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Variation in the Care of Surgical Conditions: Obesity

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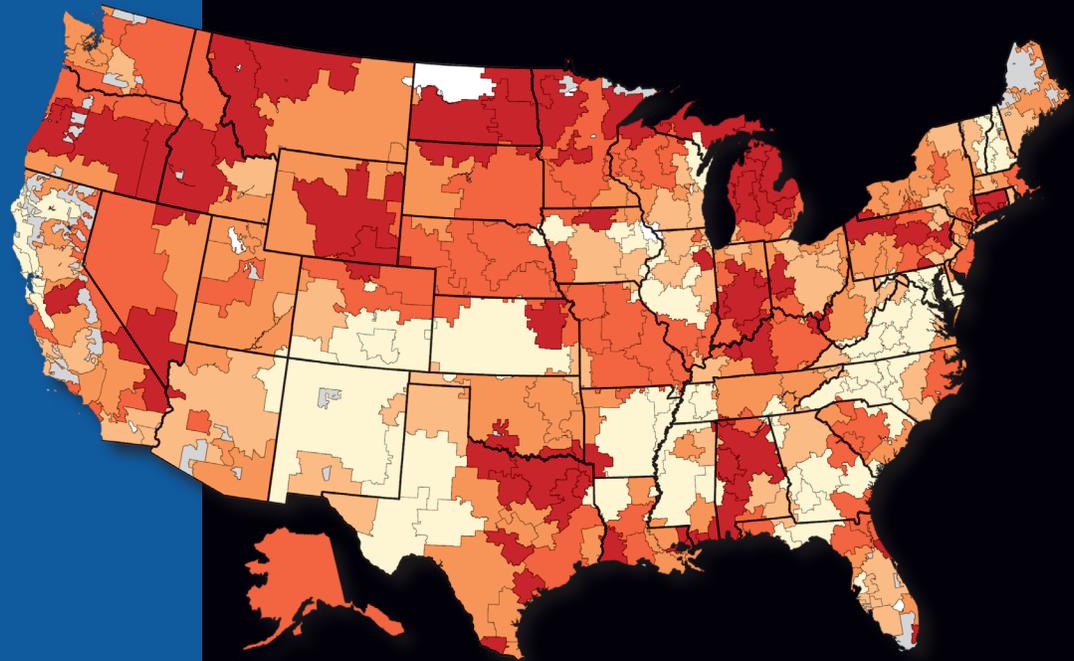
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Variation in the Care of Surgical Conditions: Obesity

A Dartmouth Atlas of Health Care Series



Variation in the Care of Surgical Conditions: Obesity

A Dartmouth Atlas of Health Care Series

The Michigan Bariatric Surgery Collaborative

Bradley N. Reames, MD, MS
Nancy J. Birkmeyer, PhD
Justin B. Dimick, MD, MPH

The Dartmouth Institute of Health Policy & Clinical Practice

Philip R. Goodney, MD, MS
Nino Dzebisashvili, PhD
David C. Goodman, MD, MS
Kristen K. Bronner, MA



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Foreword

The new Dartmouth Atlas series on variation in the care of surgical conditions, starting with this report on the surgical treatment of obesity, raises new questions regarding surgical management of both common and less frequently occurring medical conditions. This report carefully details the scope of the ever-increasing problem of obesity and, as in previous Atlas analyses, emphasizes geographic practice variation in surgical treatment rates. However, the report also takes a more longitudinal view. The changes over time in which bariatric procedure is favored are particularly fascinating, driven as they appear to be by a mix of clinical evidence—including emerging long-term results—and reimbursement policy. Obese patients will often ask me, as a primary care physician, whether they should have one of these procedures, and, if so, where. These questions have always been hard to answer. Population-based registries, as described in the report, should go a long way toward producing the kind of widely applicable data upon which patient decision support tools should be based. Patients want to know procedure and facility-based risks and benefits. Just as the future of medicine is personalization of diagnosis and treatment, so too the future of decision support is to increasingly provide information tailored to the person and his or her health care environment. Ultimately, it is the active participation of fully informed patients that can address the question of “which rate is right,” so provocatively posed by the Dartmouth Atlas analyses. I enjoyed reading this report and will look forward to future analyses targeting other common, preference-sensitive interventions.

Michael J. Barry, M.D.

President, Informed Medical Decisions Foundation

Clinical Professor of Medicine, Harvard Medical School

Variation in the Care of Surgical Conditions

A Dartmouth Atlas of Health Care Series

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.

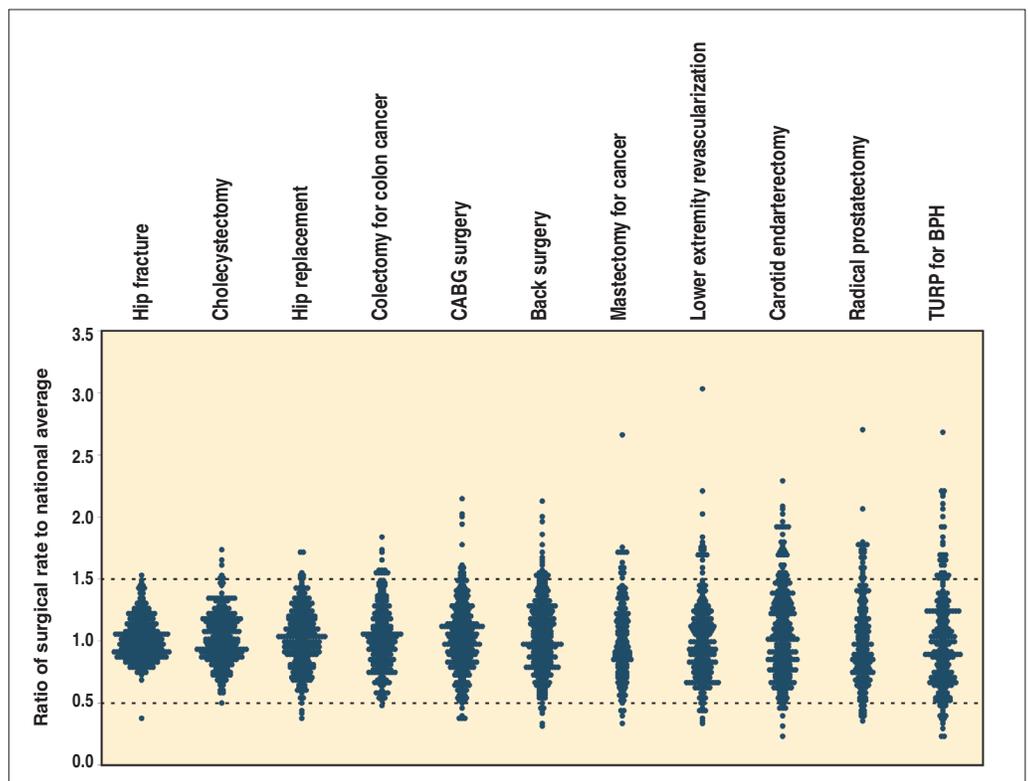
Variation in decision-making for surgical conditions

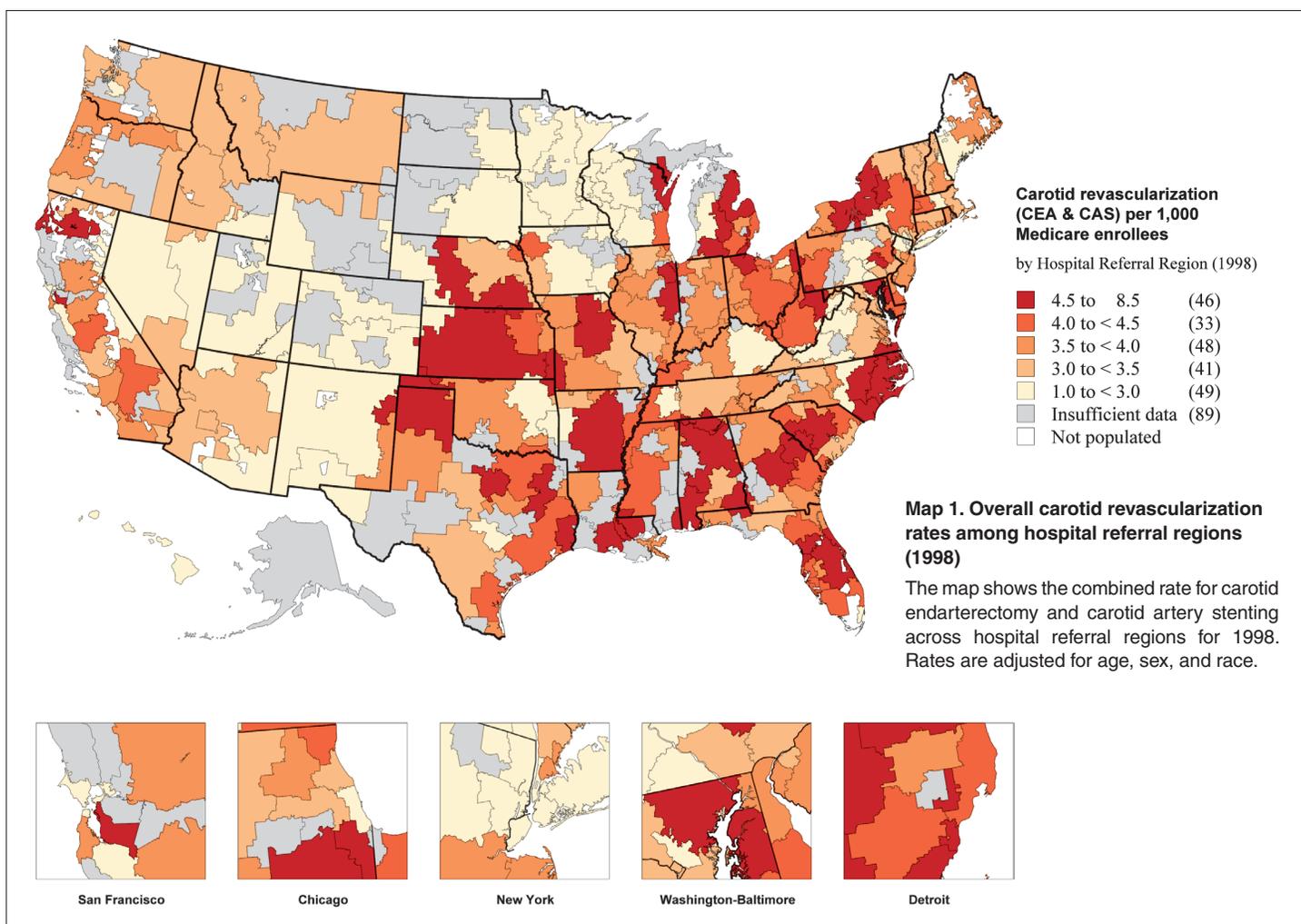
Experienced leaders and educators in surgery often emphasize to their trainees and students that performing an operation is easy: choosing the right patients for surgery is much more difficult. Over the last decade, important changes have occurred related to how surgeons and patients decide whether, 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 1).^{1,2}

Figure 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.





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 uncertainty 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 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 1.

Table 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 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.

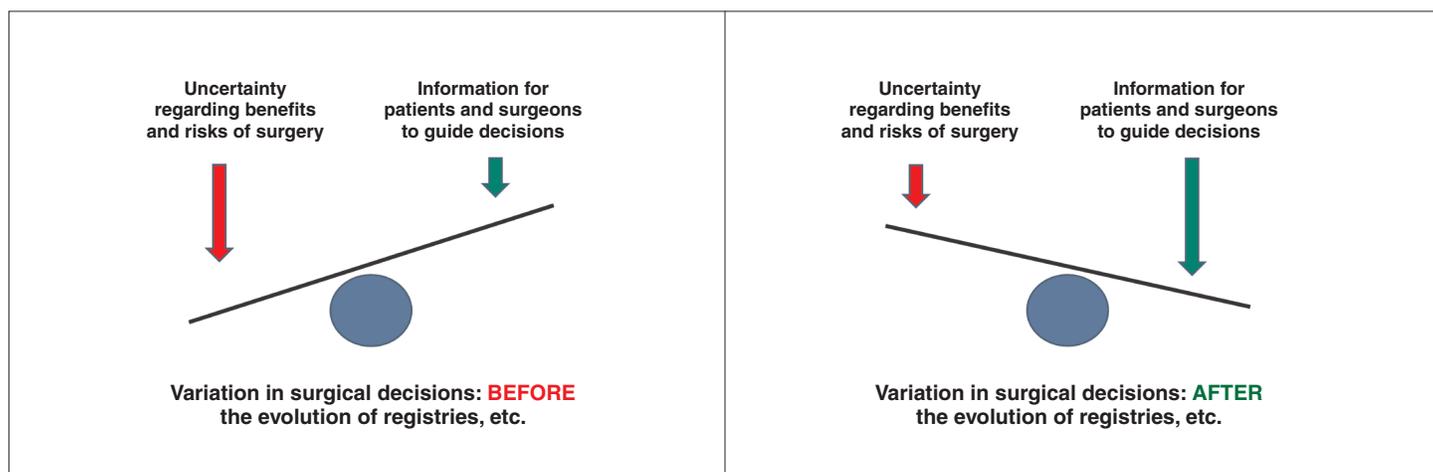


Figure 2. How information and uncertainty can affect variation in surgical care

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 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.

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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 2). 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.

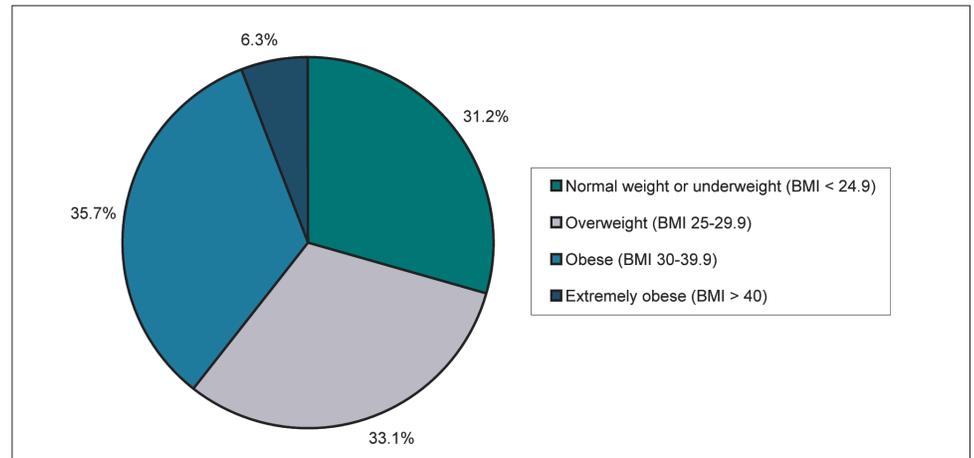
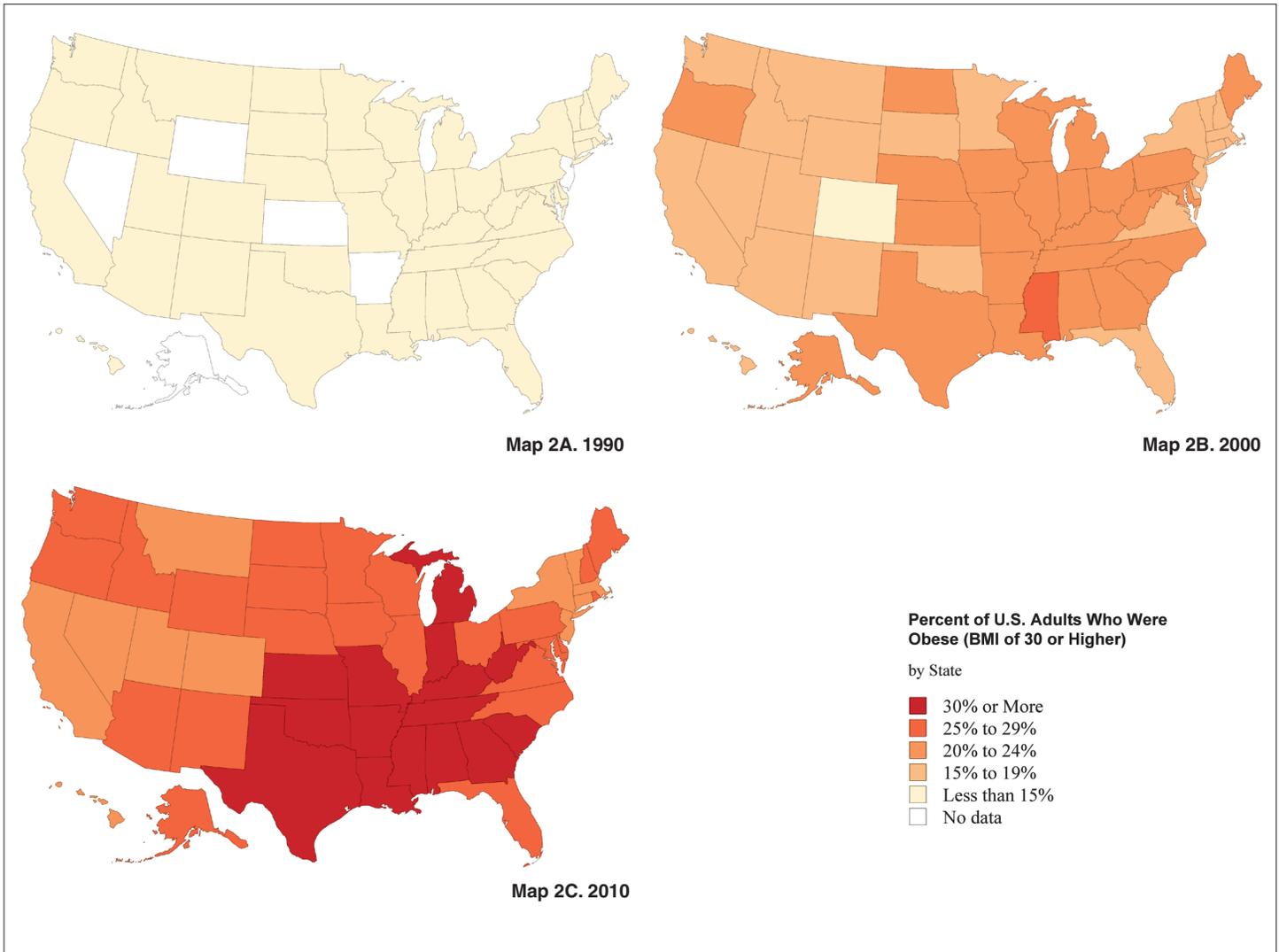


Figure 3. Burden of obesity among Americans (2009-10)

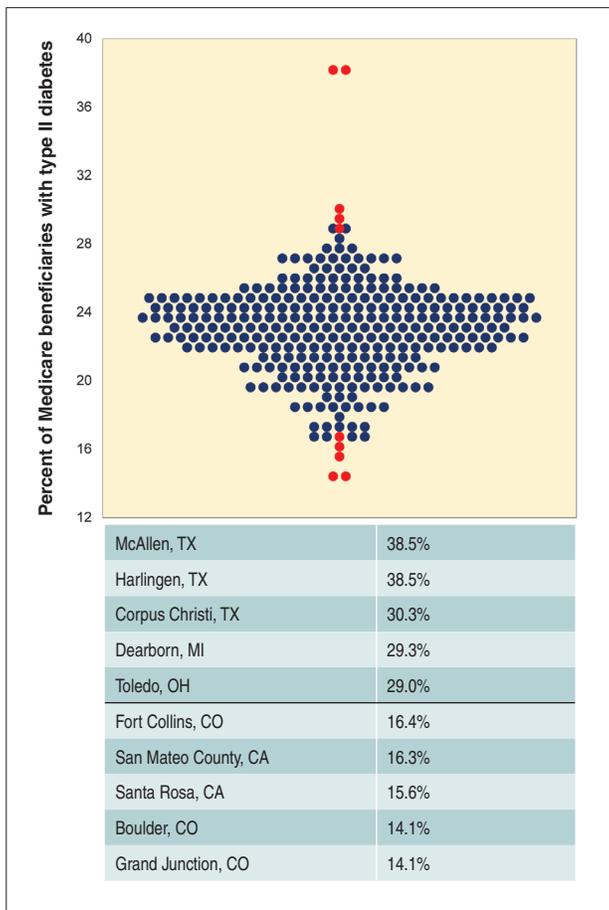
Source: The Centers for Disease Control and Prevention; National Health and Nutrition Examination Survey (NHANES).



Map 2. Obesity trends among U.S. adults

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

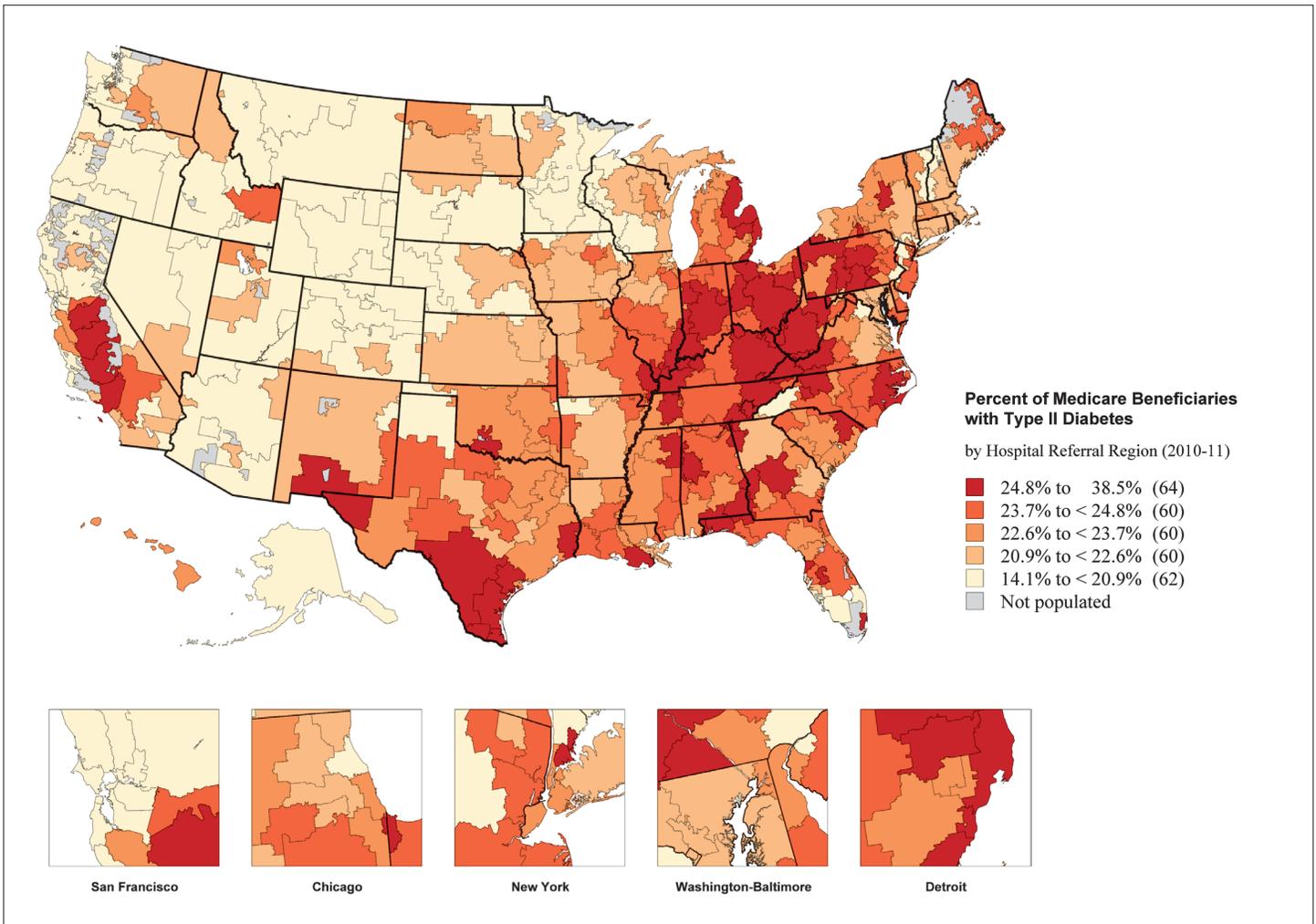
Source: The Centers for Disease Control and Prevention; Behavioral Risk Factor Surveillance System (BRFSS).



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 4), with the highest rates of diabetes evident in southeastern regions (Map 3), 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 4. 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 3. Percent of Medicare beneficiaries with type II diabetes (2010-11)

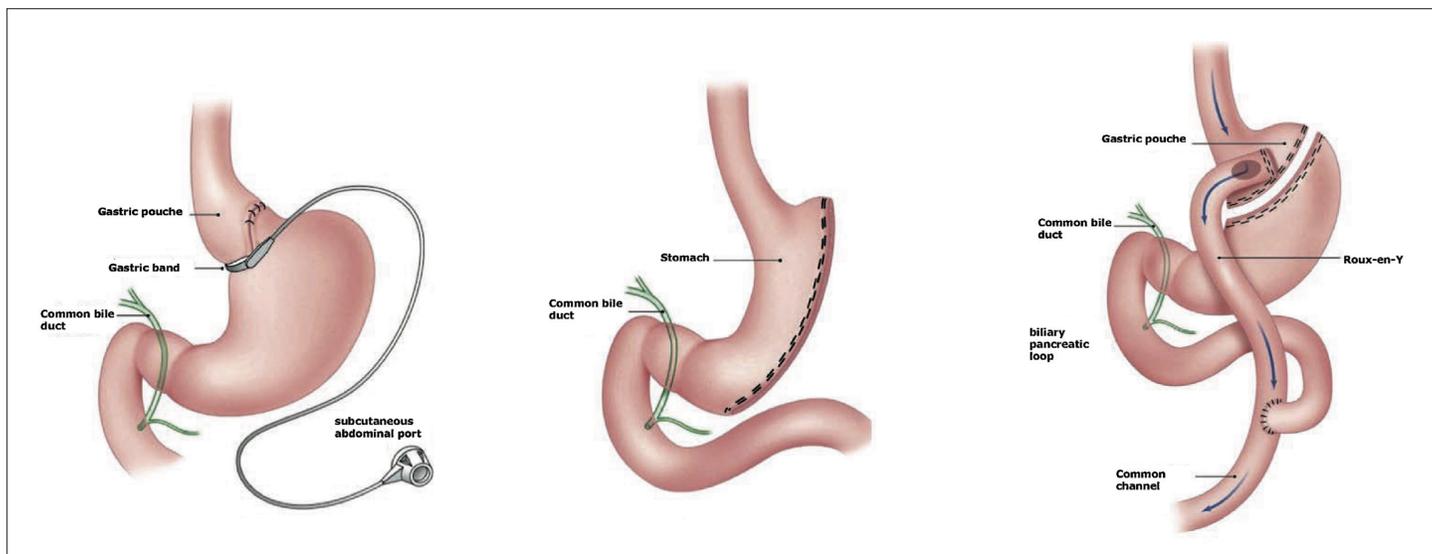
Rates are adjusted for age, sex, and race.

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 5). 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 5A). 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 5B). 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 5C). 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 5. 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 6. 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 6.

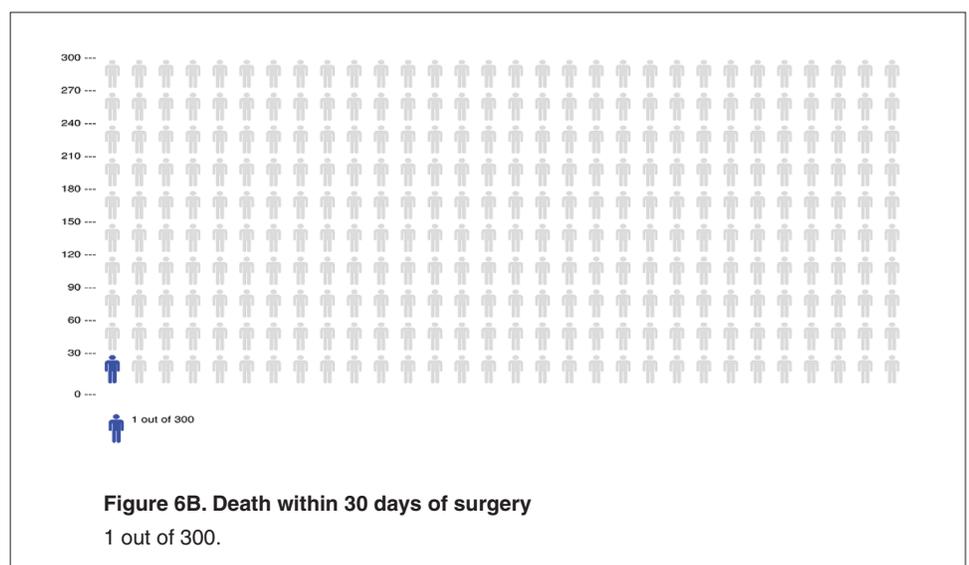
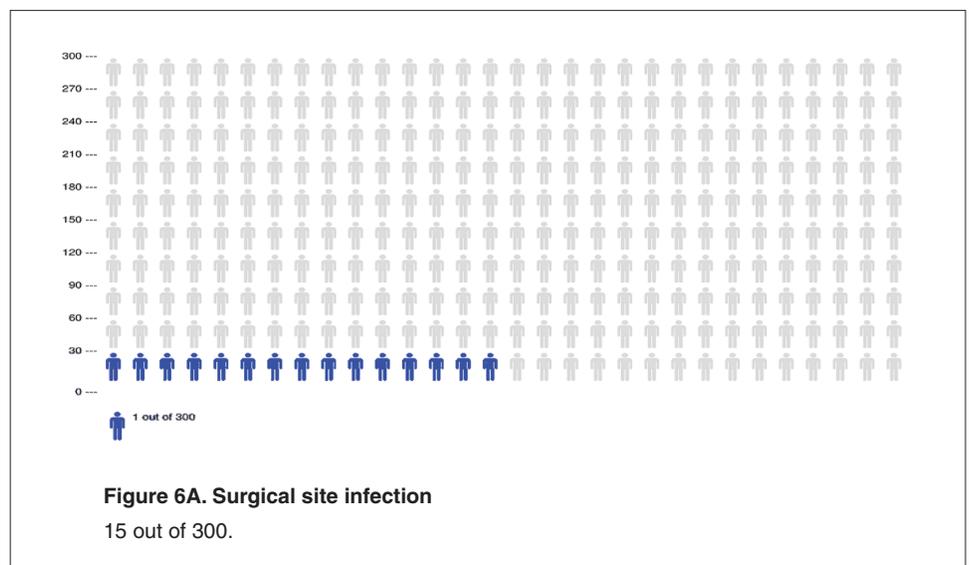


Figure 6. Risks of complications from bariatric surgery

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	<u>Measurement of:</u> Weight loss Patient satisfaction Quality of life

Figure 7. 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 7). 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 8 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

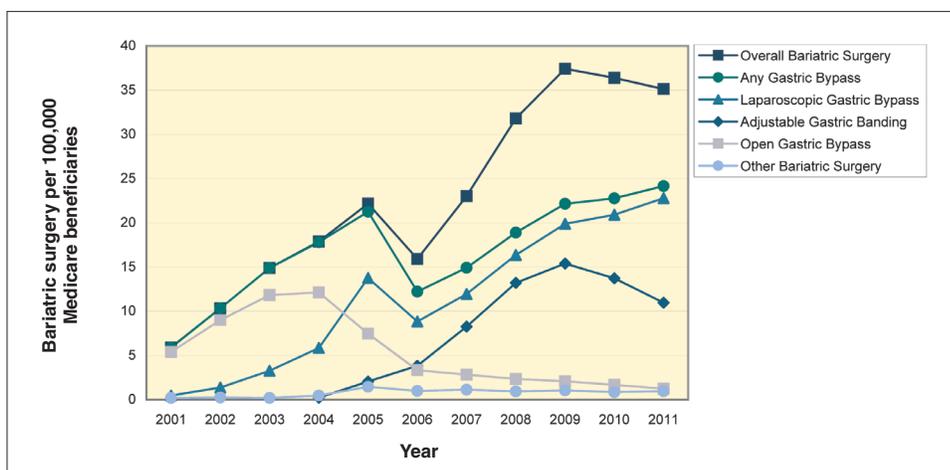


Figure 8. Bariatric surgery utilization trends among Medicare beneficiaries (2001-11)

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 8. 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.

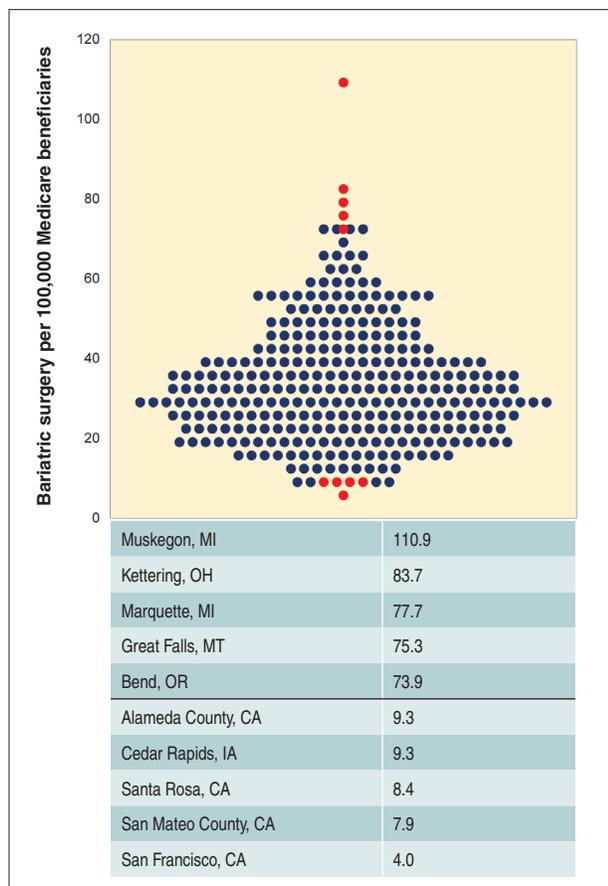
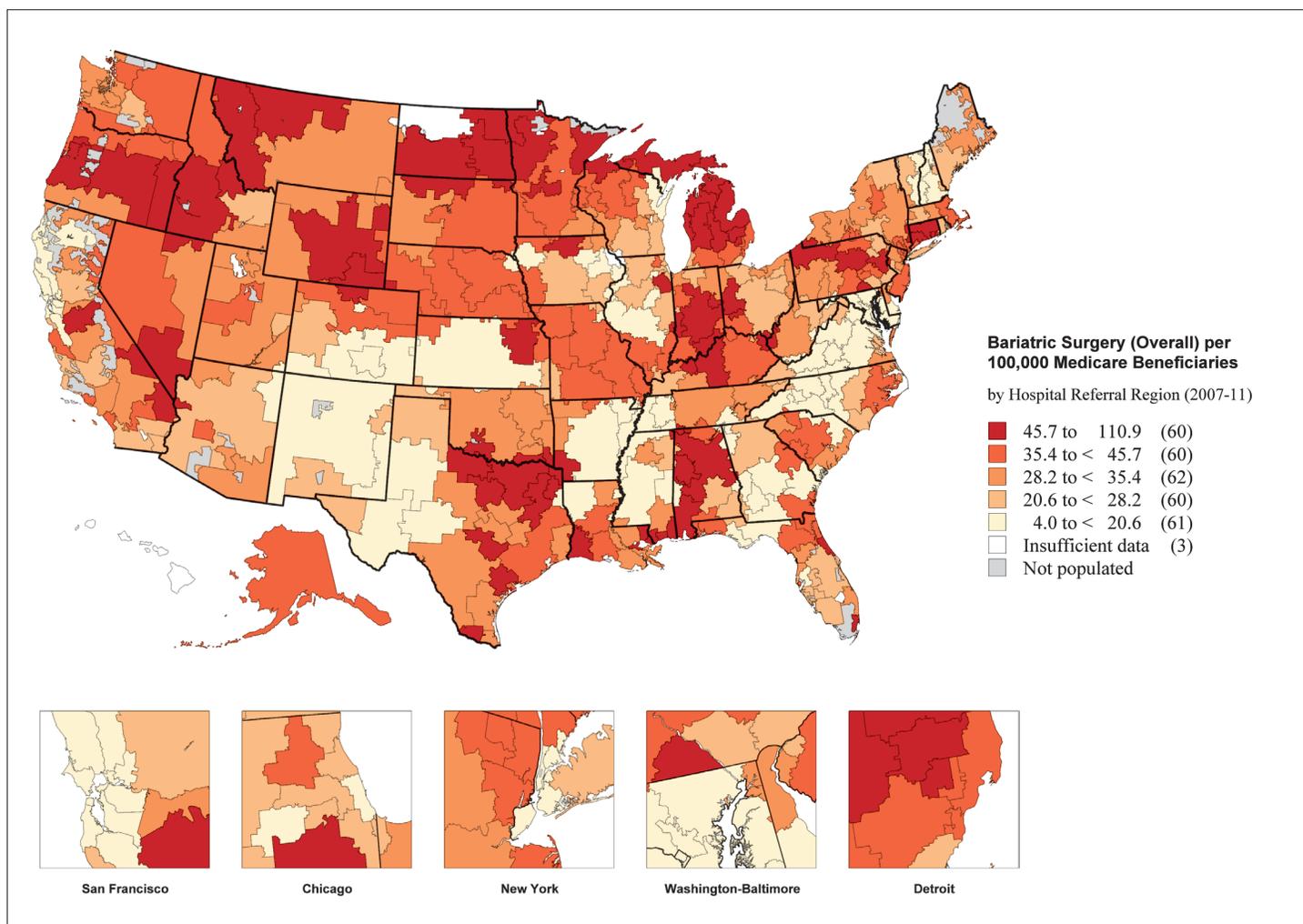


Figure 9. Bariatric surgery among 100,000 Medicare beneficiaries among hospital referral regions (2007-11)

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 4. 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 9). In general, rates of bariatric surgery were higher in the Midwest and northwestern regions than in the southern states (Map 4). The national average rate of bariatric surgery during the period from 2007 to 2011 was 32.8 per 100,000 enrollees.

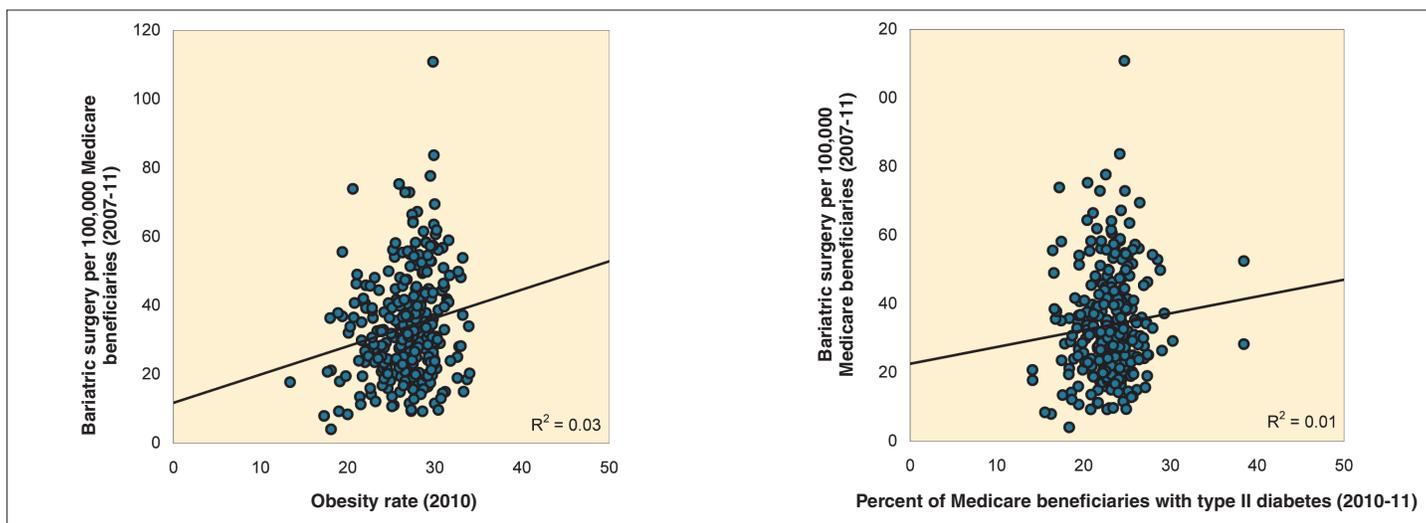


Figure 10A. Relationship between obesity rates and bariatric surgery among hospital referral regions

Figure 10B. 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 10 shows a hospital referral region’s rates of obesity (Figure 10A) or diabetes (Figure 10B) 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 11 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.

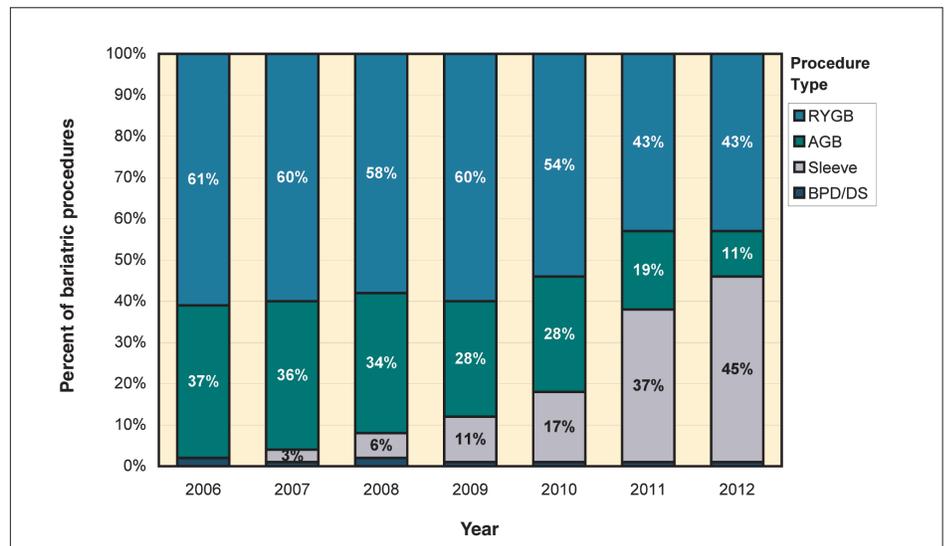


Figure 11. Trends in utilization of gastric bypass, adjustable gastric banding, and sleeve gastrectomy in Michigan (2006-12)

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 12). Difference-in-differences analysis failed to reveal an independent effect of the CMS policy.

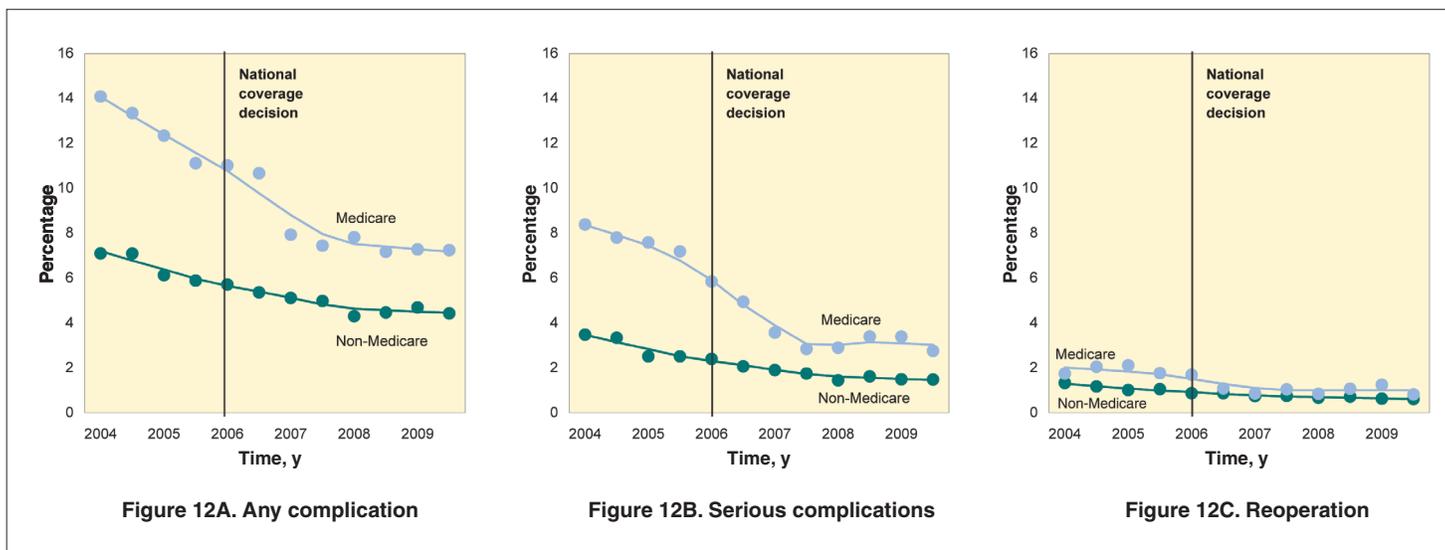


Figure 12. Trends in adverse outcomes before and after the implementation of the Centers for Medicare & Medicaid Services bariatric surgery national coverage decision

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 3 and 4 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 3. 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 4. 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		
Darville	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 7) 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.

Methods

In this report, 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). To accomplish this, we studied all patients with evidence of diagnostic codes for these conditions (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.

Table A. 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	

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

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

Appendix 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.

Appendix 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	

Appendix 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.

Appendix 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	

Appendix 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.

Appendix 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		

Appendix 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.

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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 Atlas

The Dartmouth Institute
for Health Policy and Clinical Practice
Center for Health Policy Research

Contact: Kristen Tyagi
(202) 683-3283
kristen.tyagi@msslgroup.com

www.dartmouthatlas.org

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The Dartmouth Atlas Working Group

Leadership

Elliott S. Fisher, MD, MPH, Dartmouth Atlas Co-Principal Investigator
David C. Goodman, MD, MS, Dartmouth Atlas Co-Principal Investigator
Jonathan S. Skinner, PhD, Senior Scholar
John E. Wennberg, MD, MPH, Founder of the Dartmouth Atlas
Kristen K. Bronner, MA, Managing Editor

Senior Authors and Faculty

John Erik-Bell, MD
Shannon Brownlee, MS
Julie P.W. Bynum, MD, MPH
Chiang-Hua Chang, PhD
Philip P. Goodney, MD, MS
Nancy E. Morden, MD, MPH
Jeffrey C. Munson, MD, MS
Thérèse A. Stukel, PhD
James N. Weinstein, DO, MS

Analytic and Administrative Staff

Thomas A. Bubolz, PhD
Donald Carmichael, MDiv
Julie Doherty, BA
Jennifer Dong, MS
Daniel J. Gottlieb, MS
Jia Lan, MS
Martha K. Lane, MA
Stephanie R. Raymond, BA
Sandra M. Sharp, SM
Jeremy Smith, MPH
Yunjie Song, PhD
Dean T. Stanley, RHCE
Yin Su, MS
Stephanie Tomlin, MPA
Rebecca Zaha, MPH
Weiping Zhou, MS

Design and Production

Jonathan Sa'adah and Elizabeth Adams