444,739	81.9	34.5
McAllen	TX	255,625	73.2	37.9
Odessa	TX	206,455	110.9	62.3
San Angelo	TX	125,445	85.5	34.7
San Antonio	TX	1,184,382	55.4	39.6
Temple	TX	156,536	36.8	27.8
Tyler	TX	434,016	106.3	88.5
Victoria	TX	119,113	78.1	38.0
Waco	TX	219,028	44.2	43.8
Wichita Falls	TX	163,689	74.3	42.8
Ogden	UT	183,192	94.4	29.2
Provo	UT	161,789	89.9	30.8
Salt Lake City	UT	836,139	80.9	45.7
Burlington	VT	449,412	59.1	30.0
Arlington	VA	866,789	52.5	66.5
Charlottesville	VA	400,815	99.2	48.5
Lynchburg	VA	197,415	151.0	27.9
Newport News	VA	362,626	104.5	87.4
Norfolk	VA	726,543	56.0	67.9
Richmond	VA	1,016,211	82.0	64.3
Roanoke	VA	547,605	95.6	29.0
Winchester	VA	278,536	89.6	44.8
Everett	WA	281,257	110.0	28.9
Olympia	WA	206,427	126.0	57.5
Seattle	WA	1,322,823	112.4	44.3
Spokane	WA	932,111	145.0	52.3
Tacoma	WA	353,221	200.7	63.5
Yakima	WA	168,224	116.0	44.4
Charleston	WV	616,385	45.6	21.1
Huntington	WV	267,118	62.6	19.6
Morgantown	WV	276,451	59.0	25.3
Appleton	WI	179,914	77.3	50.9
Green Bay	WI	344,975	121.8	32.1
La Crosse	WI	216,541	85.9	19.4
Madison	WI	643,338	66.1	35.6
Marshfield	WI	272,431	50.0	27.0
Milwaukee	WI	1,528,985	69.1	33.3
Neenah	WI	142,774	78.4	47.7
Wausau	WI	145,152	40.9	33.8
Casper	WY	145,133	155.8	73.4
United States	US	165,390,225	80.0	41.1

Rates are adjusted for age, sex, and race. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period. The averages were created based on odd-numbered years from 2001 to 2011.

Variation in the Care of Surgical Conditions: End-Stage Renal Disease

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Kidney Failure

Kidneys perform several essential functions for the body. They maintain normal blood pressure and electrolyte balance, generate signals to create new blood cells, and eliminate waste from the body as urine. Before the 1950s, kidney failure, also called end-stage renal disease (ESRD)—a permanent decline in function of the kidneys—was associated with certain death. Advances in medical technology over the last 60 years have allowed patients to resume nearly normal lives, even when their own kidneys no longer function. Renal replacement therapy, either through dialysis or kidney transplantation, offers a substitute for the patient's own kidney function.

Dialysis and kidney transplantation represent major steps forward in ESRD care. Unfortunately, current systems deliver therapy in a fragmented fashion. Patient care is spread across multiple locations, including primary care and specialist offices, dialysis facilities, and transplant centers. This often results in poor coordination and uneven provision of services.

This report highlights treatments for kidney failure—both dialysis and kidney transplantation—and describes patterns of care for patients in the United States. The evolution of ESRD treatments is first presented, from basic surgical techniques and rudimentary dialysis machines to the complex, multi-specialty model practiced today. Most importantly, the report examines current quality improvement initiatives and identifies areas in need of system-level improvement.

Before surgery

History of ESRD treatment in the U.S.

Transplantation and dialysis were developed in parallel during the 1950s, culminating in successful long-term survival for patients with ESRD for the first time. These techniques translated basic science and clinical research from dedicated surgeons and physicians into a therapeutic reality for ESRD patients.

Development of kidney transplantation

A knife-wielding assassin inspired the surgical techniques for organ transplantation. French President Sadi Carnot died in 1894 after an attack that purportedly left his abdominal blood vessels damaged beyond repair. Alexis Carrel, a young French surgeon, seeking a technique that might have saved Carnot, developed suturing methods enabling blood vessels to be joined. He received a Nobel Prize for these efforts in 1912.

In December of 1954, Joseph Murray, a surgeon at the Peter Bent Brigham Hospital in Boston, employed the vascular surgery techniques developed by Carrel to successfully transplant a kidney from Ronald Herrick to his identical twin brother, Richard. Murray posited that an organ transplanted from one identical twin to the other would survive, based on successful skin-grafting experiments performed weeks before the kidney surgery.[1] Richard's body accepted his brother's kidney as its own, and he lived for eight more years. Because the brothers were identical twins, organ rejection was not a problem. Murray also received the Nobel Prize for this work in 1990.

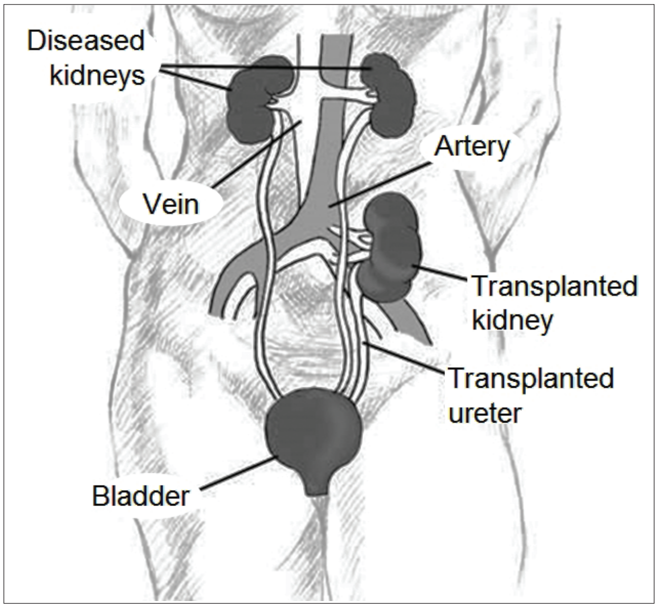


Figure 5.1. Kidney transplant

Source: National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), National Institutes of Health (NIH). Accessed October 23, 2014 at: kidney.niddk.nih.gov/kudiseases/pubs/transplant/

It is rare that ESRD patients have a twin able to donate an organ. To become more generally useful, transplantation required physicians to understand and suppress the immune system in order to prevent organ rejection from non-identical donors. Peter Medawar's work in immunology characterized a cell's ability to distinguish between self and non-self, forming the basis for immunosuppressive medications.[2] Subsequently, anti-rejection medications emerged, effectively controlling rejection and allowing organ transplantation to become a durable, broadly-available therapy.[3]

Subsequent research established kidney transplantation as the most medically and economically efficacious renal replacement therapy.[1] Over 16,000 patients receive transplants from either living or deceased kidney donors every year.[4] With current immunosuppression methods, over 94% of all kidneys transplanted function after one year, and nearly

75% work at five years.[5] Compared with dialysis, kidney transplantation costs less and leads to longer survival.[6]

Development of hemodialysis

While transplantation offers thousands of patients an opportunity for a nearly normal life, tens of thousands are not able to receive a kidney, either because they are too ill or as a result of the shortage of available donor organs. For these patients, an alternative therapy—dialysis—is used to support life until either their kidneys recover or a donor organ becomes available. Hemodialysis machines filter the blood to remove toxins, salt, and fluids. Treatments generally occur three times per week, with each dialysis treatment lasting three to five hours.

Choosing whom to dialyze with the limited number of available machines challenged clinicians in the early years, and cost was often prohibitive. In a highly publicized program at the University of Washington, Seattle in the early 1960s, patients seeking dialysis were screened first for medical suitability by a panel of doctors. They were then reviewed by a separate panel, including a pastor, a lawyer, a doctor, and a businessman. This second group approved patients based on their social contributions, choosing 10 of the first 17 ESRD candidates to dialyze.[4] The remaining patients died from untreated renal failure. These systems persisted until funding for dialysis was incorporated into Medicare in 1972, leading to a dramatic expansion of dialysis capacity in the U.S.

Insurance reform

Despite the existence of reliable methods to treat kidney failure, availability and costs hindered both transplantation and hemodialysis until President Richard Nixon signed Public Law 92-603, which initiated Medicare coverage for people under age 65 affected by ESRD. At the time, 7,000 Americans qualified for either dialysis or kidney transplantation; their treatment was fully reimbursed by the United States government. With this change, ESRD became a chronic, rather than fatal, medical condition. Public and political sentiment supported the expansion of treatment. Demand increased in the 40 years following Medicare coverage. The most recent report from the United States Renal Data System, the *USRDS 2013 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States,* showed that, as of December 31, 2010, the ESRD population in the United States comprised 488,938 people and consumed 6.3% of Medicare's total budget.[5]

Safer dialysis: creating fistulas

Hemodialysis requires durable access to large blood vessels that allow fluid exchange through the dialysis machine. Brescia, Cimino, Appel, and Hurwich described direct artery-vein connections—called arteriovenous (AV) fistulas—for hemodialysis in 1966.[7] This technique grew in practice and became the primary mode of vascular access in ESRD treatment (Figure 5.2).

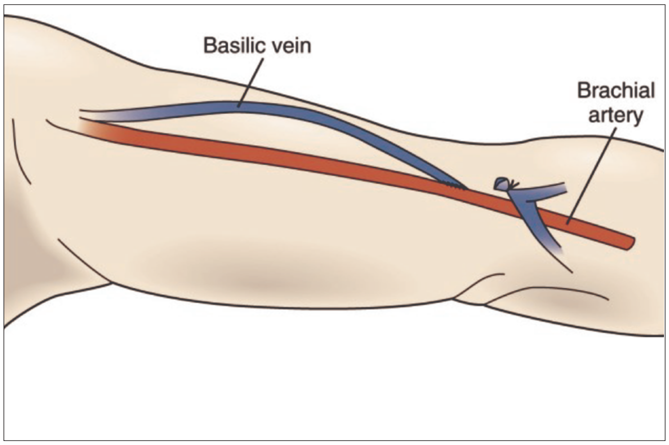


Figure 5.2. AV fistula

In an AV fistula, the surgeon divides one of the veins in the arm and attaches it directly to the side of the main artery to the arm. This results in a blood vessel with rapid blood flow and thicker walls which can be used for dialysis. The dialysis machine is connected by placing two needles through the skin into the blood vessel to remove the blood, clean it in the dialysis machine, and return it to the patients circulation.

Source: Macsata RA, Sidaway AN. Hemodialysis Access: General Considerations. In: Cronenwett JL, Johnston KW, eds. Rutherford's Vascular Surgery. Vol 1. 7th ed: Elsevier; 2010.

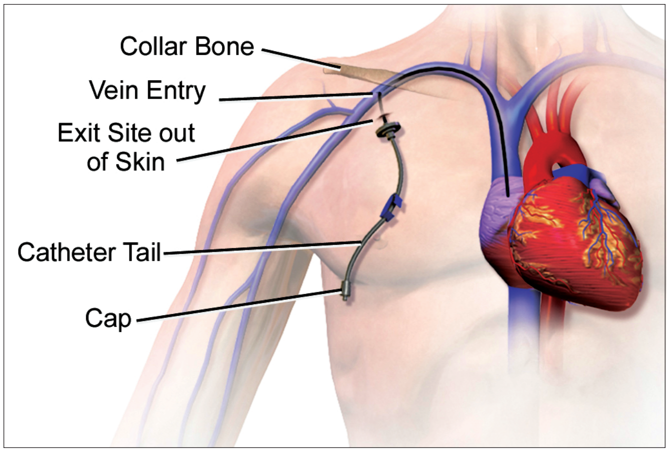


Figure 5.3. Non-tunneled central venous catheter

Source: Blausen.com staff. "Blausen gallery 2014." Wikiversity Journal of Medicine. DOI:10.15347/wjm/2014.010.

Intravascular hemodialysis catheters are large intravenous tubes placed to ensure easy access to patients' blood vessels for hemodialysis (Figure 5.3). While simple to place, it is difficult to maintain them and prevent infection. Dialysis catheters appeared in the 1980s, supplanting fistulas as the dominant access mode and increasing dialysis-associated costs.[8] Studies have demonstrated inferior survival and increased morbidity associated with the indwelling catheters.[8-11]

The National Kidney Foundation-Kidney Dialysis Outcomes Quality Initiative (NKF-KDOQI) published practice guidelines regarding permanent hemodialysis access creation and maintenance in 1997. The NKF set a goal that nearly half (40%) of existing dialysis patients have a fistula, and 50% of new dialysis patients start dialysis with a fistula.[3] An update in 2005 reflected the Centers for Medicare and Medicaid Services' Fistula First Breakthrough Initiative (FFBI).[8] While overall fistula prevalence doubled to 60% in the seven years after the initiation of the FFBI,[12] in 2005, fewer than 20% of ESRD patients started dialysis through a fistula, a clear opportunity for improvement based on these guidelines.[13] Patients also have the option of peritoneal dialysis, which, unlike hemodialysis, filters toxins from the blood stream through the lining of the patient's abdominal cavity into fluid instilled and removed through an access port.

Current epidemiology of ESRD

The United States Renal Data System (USRDS) publishes reports on ESRD patients in the U.S. every year (www.usrds.org). According to the *USRDS 2013 Annual Data Report*, 112,788 new patients initiated dialysis in 2011. The number of patients receiving dialysis on December 31, 2011 was 430,273, while 185,626 patients were alive with functional kidney transplants (Figure 5.4).[5]

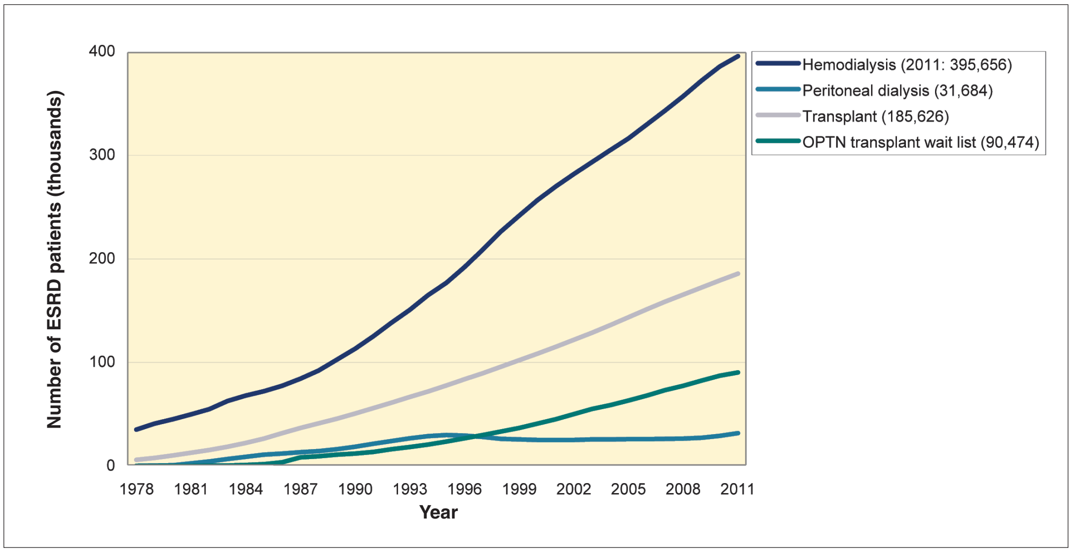


Figure 5.4. ESRD patients' treatment modalities and transplant waiting list patients

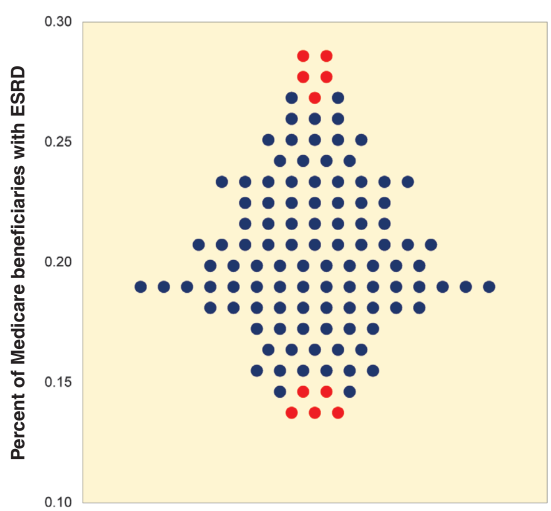
The number of transplants includes all functioning transplants performed since 1978.

Source: U.S. Renal Data System, *USRDS 2013 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States.* National Institutes of Health: National Institute of Diabetes and Digestive and Kidney Diseases; Bethesda, MD, 2013.

Regional variation in the prevalence of ESRD

End-stage renal disease care varies by location within the United States. Axelrod et al previously analyzed data from transplant registries to determine where patients living in each ZIP code received their transplant care and then used this information to define 113 transplant referral regions (TRRs) within the United States.[14] These regions have strikingly different care patterns, as the treatment provided to ESRD patients varies among transplant centers. Furthermore, the way transplant care is delivered can dramatically affect both the cost and survival of patients with ESRD.

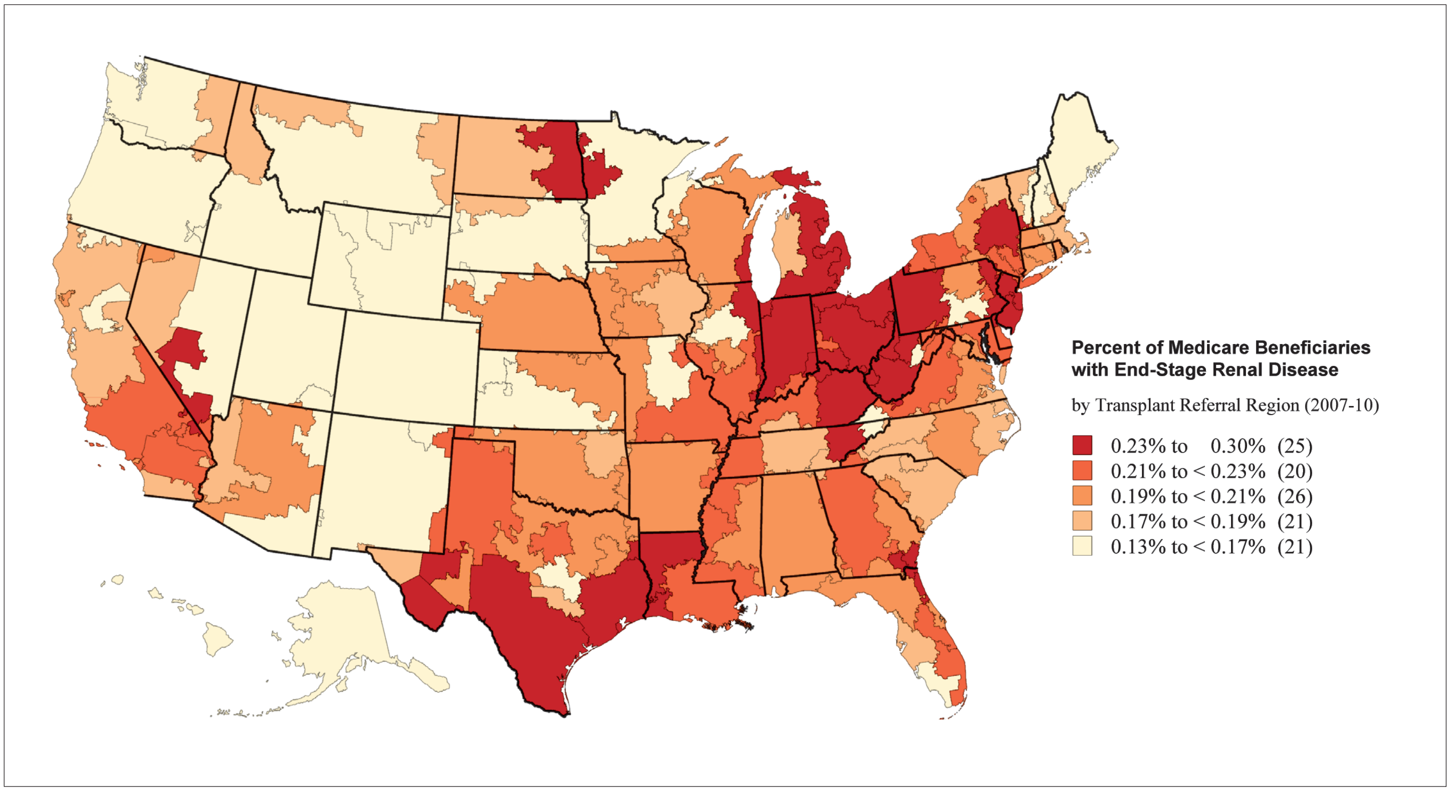
Figure 5.5 shows the variation in diagnosis of ESRD among patients living in each transplant referral region. On average, 0.21% of Medicare beneficiaries had a diagnosis of ESRD during the period from 2007 to 2010. This rate varied more than twofold across transplant referral regions, from less than 0.15% of beneficiaries in Portland, Maine (0.13%), Honolulu, Hawaii (0.13%), and Fort Myers, Florida (0.14%) to almost 0.30% in Toledo, Ohio (0.29%), Columbus, Ohio (0.28%), and Newark, New Jersey (0.28%). In general, rates of ESRD were high in the Midwest and Texas compared to other regions of the country (Map 5.1).



Toledo, OH	0.29%
Columbus, OH	0.28%
Newark, NJ	0.28%
Cincinnati, OH	0.28%
Houston, TX	0.27%
Tucson, AZ	0.15%
Lebanon, NH	0.15%
Fort Myers, FL	0.14%
Honolulu, HI	0.13%
Portland, ME	0.13%

Figure 5.5. Percent of patients with end-stage renal disease among transplant referral regions (2007-10)

Each blue dot represents the percent of patients with ESRD in one of 113 transplant referral regions in the U.S. Red dots indicate the regions with the 5 lowest and 5 highest rates.



Map 5.1. Percent of patients with end-stage renal disease (2007-10)

Rates are adjusted for age, sex, and race.

Disease progression: how and why does kidney failure occur?

Chronic kidney disease describes a slow decline in kidney function, usually from long-standing genetic or acquired diseases such as diabetes and obesity. Figures 5.6 and 5.7 show the relationships between the prevalence of two of these diseases and rates of ESRD. The proportion of patients with ESRD is the highest in regions with elevated rates of diabetes and obesity, although there are many other factors that contribute to renal failure.

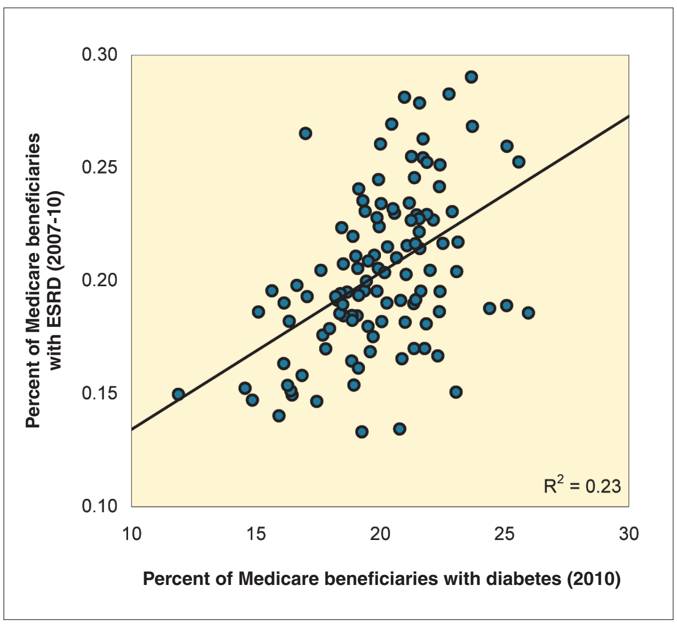


Figure 5.6. Relationship between the percent of patients with diabetes and ESRD among transplant referral regions

The Medicare population includes all adult patients ages 18-99 with Medicare coverage for ESRD.

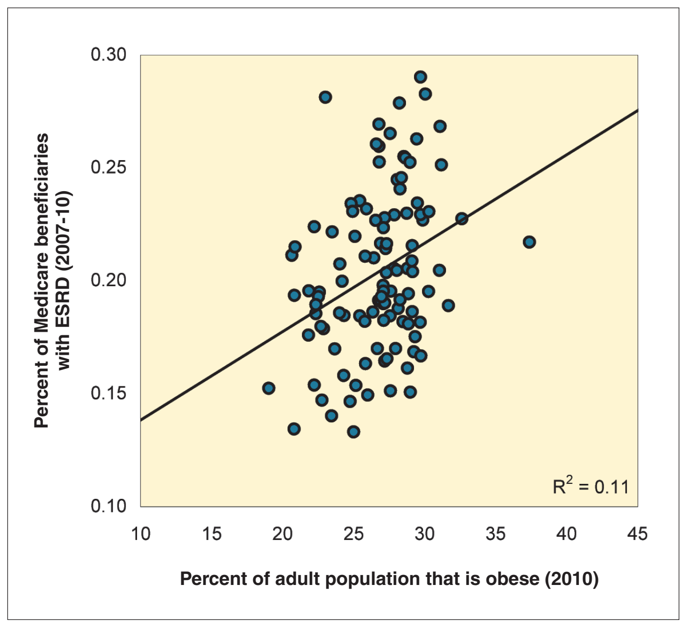


Figure 5.7. Relationship between the percent of patients with obesity and ESRD among transplant referral regions

Obesity: BMI $\geq$30, or about 30 lbs. overweight for 5'4" person.

Source: The Centers for Disease Control and Prevention; Behavioral Risk Factor Surveillance System (BRFSS).

Who cares for patients with kidney failure?

When chronic kidney failure progresses, patients experience fatigue, nausea, and anorexia, indicating the need for renal replacement therapy. Patients whose kidney function declines to this level require multi-disciplinary counseling and an individualized care plan. This process is complex, usually involving a primary care provider, a nephrologist, and a vascular access surgeon, as well as a transplant center in some cases. Each member of the health care team has a distinct yet complementary role, as outlined below:

Primary care provider: Primary care providers, including physicians, nurse practitioners, and physician assistants, may be the first to notice signs, symptoms, and laboratory values suggesting renal dysfunction. Often, patients developing kidney disease are already being actively managed for hypertension and diabetes, the two diseases most responsible for nephropathy leading to ESRD in the United States. While controlling these processes is important, early specialist referral is essential.[15]

Nephrologist: A nephrologist is a medical specialist who cares for patients with kidney dysfunction and failure, managing both acute kidney failure—a rapid decline in kidney function after an illness, surgery, or trauma—and chronic kidney disease. When a patient's renal failure approaches ESRD, nephrologists administer dialysis treatments and refer patients for transplant evaluation when appropriate.

Dialysis access surgeon: General, vascular, and transplant surgeons may all be credentialed to place vascular access, including arteriovenous (AV) fistulas, AV grafts, hemodialysis catheters, and peritoneal dialysis catheters. Patients may require additional treatments to maintain the chosen dialysis modality, such as angioplasty or stent placement to preserve function in failing AV fistulas or grafts; such procedures are performed by vascular surgeons or interventional radiologists.

Transplant center team: Transplant centers' multidisciplinary teams include surgeons, nephrologists, social workers, nurse coordinators, and dieticians. Each plays a role along the path of organ transplantation, including pre-transplant social and medical assessment, ESRD care management while awaiting a kidney, performing the surgery, and adjusting medications post-operatively. Transplant centers are generally based within tertiary care academic hospitals.

Factors that influence the quality of ESRD care

Health services researchers have begun to explore the factors that make it more—or less—likely that an individual patient will get optimal access to dialysis access surgery and transplantation. For example, early engagement with a nephrologist increases the likelihood that a patient will initiate hemodialysis with a functional fistula—rather than a hemodialysis catheter, where outcomes are much poorer—by a factor of eleven.[16] Patients with longer nephrology follow-up are also more likely to have a functional AV fistula at the start of dialysis (Figure 5.8). Early nephrology care is also associated with a higher rate of listing for a transplant, a significant contributor to improved survival.[17]

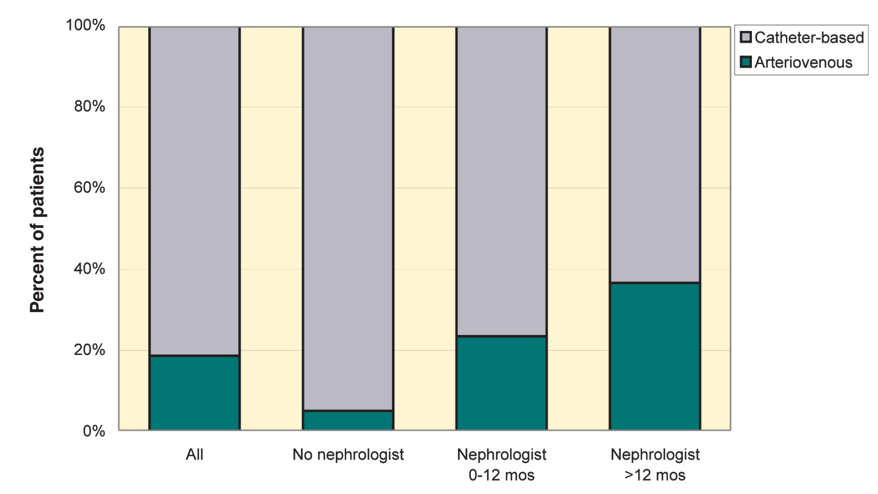


Figure 5.8. Dialysis access modality utilized during the first outpatient hemodialysis by pre-ESRD nephrology care (2011)

Source: U.S. Renal Data System, *USRDS 2013 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States.* National Institutes of Health: National Institute of Diabetes and Digestive and Kidney Diseases; Bethesda, MD, 2013.

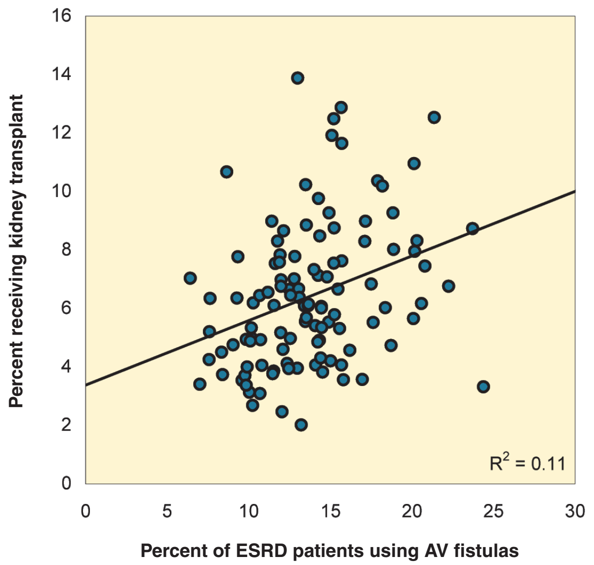


Figure 5.9. Relationship between rates of incident AV fistula use and kidney transplantation among transplant referral regions (2007-10)

Despite recommendations from the National Kidney Foundation, most patients start dialysis with catheters, the least effective and least safe access method. More than 70% of new patients—about 80,000 people—resorted to this strategy in 2011.[5] Patients who initiate dialysis with catheters have poorer long-term survival than patients who initiate dialysis with AV fistulas, and these patients are less likely to be treated with kidney transplantation. The positive correlation between the use of AV fistulas and transplantation (Figure 5.9) may be a result of greater care coordination, including the early involvement of a nephrologist.

As outlined in this report, patients with ESRD face difficult decisions regarding their care. Resources available to help patients and their loved ones navigate the healthcare system and make well-informed decisions include:

Explore Transplant: exploretransplant.org

The National Kidney Foundation: www.kidney.org/atoz/content/kidneytransnewlease

Kidney Link: www.kidneylink.org

The National Institute of Diabetes and Digestive and Kidney Diseases: kidney.niddk.nih.gov/kudiseases/pubs/transplant/

Decision quality and shared decision-making

The most important decision ESRD patients face is choosing to either continue dialysis or to receive a transplant. Patients and their families are often anxious about transplantation surgery. The initiative Explore Transplant (www.exploretransplant.org) is a comprehensive patient education program designed to help ESRD patients make well-informed decisions about ESRD care. The program also offers an education module for dialysis providers to facilitate relationships between dialysis and transplant centers and to promote early patient education and referral for transplant evaluation. A separate module educates potential living organ donors about the risks and outcomes of organ donation.

Additional tools are available to help answer patients' questions about renal disease and assess values and preferences related to their care. The Option Grid, shown in Figure 5.11, is one such decision aid. These tools are starting points to help patients better understand ESRD therapy options.

Treatment Options	Decision Support Tool Components			Patient Outcomes
	Patient Needs	Decision Support	Decision Quality	
Dialysis a. AV fistulas and grafts b. Hemodialysis c. Peritoneal dialysis Kidney transplantation a. Living donor transplant b. Deceased donor transplant	Clarification of individual values and preferences Knowledge of procedure risks, benefits, and other considerations Assistance with decision to list for kidney transplantation Access to available deceased donor organs or live donation	**Continuously updated, patient-specific data regarding risks and benefits** **Tracking disease progression and outcomes for dialysis patients via USRDS renal registry** **Tracking disease progression and outcomes for patients listed for and receiving kidney transplantation via OPTN registry** Guidance for the patient/surgeon interaction	Assessment of patient knowledge and understanding Assessment of congruence with pre-specified values and preferences Assessment of organ quality prior to transplantation Assessment of patients' severity of illness prior to transplantation Assessment of organ donor and recipient compatibility	Measurement of: Mortality Patient satisfaction Quality of life Quality of donor organ Organ failure (after kidney transplantation) Post-surgical complications

Figure 5.10. Conceptual model for decision support process

THE Dartmouth INSTITUTE FOR HEALTH POLICY & CLINICAL PRACTICE

Chronic kidney disease

Use this grid to help you and your healthcare team talk about how best to treat chronic kidney disease.

option grid

Frequently asked questions	Peritoneal dialysis - CAPD/APD	Haemodialysis at a dialysis unit	Haemodialysis at home	Transplantation	Conservative management
	Bags at home	***Machine in special unit***	***Machine at home***	***Donated kidney***	***No dialysis or transplant***
What does it involve?	Fluid goes in and out of your abdomen four times a day, or by using a machine, overnight.	Your blood is cleaned by a machine in a dialysis unit.	Your blood is cleaned by a machine that is at your home.	You are given a kidney from either a dead or living donor.	You receive medication to keep you well for as long as possible.
How will my kidneys be affected?	Your remaining kidney function will slowly get worse. You may continue to pass urine for a few years.	Your remaining kidney function will slowly get worse, probably more rapidly than on peritoneal dialysis. You eventually stop passing urine.	Your remaining kidney function will slowly get worse, probably more rapidly than on peritoneal dialysis. You eventually stop passing urine.	Your kidney function will come back and you will pass urine as normal.	It is difficult to predict what will happen to your remaining kidney function. It is likely to get worse.
How often will I need this treatment?	Continuous ambulatory peritoneal dialysis (CAPD) needs four bag changes every day, no days off. Automated peritoneal dialysis (APD) is carried out by a machine overnight, every night.	You will have a total of 12 hours of treatment per week, spread over three days. Each treatment takes four hours and happens on fixed days.	You will have a total of 12 hours of treatment per week, usually spread over three days. Treatment times can be flexible.	You will use medication to suppress your immune system, so you will be at higher risk of infections.	You will have regular medication, checks and support.
How will I feel?	This is a gentle treatment. Overall, you should feel better.	You may feel tired after each treatment, but overall you should feel better.	You may feel tired after each treatment, but overall you should feel better.	Once you have recovered from your operation, you should feel well.	If your kidney function gets worse, you will develop kidney failure. Medication is available to control most of these symptoms, but you will eventually need end of life care.
How will my life be affected?	You can continue working and doing your usual activities.	You will have fixed times for dialysis. Work will need to fit around these times.	This kind of dialysis can be made to fit around your work and usual activities.	You will have clinic appointments. You can do your usual activities when you recover from the operation.	You can discuss how regularly you want to come to clinic appointments.
Will I need an operation?	Yes, a small operation to put a tube into your abdomen is done one month before dialysis starts.	You will usually be offered surgery to create a fistula on your arm. This is done 6 weeks before dialysis.	You will usually be offered surgery to create a fistula on your arm. This is done 6 weeks before dialysis.	You will need an operation to transplant the donated kidney.	No operation is required.
Who will do my treatment and who will I see?	You do your own treatment at home. Cleanliness is very important. Expert dialysis nurses will support you.	Expert dialysis nurses will do your treatment. You will have regular contact with other patients having haemodialysis.	You do your own treatment at home. Expert dialysis nurses will support you.	Apart from medication, no ongoing treatment. You won't be in direct contact with other similar patients.	Apart from medication, no ongoing treatment.
How will my diet and fluid intake be affected?	You may have restrictions on what you eat and drink.	You will have restrictions on what you can eat and drink.	You will have restrictions on what you can eat and drink.	You will have restrictions on what you can eat and drink.	You will usually have fewer restrictions than you would if you were on dialysis.
Will I need to store equipment at home?	Dialysis equipment will be delivered to your home and it will need storage space.	No equipment is required at your home.	The dialysis machine will need to be set up in a room in your home. You will need water and electrical connections.	No equipment is required at your home.	No equipment is required at your home.
Can I change from one treatment option to another?	Yes.	Yes, but peritoneal dialysis may be less effective after you have had haemodialysis.	Yes, but peritoneal dialysis may be less effective after you have had haemodialysis.	Yes.	Yes.
Can I still travel?	Yes, but you will need to plan because some restrictions apply. Equipment can be transported by car.	Yes, but your treatment will need to be planned at a dialysis unit at your destination.	Yes, but your treatment will need to be planned at a dialysis unit at your destination.	Yes.	Yes.
How long will this treatment be effective?	Half of the people who start peritoneal dialysis will stay on it for 2 to 3 years. Many go on to have haemodialysis or a transplant.	Some people continue haemodialysis for up to 20 years - but it can be much shorter than that.	Some people continue haemodialysis for up to 20 years - but it can be much shorter than that.	On average, kidney transplants are effective for up to 15 years.	This will depend on many other issues.

Editors: Glyn Elwyn, Alison Prichard, Nerys Thomas, Donal O'Donoghue, Hilary Bekker, Charlie Tomson, Rob Elias, Amy Lloyd.
Evidence document: See www.optiongrid.org/resources/chronickidneydisease_evidence.pdf
Publication date: 13 January 2014 **Expiry date**: 13 January 2015 **ISBN**: 978-0-9571887-5-4 **License**: CC BY-NC-ND 4.0 (International)
Download the most current version from: http://www.optiongrid.org

Figure 5.11. Option grid for chronic kidney disease

Source: The Option Grid Collaborative (www.optiongrid.org).

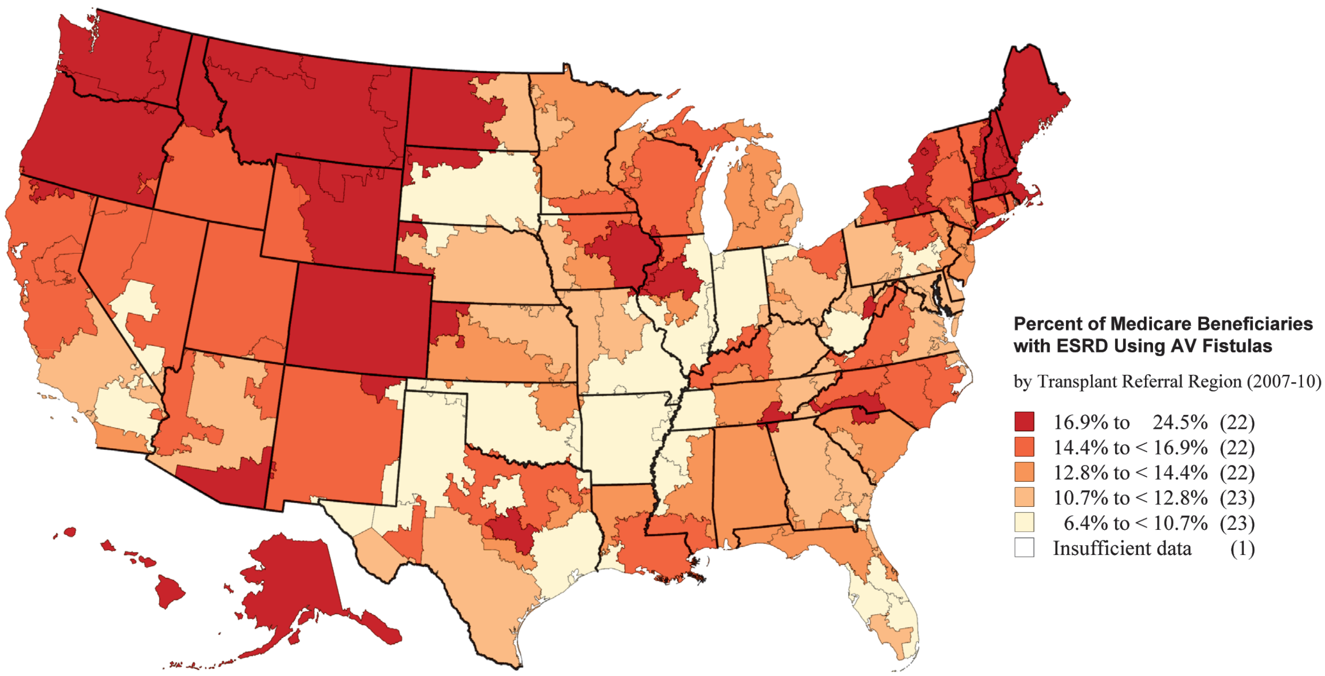
During surgery

In general, vascular access procedures are performed on an outpatient basis. However, patients are occasionally admitted following more extensive surgery. Further, patients often have to wait several days to several weeks before vascular access connections are useable for dialysis, which further complicates the timing and care of these very ill patients.

Arteriovenous fistulas

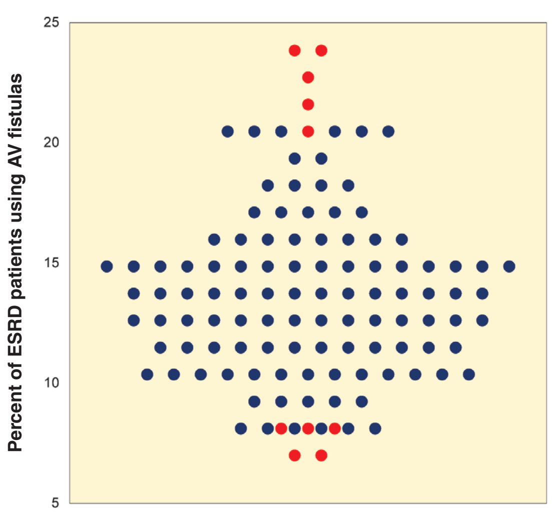
Patients diagnosed with ESRD require a surgical procedure to allow blood stream access for dialysis therapy or transplantation. AV fistulas and grafts create connections between arteries and veins to create high-flow access sites protected by the skin. Access to the blood stream using this method is achieved by inserting two needles through the skin into the conduit connecting the blood vessels to withdraw and return blood (Figure 5.2). The National Kidney Foundation-Kidney Disease Outcomes Quality Initiative (NKF-KDOQI) Practice Guideline 2 recommends autogenous fistulas—those using a patient's own veins—rather than artificial grafts, because the natural fistulas last longer and are less prone to degeneration and infection.[13] For patients who cannot undergo fistula placement, or who do not have a working fistula, hemodialysis catheters are inserted through the skin into large central veins (Figure 5.3). Patients who choose to receive peritoneal dialysis (PD) require placement of a PD catheter (a tube to carry the fluid) in the abdomen.

Ensuring access to the best surgical treatments for patients with ESRD—especially methods such as fistulas—can be challenging given the complexity of caring for this very ill population. As a result, there is significant variation in the use of these procedures across the United States. Use of AV fistulas varied nearly fourfold across transplant referral regions during the period from 2007 to 2010, from less than 8% of ESRD patients in Lubbock, Texas (6.4%), El Paso, Texas (7.0%), and Jacksonville, Florida (7.6%) to more than 20% in Honolulu, Hawaii (24.4%), Portland, Maine (23.7%), and Springfield, Massachusetts (22.3%) (Figure 5.12). The national average was 13%. Rates of AV fistula use were generally higher in the Northwest and New England than in other regions of the country (Map 5.2).



Map 5.2. Percent of ESRD patients using AV fistulas (2007-10)

Rates are unadjusted.



Honolulu, HI	24.4%
Portland, ME	23.7%
Springfield, MA	22.3%
Lebanon, NH	21.4%
Portland, OR	20.8%
Toledo, OH	7.6%
Little Rock, AR	7.6%
Jacksonville, FL	7.6%
El Paso, TX	7.0%
Lubbock, TX	6.4%

Figure 5.12. Percent of ESRD patients using AV fistulas among transplant referral regions (2007-10)

Each blue dot represents the percent of ESRD patients using AV fistulas in one of 113 transplant referral regions in the U.S. Red dots indicate the regions with the 5 lowest and 5 highest rates.

Kidney transplantation

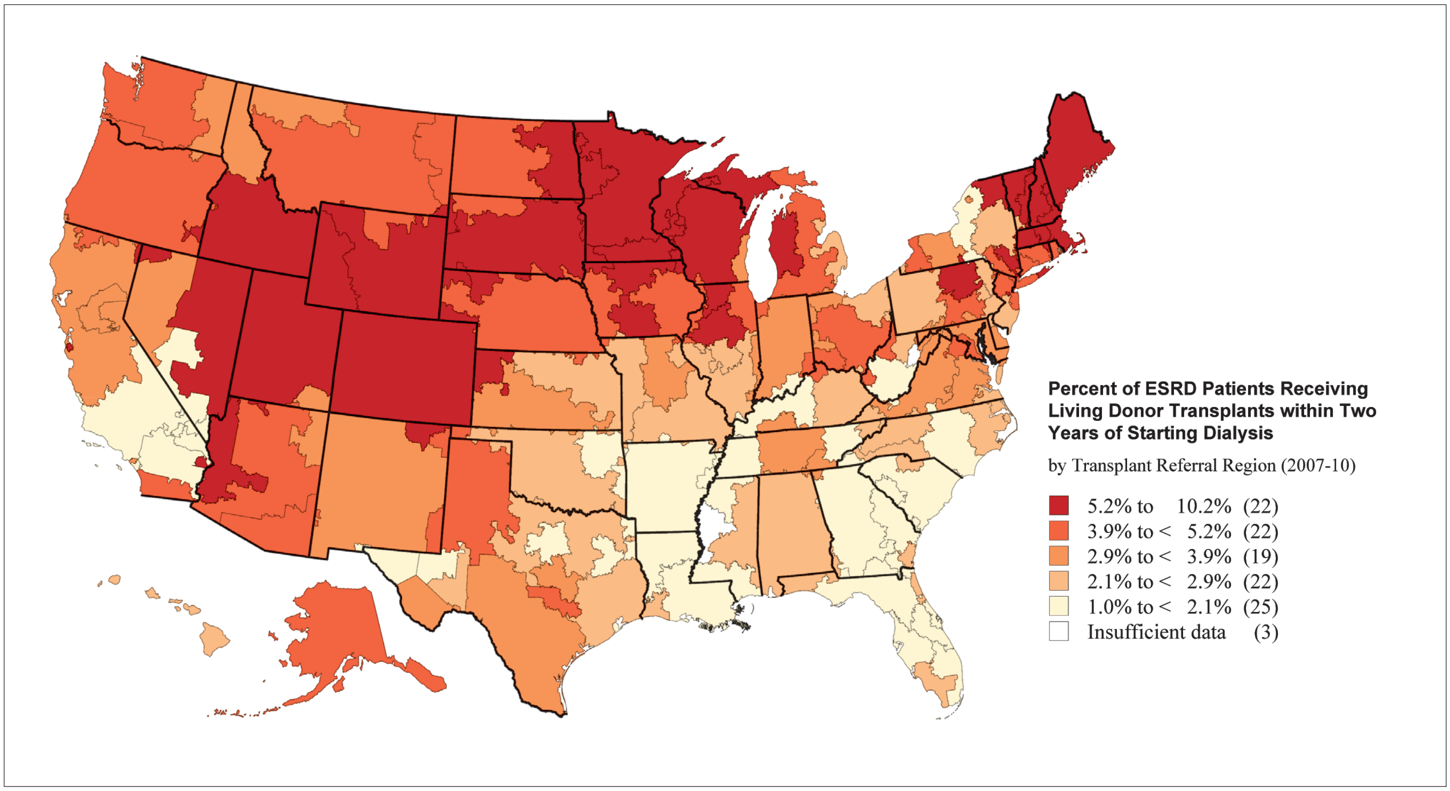
When available, kidney transplantation offers better quality of life, increased survival, and lower cost for most patients compared to continued dialysis. This surgery involves two procedures, one for the donor and one for the recipient. Kidney donors can be either living or deceased. Live donor kidneys are removed through small incisions, with guidance from a camera. Deceased donor organs are recovered from patients who suffer devastating brain injuries, and are generally retrieved along with multiple other organs. Donor kidneys are surgically attached to the artery and vein supplying the leg and pelvis (Figure 5.1). Next, the ureter is connected directly to the bladder. Patients generally stay in the hospital fewer than four days.

For several reasons, not every ESRD patient is able to receive a transplant. Patients' medical comorbidities are a major limitation, as is organ availability; the number of ESRD patients outstrips the donor organ supply. Growing demand has increased waiting list lengths, leading to innovative approaches aimed at increasing transplant rates, as well as attempts to make hemodialysis safer.

Living donor versus deceased donor transplant

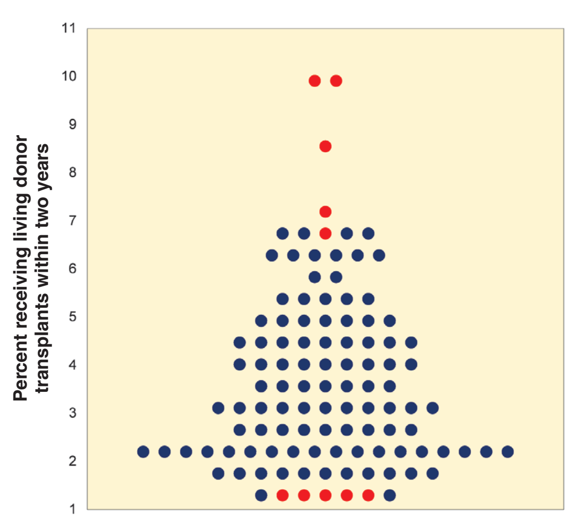
Every year, more than 6,000 ESRD patients are able to find friends or family members willing to donate a kidney for transplant. Living donor kidney transplant recipients have the longest survival and the most frequent immediate organ function, as well as flexibility in surgical scheduling. Kidney donors need compatible, though not identical, blood types. They are evaluated to ensure normal pre-donation kidney function, the absence of risk factors for chronic kidney disease—including diabetes or uncontrolled high blood pressure—and normal kidney anatomy. Counseling ensures that both donors and recipients understand that organ gifts are voluntary. Finally, the potential donors and recipients are carefully cross-matched to prevent organ rejection.

Access to living donor transplant also depends on transplant center practices. Some programs are more proactive in seeking and supporting living donation than others. On average, 3.3% of ESRD patients received transplants from living donors within two years of first dialysis during the period from 2007 to 2010. There was more than tenfold variation across transplant referral regions, from about 1% of ESRD patients in Shreveport, Louisiana (1.1%), Augusta, Georgia (1.2%), and Charleston, West Virginia (1.2%) to about 10% of ESRD patients in the Minnesota regions of Rochester (10.1%) and Minneapolis (9.9%) (Figure 5.13). On average, rates were lower in the Southeast and in southern California than in other parts of the country (Map 5.3).



Map 5.3. Percent of ESRD patients receiving living donor transplants within two years of starting dialysis (2007-10)

Rates are unadjusted.



Rochester, MN	10.1%
Minneapolis, MN	9.9%
Lebanon, NH	8.5%
Salt Lake City, UT	7.1%
Boston, MA	6.9%
Las Vegas, NV	1.3%
Jacksonville, FL	1.3%
Charleston, WV	1.2%
Augusta, GA	1.2%
Shreveport, LA	1.1%

Figure 5.13. Percent of ESRD patients receiving living donor transplants within two years of starting dialysis among transplant referral regions (2007-10)

Each blue dot represents the percent of ESRD patients receiving living donor transplants within two years of starting dialysis in one of 113 transplant referral regions in the U.S. Red dots indicate the regions with the 5 lowest and 5 highest rates.

Patients unable to identify a living kidney donor are listed with the United Network for Organ Sharing (UNOS), which administrates the national Organ Procurement and Transplantation Network (OPTN). Deceased donor kidneys are allocated to patients based on criteria established by UNOS under the direction of the Health Services and Resources Administration (HRSA) division of the U.S. Department of Health and Human Services. Under current kidney allocation rules, blood type, wait time, match difficulty related to antibody sensitization, and need for other simultaneous, non-renal organ transplants are evaluated. Donor kidneys are initially offered to patients locally, and are only shared more broadly if local transplant centers decline the organs. Consequently, there is significant variation in deceased donor kidney transplant rates due to differences in local and regional organ supply, waiting list size, and organ acceptance decisions (Figure 5.14).[18] Similarly, average waiting times vary significantly across donation service areas, varying from less than 19 months to more than 37 months.[19]

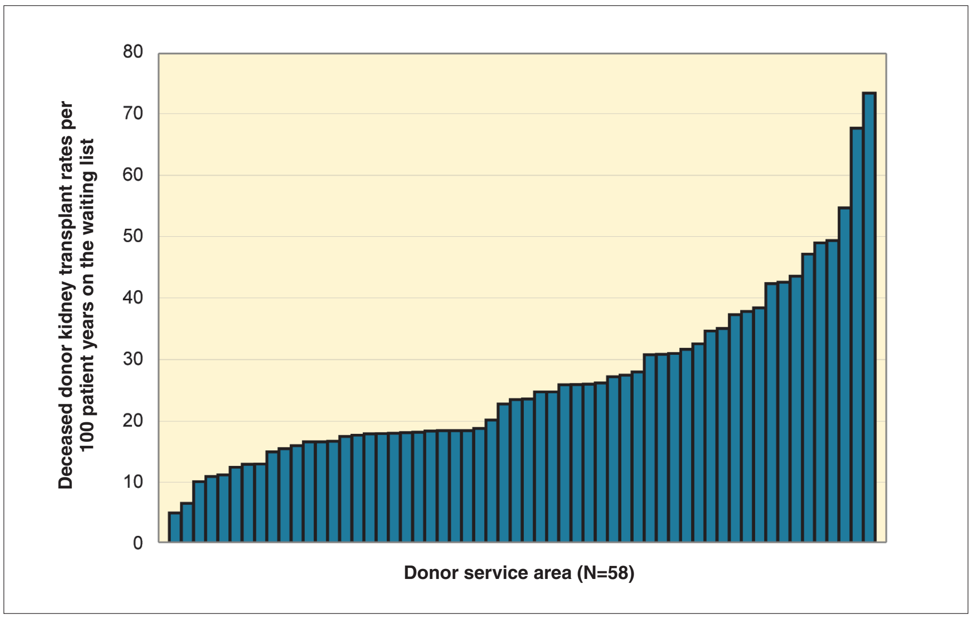


Figure 5.14. Deceased donor kidney transplant rates among active adult candidates, by donor service area (2011-12)

Transplant rates are given by donor service area of the listing center, limited to those with active time on the waiting list in 2011 and 2012. Maximum time per listing is two years.

Source: *2004 Annual Report of the U.S. Organ Procurement and Transplantation Network and the Scientific Registry of Transplant Recipients: Transplant Data 1994-2003.* Department of Health and Human Services, Health Resources and Services Administration, Healthcare Systems Bureau, Division of Transplantation, Rockville, MD; United Network for Organ Sharing, Richmond, VA; University Renal Research and Education Association, Ann Arbor, MI.

Options for patients without a compatible kidney donor

Frequently, patients are able to identify a willing donor whose blood type or immunologic profile would preclude transplant. However, several options now exist, including paired donor exchange. In these programs, two or more donor-recipient pairs with incompatible cross-matches are grouped so that compatible organs can be shared. Drs. Segev and Gentry created a mathematical model to apportion kidneys among incompatible ESRD patients and their donors across multiple centers.[20] Paired donation accounted for 10%—approximately 500—of the living donor kidney transplants in 2011, a significant increase since the exchange programs were initiated ten years ago.[21] At this writing, the longest open chain in the United States was under way at the University of Alabama, where twenty-one people received kidney paired donations.[22]

How long will patients live without a transplant?

In general, patients do not live for a long time without transplantation if they simply remain on dialysis. Their overall five-year mortality rate is 47%, meaning that fewer than one in two are still alive within five years of starting dialysis; and, as a result of the long waiting period for transplant, unfortunately, many people on a waiting list for transplantation die prior to receiving a kidney. Long-term survival is even less likely for patients whose age or medical condition preclude transplant. Among patients deemed to ill to undergo transplantation, nearly half—44%—will die within the first year of starting dialysis (Figure 5.15).

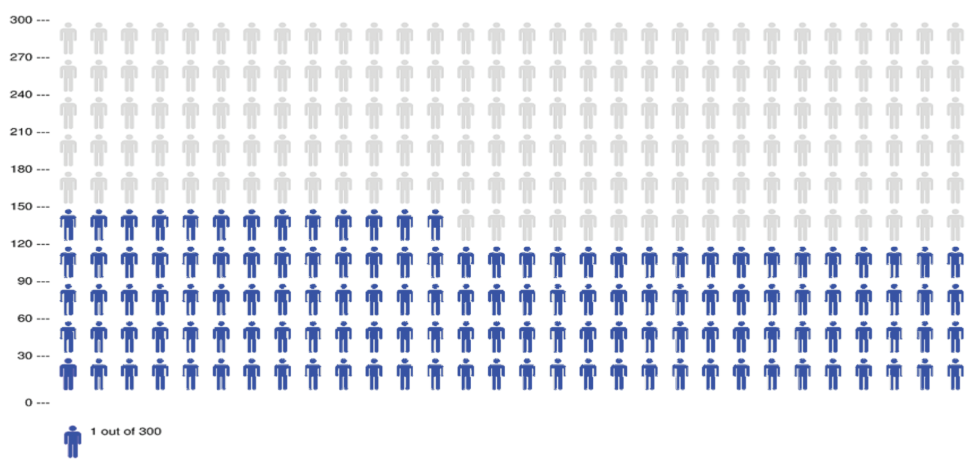


Figure 5.15. Risk of mortality within one year of starting dialysis without kidney transplant
133 out of 300 (44%).

After surgery

Surgery—either placing a dialysis access fistula or performing a kidney transplant—is only one aspect of managing ESRD. Long-term success requires cooperation between nephrologists, primary care physicians, and patients in a complex, multidisciplinary process.

Kidney transplantation requires several days in the hospital to recover, evaluate organ function, and adjust immunosuppressant medications. Following discharge, patients are seen frequently by a surgeon, and later by a transplant nephrologist to manage the medications necessary to prevent rejection. Treating comorbid diseases, such as diabetes and hypertension, helps to protect a patient's newly transplanted kidney. Patients are often readmitted to the hospital within 30 days of receiving a kidney (Table 5.1), for reasons such as rejection, medication adjustments, or infection.

Table 5.1. Percent of ESRD patients receiving kidney transplants within two years of starting dialysis readmitted within 30 days following transplant among transplant referral regions (2007-10)

TRR	State	Percent readmitted within 30 days following transplant
10 highest TRRs		
Wichita	KS	81.3%
Augusta	GA	78.4%
Greenville	NC	77.3%
Allentown	PA	75.0%
Fort Worth	TX	74.2%
Burlington	VT	73.7%
New Haven	CT	73.3%
Toledo	OH	70.0%
Seattle	WA	64.9%
Columbia	MO	64.7%
10 lowest TRRs		
Sacramento	CA	41.9%
Memphis	TN	41.7%
Danville	PA	41.4%
Tulsa	OK	40.7%
Tucson	AZ	40.7%
Columbus	OH	40.7%
Spokane	WA	40.6%
Knoxville	TN	40.0%
Fargo/Moorhead MN	ND	40.0%
Grand Rapids	MI	40.0%

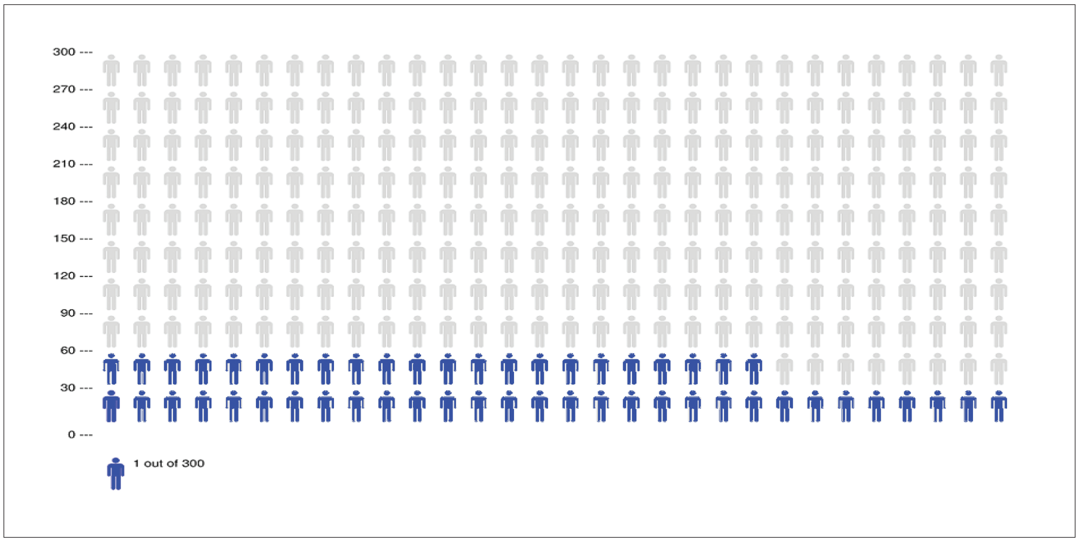


Figure 5.16. Risk of mortality within one year of kidney transplant
52 out of 300 (17%).

One-year mortality after kidney transplantation among Medicare beneficiaries is 17%, often caused by early post-transplant organ failure (Figure 5.16).

Beyond surgery

Quality initiatives in ESRD care

Priority #1: Increase the use of fistulas rather than catheters

Sustaining patients with kidney failure is an expensive undertaking with two notable shortcomings in current practice. First, most patients initiate dialysis using intravascular catheters, which results in less than optimal survival.[23] The Fistula First Breakthrough Initiative, enacted in 2005, increased the frequency with which patients dialyzing with catheters converted to fistulas.[8] However, there has been minimal improvement in incident fistula frequency; it increased from 13% to 15% between 2005 and 2010.[24] Policy changes aimed at physician awareness appear to have had little effect on this trend. Federal reimbursement policy may be the root cause; Medicare reimburses patients for ESRD-related medical expenses three months after beginning chronic dialysis at a clinic or one month after beginning in-home therapy.[25] Pre-emptive fistula creation is not covered,[26] even though transplant recipients receive retroactive coverage for costs incurred up to two months prior to surgery.[26,27] Revising Medicare dialysis access provisions to mirror transplant policy would incentivize improvement in current practices.

Priority #2: Prioritize the most cost-effective treatments

Kidney transplants and fistulas not only improve outcomes; they also save money. In 2011, 430,273 patients comprised the prevalent hemodialysis population.[5] The estimated cost differential to dialyze a patient with a catheter, as opposed to a fistula, for one year is $23,808: $127,677 versus $103,869 in 2006 dollars.[28] With the ESRD population reaching 430,000, 80% of which employed catheter-based access at some point in their care, an enormous potential savings exists. Fistula creation is technically challenging, but clearly represents a laudable goal for both improving outcomes and providing cost-effective care for patients with ESRD.

Further, transplantation should be emphasized whenever possible. Data from the *USRDS 2013 Annual Data Report* describe a distinct cost advantage to transplantation over dialysis. Medicare expenditures for hemodialysis were $34.3 billion in 2010—6.2% of the total Medicare budget—or $87,945 per person per year. Comparative renal transplant costs were $2.8 billion, or $32,922 per person per year.[5] Transplant costs are amortized over the organ's functional life span. The break-even point between living donor kidney transplant and dialysis is 2.3 years, while that for deceased donor kidney transplant and dialysis is 3.6 years.[29] Quality-of-life parameters are not factored into this assessment. When they are included, the Medicare savings is projected to be about $270,000 per transplant in comparison to dialysis.[30]

High-quality, coordinated ESRD care is evident when patients start dialysis with a fistula and the best candidates receive transplants. These data provide an important emphasis for the second priority: evidence-based transplant care centered on multidisciplinary care coordination and effective, lower-cost treatments, leading to better outcomes for patients.

Priority #3: Emphasize new technology for organ supply and vascular access

The limited donor organ supply restricts transplantation, contributing to excess ESRD-related mortality. Recently, the organ allocation system for deceased donor kidneys has been revised to consider donor age; donor kidneys from younger patients demonstrated improved performance when matched to younger recipients.[31] The donor pool has also been expanded with organ preservation pumps, which maintain blood flow in organs during transport, particularly kidneys donated after cardiac death. Overall, donation of organs per 100 eligible deaths increased from 69 to 73 between 2009 and 2012.[32]

Regenerative medicine offers another hopeful direction. American and Italian scientists have removed cells from pig kidneys, while retaining the fiber lattices that support the organ's shape and blood vessel networks.[33,34] Subsequent work by the same American group at Wake Forest University in Winston-Salem, North Carolina replicated this technique with a human kidney.[33] A functional organ fit for transplantation is not yet available, but research efforts continue.

Novel technologies are also being developed for dialysis patients. Rather than resorting to synthetic materials, like polyester or polytetrafluoroethylene, current studies are examining the safety of tissue-engineered vascular grafts to use in dialysis.[35] Not all ESRD patients have adequate veins for AV fistula creation. For these patients, bioengineered tissues could provide a better-functioning alternative to polymer grafts. Finally, Fissell and colleagues at Vanderbilt University in Nashville, Tennessee envision wearable or implantable continuous dialysis devices that would serve as mechanical alternatives to renal transplant.[36]

Conclusion

Transplantation is the most efficacious and cost-effective therapy for patients suffering from end-stage renal disease. Applying cost-effective, high-quality care strategies—such as early provision of AV fistulas to patients—requires an integrated and coordinated approach. The best care saves lives and money, a philosophy worth disseminating and implementing in caring for patients everywhere.

Chapter 5 Table. Prevalence of end-stage renal disease, use of AV fistulas, living and deceased donor kidney transplants, and 30-day readmissions following kidney transplant among transplant referral regions (2007-10)

TRR Name	State	Number of Medicare beneficiaries with ESRD	Percent of patients with end stage renal disease	Percent of ESRD patients using AV fistulas	Percent of ESRD patients receiving living donor transplants within two years of starting dialysis	Percent of ESRD patients receiving deceased donor transplants within two years of starting dialysis	Percent readmitted within 30 days following transplant
Birmingham	AL	8,451	0.20	14.1	2.4	1.7	43.1
Little Rock	AR	3,421	0.19	7.6	1.6	3.6	45.0
Phoenix	AZ	692	0.19	14.9	6.4	2.9	
Sun City	AZ	2,220	0.19	12.0	4.8	2.2	63.5
Tucson	AZ	616	0.15	18.9	4.0	4.0	40.7
Los Angeles	CA	10,361	0.21	10.7	2.0	1.0	49.3
Orange County	CA	905	0.20	12.4	3.1	1.0	60.0
Sacramento	CA	1,217	0.17	15.3	3.8	1.9	41.9
San Bernardino	CA	2,050	0.21	10.0	1.9	1.3	43.5
San Diego	CA	1,912	0.19	12.8	4.3	2.7	48.0
San Francisco	CA	7,771	0.18	14.5	3.2	2.1	48.1
San Jose	CA	222	0.15	14.0	5.4	1.9	
Santa Rosa	CA	61	0.20			2.4	
Denver	CO	2,378	0.15	18.2	6.6	3.6	47.2
Hartford	CT	1,637	0.20	15.5	4.8	1.9	50.0
New Haven	CT	1,469	0.19	17.5	4.8	2.1	73.3
Washington	DC	4,080	0.21	12.0	4.4	2.3	59.1
Fort Myers	FL	859	0.14	12.1	2.2	2.4	63.2
Gainesville	FL	3,371	0.19	13.5	2.0	3.6	51.3
Jacksonville	FL	561	0.26	7.6	1.3	3.0	
Miami	FL	4,949	0.21	9.1	2.0	2.7	44.4
Orlando	FL	2,649	0.22	9.9	1.8	3.1	57.4
Ormond Beach	FL	1,148	0.26	12.0	2.2	2.9	55.9
Tampa	FL	3,953	0.18	10.2	1.9	3.0	55.6
Atlanta	GA	7,300	0.21	11.5	2.0	1.8	53.2
Augusta	GA	1,592	0.20	12.1	1.2	1.3	78.4
Honolulu	HI	991	0.13	24.4	2.3	1.0	
Des Moines	IA	634	0.19	13.5	6.0	4.3	42.3
Iowa City	IA	1,578	0.18	20.3	4.5	3.8	56.0
Chicago	IL	10,754	0.23	9.3	4.0	2.3	54.0
Peoria	IL	742	0.16	17.9	6.4	3.9	48.4
Springfield	IL	621	0.21	14.1	2.8	2.6	
Indianapolis	IN	6,293	0.25	10.7	3.6	2.9	57.7
Wichita	KS	895	0.16	13.5	3.5	2.2	81.3
Lexington	KY	2,395	0.25	12.5	2.9	3.8	50.0
Louisville	KY	2,534	0.22	16.2	1.5	3.1	42.2
New Orleans	LA	4,931	0.23	14.4	1.6	2.7	53.0
Shreveport	LA	1,938	0.26	13.2	1.1	0.9	
Boston	MA	4,875	0.19	18.8	6.9	2.3	54.7

Rates of ESRD are adjusted for age, sex, and race. The percent using AV fistulas and the percent receiving living and deceased donor transplants are unadjusted. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Chapter 5 Table. Prevalence of end-stage renal disease, use of AV fistulas, living and deceased donor kidney transplants, and 30-day readmissions following kidney transplant among transplant referral regions (2007-10)

TRR Name	State	Number of Medicare beneficiaries with ESRD	Percent of patients with end stage renal disease	Percent of ESRD patients using AV fistulas	Percent of ESRD patients receiving living donor transplants within two years of starting dialysis	Percent of ESRD patients receiving deceased donor transplants within two years of starting dialysis	Percent readmitted within 30 days following transplant
Springfield	MA	920	0.20	22.3	5.3	1.5	
Worcester	MA	467	0.18	20.1	6.3	4.7	57.9
Baltimore	MD	5,927	0.23	11.6	3.9	3.7	58.8
Portland	ME	1,028	0.13	23.7	5.6	3.2	50.0
Ann Arbor	MI	4,588	0.23	13.4	4.0	2.1	56.3
Detroit	MI	5,284	0.23	10.7	2.9	2.0	61.3
Grand Rapids	MI	1,196	0.18	13.5	6.5	2.3	40.0
Minneapolis	MN	2,399	0.16	13.0	9.9	3.9	61.8
Rochester	MN	1,008	0.20	15.7	10.1	2.7	
Columbia	MO	654	0.17	11.9	3.4	4.4	64.7
Kansas City	MO	3,235	0.21	11.9	2.3	5.3	45.1
St Louis	MO	5,860	0.23	10.2	2.7	2.7	63.2
Jackson	MS	659	0.22	10.3		2.2	
Charlotte	NC	2,069	0.17	20.1	2.3	3.3	55.6
Durham	NC	4,405	0.20	14.5	2.1	1.8	47.5
Greenville	NC	1,259	0.19	15.8	2.4	1.1	77.3
Winston-Salem	NC	2,255	0.19	15.7	2.1	5.5	53.1
Bismarck	ND	461	0.18	17.2	5.0	4.0	
Fargo/Moorhead MN	ND	667	0.27	11.4	5.4	3.5	40.0
Omaha	NE	2,225	0.20	12.1	4.9	3.8	49.2
Lebanon	NH	498	0.15	21.4	8.5	4.0	
New Brunswick	NJ	268	0.24	14.3	6.6	3.1	
Newark	NJ	7,372	0.28	13.1	4.7	2.0	51.9
Albuquerque	NM	1,415	0.15	15.6	3.0	2.3	50.0
Las Vegas	NV	1,345	0.23	9.6	1.3	2.2	46.7
Albany	NY	1,748	0.24	15.0	2.2	2.0	55.9
Buffalo	NY	1,160	0.23	14.8	4.3	2.8	60.5
East Long Island	NY	187	0.19	17.1	6.6	1.7	
Manhattan	NY	11,993	0.22	15.2	5.1	2.5	51.6
Rochester	NY	1,084	0.21	17.6	3.8	1.7	44.1
Syracuse	NY	1,341	0.20	17.0	2.0	1.5	52.2
White Plains	NY	1,020	0.22	12.8	6.2	1.5	60.0
Cincinnati	OH	2,571	0.28	11.6	4.7	1.4	59.7
Cleveland	OH	4,997	0.25	15.7	2.5	1.5	62.6
Columbus	OH	4,937	0.28	11.2	3.9	2.6	40.7
Dayton	OH	885	0.23	14.3	3.1	4.1	48.1
Toledo	OH	1,228	0.29	7.6	3.6	2.7	70.0
Oklahoma City	OK	2,653	0.21	10.1	2.2	2.7	44.0
Tulsa	OK	1,172	0.18	13.0	1.8	2.1	40.7

Chapter 5 Table. Prevalence of end-stage renal disease, use of AV fistulas, living and deceased donor kidney transplants, and 30-day readmissions following kidney transplant among transplant referral regions (2007-10)

TRR Name	State	Number of Medicare beneficiaries with ESRD	Percent of patients with end stage renal disease	Percent of ESRD patients using AV fistulas	Percent of ESRD patients receiving living donor transplants within two years of starting dialysis	Percent of ESRD patients receiving deceased donor transplants within two years of starting dialysis	Percent readmitted within 30 days following transplant
Portland	OR	1,908	0.15	20.8	4.3	3.2	57.4
Allentown	PA	500	0.22	9.4	2.7	5.0	75.0
Danville	PA	848	0.20	15.3	6.3	2.5	41.4
Harrisburg	PA	1,504	0.17	10.3	4.1	2.0	54.8
Philadelphia	PA	8,070	0.23	13.7	2.9	3.2	48.4
Pittsburgh	PA	3,818	0.24	12.6	2.6	2.4	58.6
Providence	RI	749	0.19	14.9	4.1	1.4	60.0
Charleston	SC	4,403	0.19	14.4	1.8	3.1	48.8
Sioux Falls	SD	705	0.15	8.7	6.4	4.2	54.2
Chattanooga	TN	677	0.18	18.7	3.0	1.7	
Johnson City	TN	576	0.17	11.8	2.1	6.2	
Knoxville	TN	1,455	0.25	12.5	1.8	2.2	40.0
Memphis	TN	3,087	0.23	9.8	1.5	2.2	41.7
Nashville	TN	2,128	0.18	13.7	3.3	2.8	53.6
Austin	TX	900	0.18	13.1	4.3	2.1	45.8
Dallas	TX	4,854	0.20	14.5	2.8	3.2	45.0
El Paso	TX	601	0.19	7.0	2.1	1.3	
Fort Worth	TX	1,123	0.23	8.4	2.0	1.7	74.2
Houston	TX	6,807	0.27	8.3	2.3	2.2	50.4
Lubbock	TX	1,175	0.22	6.4	4.7	2.3	
Odessa	TX	523	0.25	9.9	1.9	2.1	
San Antonio	TX	5,713	0.25	10.8	3.2	0.8	52.5
Temple	TX	315	0.17	20.6	3.0	3.2	
Tyler	TX	566	0.19	14.2	1.9	2.9	
Salt Lake City	UT	1,699	0.16	15.1	7.1	4.8	49.0
Charlottesville	VA	2,554	0.22	14.5	3.6	2.4	52.4
Norfolk	VA	1,587	0.19	11.5	2.8	1.0	44.7
Richmond	VA	2,256	0.19	12.6	3.4	3.0	44.4
Burlington	VT	601	0.18	15.2	5.4	7.1	73.7
Seattle	WA	4,065	0.15	20.2	4.6	3.4	64.9
Spokane	WA	1,000	0.18	18.4	3.6	2.4	40.6
Madison	WI	3,030	0.19	15.7	5.9	5.7	50.9
Milwaukee	WI	2,216	0.24	14.4	3.3	5.2	45.8
Charleston	WV	1,303	0.27	9.9	1.2	2.1	60.7
Morgantown	WV	38	0.15	20.4		1.9	
United States	US	282,820	0.21	13.0	3.3	2.5	53.4

Rates of ESRD are adjusted for age, sex, and race. The percent using AV fistulas and the percent receiving living and deceased donor transplants are unadjusted. Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Variation in the Care of Surgical Conditions: Prostate Cancer

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Prostate Cancer

Cancer of the prostate (a walnut-sized gland in the male genitourinary system) is a common disease that is associated with aging. While most prostate cancer is slow-growing and not likely to cause harm, some men will develop aggressive disease that causes death. Most prostate cancers are detected by screening in otherwise healthy men through blood testing (prostate-specific antigen, or PSA testing) and a prostate exam followed by a biopsy in those with suspicious findings.

The implementation of PSA screening in the late 1980s was associated with a significant increase in prostate cancer diagnoses (Figure 6.1). In 2013, approximately 240,000 men were diagnosed with prostate cancer in the United States, and about 30,000 men died from this condition.[1] The death rate from prostate cancer has gradually decreased in the last 20 years, from 38.6 to 21.8 deaths per 100,000 men from 1990 to 2010. Reasons for this lower death rate are thought to include both the effects of screening and the development of more effective treatments. While prostate cancer remains the second leading cause of cancer-related death in men in the United States, most men die with prostate cancer, but not because of it (Figure 6.2). Notably, black patients are at increased risk of both diagnosis and death from prostate cancer.

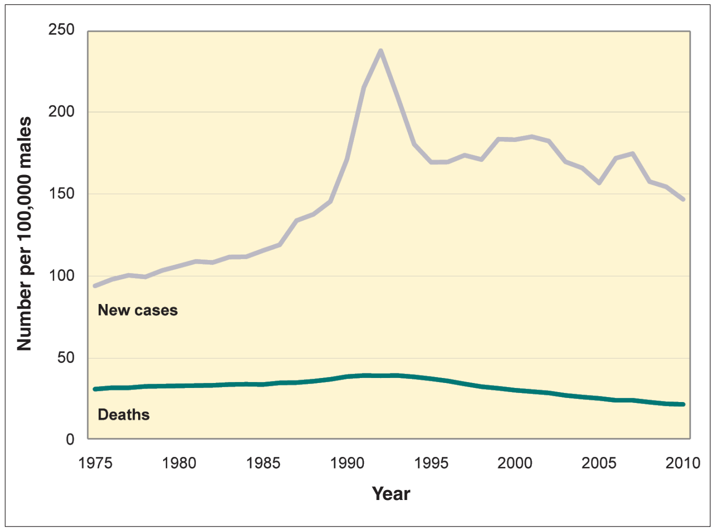

Figure 6.1. Trends in prostate cancer incidence (new cases) and deaths, 1975-2010

Source: SEER Stat Fact Sheets: Prostate Cancer. seer.cancer.gov/statfacts/html/prost.html.

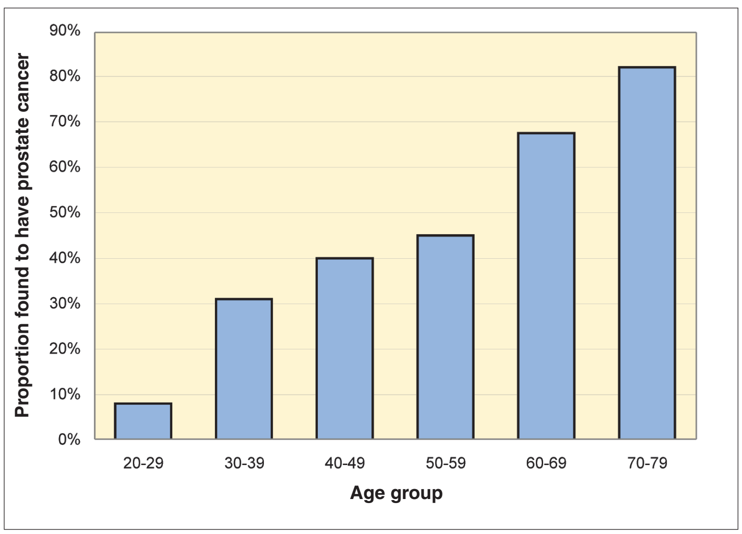

Figure 6.2. Diagnosis of prostate cancer on autopsy studies based on age

Source: Welch HG, Schwartz L, Woloshin S. *Overdiagnosed: Making People Sick in the Pursuit of Health.* Boston, MA: Beacon Press, 2011. Data abstracted from: Sakr WA, Grignon DJ, Haas GP, Heilbrun LK, Pontes JE, Crissman JD. Age and racial distribution of prostatic intraepithelial neoplasia. *Eur Urol.* 1996;30(2):138-44.

Before surgery

Screening/PSA controversy: Deciding before a diagnosis

At first glance, the rationale for prostate cancer screening seems straightforward. The goal of screening is early detection of prostate cancer to prevent death and suffering from advanced disease. However, our tools for identifying those at risk for more serious cancer are limited. PSA testing is the leading tool for early detection, but while an elevated PSA value reflects a higher risk of cancer, it may be also be elevated due to non-cancerous conditions such as inflammation, urinary tract infection, prostatic enlargement, and urinary retention. Furthermore, there is no PSA value that ensures the presence or absence of cancer; rather, PSA values reflect a spectrum of risk. While elevated PSA levels indicate higher risk of serious cancer, most cancers detected by PSA screening are at an early stage and non-aggressive. Other factors that influence risk of cancer are patient age, ethnicity, family history, and presence or absence of a prostate nodule (a "bump" on the prostate detected by rectal exam). Counseling patients regarding their risk, and determining whether a biopsy is warranted, can be challenging given these nuances and the limitations of screening methods.

Given the high prevalence of prostate cancer and its generally indolent behavior, most men will die *with* rather than *from* their disease. Screening, therefore, identifies a large number of patients with cancer who might never have been harmed, and hence are "overdiagnosed." However, when prostate cancer is aggressive, it may cause significant harm to men; early detection of these more dangerous cancers is a worthwhile aim. A major limitation of PSA screening is that selective identification of more aggressive cancer is not yet possible. For patients and physicians, it is not clear how best to reconcile the competing interests of detecting dangerous cancer while not causing needless worry, as well as potential harm from biopsy and treatment. For these reasons, there is a growing consensus that traditional, systematic screening of asymptomatic men causes more harm than good.

What are the benefits and harms of screening? Evidence suggests that routine screening can reduce the likelihood of cancer-related death and metastatic disease. However, a large number of men need to be screened to achieve this benefit; about 1,000 asymptomatic men need to be screened to save one life.[2] Potential harms of screening include: 1) Anxiety and uncertainty associated with the screening process ("Do I have cancer? Do I need a prostate biopsy?"); 2) Risks associated with prostate biopsy (e.g., bleeding and infection); 3) Diagnosis of indolent disease that would never have caused harm; and 4) Potential side effects of treatment (e.g., erectile dysfunction, urinary control issues) when patients elect for treatment. Whether screening is worthwhile is often a matter of perspective, and whether the decision-maker is a patient, provider, and/or policymaker.

Table 6.1. Comparing the benefits and harms of screening	
Benefit of Screening	**Rate at which it occurs**
Avoiding a prostate-cancer related death	1 in 1,000
Harms of Screening	**Rate at which it occurs**
"False alarm" PSA result leading to a biopsy	150-200 in 1,000
Diagnosis of prostate cancer that was unlikely to cause harm	30-100 in 1,000
Complication from prostate cancer treatment	10-50 in 1,000

Outcomes research has attempted to clarify the effects of screening to guide both policy and clinical decision-making. There have been large prospective registries of cancer patients that have demonstrated a decline in prostate cancer mortality and metastatic disease within the last 20 years,[1] with estimates that 45-70% of the decline in mortality decline can be attributed to screening.[3,4] Other studies based on registry data have demonstrated, however, that the rate of "overdiagnosis" may exceed 50%.[5] Long-term comparative studies that have evaluated the effects of screening on prostate cancer mortality and the development of metastatic disease have often reported different results. In part this is the result of studying different screening protocols within different populations.[2,6] A reasonable conclusion from these studies is that screening does "save lives"—about 1 for every 1,000 screened. Of these 1,000 men, 30 to 40 will develop erectile dysfunction or urinary incontinence, 2 will experience a serious cardiovascular event, and 1 will develop a serious blood clot due to treatment.[7]

Screening and treatment for prostate cancer continue to be controversial. Many people hoped that the two large randomized trials of screening, conducted in the United States and Europe, would settle the question, but the trial results conflicted. At best, the European trial showed a small prostate cancer mortality reduction over 11 years, as well as considerable overdiagnosis and potential for overtreatment. Subsequently, the U.S. PIVOT study comparing radical prostatectomy with observation showed that, while observation was the optimal strategy for most men, a subset of men with more aggressive cancers had a reduction in overall mortality with surgery. The U.S. Preventive Services Task Force (USPSTF) has now recommended against prostate cancer screening, while other national guideline groups have recommended a shared decision-making approach to screening, focused on men age 55-69 who appeared to experience at least some benefit in the European screening trial.

In this report from the Dartmouth Atlas of Health Care, the reader begins to see how these research results are starting to play out in clinical practice. The rate of PSA testing among "younger" Medicare beneficiaries in 2010 varied from about 4% in Lebanon, New Hampshire (near the home of the Atlas) to almost 60% in Miami! The incidence of prostate cancer and rates of radical prostatectomy varied almost as impressively.

The results presented here cry out for an analysis of time trends and correlations. Are PSA testing rates dropping among 65-74 year olds? Does screening appear to drive incidence and treatment? The finding that Minot, North Dakota, has a low PSA testing rate but a high incidence rate is a curious finding that deserves further exploration. Such differences in screening and treatment create the opportunity for "natural experiments" comparing areas with more or less aggressive approaches. Though the impetus to reduce overdiagnosis is broadly accepted, advocates of screening worry that dropping screening rates will ultimate lead to a reversal of the recent trend toward lower population-based prostate cancer mortality in the United States.

Much thought is being given today to whether most of any small benefit of PSA screening can be maintained with a much less aggressive screening and treatment strategy: fewer tests, higher biopsy thresholds, and treatment for only the most aggressive cancers. This change in mindset will be difficult, if not impossible, for American physicians and patients. And more evidence is coming. The large PROTECT trial in the United Kingdom, a treatment trial (comparing surgery, radiation, and observation) nested within a screening trial, is scheduled to be completed at the end of 2015. I'll look forward to the "next steps" in this complicated and interesting journey.

Michael J Barry MD

President, Informed Medical Decisions Foundation
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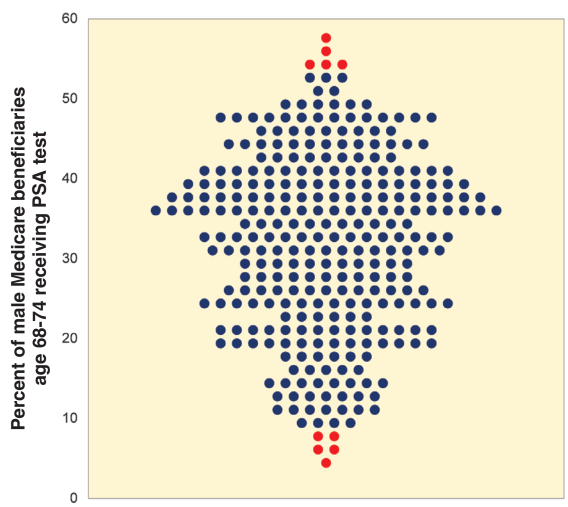
Given the weak benefits of screening for a disease that leads to over 30,000 deaths a year, it is not surprising that clinical guidelines do not agree on who should be screened for prostate cancer. This is confusing for clinicians and patients alike. In 2012, the U.S. Preventive Services Task Force (USPSTF) issued the recommendation, "Do not use prostate-specific antigen (PSA)–based screening for prostate cancer." The Task Force based its decision on the aforementioned data showing a high "number needed to screen" to save one life, weighed against the psychological and physical effects of screening and subsequent treatment.[7] Other professional groups have been skeptical of these recommendations. The American Urological Association's most recent guidelines state, "For men ages 55 to 69 years the Panel recognizes that the decision to undergo PSA screening involves weighing the benefits of preventing prostate cancer mortality in 1 man for every 1,000 men screened over a decade against the known potential harms associated with screening and treatment. For this reason, the Panel strongly recommends shared decision-making for men age 55 to 69 years that are considering PSA screening, and proceeding based on a man's values and preferences."[8]

These guidelines (Table 6.2) for screening emphasize a "risk-based" approach—screen those with the highest risk of significant cancer, who are most likely to benefit—as well as collaborative decision-making with patients that includes a detailed discussion of benefits and harms. There has also been a growing dialogue between urologists, primary care practitioners, and policy experts to narrow their differences on screening, relying on evidence rather than historical practice.[9] Indeed, there is evidence that the medical community has done poorly in screening men appropriately, with high rates of screening of older, sicker patients who are least likely to benefit.[10] Most importantly, there are ongoing studies to develop novel tools for early diagnosis that are more specific to dangerous forms of prostate cancer, so that overdiagnosis might be minimized.

Table 6.2. Recommendations for prostate cancer screening

United States Preventive Services Task Force (USPSTF)	"The USPSTF recommends against the service [prostate cancer screening]. There is moderate or high certainty that the service has no net benefit or that the harms outweigh the benefits."
American Urological Association (AUA)	For men 55-69 years old, there should be shared decision-making and screening based on a man's "values and preferences."
	For men <55 at higher risk (African-American descent, significant family history), decisions should be individualized.
	The Panel does not recommend routine PSA screening in men age 70+ years or any man with less than a 10 to 15 year life expectancy. Some men age 70+ years who are in excellent health may benefit from prostate cancer screening.
American Cancer Society (ACS)	Starting at age 50, men should discuss pros and cons of PSA testing with their doctors.
	If a patient is African-American or has a father or brother diagnosed with prostate cancer before age 65, this conversation should occur at age 45.
American Society of Clinical Oncology (ASCO)	For men with a life expectancy of <10 years, general screening with PSA should be discouraged because harms seem to outweigh potential benefits.
	For men with life expectancy >10 years, physicians should discuss with their patients whether PSA testing is appropriate.

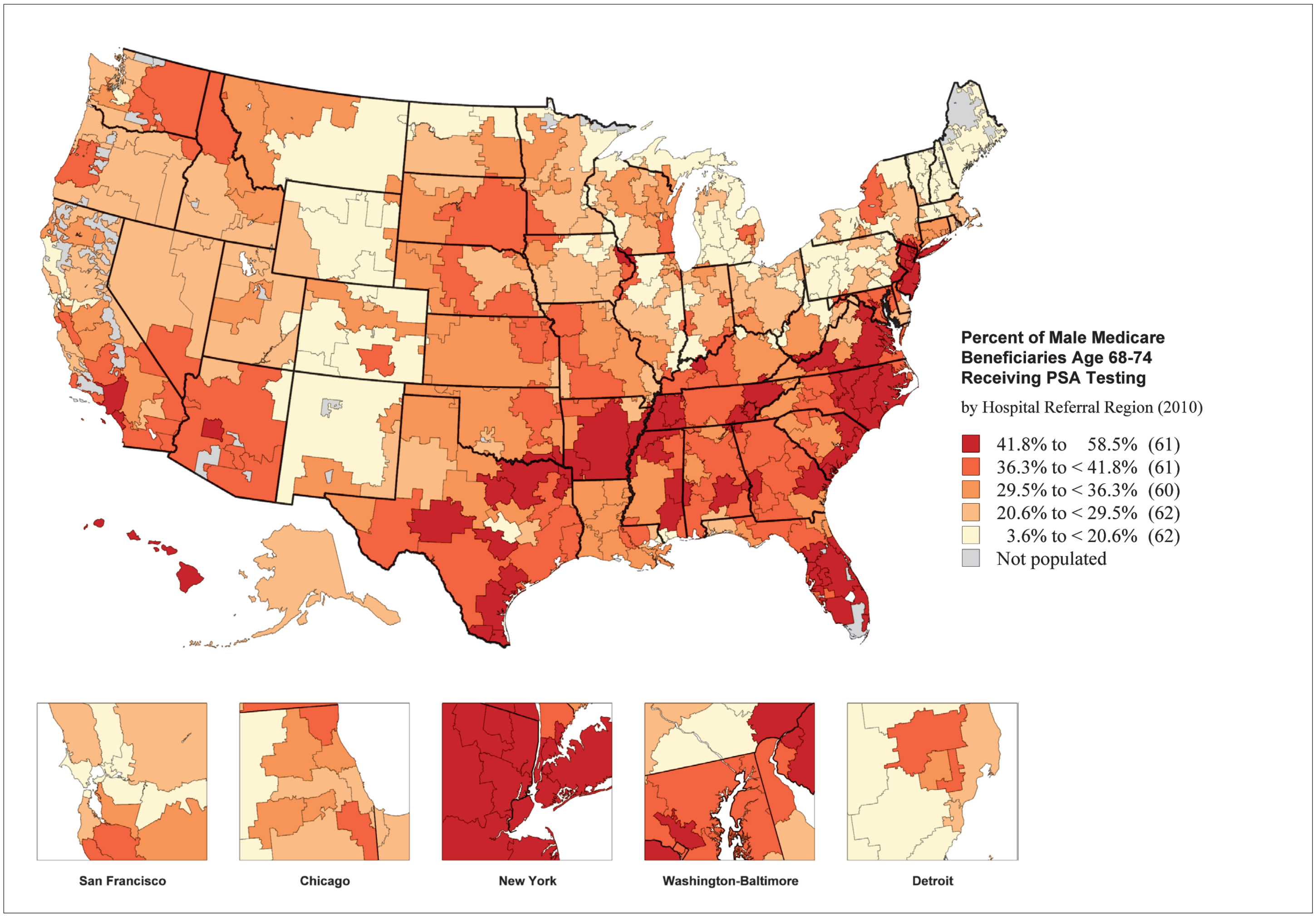
Not surprisingly, diverse recommendations, an unclear risk-to-benefit ratio, and dogmatic practice have led to significant variation in prostate cancer screening. Prior studies have shown that this regional variation in screening practices reflects provider and local health system practice styles, rather than differences in population risk for prostate cancer.[11-13] Among male Medicare beneficiaries age 68-74, rates of PSA testing varied by a factor of more than fifteen among hospital referral regions during 2010, from 3.6% of men in Lebanon, New Hampshire to 58.4% in Miami. Less than 10% of men in this group were screened for prostate cancer using PSA testing in Mason City, Iowa (5.8%), Burlington, Vermont (6.8%), Minot, North Dakota (7.2%), and Binghamton, New York (7.2%). By contrast, more than 50% of men were screened in Wilmington, North Carolina (55.8%), Sun City, Arizona (55.1%), Paterson, New Jersey (53.7%), and McAllen, Texas (53.5%) (Figure 6.3). The national average rate of PSA testing among men in this cohort was 34.5%. In general, PSA testing rates were higher in the Southeast than in other parts of the country (Map 6.1).



Miami, FL	58.4%
Wilmington, NC	55.8%
Sun City, AZ	55.1%
Paterson, NJ	53.7%
McAllen, TX	53.5%
Binghamton, NY	7.2%
Minot, ND	7.2%
Burlington, VT	6.8%
Mason City, IA	5.8%
Lebanon, NH	3.6%

Figure 6.3. Variation in prostate cancer screening among hospital referral regions (2010)

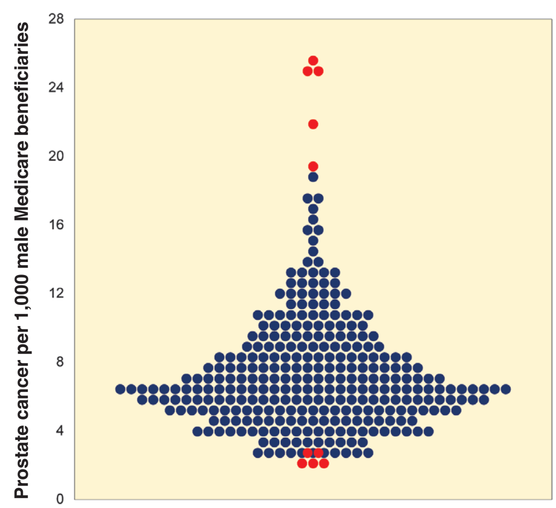
Each blue dot represents the rate of PSA testing in one of 306 hospital referral regions in the U.S. Red dots indicate the regions with the 5 lowest and 5 highest rates.



Map 6.1. Variation in prostate cancer screening (2010)

Rates are adjusted for race.

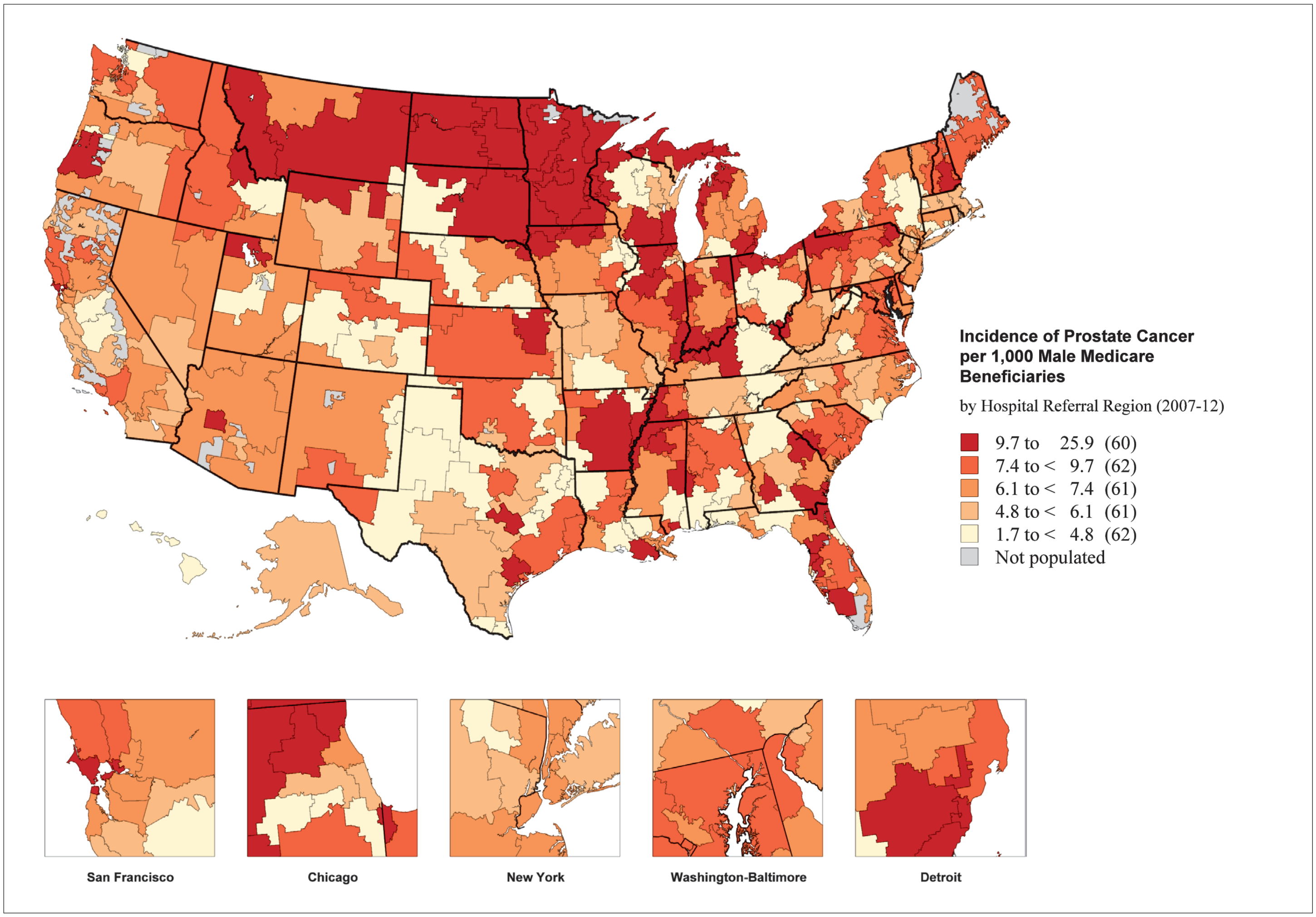
New prostate cancer diagnoses also vary more than twelvefold, even after adjustment for age and race. This variation is concerning as it reflects the lack of a consistent standard of care, with potential for over- and under-detection of prostate cancer depending on individual and regional practice. The national average rate of prostate cancer among Medicare beneficiaries was 7.4 per 1,000 men during the period from 2007 to 2012. Among hospital referral regions, this rate varied from less than 2 per 1,000 men in Longview, Texas (1.8) and Cedar Rapids, Iowa (1.9) to more than 24 per 1,000 in Mason City, Iowa (25.9), Fargo, North Dakota/Moorhead, Minnesota (24.8), and Minot, North Dakota (24.7) (Figure 6.4). Rates of prostate cancer diagnosis were generally higher in the northern Midwest and mountain states than in other regions (Map 6.2).



Mason City, IA	25.9
Fargo, ND/Moorhead, MN	24.8
Minot, ND	24.7
Sioux City, IA	21.9
Little Rock, AR	19.3
Marshfield, WI	2.4
Jonesboro, AR	2.4
Harlingen, TX	2.2
Cedar Rapids, IA	1.9
Longview, TX	1.8

Figure 6.4. Incidence of prostate cancer among hospital referral regions (2007-12)

Each blue dot represents the incidence of prostate cancer in one of 306 hospital referral regions in the U.S. Red dots indicate the regions with the 5 lowest and 5 highest rates.



Map 6.2. Incidence of prostate cancer (2007-12)

Rates are adjusted for age and race.

Treatment options: Effectiveness, trade-offs, and knowledge gaps

When prostate cancer is detected through biopsy, it is assigned a risk category (low, intermediate, or high) based on microscopic inspection of the tumor, PSA level, and the presence or absence of a prostate nodule on physical exam. This category reflects the likelihood of aggressive behavior and is central to discussions about whether treatment is required. Specifically, "low-risk" cancer is often observed rather than treated immediately, while higher risk categories are generally treated with surgery or radiation therapy. Decision-making regarding treatment is complex and involves diverse factors such as disease risk, patient age, health status, urinary and sexual function, and personal preferences.

For low-risk (non-aggressive) cancer, there has been growing support for observational strategies rather than treatment. A common approach to observation is "active surveillance," or AS, which involves monitoring the cancer for signs of progression through PSA testing, physical exam, and periodic follow-up biopsy. Treatment is pursued only if there is disease progression or if patients desire treatment. For younger men, the purpose of AS is to delay side effects of treatment, such as impotence and urinary leakage, without compromising cancer cure. For older men, treatment may be obviated entirely if they reach a certain age without progression. Studies have demonstrated that surveillance is safe; in large prospective studies of men with low-risk cancer, there were very low rates of cancer death.[14,15]

Despite the fact that most low-risk cancer can be safely observed, there has been a high rate of treatment with radiation or surgical therapy,[16,17] especially as advanced treatment options have been introduced. These are concerning trends, as these patients often incur the side effects of treatment without a clinical benefit. Impediments to the adoption of observational strategies include the anxiety related to a cancer diagnosis, lack of education among patients and providers regarding the nuances of disease risk, medico-legal concerns among providers, and others.

During surgery

Variation among treatment strategies in Medicare patients

When diagnosed with prostate cancer, men can choose from four distinct treatment strategies: prostatectomy, radiation therapy, hormone treatments, and active surveillance. The treatment that men receive varies not only by region, but also by individual factors such as age. For example, among men age 65 to 70, about 24% receive surgery, 28% radiation, 13% hormone therapy, and, for 35%, treatment is deferred or they receive active surveillance (Figure 6.5). While these data are affected by the stage of patients' cancer, age has a distinct impact on treatment choices, as less invasive and/or aggressive therapies (radiation and hormone therapy) become more common in men as they age.

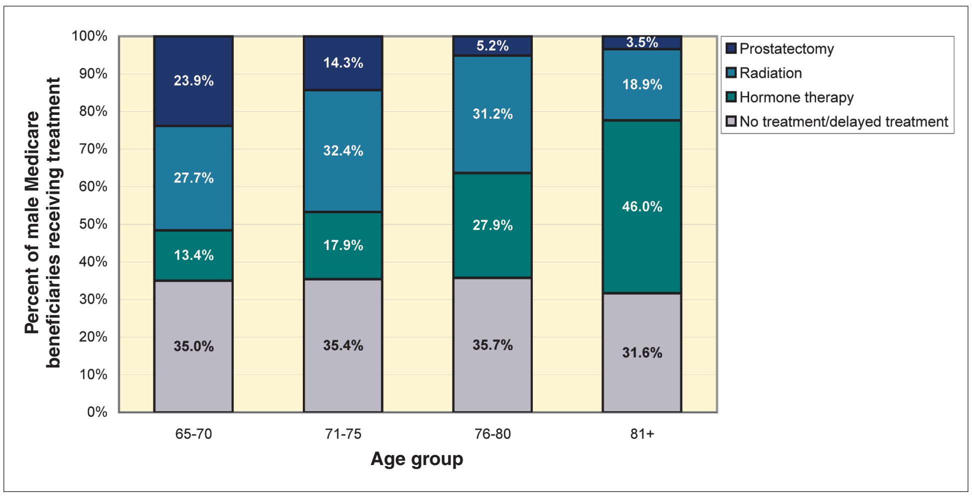


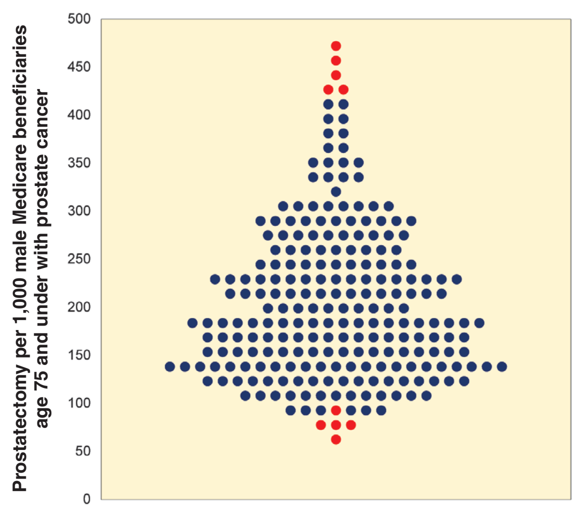
Figure 6.5. Prostate cancer treatment, by age (2007-12)

When should patients be treated? The best evidence suggests, not surprisingly, that younger patients with higher-risk disease are most likely to benefit from treatment. A large trial in Scandinavia demonstrated that men under 65 years old and with higher-risk disease were most likely to have a survival benefit from surgery, though older patients might benefit from a decreased risk of metastatic disease.[18] The Prostate cancer Intervention Versus Observation Trial (PIVOT), based in the Veterans Administration (VA) system in the United States, demonstrated that men with higher PSA values and intermediate-high-risk cancer were more likely to benefit from surgery rather than from observation.[19] The take-away message of these trials—which require careful analysis based on their populations (i.e., Northern Europeans with palpable disease, and VA patients who are older with more baseline illness, respectively)—is that discussions with patients should be tailored to the patient's age and level of risk for significant cancer. Younger patients with higher-risk cancer are more likely to benefit from aggressive treatment, while those who are older with lower-risk cancer are most likely to benefit from observation.

Deciding which treatments are best when treatment is necessary

While first-line treatments for prostate cancer include radiation therapy and surgery, there are no evidence-based recommendations for “preferred” therapy. This is primarily due to the lack of strong evidence supporting one primary treatment versus another.[19] This lack of evidence has resulted from the logistical challenges of a trial comparing treatment options, which would require long-term study (>10 years) to assess differences in effect and could not readily account for changes in therapies over time. While there are often patient factors that make one treatment more desirable (e.g., age, health status, disease risk, priorities regarding urinary and sexual function), many patients nonetheless struggle with the complexities of treatment decisions.

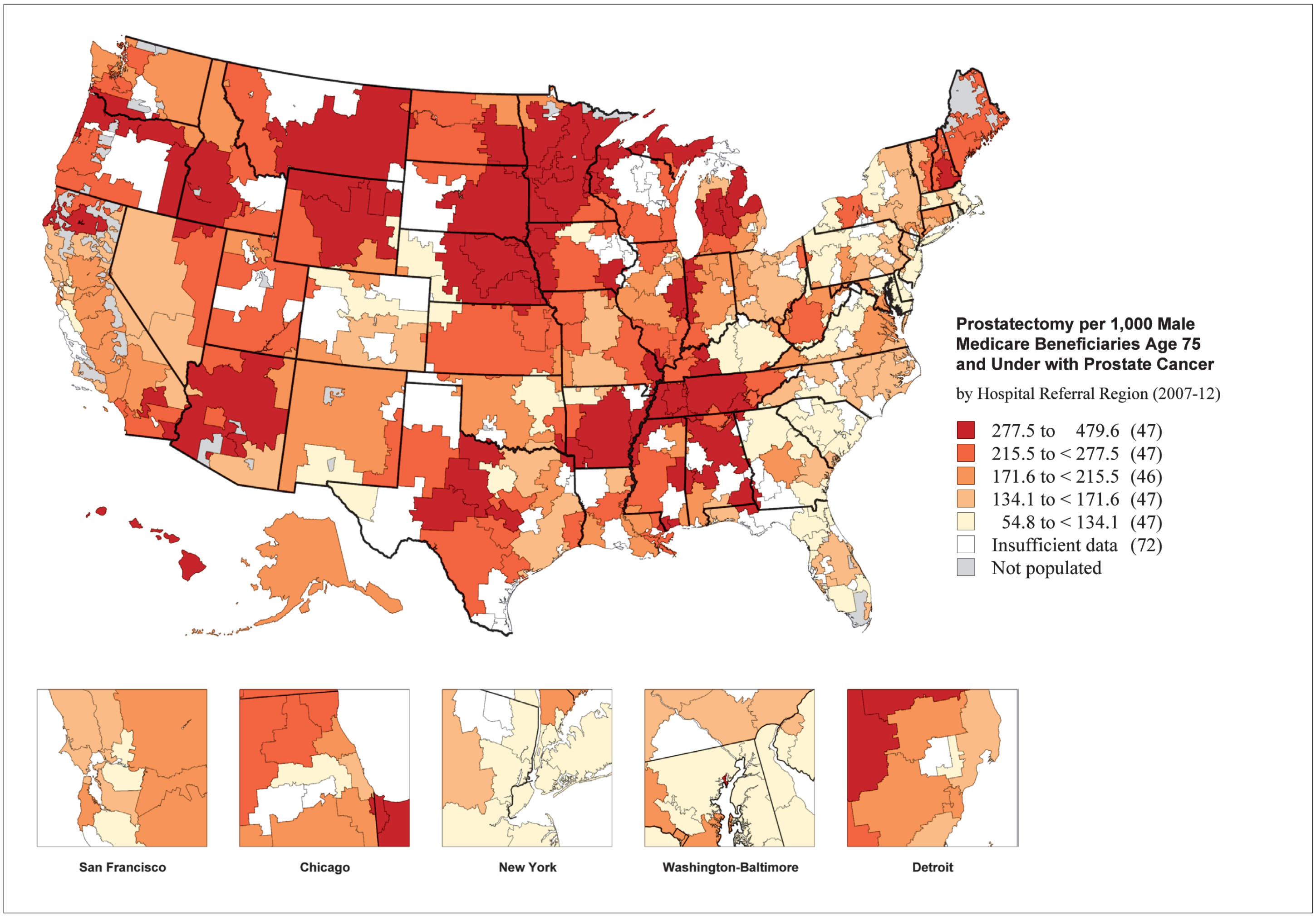
The lack of clear guidelines has led to regional variation in the treatment of prostate cancer. A 2010 analysis of national registry data demonstrated substantial variation in treatment that was attributable to the site of treatment rather than disease characteristics; this is considered unwarranted variation.[16] Previous work by the Dartmouth Atlas showed that prostatectomy had the greatest local variation among the ten most commonly performed inpatient procedures in the U.S. The use of prostate surgery varied nearly tenfold between the hospital referral regions with the lowest and highest rates of prostatectomy (0.5 to 4.7 per 1,000 Medicare patients).[20]



Munster, IN	479.5
Meridian, MS	459.1
San Angelo, TX	437.1
Casper, WY	428.8
Texarkana, AR	421.9
Hackensack, NJ	86.2
Columbia, SC	82.1
Wilmington, DE	77.5
Tulsa, OK	71.7
Ocala, FL	54.8

Figure 6.6. Prostatectomy per 1,000 male Medicare beneficiaries age 75 and under with prostate cancer by hospital referral region (2007-12)

Each blue dot represents the rate of prostate surgery in one of 306 hospital referral regions in the U.S. Red dots indicate the regions with the 5 lowest and 5 highest rates.



Map 6.3. Prostatectomy per 1,000 male Medicare beneficiaries age 75 and under with prostate cancer (2007-12)

Rates are adjusted for race.

Contemporary Medicare data demonstrate considerable variation in prostatectomy rates by hospital referral region. In age and race adjusted analyses of Medicare patients age 75 and under, rates of prostatectomy varied more than eightfold across the United States. There were fewer than 80 procedures per 1,000 men in Ocala, Florida (54.8), Tulsa, Oklahoma (71.7), and Wilmington, Delaware (77.5); by contrast, there were more than 430 prostatectomies per 1,000 men in Munster, Indiana (479.5), Meridian, Mississippi (459.1), and San Angelo, Texas (437.1) (Figure 6.6). The national average rate was 189.3. Prostatectomy rates tended to be lower on the East Coast than in other regions (Map 6.3).

Other analyses have demonstrated that, in areas with higher Medicare spending, those enrolled in fee-for-service Medicare are more likely to undergo treatment rather than observation.[21] For patients older than 75, there is marked variation in all types of treatment based on geographic region, though this is greatest for prostatectomy (Figure 6.7). Patients with more medical problems are less likely to be treated with prostatectomy, largely because of concern for surgical risks and competing risks of death (Table 6.3). Interestingly, black patients appear less likely to receive surgery or treatment overall,[22] while Medicare data demonstrate wider variation in prostatectomy rates for black compared to non-black patients (Table 6.4). These findings may indicate racial disparities in the provision of care.

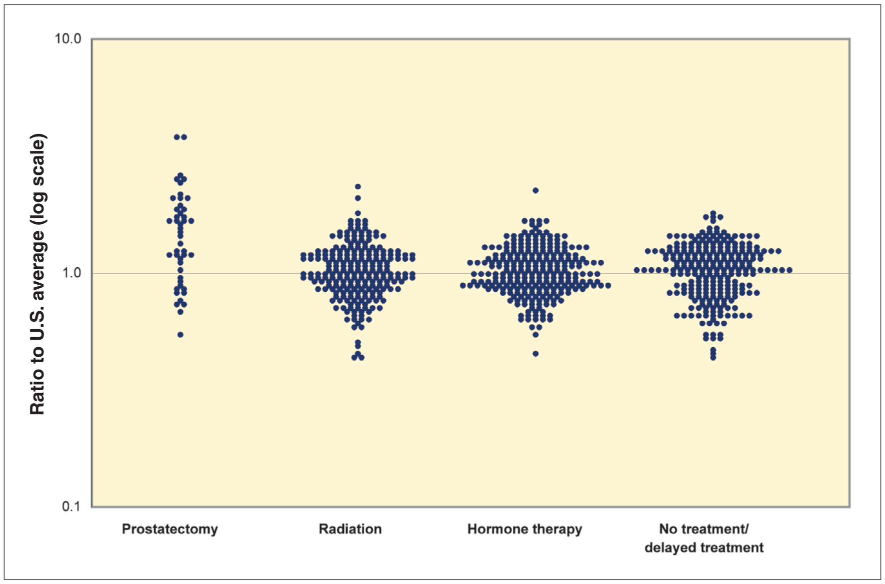


Figure 6.7. Variation in rates of prostate surgery and three non-surgical treatment options among male Medicare beneficiaries over age 75 with prostate cancer (2007-12)

The figure profiles the pattern of variation among male Medicare beneficiaries over age 75 for four treatment options for prostate cancer: prostatectomy, radiation, hormone therapy, and no treatment or delayed treatment. Each dot represents one of the 306 hospital referral regions in the United States. The rates are expressed as the ratio to the U.S. average (plotted on a log scale).

For those who choose surgery: What kind of operation works best?

Patients electing for surgery must choose between traditional open surgery (through a larger single incision) and a less invasive approach. The latter consists most frequently of robotic prostatectomy, a form of laparoscopic surgery—through small incisions, guided by a camera—in which the surgeon controls robotic “wrists” within the abdomen. There is no rigorous evidence comparing outcomes for these approaches, although historical comparisons suggest similar rates of complications, complete removal of the tumor, and the need for additional cancer treatments.[23] Robotic surgery is associated with a decreased risk of blood transfusion and

Table 6.3. Prostatectomy per 1,000 male Medicare beneficiaries age 75 and under with prostate cancer among hospital referral regions by comorbidity status (2007-12)

Fewer than 2 chronic illnesses			2 or more chronic illnesses		
10 highest HRRs			10 highest HRRs		
Munster	IN	505.5	Munster	IN	403.1
Memphis	TN	409.8	Little Rock	AR	242.2
Nashville	TN	337.6	Memphis	TN	228.0
Phoenix	AZ	326.7	Orange County	CA	207.1
Little Rock	AR	315.9	Nashville	TN	191.1
Birmingham	AL	311.0	Milwaukee	WI	184.7
Milwaukee	WI	271.7	Birmingham	AL	180.1
Orange County	CA	263.7	Los Angeles	CA	159.4
St. Louis	MO	248.8	Phoenix	AZ	154.6
Los Angeles	CA	220.9	Springfield	IL	151.6
10 lowest HRRs			10 lowest HRRs		
Houston	TX	175.5	Miami	FL	139.3
Cleveland	OH	175.0	Baltimore	MD	122.9
Philadelphia	PA	163.2	Indianapolis	IN	114.5
Detroit	MI	163.2	Orlando	FL	110.6
Miami	FL	163.0	Camden	NJ	107.9
East Long Island	NY	134.9	Detroit	MI	103.1
Manhattan	NY	129.7	Washington	DC	100.4
Baltimore	MD	128.0	Cleveland	OH	97.5
Camden	NJ	123.8	East Long Island	NY	87.7
Boston	MA	109.4	Boston	MA	72.8

Rates are adjusted for race.

Table 6.4. Prostatectomy per 1,000 male Medicare beneficiaries age 75 and under with prostate cancer among hospital referral regions by race (2007-12)

Black patients			Non-black patients		
10 highest HRRs			10 highest HRRs		
Temple	TX	500.0	Meridian	MS	436.6
Meridian	MS	411.8	Memphis	TN	407.1
Gulfport	MS	407.4	Gulfport	MS	383.0
Milwaukee	WI	280.0	Temple	TX	383.0
Nashville	TN	224.1	Little Rock	AR	321.1
Cleveland	OH	213.7	Nashville	TN	310.7
Memphis	TN	204.3	Birmingham	AL	298.3
Birmingham	AL	200.0	Milwaukee	WI	257.5
Jackson	MS	198.3	Jackson	MS	247.9
Washington	DC	189.7	Los Angeles	CA	218.3
10 lowest HRRs			10 lowest HRRs		
Houston	TX	157.9	Durham	NC	157.9
Dallas	TX	157.9	Richmond	VA	155.6
East Long Island	NY	142.9	Washington	DC	146.0
Orlando	FL	133.3	Cleveland	OH	143.8
Philadelphia	PA	131.1	Manhattan	NY	142.9
Chicago	IL	129.3	Chicago	IL	136.8
Los Angeles	CA	122.8	Baltimore	MD	135.9
Detroit	MI	118.1	Detroit	MI	132.3
Baltimore	MD	82.1	Dallas	TX	130.3
Manhattan	NY	81.8	East Long Island	NY	116.7

Rates are unadjusted.

shorter hospital stays.[24] There is ongoing discussion concerning whether robotic surgery was adopted too rapidly, given its unclear overall benefits compared to open surgery and significantly greater cost. Nonetheless, robotic prostatectomy has become the most common surgical treatment for prostate cancer in the U.S.

Role of non-surgical treatments: Hormone therapy

Androgen deprivation therapy (ADT), which suppresses physiological testosterone levels, is used for treatment of metastatic prostate cancer, or in conjunction with radiation therapy for treatment of higher-risk disease. While it is not appropriate as monotherapy (solitary treatment) for non-metastatic cancer, it has been used for this purpose.[25] Studies have demonstrated variation in the use of ADT for both appropriate and inappropriate indications, attributable to urologist practice styles and other non-medical factors.[26,27] These data underscore the need for effective implementation of evidence-based guidelines, as well as scrutiny of practices by professional societies and other stakeholders to ensure appropriate care.

After surgery

Post procedure care and long-term outcomes

Side effects of surgery and radiation therapy vary, though each can impact patients' quality of life.[28] Detailed counseling prior to treatment is needed to ensure that patients have reasonable expectations regarding acute and chronic effects. Surgery in particular engenders risks of "stress urinary incontinence" (i.e., leakage of urine with coughing, sneezing, lifting) and erectile dysfunction (ED). These side effects often abate, and in many instances resolve over time. Risk of ED in particular is modulated by patient age, preoperative function, interest in sex, other medical problems, degree of "nerve-sparing surgery" (preservation of erectile nerves during the procedure), and the point in time postoperatively (recovery continues up to two years after treatment). Radiation side effects may include irritation of the bladder and rectum, leading to increased frequency and urgency of urination and bowel movements, as well as ED. Table 6.5 outlines common side effects associated with surgery and non-surgical therapies.

Table 6.5. Side effects of two treatment types

Treatment	Side effects
Surgery	Urinary incontinence
	Erectile dysfunction
	Surgical complications (bleeding, infection, adjacent organ injury)
	Urethral scar tissue
	Anesthesia-related complications
Radiation therapy	Bladder inflammation
	Rectal inflammation
	Erectile dysfunction
	Urethral scar tissue
	Increased risk of other pelvic cancers

This list is not exhaustive, and often side effects resolve with time. Rates and severity of complications vary based on patient, disease, and treatment factors.

Rates of retreatment or reintervention after surgery or radiation therapy are low, but additional procedures may be required for treatment of the side effects listed in Table 6.5. Rates of readmission following prostatectomy are low as reflected in recent Medicare data, but appear to be impacted by patient age and health status (Figure 6.8).

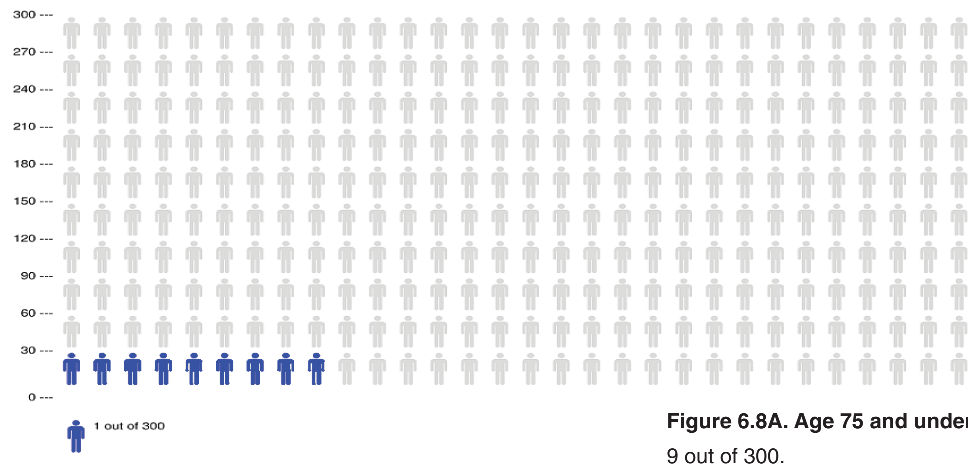


Figure 6.8A. Age 75 and under

9 out of 300.

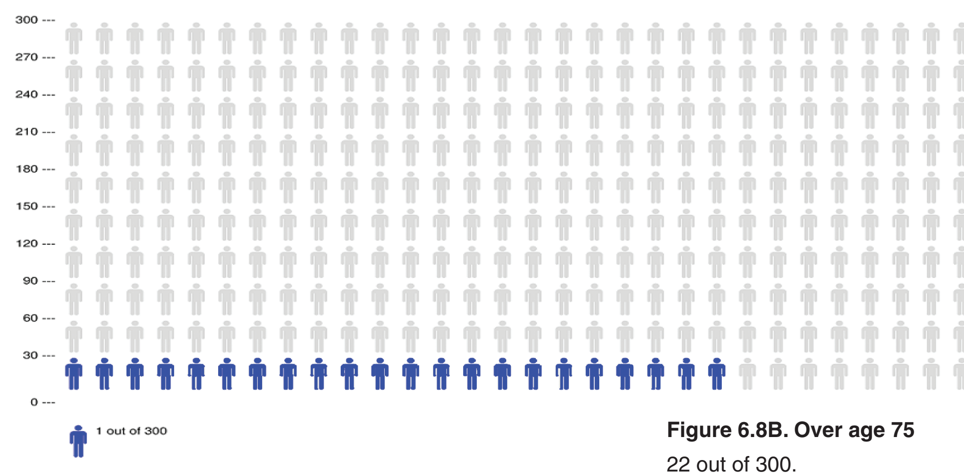


Figure 6.8B. Over age 75

22 out of 300.

Figure 6.8. Risk of 30-day readmission following prostatectomy, by age (2007-12)

There are methodological challenges in estimating the risk of side effects after prostate cancer therapy. Outcomes depend largely on patient characteristics; for example, patients with impaired preoperative erectile function are more likely to have long-term compromise after treatment. Urinary effects are also modulated by age and preexisting urinary function. Furthermore, outcomes in the literature may not be representative of real-world practice. These outcomes may reflect publication bias (providers may be more likely to publish favorable results); self- or physician reports of side effects may be subject to bias; definitions of “incontinence” and “erectile dysfunction” may vary; and symptoms may be assessed at different time points in the healing process. Finally, side effects can have a variable impact on men—ED may be devastating for one man but inconsequential for another. These points highlight the challenges of counseling men regarding their risks and helping them make the best decision regarding treatment.

Beyond surgery

As demonstrated in this report, there is wide variation in screening and treatment practices for prostate cancer. While the lack of consensus on optimal practices will likely continue, the degree of variation also presents an opportunity to improve the quality of care for men.

How to reduce variation?

Shared decision-making is an approach to clinical care that explicitly incorporates patient preferences into treatment decisions. Shared decision-making is both a philosophy and a practical approach that includes decision aids: tools developed in various media that delineate risks and benefits of treatment options while addressing patient preferences. Decision aids been shown to improve the quality of decision-making and may reduce overuse of invasive treatments.[29] Shared decision-making is often used for prostate cancer treatment decisions given the uncertainties regarding benefits and harms of treatment for low-risk cancer. An "option grid" was recently developed for this purpose (Figure 6.9).

Localised prostate cancer - low risk

Use this Grid to help you and your healthcare provider talk about how best to treat your low risk localised prostate cancer.

option grid

	Watch and wait	Active surveillance	Low dose brachytherapy	Radiotherapy and neoadjuvant hormones	Surgery
What does this treatment involve?	Treatment will aim to control symptoms. You will get regular checks and blood tests.	You will get regular checks with blood tests and prostate biopsies. If you change your mind or if the cancer changes, you will be offered treatment aimed at cure.	We try to cure your cancer. Small radioactive pellets are put into your prostate under general anaesthetic.	We try to cure your cancer. Radiation beams and hormone therapy are used together for 4 to 8 weeks, where you visit the hospital every weekday.	We try to cure your cancer. The prostate gland is removed under general anaesthetic. You will stay in hospital for at least one night.
How will this treatment affect long-term survival?	At around 10 years, approximately 85 in every 100 men (85%) will be alive.	At around 10 years, approximately 90 in every 100 (90%) men will be alive.	At around 10 years, approximately 90 in every 100 men (90%) will be alive.	At around 10 years, approximately 90 in every 100 men (90%) will be alive.	At around 10 years, approximately 90 in every 100 men (90%) will be alive.
Will I need additional treatment?	Perhaps. Other treatments may be needed to control your symptoms.	Yes, around 30 in every 100 men (30%) will need additional treatment.	Yes, some men benefit from using hormones to shrink the prostate before brachytherapy.	Most patients have hormone treatment for at least 3 months before radiotherapy.	Radiotherapy might be offered to you after surgery.
What are the side effects associated with this treatment?	Does not apply.	Symptoms generally occur in the first 2 weeks after biopsy, typically pain, and blood in sperm, urine or stools. 10 in every 100 men (10%) get a urine infection.	After the treatment, most men will pass urine frequently, and have bleeding. Some men will be unable to pass urine. After 6 months, around 30 in every 100 men (30%) will have problems with erections, some men may pass urine more often than before.	After the treatment, most men will pass urine frequently, have diarrhoea and tiredness. After 6 months or more, around 30 to 60 in every 100 men (30 to 60%) will have problems with erections. A few men become incontinent and have bowel problems.	Most problems happen immediately after surgery. Most men will have some incontinence for the first 3 months. After 6 months or more, around 40 to 70 in every 100 men (40 to 70%) will have problems with erections. A few men become incontinent.
How long before I return to usual daily activities?	Does not apply.	2 days.	2 weeks.	6 weeks.	3 months.

Editors: Joseph Jelski, Nick Burns-Cox, Alf Collins, Wendy Enticott, Karen Gordon, Emma Gray, Marie-Anne Durand, Katy Marrin, Glyn Elwyn.
Evidence document:http://www.optiongrid.org/resources/lcplowrisk_evidence.pdf
More information: http://www.optiongrid.org/about.php
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Figure 6.9. Option grid for treatment of low-risk prostate cancer

Source: The Option Grid Collaborative (www.optiongrid.org).

Prostate cancer management discussions are ripe for this approach based on the diversity of reasonable options (Figure 6.10). At Dartmouth-Hitchcock Medical Center, patients with newly diagnosed cancer are mailed written and online resources to facilitate comparison of treatment options prior to clinic visits. One particularly useful resource is a booklet from Health Dialog that provides an objective discussion of treatment options with comparison of potential side effects (Figure 6.11).

Treatment Options	Decision Support Tool Components			Patient Outcomes
	Patient Needs	Decision Support	Decision Quality	
Active surveillance/ observation Radical prostatectomy Radiation therapy (external beam and/or brachytherapy)	Clarification of individual values and preferences Knowledge of procedure risks, benefits, and other considerations	**Continuously updated, patient-specific data regarding risks and benefits** Guidance for the patient/surgeon interaction Other considerations	Assessment of patient knowledge and understanding Assessment of congruence with pre-specified values and preferences	Measurement of: Mortality Functional outcomes (e.g., erectile function, urinary function) Patient satisfaction Quality of life

Figure 6.10. Conceptual model for decision support tool

Multidisciplinary clinics are another tool to improve patient education and the quality of decision-making. These clinics are offered to patients with newly diagnosed cancer and typically include appointments with a surgeon, radiation oncologist, and potentially a medical oncologist. Their purpose is to provide different treatment perspectives and reduce bias in the counseling process. A number of centers routinely offer multidisciplinary clinics to patients, and increasingly this is considered a measure of quality in prostate cancer care.[30]

Increased use of active surveillance and other observational strategies will be essential to reduce the health and psychological burdens of overtreatment. Long-term data from surveillance cohorts will help to mitigate concerns regarding safety. Improved tools to predict which cancers pose a greater threat (e.g., blood tests, genetic analysis) will help to ensure the appropriate men are treated. In the short term, improved education of both physicians and patients, and de-stigmatizing "low-risk" prostate cancer, are necessary to ensure that surveillance is considered for this subset of patients.

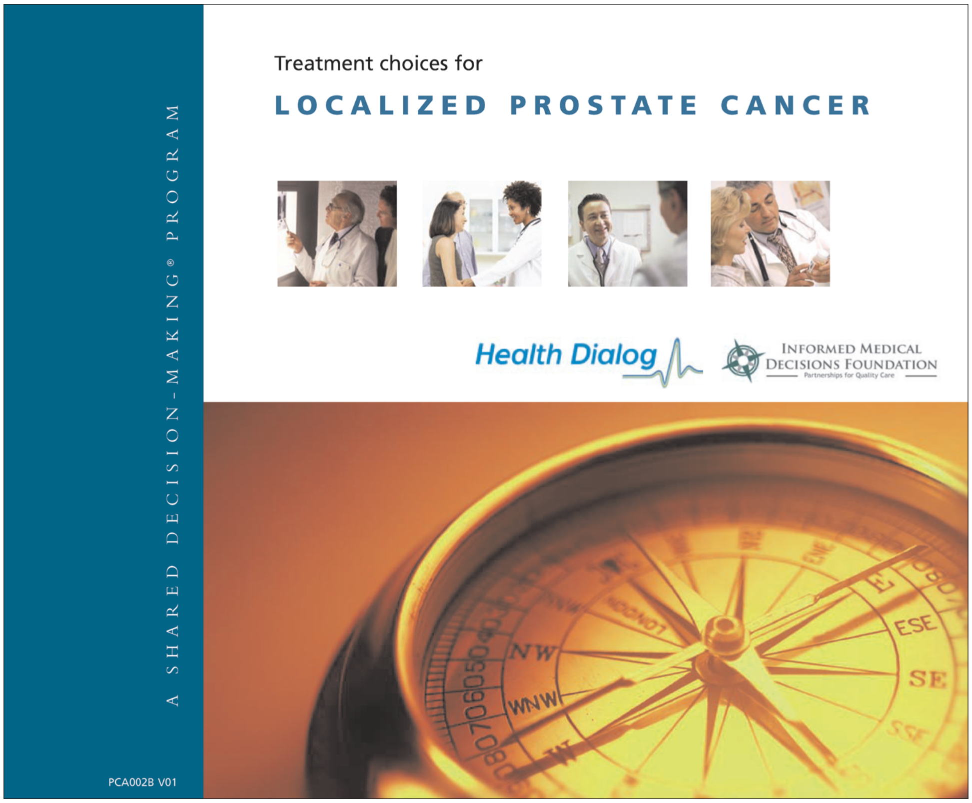

Figure 6.11. Health Dialog booklet concerning treatment choices for localized prostate cancer

Finally, regionalization of care may help to reduce variation in treatment quality. High-volume surgeons and institutions have been shown to achieve superior cancer-related outcomes with fewer side effects.[31-33] As such, it is concerning that low-volume surgeons are performing many prostatectomies.[34] Referral to higher-volume centers may ensure that quality of care is more uniform.

Summary and next steps

Despite many years of attention and study, variation in the diagnosis and treatment of prostate cancer persists in the United States. While some progress has been made—for example, screening practices are becoming more risk-based than population-based—new questions have arisen: for example, how best to counsel patients regarding their risk of cancer and the benefits and trade-offs of treatment; how to optimize outcomes related to treatment; and which patients are best treated with active surveillance. While these questions are being answered, clinicians and health systems need to strive to incorporate the best available evidence and shared decision-making into their efforts to detect and treat prostate cancer.

Chapter 6 Table. Rates of PSA testing, incidence of prostate cancer, prostatectomy, and non-surgical treatment for prostate cancer among hospital referral regions (2007-12)								
HRR Name	State	Percent of male enrollees age 68-74 having PSA test (2010)	Incidence of prostate cancer per 1,000 male Medicare beneficiaries	Prostatectomy per 1,000 male Medicare beneficiaries with prostate cancer		Radiation treatment per 1,000 male Medicare beneficiaries over age 75 with prostate cancer	Hormone therapy per 1,000 male Medicare beneficiaries over age 75 with prostate cancer	No treatment/ delayed treatment per 1,000 male Medicare beneficiaries over age 75 with prostate cancer
				Age 75 & under	Over age 75			
Birmingham	AL	36.9	9.4	286.5	35.9	364.6	391.9	207.9
Dothan	AL	41.4	5.6	281.4		267.8	298.6	376.4
Huntsville	AL	31.3	3.3	239.4		234.2	276.5	425.5
Mobile	AL	36.7	3.6	195.0		308.0	301.5	325.4
Montgomery	AL	44.9	3.3				468.5	
Tuscaloosa	AL	34.9	7.7			300.1	516.2	
Anchorage	AK	26.7	4.9	177.0				471.5
Mesa	AZ	39.4	5.1	340.7		277.6	246.7	311.7
Phoenix	AZ	40.3	6.5	298.6	96.2	306.4	271.1	324.6
Sun City	AZ	55.1	10.9	248.0	78.7	253.2	360.3	307.1
Tucson	AZ	38.6	6.5	150.3		234.7	256.3	439.3
Fort Smith	AR	29.5	6.8	234.2			418.5	378.1
Jonesboro	AR	29.1	2.4					
Little Rock	AR	43.6	19.3	300.2	68.9	253.3	319.4	358.8
Springdale	AR	40.4	7.7	118.9		297.0	259.3	443.7
Texarkana	AR	45.8	4.0	421.9				
Orange County	CA	47.2	7.3	253.8	73.4	161.1	326.5	439.2
Bakersfield	CA	36.8	5.6	174.0		251.9	453.1	183.3
Chico	CA	24.0	8.0	158.0		170.3	229.8	500.6
Contra Costa County	CA	16.5	6.2	129.9		205.5	334.4	365.4
Fresno	CA	34.8	3.3	201.1			466.1	268.6
Los Angeles	CA	46.2	8.3	207.7	93.2	191.6	322.8	392.3
Modesto	CA	31.4	4.7	175.0		233.5	355.1	353.4
Napa	CA	9.0	8.2	151.7		257.4	302.5	360.7
Alameda County	CA	31.3	6.9	137.6		344.8	234.4	352.6
Palm Springs/Rancho Mirage	CA	24.8	6.3	411.2		224.2	228.3	491.5
Redding	CA	30.2	5.3	309.0		211.0	330.6	394.2
Sacramento	CA	23.9	6.7	185.7		311.7	375.4	276.3
Salinas	CA	24.4	5.1				282.1	435.9
San Bernardino	CA	32.4	6.8	183.5	111.3	117.7	343.8	427.3
San Diego	CA	37.8	5.1	230.7	86.5	242.9	324.0	346.0
San Francisco	CA	17.7	10.5	153.4		244.4	238.9	483.7
San Jose	CA	38.8	5.4	101.7		296.3	277.8	402.9
San Luis Obispo	CA	29.4	5.9					483.3
San Mateo County	CA	21.2	7.2	177.1		299.6	208.9	453.5
Santa Barbara	CA	37.5	6.2	144.0		227.5	293.4	417.2
Santa Cruz	CA	38.5	5.8					462.0
Santa Rosa	CA	24.7	9.1	151.1		309.4	236.3	422.7
Stockton	CA	11.1	5.6	174.9				440.0

Rates are adjusted for either age and race (PSA testing, prostate cancer incidence) or race only (age-specific rates). Blank cells indicate that the rate was suppressed due to a small number of events occurring in the region during the study period.

Chapter 6 Table. Rates of PSA testing, incidence of prostate cancer, prostatectomy, and non-surgical treatment for prostate cancer among hospital referral regions (2007-12)

HRR Name	State	Percent of male enrollees age 68-74 having PSA test (2010)	Incidence of prostate cancer per 1,000 male Medicare beneficiaries	Prostatectomy per 1,000 male Medicare beneficiaries with prostate cancer		Radiation treatment per 1,000 male Medicare beneficiaries over age 75 with prostate cancer	Hormone therapy per 1,000 male Medicare beneficiaries over age 75 with prostate cancer	No treatment/ delayed treatment per 1,000 male Medicare beneficiaries over age 75 with prostate cancer
				Age 75 & under	Over age 75			
Ventura	CA	39.9	7.4	137.4		179.1	301.2	430.4
Boulder	CO	21.8	7.7					584.4
Colorado Springs	CO	19.3	4.2	158.6			442.8	390.2
Denver	CO	36.0	8.2	133.5		221.3	237.4	525.9
Fort Collins	CO	14.2	7.5	195.7				527.3
Grand Junction	CO	18.1	4.4					
Greeley	CO	17.0	3.1					
Pueblo	CO	39.3	5.5					500.9
Bridgeport	CT	33.0	5.6	192.6		265.7	379.9	341.8
Hartford	CT	30.2	6.4	178.1		261.2	333.2	350.0
New Haven	CT	30.8	4.8	137.6		216.4	413.3	347.2
Wilmington	DE	37.1	9.0	77.5		313.6	312.1	350.3
Washington	DC	41.2	7.6	178.7		312.8	311.9	358.7
Bradenton	FL	43.6	9.6			335.7	301.3	337.8
Clearwater	FL	41.1	5.2			245.3	456.6	280.8
Fort Lauderdale	FL	47.0	6.4	130.4		275.7	288.4	413.6
Fort Myers	FL	47.7	10.2	114.8		314.2	320.9	353.6
Gainesville	FL	40.9	6.6	89.2		203.3	360.0	393.2
Hudson	FL	46.0	10.8	97.3		241.1	296.7	417.1
Jacksonville	FL	35.3	11.0	123.6		424.1	299.2	248.1
Lakeland	FL	44.5	6.8			217.5	328.1	418.4
Miami	FL	58.4	6.8	156.6		201.9	393.7	364.3
Ocala	FL	47.1	10.0	54.8		203.2	290.8	490.2
Orlando	FL	44.9	8.9	164.9	33.2	236.0	359.1	371.7
Ormond Beach	FL	43.0	4.0				357.5	404.8
Panama City	FL	34.3	6.3			302.7	273.1	374.4
Pensacola	FL	26.9	4.0	166.1		327.7	259.8	401.8
Sarasota	FL	40.8	8.8	150.5		315.9	321.3	324.2
St. Petersburg	FL	42.9	4.3				390.3	387.8
Tallahassee	FL	40.2	3.7			543.5	324.5	
Tampa	FL	46.4	10.0	159.3		307.3	278.3	379.0
Albany	GA	37.5	10.9			603.7		
Atlanta	GA	41.8	4.7	90.7		221.8	319.0	441.6
Augusta	GA	36.3	13.3	118.6		370.7	297.4	316.0
Columbus	GA	48.3	6.3			389.4	388.3	
Macon	GA	36.4	5.6	176.3		234.5	446.2	279.3
Rome	GA	39.6	6.7			424.3	345.7	
Savannah	GA	45.0	6.9	165.3		279.8	276.1	416.1
Honolulu	HI	43.9	2.8	284.3		369.2	324.7	203.8

Chapter 6 Table. Rates of PSA testing, incidence of prostate cancer, prostatectomy, and non-surgical treatment for prostate cancer among hospital referral regions (2007-12)

HRR Name	State	Percent of male enrollees age 68-74 having PSA test (2010)	Incidence of prostate cancer per 1,000 male Medicare beneficiaries	Prostatectomy per 1,000 male Medicare beneficiaries with prostate cancer		Radiation treatment per 1,000 male Medicare beneficiaries over age 75 with prostate cancer	Hormone therapy per 1,000 male Medicare beneficiaries over age 75 with prostate cancer	No treatment/ delayed treatment per 1,000 male Medicare beneficiaries over age 75 with prostate cancer
				Age 75 & under	Over age 75			
Boise	ID	21.7	7.9	340.1	169.2	305.6	336.1	185.5
Idaho Falls	ID	35.6	3.3					
Aurora	IL	32.5	3.3				792.2	
Blue Island	IL	36.3	4.7	198.6		294.4	375.4	242.2
Chicago	IL	29.2	6.1	148.7	49.2	235.5	313.0	402.7
Elgin	IL	32.9	12.6	239.3	65.9	310.4	359.9	263.0
Evanston	IL	35.1	6.3	184.4		319.5	346.9	306.0
Hinsdale	IL	34.8	4.4			363.3	294.4	317.5
Joliet	IL	26.2	7.9	178.5		415.4	315.6	222.3
Melrose Park	IL	26.0	5.1	104.5		217.5	449.2	292.6
Peoria	IL	14.8	15.4	171.8	52.2	273.9	451.2	222.9
Rockford	IL	17.2	10.7	276.3		303.4	519.7	144.6
Springfield	IL	26.3	9.4	173.9	42.4	198.0	479.0	281.6
Urbana	IL	20.3	12.0	343.6		417.3	340.8	178.8
Bloomington	IL	26.2	7.0					
Evansville	IN	14.6	11.2	218.0	75.0	237.0	484.9	203.3
Fort Wayne	IN	24.7	17.2	190.9		381.6	382.9	231.7
Gary	IN	23.4	9.3	285.2	90.5	195.3	440.3	273.7
Indianapolis	IN	25.8	6.8	175.5	37.6	362.2	324.8	274.7
Lafayette	IN	18.9	16.6	286.8		258.3	306.9	392.0
Muncie	IN	39.2	8.0				426.3	350.2
Munster	IN	25.5	12.7	479.5	105.9	300.5	345.5	247.8
South Bend	IN	35.7	5.7	208.0		167.1	452.6	281.3
Terre Haute	IN	41.5	8.5	278.7		364.6	451.7	
Cedar Rapids	IA	26.8	1.9					
Davenport	IA	37.5	3.8				584.8	300.6
Des Moines	IA	23.2	6.2	245.4	69.9	231.4	477.9	221.2
Dubuque	IA	46.9	4.1					
Iowa City	IA	23.2	7.9	336.0		209.4	387.8	346.8
Mason City	IA	5.8	25.9	107.9		375.3	461.3	150.6
Sioux City	IA	32.9	21.9	285.8		228.2	497.2	224.1
Waterloo	IA	11.0	6.5					
Topeka	KS	37.4	10.2	226.4		244.7	472.6	261.5
Wichita	KS	36.1	9.6	225.4	32.3	198.3	590.5	181.1
Covington	KY	13.1	2.6					
Lexington	KY	31.5	4.2	130.8		295.9	414.9	272.3
Louisville	KY	36.5	11.9	116.8	32.8	409.7	320.9	236.5
Owensboro	KY	52.7	14.2	303.5		339.4	410.5	
Paducah	KY	38.4	6.8	236.1		220.0	462.1	222.6

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Chapter 6 Table. Rates of PSA testing, incidence of prostate cancer, prostatectomy, and non-surgical treatment for prostate cancer among hospital referral regions (2007-12)

HRR Name	State	Percent of male enrollees age 68-74 having PSA test (2010)	Incidence of prostate cancer per 1,000 male Medicare beneficiaries	Prostatectomy per 1,000 male Medicare beneficiaries with prostate cancer		Radiation treatment per 1,000 male Medicare beneficiaries over age 75 with prostate cancer	Hormone therapy per 1,000 male Medicare beneficiaries over age 75 with prostate cancer	No treatment/ delayed treatment per 1,000 male Medicare beneficiaries over age 75 with prostate cancer
				Age 75 & under	Over age 75			
Alexandria	LA	33.4	8.3	238.2		315.9	417.1	
Baton Rouge	LA	40.6	3.4	201.9			533.0	
Houma	LA	35.4	12.2	178.4		258.3	500.6	241.4
Lafayette	LA	30.9	4.8			258.7	523.2	215.1
Lake Charles	LA	32.7	6.9	187.9			451.3	423.5
Metairie	LA	24.3	7.2	233.1		334.0	427.9	
Monroe	LA	33.5	7.5	152.9			494.2	
New Orleans	LA	31.8	7.1	215.6			470.7	
Shreveport	LA	30.5	2.8			318.9	313.3	341.5
Slidell	LA	20.2	7.7	320.3			574.4	
Bangor	ME	16.1	8.4	274.2		180.9	513.8	221.6
Portland	ME	12.3	8.7	244.1		229.8	384.4	335.6
Baltimore	MD	39.3	8.2	127.5		211.2	314.6	446.7
Salisbury	MD	21.7	7.1	126.9		198.3	301.1	488.0
Takoma Park	MD	48.7	6.3	103.9		263.2	280.4	423.2
Boston	MA	21.1	5.8	102.9	24.5	246.2	244.5	484.8
Springfield	MA	15.1	5.7	124.8			275.5	581.3
Worcester	MA	11.2	5.6	142.2			380.0	445.0
Ann Arbor	MI	15.5	10.3	189.7		274.2	360.1	334.6
Dearborn	MI	24.7	10.2	198.3		175.4	352.7	398.4
Detroit	MI	26.6	8.2	144.7		239.7	320.7	399.9
Flint	MI	37.8	7.2	212.5		270.0	352.0	299.3
Grand Rapids	MI	19.1	6.1	284.7		203.4	376.8	352.6
Kalamazoo	MI	16.8	4.1	255.9		244.0	311.5	400.1
Lansing	MI	12.2	6.2	372.1	164.2	216.5	270.7	346.6
Marquette	MI	9.5	15.7	352.9			569.2	242.4
Muskegon	MI	8.6	11.5	328.3			465.5	357.4
Petoskey	MI	19.7	10.0			286.6	530.7	
Pontiac	MI	35.6	8.4			282.3	264.8	390.4
Royal Oak	MI	37.6	11.8	133.7		277.0	287.8	388.1
Saginaw	MI	15.2	6.2	282.2		257.1	337.0	356.5
St. Joseph	MI	14.2	7.2	264.8				
Traverse City	MI	24.4	10.7	155.9		306.8	213.0	423.3
Duluth	MN	13.8	11.8	277.7		231.0	459.3	256.0
Minneapolis	MN	25.6	11.7	346.7	53.6	241.6	431.4	273.8
Rochester	MN	28.7	16.6	257.3		323.7	452.4	179.8
St. Cloud	MN	31.7	10.8	385.9			381.5	352.0
St. Paul	MN	19.5	12.6	284.6	113.3	128.6	354.6	403.4
Gulfport	MS	12.4	17.3	402.3			443.8	299.1

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				Age 75 & under	Over age 75			
Hattiesburg	MS	47.0	3.7					
Jackson	MS	35.1	6.6	254.6		211.4	403.4	330.5
Meridian	MS	44.5	11.9	459.1			409.6	394.3
Oxford	MS	42.1	12.0				425.8	313.8
Tupelo	MS	39.1	8.7	185.2		125.5	362.4	454.2
Cape Girardeau	MO	29.2	5.3	279.5			477.8	285.9
Columbia	MO	32.7	5.4	169.0		232.2	326.7	415.1
Joplin	MO	24.0	5.8	180.9		330.0	317.4	296.8
Kansas City	MO	37.9	5.9	217.9		257.7	350.8	363.9
Springfield	MO	37.3	3.0	163.5		194.8	380.2	410.6
St. Louis	MO	33.9	6.6	226.7	38.3	237.2	387.8	336.7
Billings	MT	10.6	13.2	350.3		300.7	261.4	371.1
Great Falls	MT	35.9	6.1					
Missoula	MT	31.4	10.5	225.4		282.9	228.1	465.1
Lincoln	NE	41.6	3.0	287.7		252.8	450.5	255.8
Omaha	NE	25.2	6.3	400.8	82.9	151.5	508.3	258.2
Las Vegas	NV	40.8	4.8	137.2		185.4	352.2	411.6
Reno	NV	22.4	6.2	136.2		245.0	331.7	400.6
Lebanon	NH	3.6	9.2	245.0		256.2	438.9	294.7
Manchester	NH	11.4	11.1	302.3		297.8	233.0	416.9
Camden	NJ	44.0	6.2	119.9		282.8	314.6	387.1
Hackensack	NJ	52.8	6.2	86.2		241.6	349.1	367.0
Morristown	NJ	47.5	5.9	141.0		161.6	323.7	485.4
New Brunswick	NJ	48.8	6.4	119.5		190.3	317.7	476.3
Newark	NJ	47.9	5.6	96.4		250.4	385.1	349.7
Paterson	NJ	53.7	3.0					
Ridgewood	NJ	49.3	5.6			216.0	348.3	382.5
Albuquerque	NM	19.1	6.2	212.0	92.4	172.3	292.0	442.8
Albany	NY	28.3	4.6	139.9		236.0	313.0	421.3
Binghamton	NY	7.2	7.9	134.1		284.0	446.7	206.6
Bronx	NY	41.8	6.2	133.5		254.3	392.6	331.3
Buffalo	NY	26.4	8.1	119.1		357.1	352.3	278.1
Elmira	NY	32.6	3.4				390.3	
East Long Island	NY	52.9	5.2	120.3	30.3	206.7	387.7	375.3
Manhattan	NY	51.5	7.3	133.7	62.1	223.5	268.1	446.9
Rochester	NY	12.7	5.9	253.5		320.6	226.7	440.7
Syracuse	NY	38.7	8.6	100.8		379.9	226.3	375.1
White Plains	NY	41.8	6.4	186.3		243.5	399.2	299.9
Asheville	NC	36.1	6.9	139.6		174.7	346.0	432.2

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				Age 75 & under	Over age 75			
Charlotte	NC	38.5	6.6	111.6		193.2	372.3	419.5
Durham	NC	43.4	5.4	171.3		268.4	290.8	425.4
Greensboro	NC	46.2	7.6			264.9	235.4	485.8
Greenville	NC	47.3	6.3	145.6		114.0	416.6	438.3
Hickory	NC	40.7	4.0					478.7
Raleigh	NC	49.2	5.3	155.6		184.3	307.4	484.3
Wilmington	NC	55.8	4.1			374.4		399.4
Winston-Salem	NC	39.4	5.8	143.1		179.4	367.7	424.5
Bismarck	ND	24.8	10.4	233.7		243.2	583.7	
Fargo/Moorhead MN	ND	34.9	24.8	284.3		320.0	437.0	232.4
Grand Forks	ND	10.9	18.8	197.3		240.8	449.6	270.8
Minot	ND	7.2	24.7	265.4		322.3	363.4	221.3
Akron	OH	19.1	6.7			349.4	404.3	231.7
Canton	OH	19.3	7.9			263.6	387.3	349.8
Cincinnati	OH	31.0	8.6	161.3	72.4	235.3	472.2	219.9
Cleveland	OH	20.7	13.4	159.7	35.9	331.0	388.4	245.0
Columbus	OH	23.7	4.7	144.5		207.5	527.8	239.8
Dayton	OH	28.6	4.2	176.2		256.3	438.8	292.6
Elyria	OH	15.6	9.6	159.4			400.2	400.0
Kettering	OH	40.1	5.2				354.8	
Toledo	OH	18.7	13.9	167.5		220.3	507.1	253.1
Youngstown	OH	27.7	6.0	223.7		266.7	373.3	333.3
Lawton	OK	20.9	5.5					
Oklahoma City	OK	33.2	7.9	209.4	45.9	282.5	387.1	284.5
Tulsa	OK	40.1	4.4	71.7		290.6	318.9	374.5
Bend	OR	28.2	5.6					
Eugene	OR	37.5	10.7	235.0		275.6	410.0	222.5
Medford	OR	27.5	6.6	251.0		226.3	423.8	298.7
Portland	OR	24.1	6.8	299.9	73.8	241.9	295.6	388.0
Salem	OR	28.0	4.1					
Allentown	PA	29.5	6.9	134.5		269.8	412.8	282.4
Altoona	PA	13.0	7.6	211.7		302.5	588.1	
Danville	PA	12.7	8.7	112.4		153.1	519.7	309.8
Erie	PA	19.0	14.1	129.8		219.3	435.3	329.4
Harrisburg	PA	24.5	4.9	163.6		245.4	412.5	295.7
Johnstown	PA	18.1	5.4					
Lancaster	PA	18.4	7.7	151.4		231.5	263.5	486.0
Philadelphia	PA	42.5	5.6	159.1	52.5	294.9	308.2	345.5
Pittsburgh	PA	14.9	9.2	108.6	38.1	339.9	397.8	223.9

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				Age 75 & under	Over age 75			
Reading	PA	20.5	3.9			310.2	356.3	292.1
Sayre	PA	21.8	8.0			393.4	343.1	
Scranton	PA	20.4	10.2	128.4		159.5	555.6	287.8
Wilkes-Barre	PA	20.1	13.2	134.8		382.6	431.5	157.4
York	PA	10.7	6.2			328.3	356.6	301.5
Providence	RI	25.1	5.5	92.3		113.6	409.2	448.6
Charleston	SC	43.4	8.1	124.6		187.3	257.5	501.7
Columbia	SC	33.5	8.9	82.1		259.4	301.4	399.2
Florence	SC	44.3	8.7			394.2	315.6	278.8
Greenville	SC	35.3	5.1	126.5		199.9	412.7	375.0
Spartanburg	SC	37.9	4.4					462.0
Rapid City	SD	32.6	2.8					
Sioux Falls	SD	36.5	9.8	283.0	52.7	248.6	411.4	287.5
Chattanooga	TN	48.0	6.1	280.8		235.1	468.2	259.1
Jackson	TN	44.2	9.4	370.8			513.9	328.4
Johnson City	TN	32.2	5.0					434.1
Kingsport	TN	35.7	5.7	178.2		379.5	336.1	267.2
Knoxville	TN	45.1	4.0	231.7		197.0	328.1	406.3
Memphis	TN	45.6	15.9	375.3	83.3	179.3	425.4	311.4
Nashville	TN	39.3	5.7	301.0	72.4	183.1	404.7	339.7
Abilene	TX	30.3	3.9	291.7			380.4	351.8
Amarillo	TX	36.3	4.8				480.1	348.1
Austin	TX	43.7	4.8	215.7		172.8	348.0	459.5
Beaumont	TX	39.2	8.7	216.2		355.4	283.3	340.0
Bryan	TX	28.4	4.0					
Corpus Christi	TX	47.3	5.0				374.5	458.0
Dallas	TX	49.9	5.1	136.2		290.0	344.9	345.3
El Paso	TX	32.1	8.3	113.3		378.8	332.0	239.6
Fort Worth	TX	45.7	7.5	90.3	53.3	165.8	324.9	456.3
Harlingen	TX	48.3	2.2					612.2
Houston	TX	40.6	9.7	170.3	50.6	258.4	309.9	381.3
Longview	TX	49.1	1.8					
Lubbock	TX	23.7	3.7	234.7		217.0	283.1	391.2
McAllen	TX	53.5	2.5				504.1	
Odessa	TX	36.9	2.6					
San Angelo	TX	48.4	5.4	437.1				482.4
San Antonio	TX	39.6	5.3	232.1		297.8	322.0	340.5
Temple	TX	20.4	12.9	418.6		302.3	339.8	342.5
Tyler	TX	38.1	4.5	190.0		286.8	329.6	342.7

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HRR Name	State	Percent of male enrollees age 68-74 having PSA test (2010)	Incidence of prostate cancer per 1,000 male Medicare beneficiaries	Prostatectomy per 1,000 male Medicare beneficiaries with prostate cancer		Radiation treatment per 1,000 male Medicare beneficiaries over age 75 with prostate cancer	Hormone therapy per 1,000 male Medicare beneficiaries over age 75 with prostate cancer	No treatment/ delayed treatment per 1,000 male Medicare beneficiaries over age 75 with prostate cancer
				Age 75 & under	Over age 75			
Victoria	TX	42.8	10.9	241.9		465.9	195.9	303.4
Waco	TX	35.7	5.9	225.5				576.8
Wichita Falls	TX	34.0	4.0	299.2				
Ogden	UT	27.8	13.0	214.2		430.5	277.6	217.8
Provo	UT	29.7	3.8					
Salt Lake City	UT	22.6	6.7	273.4		222.3	308.6	402.1
Burlington	VT	6.8	6.2	158.6		163.3	248.8	565.6
Arlington	VA	46.4	8.4	123.3		257.5	269.5	448.1
Charlottesville	VA	27.1	7.3	109.8		210.3	347.6	418.3
Lynchburg	VA	35.9	3.9					
Newport News	VA	50.9	7.7	206.8		309.5	163.5	508.2
Norfolk	VA	38.4	8.1	171.0		307.4	401.1	268.4
Richmond	VA	42.0	9.0	178.2	40.0	213.8	323.1	422.3
Roanoke	VA	46.0	5.1	105.1		314.2	392.3	271.9
Winchester	VA	29.5	4.7				491.8	342.1
Everett	WA	27.9	4.7	243.4			387.8	411.0
Olympia	WA	29.8	5.2	237.2				429.4
Seattle	WA	25.4	8.5	173.6	53.7	278.7	306.9	360.3
Spokane	WA	39.8	9.4	209.2	75.1	300.2	347.7	275.7
Tacoma	WA	19.8	8.4	227.5		352.7	302.6	269.1
Yakima	WA	37.9	5.1				392.1	306.1
Charleston	WV	32.3	7.2	218.2	108.8	328.7	316.5	244.4
Huntington	WV	19.9	11.6	203.2		293.7	520.7	176.1
Morgantown	WV	20.6	5.8	191.8		195.3	484.3	303.9
Appleton	WI	36.1	6.1				417.2	
Green Bay	WI	33.2	5.7	226.1			487.3	333.9
La Crosse	WI	19.6	7.0	268.0		295.7	428.1	277.0
Madison	WI	23.4	12.8	264.6	58.2	285.0	368.1	288.2
Marshfield	WI	34.3	2.4					
Milwaukee	WI	37.3	10.4	255.8		310.6	424.8	242.3
Neenah	WI	31.8	4.9					
Wausau	WI	27.2	2.5					
Casper	WY	10.1	6.0	428.8		402.2		
United States	US	34.5	7.4	189.3	44.2	258.4	358.3	339.1

Methods

CHAPTER 1: OBESITY

In this chapter, we examined secular trends in the rates of obesity, diabetes, bariatric surgery, and outcomes following bariatric surgery at the level of the hospital referral region (HRR) among Medicare beneficiaries age 65 to 99. To accomplish this, we studied all patients with evidence of diagnostic codes for diabetes and obesity, as well as procedure codes indicative of bariatric procedures. We also used data from the Centers for Disease Control and Prevention to establish HRR-level rates of obesity. All diagnostic codes indicative of diabetes and the procedure codes indicating bariatric surgery procedures are shown in Table A.

After establishing our inclusion criteria, we examined the incidence of each event over time between 2001 and 2011. We assessed rates by each year individually. The numerator for calculating the crude rates consisted of the number of procedures in each year selected as described above; the denominator consisted of the number of beneficiaries eligible as of June 30 for each year (a mid-year denominator). These rates were adjusted for changes in age, sex, and race occurring over time using the population during the year 2001 as the standard population.

After defining the rates of bariatric procedures over time, we assessed differences in outcomes. We used t-tests to compare rates between regions, and non-parametric tests of trend were used to test significance across years; p values <0.05 were considered significant.

CHAPTER 2: CEREBRAL ANEURYSMS

In this chapter, we examined trends in the rates of ruptured and unruptured cerebral aneurysms, rates of clipping and coiling procedures, and outcomes following these procedures at the HRR level among Medicare beneficiaries age 65 to 99. We studied all patients with evidence of diagnostic codes for ruptured and unruptured cerebral aneurysms and treatment procedures; diagnostic codes indicative of cerebral aneurysms and the procedure codes indicating clipping and coiling are shown in Table A.

After establishing our inclusion criteria, we examined the incidence of each diagnosis and procedure over time between 2007 and 2012. We assessed rates by each year individually. The numerator for calculating the crude rates consisted of the number of index diagnoses or procedures between 2007 and 2012; the denominator consisted of the number of beneficiaries eligible across the same years. The rates were adjusted via the indirect method for age, sex, and race using the national standard Medicare population. After defining the rates of clipping and coiling over time, we assessed differences in outcomes.

CHAPTER 3: DIABETES AND PERIPHERAL ARTERY DISEASE

In this chapter, we examined trends in the rates of amputation and other pertinent outcomes among patients with diabetes and peripheral arterial disease at the HRR level among Medicare beneficiaries age 65 to 99. We included all patients with diagnostic codes for diabetes and peripheral arterial disease; diagnostic codes indicative of diabetes and PAD and the procedure codes indicating vascular interventions are shown in Table A.

After establishing our inclusion criteria, we examined the incidence of each event over time between 2001 and 2011. We assessed rates by each year individually. The numerator for calculating the crude rates consisted of the number of procedures in each year selected as described above; the denominator consisted of the number of beneficiaries eligible as of June 30 for each year (a mid-year denominator). These rates were adjusted for changes in age, sex, and race occurring over time using the population during the year 2001 as the standard population.

After defining the rates of vascular procedures over time, we assessed differences in outcomes. We used t-tests to compare rates between regions, and non-parametric tests of trend were used to test significance across years; p values <0.05 were considered significant.

CHAPTER 4: SPINAL STENOSIS

We examined the 100% sample of the Medicare Provider Analysis and Review (MedPAR) file for patients undergoing an initial inpatient lumbar spinal fusion or decompression operation for spinal stenosis from 2001 to 2011 among Medicare beneficiaries age 65 and older. We combined data from 2001 through 2011 to estimate age-, sex-, and race-adjusted trends in the rates of decompression and fusion operations for spinal stenosis per 100,000 Medicare beneficiaries.

Admissions associated with the surgical indication of spinal stenosis were identified using a previously published and validated hierarchical coding algorithm (www.researchgate.net/publication/257631899_SPINEDEF_%28Version_6%29_Coding_definitions_for_characterizing_spine-related_medical_encounters). All inpatient admissions that involved an initial (incident) thoracolumbar, lumbar, or lumbosacral fusion or decompression operation for spinal stenosis from 2001 through 2011 were included. However, admissions that included codes for refusion, artificial disc replacement, corpectomy, osteotomy, and kyphectomy were excluded. We further excluded admissions that contained codes for non-degenerative lumbar spinal admissions, such as spinal fracture, vertebral dislocation, spinal cord injury, cervical or thoracic conditions, and inflammatory spondylopathy. Finally, we excluded admissions associated with codes for accidents, neoplasm, HIV or immune deficiency, intraspinal abscess, or osteomyelitis.

Orthopaedic device complications, wound problems, life-threatening medical complications, and repeat surgery were ascertained for each patient. To calculate the rate and difference in surgical risk between fusion and decompression, we performed a logistic regression for each type of complication, including variables for patient age, sex, race, comorbidity, and previous hospitalizations. Similarly, we examined differences in long-term rates of repeat spine operation between decompression and fusion. We used a Cox proportional hazard regression model to examine differences in the time until a first reoperation between patients undergoing initial decompression and fusion operations.

For the economic analyses presented in this report, we updated our previously published analysis of the Medical Expenditure Panel Survey with data through 2012 to estimate the treated prevalence and the economic burden of back and neck problems in the United States. MEPS is a household survey of medical expenditures weighted to represent national estimates. We focused on adults (> 17 years) with self-reported neck and back problems mapped to spine-related codes from the International Classification of Disease (ICD-9-CM). Inflation-adjusted, survey-weighted generalized linear regression models, adjusting for age-, sex-, and Charlson comorbidity, were used to calculate the incremental difference in health care costs between patients with and without spine problems.

CHAPTER 5: END-STAGE RENAL DISEASE

In this chapter, we examined the rates of end-stage renal disease (ESRD) in the Medicare population (age 18-99) and the proportion of ESRD treatments employed among both Medicare beneficiaries and the national ESRD population. We also examined the outcomes of mortality and 30-day readmission. To accomplish this, we first selected all patients with evidence of a procedure code for dialysis among Medicare fee-for-service beneficiaries. We also obtained data on all ESRD patients in the United States from the United States Renal Data Registry (USRDS). USRDS includes information from CMS form 2728, which is completed at the time of the first dialysis procedure to gain Medicare eligibility. The form provides an accurate record of initiating dialysis type and access modality. Thus, information on the use of AV fistulas and grafts and hemodialysis catheters came from the renal registry, along with data on live and deceased donor kidney transplants. To track outcomes among ESRD patients in the Medicare population, we used both diagnosis and procedure codes for kidney transplantation. All diagnosis and procedure codes indicative of ESRD and kidney transplantation in Medicare claims are shown in Table A.

After establishing our inclusion criteria, we examined the incidence of ESRD and treatment outcomes between 2007 and 2010. For Medicare beneficiaries, we assessed ESRD rates by year and transplant referral region for the combined years 2007-10. Transplant referral regions (TRR) were constructed by aggregating patient residential ZIP codes into hospital service areas (HSAs), and HSAs into TRRs, after examining patterns of listing for kidney transplantation. Each of the 113 TRRs included at least one transplant center. Centers in the large metropolitan areas were assigned to one "super-provider" TRR.

The numerator for calculating the crude ESRD rates consisted of the number of patients initiating chronic dialysis (two or more encounters separated by three months) between 2007 and 2010; the denominator consisted of the number of beneficiaries eligible across the same years. ESRD and death rates were adjusted via the indirect method for age, sex, and race using the national standard Medicare population.

CHAPTER 6: PROSTATE CANCER

In this chapter, we examined the rates of PSA testing, prostate cancer incidence, surgical and nonsurgical treatments for prostate cancer, and outcomes following surgical treatment at the HRR level among male Medicare beneficiaries age 65 to 99. We studied all patients with evidence of diagnostic codes for prostate cancer and examined whether they had undergone any of the following treatment options: prostatectomy, radiation therapy, hormone therapy or no treatment/delayed treatment (also identified based on diagnostic and procedure codes). All diagnostic and procedure codes indicative of prostate cancer diagnosis and treatments are shown in Table A.

After establishing our inclusion criteria, we examined the incidence of each diagnosis and procedure between 2007 and 2012. We assessed national rates by year and HRR-level rates for the combined years 2007-12. The numerator for calculating the crude rates consisted of the number of index diagnosis or procedures between 2007 and 2012; the denominator consisted of the number of beneficiaries eligible across the same years. These rates were adjusted via the indirect method for age and race using the national standard Medicare population. Additionally, we examined variation in treatment for beneficiaries age 75 and under and over age 75, black and non-black beneficiaries, and beneficiaries with two or more chronic conditions to show the prevalence of selected treatments by age, race, and comorbidity status. After defining the rates over time, we assessed differences in readmissions following prostatectomy.

Table A. Codes used to identify patients with surgical conditions and surgical procedures

All analyses were performed using SAS (SAS Institute, Cary, NC), and STATA (College Station, TX). To learn more about Dartmouth Atlas methods, please visit www.dartmouthatlas.org.

Codes used to identify patients with type II diabetes and bariatric surgery		
Measure	**Codes**	**Inclusion/exclusion criteria**
Type II diabetes*	ICD-9 diagnosis codes 250, 357.2, 362.0, 366.41, 648.0 CPT visit codes: Outpatient: 92002-92014, 99201-99205, 99211-99215, 99217-99220, 99241-99245, 99341-99345, 99347-99350, 99384-99387, 99394-99397, 99401-99404, 99411, 99412, 99420, 99429, 99455, 99456 Non-acute inpatient: 99304-99310, 99315, 99316, 99318, 99324-99328, 99334-99337 Acute inpatient: 99221-99223, 99231-99233, 99238, 99239, 99251-99255, 99291 Emergency department: 99281-99285 Revenue center codes: Outpatient: 051x, 0520-0523,0526-0529, 057x-059x, 082x-085x, 088x, 0982, 0983 Non-acute inpatient: 0118, 0128, 0138, 0148, 0158, 019x, 0524, 0525, 055x, 066x Acute inpatient: 010x, 0110-0114, 0119, 0120-0124, 0129, 0130-0134, 0139, 0140-0144, 0149, 0150-0154, 0159, 016x, 020x,021x, 072x, 080x, 0987 Emergency department: 045x, 0981	Beneficiary must be enrolled in Medicare Parts A & B for at least 11 months during the year and at year end. Diabetic diagnosis must be noted in at least two outpatient or one inpatient physician encounter(s).
Bariatric surgery		
Gastric bypass	ICD-9 procedure codes 44.3, 44.31, 44.38, 44.39 CPT codes 43846, 43847, 43644, 43645, 43844, 43659, S2085	Primary/secondary diagnosis of morbid obesity (ICD-9 codes 278.0, 278.00, 278.01, V77.8) and DRG code for weight loss surgery (DRG 288: MSDRG 619-621)
Adjustable gastric banding	ICD-9 procedure code 44.95 CPT codes 43770, S2082	
Other procedure	ICD-9 procedure codes 43.89, 43.82, 44.68, 45.51, 45.9 CPT codes 43842, 43843, 43845, 43775	
Codes used to identify patients with cerebral aneurysms and clipping and coiling procedures		
Cerebral aneurysms		
Subarachnoid hemorrhage (SAH)	ICD-9 diagnosis code 430.xx	Not in the same index admission as: A. 094.87 (syphilitic aneurysm) B. 437.4 (cerebral arteritis) 437.5 (Moyamoya disease) C. 39.53, 92.30, 747.81 (AVM) D. 800.0-801.9, 803.0-804.9, 850.0-854.1, 873.0-873.9 (traumatic hemorrhage)
Unruptured cerebral aneurysm	ICD-9 diagnosis code 437.3	
Procedures		
Coiling	ICD-9 procedure codes 39.52 and 88.41 (excluding 39.51 in same hospitalization) 39.72, 39.79	
Clipping	ICD-9 procedure code 39.51	

*2011 Healthcare Effectiveness Data and Information Set (HEDIS) definition from the National Committee for Quality Assurance

Measure	Codes	Inclusion/exclusion criteria
Codes used to identify patients with type II diabetes and PAD, and vascular surgery		
Type II diabetes*	ICD-9 diagnosis codes 250, 357.2, 362.0, 366.41, 648.0 CPT visit codes: Outpatient: 92002-92014, 99201-99205, 99211-99215, 99217-99220, 99241-99245, 99341-99345, 99347-99350, 99384-99387, 99394-99397, 99401-99404, 99411, 99412, 99420, 99429, 99455, 99456 Non-acute inpatient: 99304-99310, 99315, 99316, 99318, 99324-99328, 99334-99337 Acute inpatient: 99221-99223, 99231-99233, 99238, 99239, 99251-99255, 99291 Emergency department: 99281-99285 Revenue center codes: Outpatient: 051x, 0520-0523,0526-0529, 057x-059x, 082x-085x, 088x, 0982, 0983 Non-acute inpatient: 0118, 0128, 0138, 0148, 0158, 019x, 0524, 0525, 055x, 066x Acute inpatient: 010x, 0110-0114, 0119, 0120-0124, 0129, 0130-0134, 0139, 0140-0144, 0149, 0150-0154, 0159, 016x, 020x,021x, 072x, 080x, 0987 Emergency department: 045x, 0981	Beneficiary must be enrolled in Medicare Parts A & B for at least 11 months during the year and at year end. Diabetic diagnosis must be noted in at least two outpatient or one inpatient physician encounter(s).
Peripheral arterial disease (PAD)	ICD-9 diagnosis codes 429.xx, 440-448xx, 451-454xx, 585, 709.8, 719.47, 727xx, 728xx, 730xx, 731xx, 733xx, 736xx, 821xx, 823xx & 824xx	
Vascular surgery		
Amputation	CPT codes 27590-27592, 27880-27882, 28805	
Endovascular procedure (therapeutic)	CPT codes 35452, 35454, 35472, 35473, 35481, 35482, 35491, 35492, 37205-37208	
Open bypass surgery	CPT codes 35351, 35355, 35361, 35363, 35521, 35537-35541, 35546, 35548, 35549, 35551, 35563, 35565, 35621, 35623, 35637, 35638, 35646, 35647, 35651, 35654, 35661, 35663, 35665	
Codes used to identify dialysis and kidney transplants		
Dialysis	CPT codes: Inpatient Part B: 90945, 90947, 90935, 90937 Outpatient: 90935, 90937 Outpatient <2009: G0317, G0318, G0319, G0321, G0322, G0323 Outpatient >2009: 90960, 90961, 90962, 90963, 90964, 90965, 90966 Home health: 99512	
Kidney transplant	ICD-9 code: V42.0 CPT code: 5569	
Codes used to identify patients with prostate cancer and treatments for prostate cancer		
PSA testing	CPT codes G0103, 84153	Men who had any history of prostate disease (prostate cancer, prostate surgery, or diagnosis of elevated PSA in the prior three years) or who had symptoms in the three months before a PSA test that might have triggered a suspicion of cancer according to diagnostic codes billed on visits and hospitalizations were excluded.
Prostate cancer	ICD-9 diagnosis code 185	
Treatment		
Prostatectomy	ICD-9 procedures codes 60.3-60.66, 60.69, 60.21, 60.29 CPT codes 55801, 55810, 55812, 55815, 55821, 55831, 55840, 55842, 55845, 55866	
Radiation therapy	ICD-9 procedure codes V58.0, V66.1, V67, 92.20-92.26, 92.28, 92.29 CPT codes 77261-77525, 77750-77799, 54521, 54535, 55859, 55860, 55862, 55865, 55875, 55876, 55920, C1715-C1719, C1728, C2632, C2636, Q3001, 76950, 76965, 76873, 79300, 79440, 79999, 4201F, 4210F, 4165F, 79200, 77014, G0174, G0242, G0243	
Hormone therapy	ICD-9 procedure codes 62.3, 62.4, 62.41, 62.42 CPT codes J1950, J9155, J9202, J9217, J9218, J9219, J9225, J9226, J141, J0128, J0970, J1000, J1056, J1380, J1390, J3315, 54251, 54520, 54522, 54530, 54535, 11980, C9216, C9430, G0356, S0165, S9560, 4164F, 96402 (drug administration code), 11980	
No treatment/delayed treatment	Diagnosis of prostate cancer and no record of prostatectomy, radiation therapy, or hormone therapy	

*2011 Healthcare Effectiveness Data and Information Set (HEDIS) definition from the National Committee for Quality Assurance

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INTRODUCTION

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CHAPTER 1: OBESITY

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