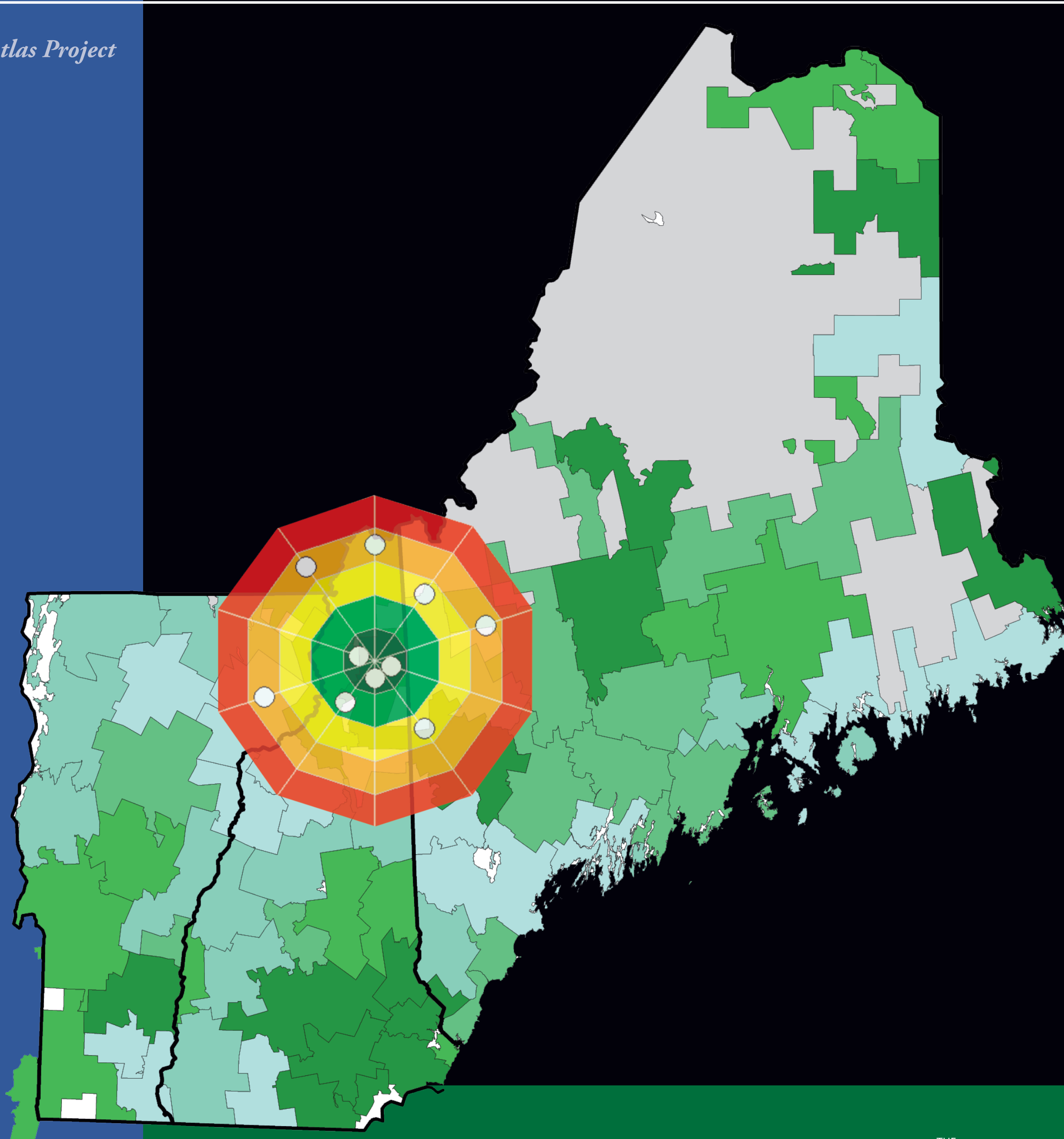
The Dartmouth Atlas of Children's Health Care in Northern New England

A Report of the Dartmouth Atlas Project



THE
Dartmouth
INSTITUTE
FOR HEALTH POLICY & CLINICAL PRACTICE

The Dartmouth Institute for Health Policy & Clinical Practice

The Dartmouth Atlas of Children's Health Care in Northern New England

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Dedicated to the memory of Professor André Busato, DVM MS, University of Bern, Institute of Social and Preventive Medicine, epidemiologist extraordinaire. He was a man of kind and generous spirit and will be missed by his family, and by many friends and colleagues. He never took the easy trail, but through fortitude and determination saw great vistas.

Preface

Some 40 years ago, my colleagues and I put together a health information system for a public planning program in Vermont so that we could examine the delivery of medical care throughout the state. We were surprised to uncover startling variations in the way children were treated when we compared one medical community to another. Of particular note were the differences among physicians in the way they treated children with enlarged tonsils. We estimated that more than 60% of children in Morrisville had their tonsils removed by age 15; in some other communities, less than 20% had the procedure.

We took the data about variation in pediatric care to the Vermont Medical Association in the hope that such information would stimulate physicians to examine their practice patterns and scrutinize the evidence supporting their clinical opinions. We learned quickly that this feedback of data could promote a reconsideration of the reasons for doing surgery. Subsequently, we noted a general reduction in rates among Vermont medical communities; most of the change was in high-rate regions. In Morrisville, the feedback resulted in a rapid change in medical opinion concerning the value of tonsillectomy, and the rate for this procedure became one of the lowest in Vermont. We reported this work in a 1977 article in the medical journal *Pediatrics*.[1]

By the end of the 1970's, interest in Vermont's statewide population-based data system waned, and recent analyses have usually focused on hospital care, particularly for adults. Recently, the Dartmouth Atlas Project gained access to the all payer claims dataset for infants and children in Vermont, Maine, and New Hampshire, and we can now take another look at tonsillectomies, as well as many other types of pediatric care.

The pattern of variation we see today is pretty much what we saw in 1973. There are striking variations among pediatric medical markets, including wide differences among areas where most of the care is delivered by academic medical centers; children living in Lebanon, New Hampshire are 2.7 times more likely to undergo tonsillectomy than those living in Burlington, Vermont.

But this Atlas isn't limited to tonsillectomy. It covers many aspects of the medical care experienced by children—the resources available to them, the hospitalizations and surgical procedures they undergo, the medications they use, and the quality of the care they receive, as well as the care they should receive but do not. We hope that this information will stimulate further inquiry into the value of the care our children receive across the country.

John E. Wennberg, MD, MPH

Introduction

While the quality of health care has a powerful influence on the well-being of infants and children, little information is available about the medical services received by children. This Dartmouth Atlas report examines small area variations in children's health care in one region of the United States—Northern New England—where the state legislatures of Maine, New Hampshire, and Vermont now require routine reporting of medical claims from commercial insurance plans. All three states offer these data, along with Medicaid claims, for research and public reporting. Using these data, the Dartmouth Atlas now offers the first report showing the patterns of care received by nearly the entire population of infants and children for ambulatory physician services, hospitalization, common surgery, imaging, and outpatient prescription fills. Most importantly, the report presents these measures by small health markets, called hospital service areas and pediatric surgical areas, revealing the care provided by specific hospitals and their medical staffs. The findings from this report show marked variation in care across the region. While there are many examples of excellent care, the findings raise troubling questions about whether the medical practice patterns reflect the care that infants and children need and that their families want.

The health and health care of infants and children

The health of children is the result of a complex set of societal, community, family, and health care system factors. Children are the most socially disadvantaged and racially/ethnically diverse age group in the United States. While they have relatively low rates of uninsurance compared to adults, they have a higher dependence on Medicaid. Children also have to travel farther for care. Physicians providing primary care services for children (e.g., pediatricians and family physicians) are fewer in number than those caring for adults, and pediatric subspecialty services are often only available in larger population centers or children's hospitals. Lower reimbursement rates also limit the number of physicians who provide care to children insured by Medicaid, forcing more families to travel outside of their area.

Many of the most important health challenges faced by children do not have straightforward preventive strategies or treatments, often reflecting causes rooted in social and economic circumstances, trends in societal diet and exercise patterns, and the health of their families. These include prematurity, dental disease, obesity, and mental health problems. The community and family determinants of health have long been recognized and are the target of many diverse public programs that range from family planning services, to Head Start, to community mental health programs. Despite these efforts, the United States lags strikingly behind other developed countries in the health of infants and children.[2]

While the fundamental determinant of children's health may not be the health care system, the most visible and costly efforts at improving children's well-being are through the efforts of physicians and hospitals. Pediatric care is provided by a complex system of physicians and nurses practicing in private offices, community clinics, and hospitals. In the past 50 years, scientific advances in pediatric care have led to the growth of pediatric subspecialties, including neonatology and cardiology, as well as surgical subspecialties. Children's hospitals have grown in number and importance, along with specialized units for providing neonatal and pediatric intensive care. Today, pediatric care is provided by 47,000 pediatricians, 74,000 family physicians,[3] 12,000 pediatric nurse practitioners,[4] and more than 230 children's hospitals.[5] Total health expenditures for children less than 19 years in 2004 were estimated to be in excess of $208 billion.[6]

The magnitude and importance of these resources has led to a growing interest in improving the value of pediatric care. Research and public reporting of children's health care has grown, but too little is still known about variations in the medical care children receive from their clinicians and hospitals. In the past 40 years, the measurement of children's health care has lagged behind that of adults, particularly the elderly, reflecting the unique challenges of measuring pediatric health care and outcomes.[7]

A framework for interpreting the causes and consequences of variation in health care

The examination of variation in health care is primarily motivated by interest in identifying variation in the performance of health care providers and systems. Health care is expected to vary to the extent that populations differ in their needs and preferences for health care. Unwarranted variation is the variation that cannot be explained by differences in population needs or preferences. Unwarranted variation is the variation in medical resources, utilization, and outcomes that is due to differences in health system performance.

Over the past two decades, a classification system for unwarranted variation has been developed by Wennberg and colleagues.[8] Variation in utilization was categorized into three types: effective care, preference-sensitive care, and supply-sensitive care. Variation in health care capacity, such as hospital beds and physicians, is a fourth, non-utilization category.

Variation in effective care

Variation in effective care reflects differences in technical quality, i.e., in care that has been shown to be beneficial with few tradeoffs. Usually, the "right" rate is known for a given population. Immunization rates are one pediatric example, where the ideal rate should approach 100%. Pediatrics has been actively involved in developing effectiveness data and is a leader in promoting system change and improvement to achieve the right rate. In this report, variation in effective care is reported using Healthcare Effectiveness Data and Information Set (HEDIS) measures from the National Committee for Quality Assurance (NCQA).[9]

Variation in preference-sensitive care

Preference-sensitive care refers to medical services where the care should reflect the decision of an informed patient after weighing the possible benefits and harms of the different care options. For this type medical care variation, there is no single "right" rate for every population or area. The right rate would reflect the decisions of fully informed patients and families reached through a process of shared decision-making. It would be expected that care choices would differ across families, and in turn, across regions. The result would be variation warranted by patient and family preferences.

The original analyses that led to this concept were studies of adult men facing treatment choices for benign prostatic hyperplasia,[10] decidedly a non-pediatric problem. Most of the research in decision quality and shared decision-making has centered on adult conditions, ranging from early-stage breast cancer in women to lower back pain. Decision aids have been developed to assist patients and clinicians in choosing care that is consistent with the patient's values. Usually, but not always, the introduction of decision aids reduces utilization rates.[11]

A list of available decision aids and their sources can be found at the Ottawa Hospital Research Institute web site.[12] These differ greatly in quality, and only a few are available for pediatric illnesses. Areas where shared decision-making is being implemented in pediatrics include otitis media, attention deficit hyperactivity disorder, and tonsillitis.[13-18] In this report, variation in preference-sensitive care is reported for surgical procedures, imaging, and prescription drug use. Supply of health care resources may also play a role in the rates of surgical procedures and imaging.

Variation in supply-sensitive care

Supply-sensitive care refers to medical services for which utilization rates are sensitive to the local availability of health care resources, such as hospital beds, imaging units (e.g., CT scanners), and physicians. While in some instances effective care may be constrained by a lack of resources, this category is principally concerned with the many types of medical care for which there is weak theory and/or little evidence that more services are generally better. Generally, the "right" rate is the lowest rate consistent with favorable outcomes. While this is a category of variation that has been studied extensively in adult patients, little research has been conducted recently concerning children's health care.[19]

Variation in health care capacity

The few studies that have been conducted show marked population-based variation in pediatric health care capacity, such as hospital beds,[19,20] intensive care unit beds, and other specialized resources. Several studies have shown marked variation in the per capita (e.g., per child or newborn) number of general pediatricians and pediatric subspecialists.[21]

Pediatric capacity is generally not located where the need is greatest. Chang et al showed a lack of association between general pediatrician supply across states and indicators of child health needs.[22] Mayer observed a very high degree of variation across Dartmouth Atlas hospital referral regions for different pediatric subspecialists,[23] and Goodman et al found little relationship between the supply of neonatologists and regional differences in perinatal risk.[20]

Current status of pediatric health system performance measurement

We know relatively little about the quality and efficiency of pediatric health care and publicly report even less. Compared to the care provided to Medicare beneficiaries, where extensive research and public information on utilization, costs, and outcomes is increasingly routine,[24] pediatric health care often occurs within a black box where the type, quantity, and outcomes of care are unknown. This does not reflect a lack of interest on the part of pediatric clinicians and researchers, who are deeply committed to the well-being of children even as their efforts to improve care are impeded by a lack of useful metrics. The reasons for the slow pace of developing health care metrics for pediatrics are multi-faceted, some simply reflecting the nature of pediatric health care, and others the fragmented data sources that are frequently owned by private insurers and providers.

It is easier to measure care in the elderly, among whom utilization rates are high and significant outcomes are common. With the exception of medical care during the newborn period, most children need and receive less care than older adults. There are fewer children with high health care needs, and serious childhood illness is often caused by many diverse and uncommon problems. Important and easily identified outcomes (e.g., death) are less frequent and are difficult to detect with available data. The lack of high quality data adds to the difficulty of evaluating the quality and efficiency of children's health care.

Quality measures for adults were pioneered with population-based administrative datasets, most notably Medicare claims datasets for fee-for-service beneficiaries. These data led to a flood of research on the value of care for the elderly and almost twenty years of publicly reported measures about the care provided within health markets and hospitals.[24,25] Medicare insures few children, and no comparable health care claims data file has been available for children insured with Medicaid and commercial insurance plans. Of the 80 million children in the U.S., 43 million are insured by Medicaid and the Children's Health Insurance Program,[26] but complete claims data have been available for only a few states and have not been used to develop publicly available measures of health system performance.

In the absence of population-based health care claims data for children, other quality measurement systems have been developed. For example, the National Committee for Quality Assurance (NCQA)[27] has developed performance quality measures for many types of pediatric care. These are primarily used by NCQA to rank the quality of insurance plans, but the actual measures of physician practice and hospital performance are usually not available. More recently, the Centers for Medicare and Medicaid Services (CMS) has reported hospital performance measures from patient surveys, hospital reports, and claims data.[25] Only one measure, inpatient asthma care, reflects the care of children. Remarkably, this set of measures, when studied across multiple children's hospitals, demonstrated little variation and no correlation with outcomes.[28]

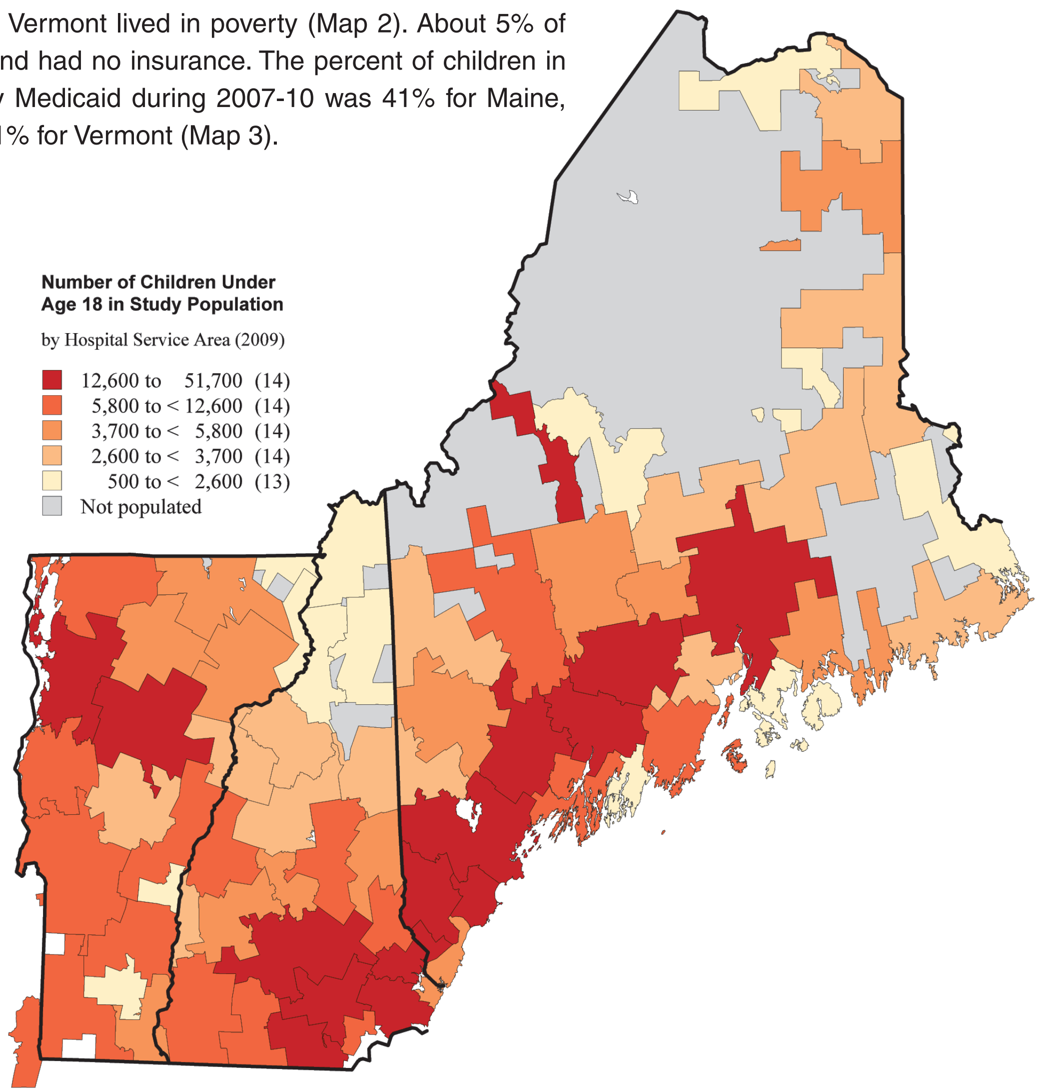
The most extensive data development has occurred in provider networks developed for research and improvement of care among the member providers. Examples of these include the Vermont Oxford Network[29] for very low birth weight infants, the Cystic Fibrosis Foundation Care Center Data[30] for patients with cystic fibrosis, and the Pediatric Health Information System[31] for children hospitalized in 43 children's hospitals.

A recent important development in data available for understanding children's health care is the creation of All Payer Claims Databases (APCD)[32] by states. Typically, these datasets include health care claims from commercial insurers and Medicaid for nearly the entire population, children included. Most state-mandated APCDs include inpatient, professional services, facility, and pharmaceutical claims that can be linked over time and place of service. These population-based datasets allow observation of patients of wide ranging health status as they seek care across the full spectrum of medical providers. The data can locate the patient by place of residence and source of care, so that measures can be developed that reflect provider behavior at a regional or hospital medical staff level. Many states permit the data to be used for research and public reporting. This Dartmouth Atlas report relies on APDC data from the states of Maine, New Hampshire, and Vermont.

Overview

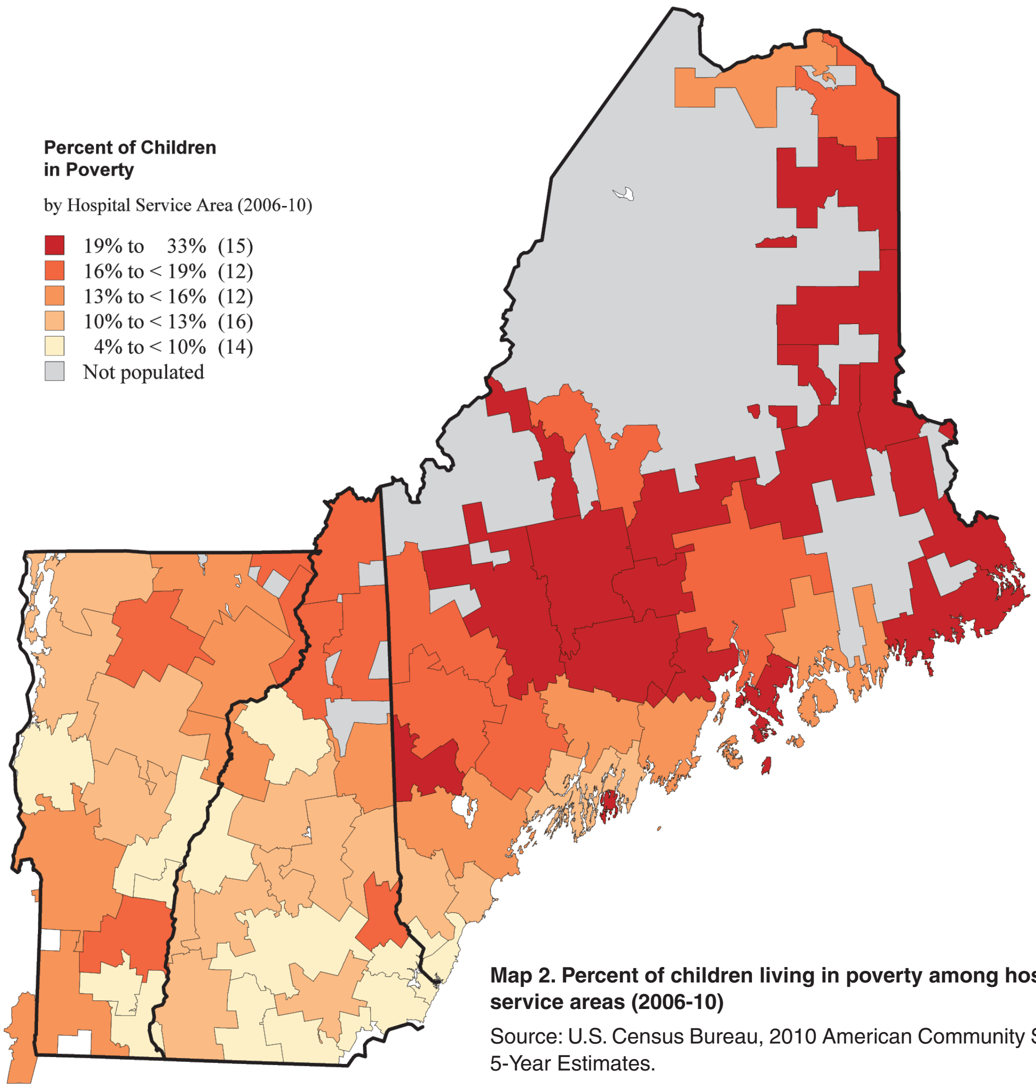
This Dartmouth Atlas report shows the variation in pediatric care across the hospital service areas of Northern New England, reflecting the care provided by local physicians and hospitals. The population included in the report is children and infants less than 18 years of age represented in the All Payer Claims Databases of Maine, New Hampshire, and Vermont for the period from 2007 through 2010. Seven domains of health care are reported: the physician workforce, ambulatory care, effective care, hospitalization, common surgical procedures, diagnostic imaging, and outpatient pharmacy prescription fills.

The region of Northern New England included 691,000 (in 2010) children less than 18 years old, living in small cities, towns, and rural areas. The pediatric population is about 90% white non-Hispanic, living in diverse socioeconomic circumstances. During the period from 2006 to 2010, 16% of children in Maine, 9% in New Hampshire, and 13% of Vermont lived in poverty (Map 2). About 5% of children in Northern New England had no insurance. The percent of children in our study population insured by Medicaid during 2007-10 was 41% for Maine, 37% for New Hampshire, and 41% for Vermont (Map 3).



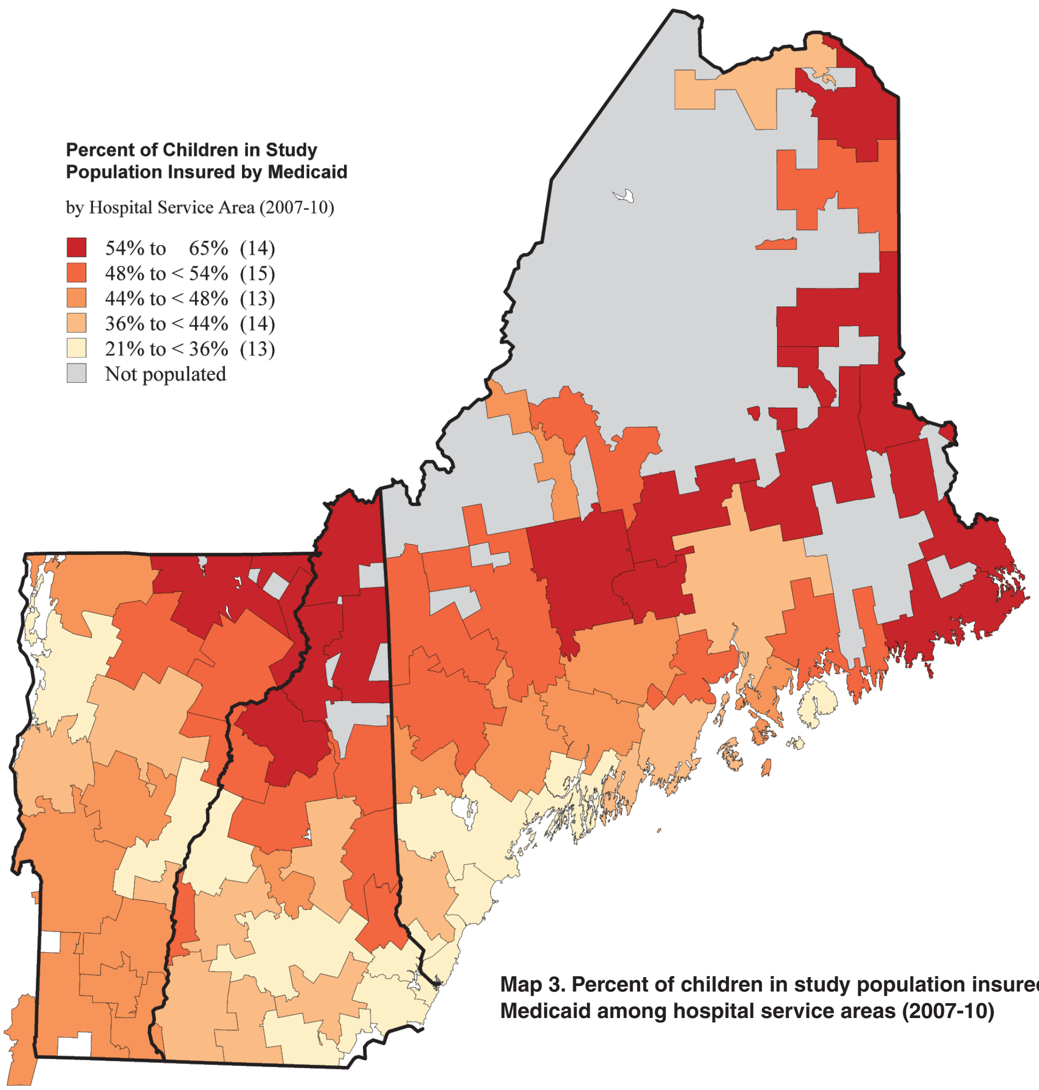
Map 1. Number of children under age 18 in study population among hospital service areas (2009)

Because the Maine 2010 Medicaid data was not available in time for the report, the map shows the number of children in the study population in each hospital service area for 2009. The number of children was estimated using the number of person-months represented in each claims database.



Map 2. Percent of children living in poverty among hospital service areas (2006-10)

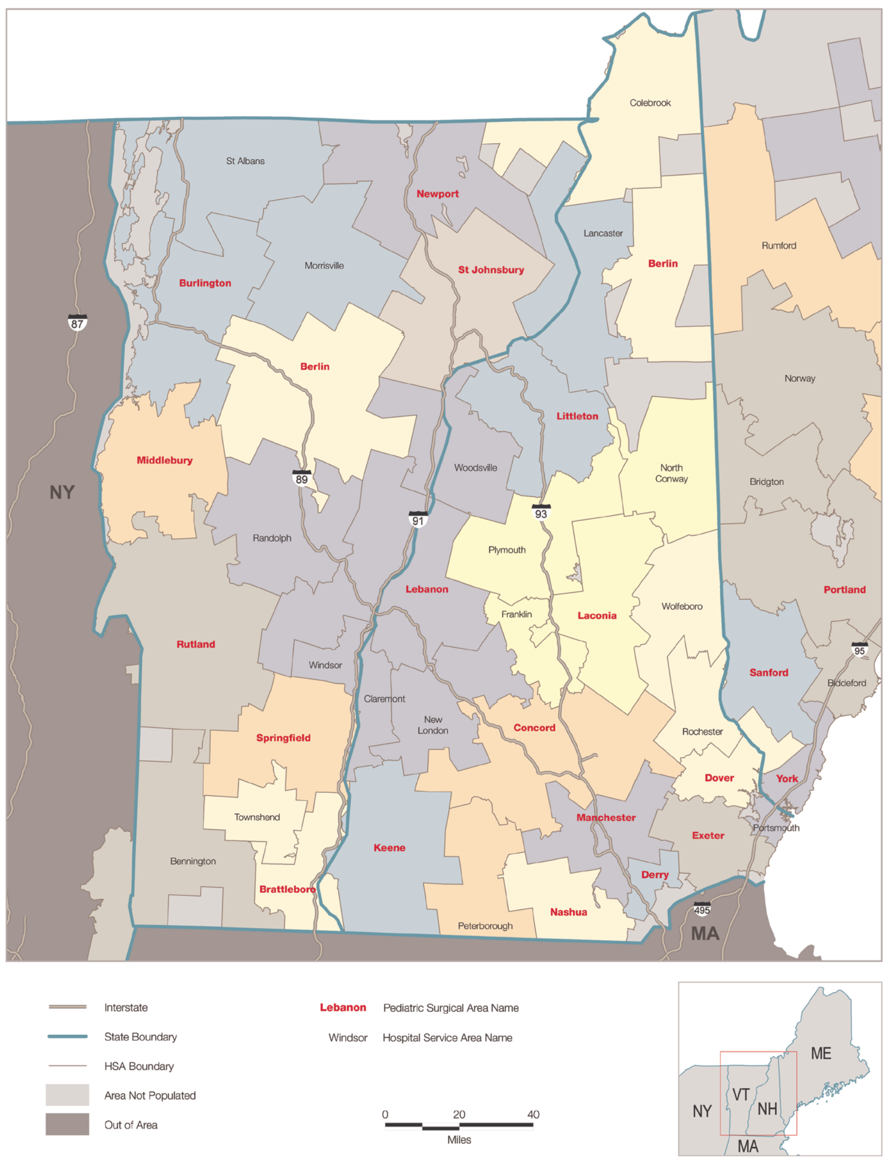
Source: U.S. Census Bureau, 2010 American Community Survey 5-Year Estimates.



Map 3. Percent of children in study population insured by Medicaid among hospital service areas (2007-10)

This report uses a harmonized dataset developed for this project by Onpoint Health Data using six data sources: the commercial APCD and Medicaid claims from Maine, New Hampshire, and Vermont (see Methods). Each state has slightly different reporting requirements for commercial insurance plans (e.g., Maine does not require reporting for plans with less than 50 covered lives), and the Maine 2010 Medicaid data was not available in time for this report.

The various measures are reported by two different sets of health service areas. Most measures were calculated for Dartmouth Atlas hospital service areas (HSAs). These 69 areas were initially defined in 1992-93 as geographic markets



Map 4. Hospital service areas and pediatric surgical areas in New Hampshire and Vermont

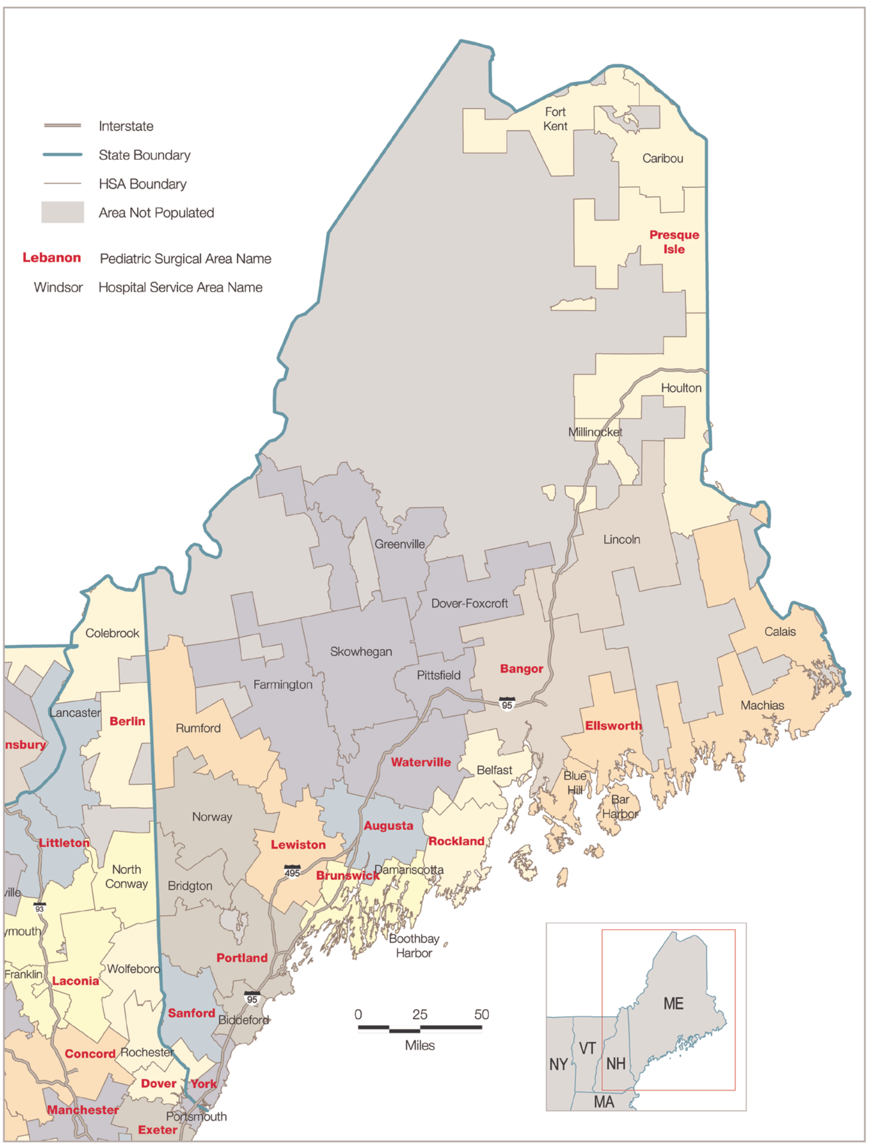
The colors on each map demonstrate how hospital service areas were aggregated into pediatric surgical areas. For example, children living in the Vermont HSAs of Burlington, Morrisville, and St. Albans all received surgical care in the Burlington PSA, which is shaded in blue.

that reflected Medicare beneficiaries' travel to hospitals for inpatient care. Unlike other regions of the U.S.,[33] HSAs remain useful for pediatric ambulatory and inpatient care in 2007-10. Travel for pediatric surgical procedures, however, is more regionalized. To address the different patterns of travel for surgical services, the Atlas project aggregated the hospital service areas into 30 pediatric surgical areas (PSAs) to define relatively self-contained geographic markets for pediatric surgery (Maps 4 and 5).

Table 1. Demographic data for Northern New England states

	Number of children in study population under age 18 (2009)*	Percent of children in poverty (2006-10)	Percent of children insured by Medicaid (2007-10)
Maine	246,237	16.5%	40.9%
New Hampshire	201,915	9.2%	37.2%
Vermont	118,961	12.6%	41.0%
Northern New England	567,113	12.7%	39.5%

*The number of children was estimated using the number of person-months represented in each claims database.



Map 5. Hospital service areas and pediatric surgical areas in Maine

The colors on each map demonstrate how hospital service areas were aggregated into pediatric surgical areas. For example, children living in the Maine HSAs of Boothbay Harbor, Brunswick, and Damariscotta all received surgical care in the Brunswick PSA, which is shaded in yellow.

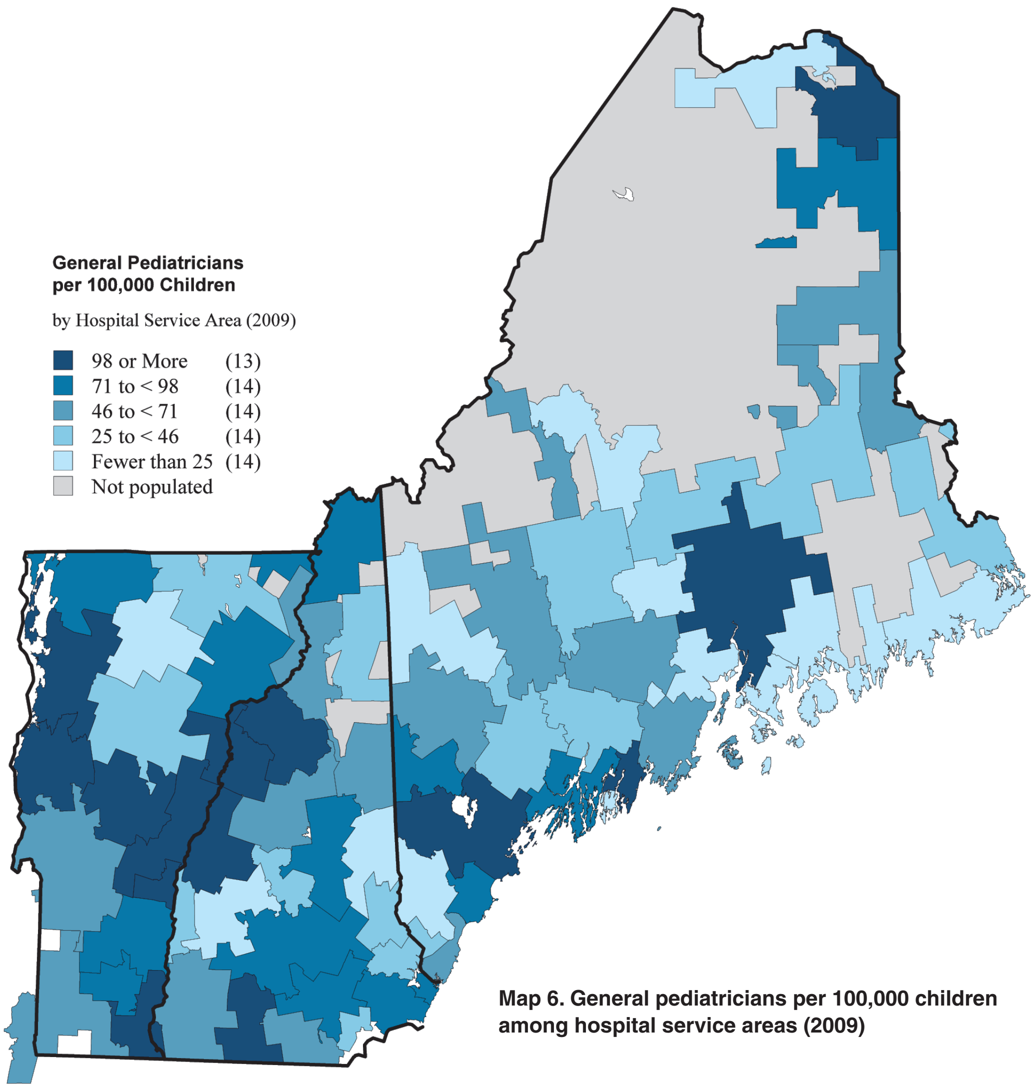
The Child Health Workforce

The physician workforce caring for children includes the primary care specialties of general pediatrics and family medicine. More highly specialized services are provided by a wide range of pediatric medical (e.g., pediatric cardiology, neonatology) and surgical (e.g., pediatric orthopedics, urology) specialties. Specialty services are also commonly provided by physician specialties that primarily care for adults (e.g., radiology, otolaryngology).

This report examines three physician specialties—general pediatrics, family medicine, and otolaryngology—as well as a composite measure of child primary care physicians that includes general pediatricians and one quarter of the number of family physicians. Because providers in some hospital service areas, including those that contain children's or other large hospitals, serve many children from outside the area, the per capita supply of physicians can vary extensively across the Northern New England region.

General pediatricians

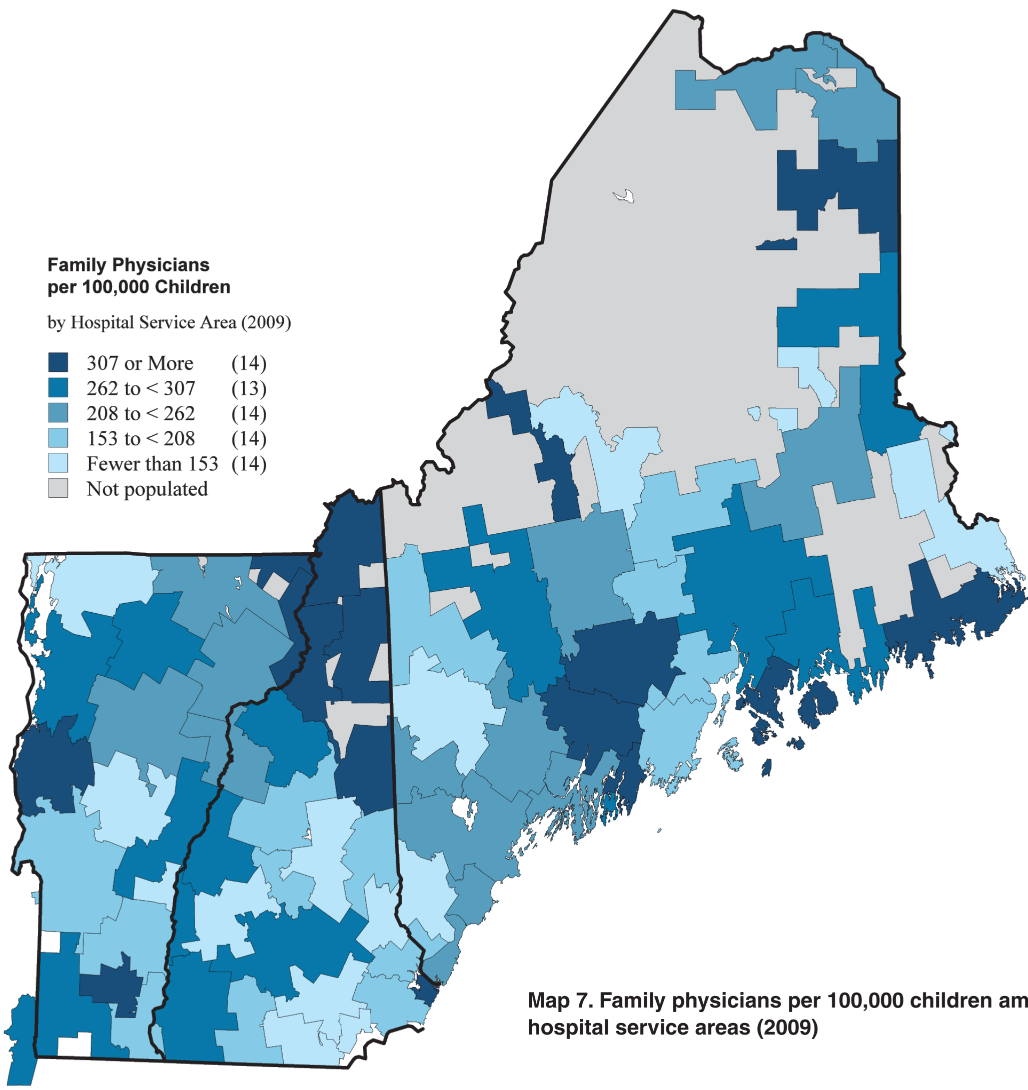
More than 530 general pediatricians practiced in Northern New England in 2009. The workforce of general pediatricians (78 per 100,000 children) was larger than the national average. There was marked variation in the supply of pediatricians across hospital service areas, from fewer than 20 physicians per 100,000 children in Sanford, Maine (7.3), Morrisville, Vermont (16.1), and Wolfeboro, New Hampshire (19.2) to more than 100 per 100,000 in Lebanon, New Hampshire (280.4), Burlington, Vermont (156.6), and Portland, Maine (121.1).



Map 6. General pediatricians per 100,000 children among hospital service areas (2009)

Family physicians

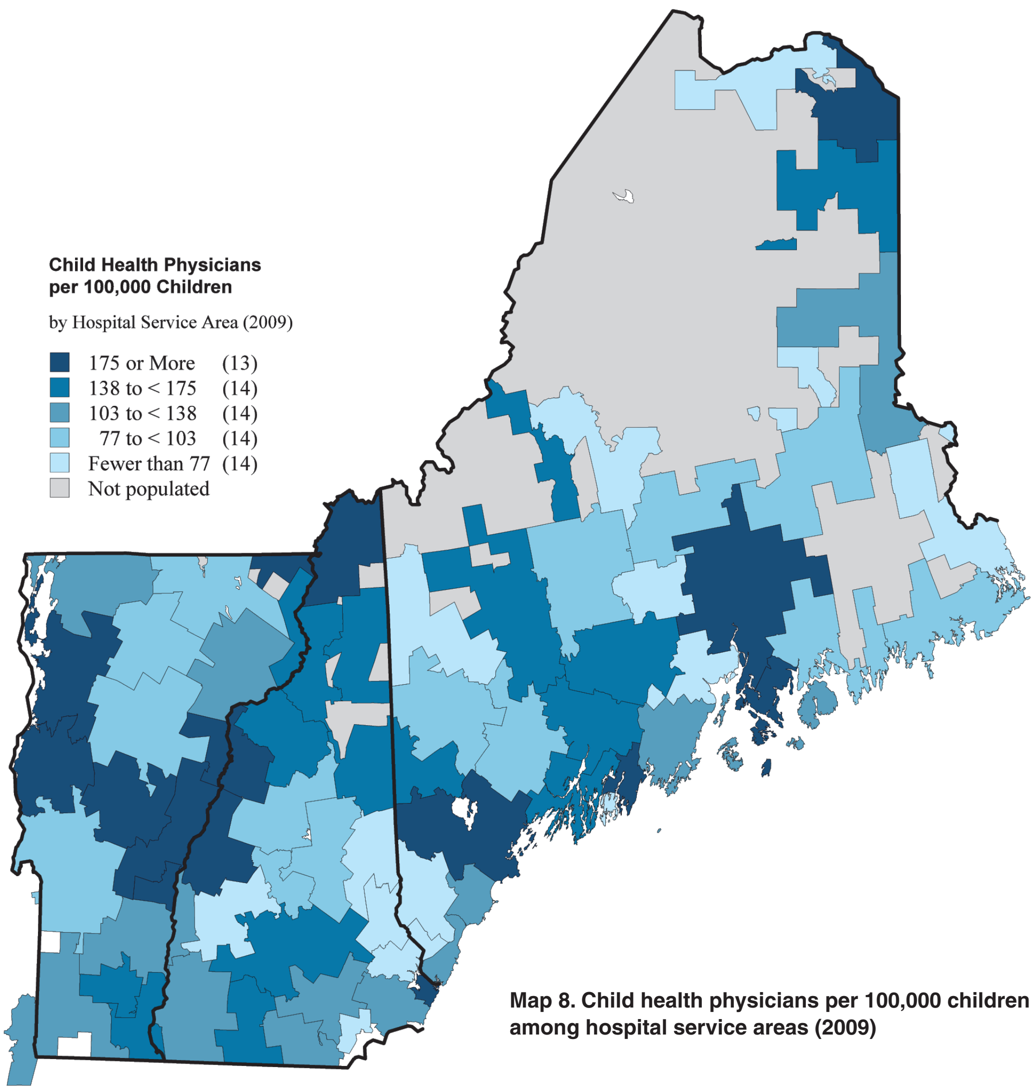
In 2009, there were more than 1,500 family physicians practicing in Northern New England. The supply of family physicians in the region (224 per 100,000 children) was higher than the national average. There were fewer than 120 family physicians per 100,000 children in Laconia, New Hampshire (95.6), St. Albans, Vermont (103.9), and Manchester, New Hampshire (117.6). There were more than 300 physicians per 100,000 in Augusta, Maine (427.1), Waterville, Maine (391.5), and Middlebury, Vermont (382.9).



Map 7. Family physicians per 100,000 children among hospital service areas (2009)

Child health physicians

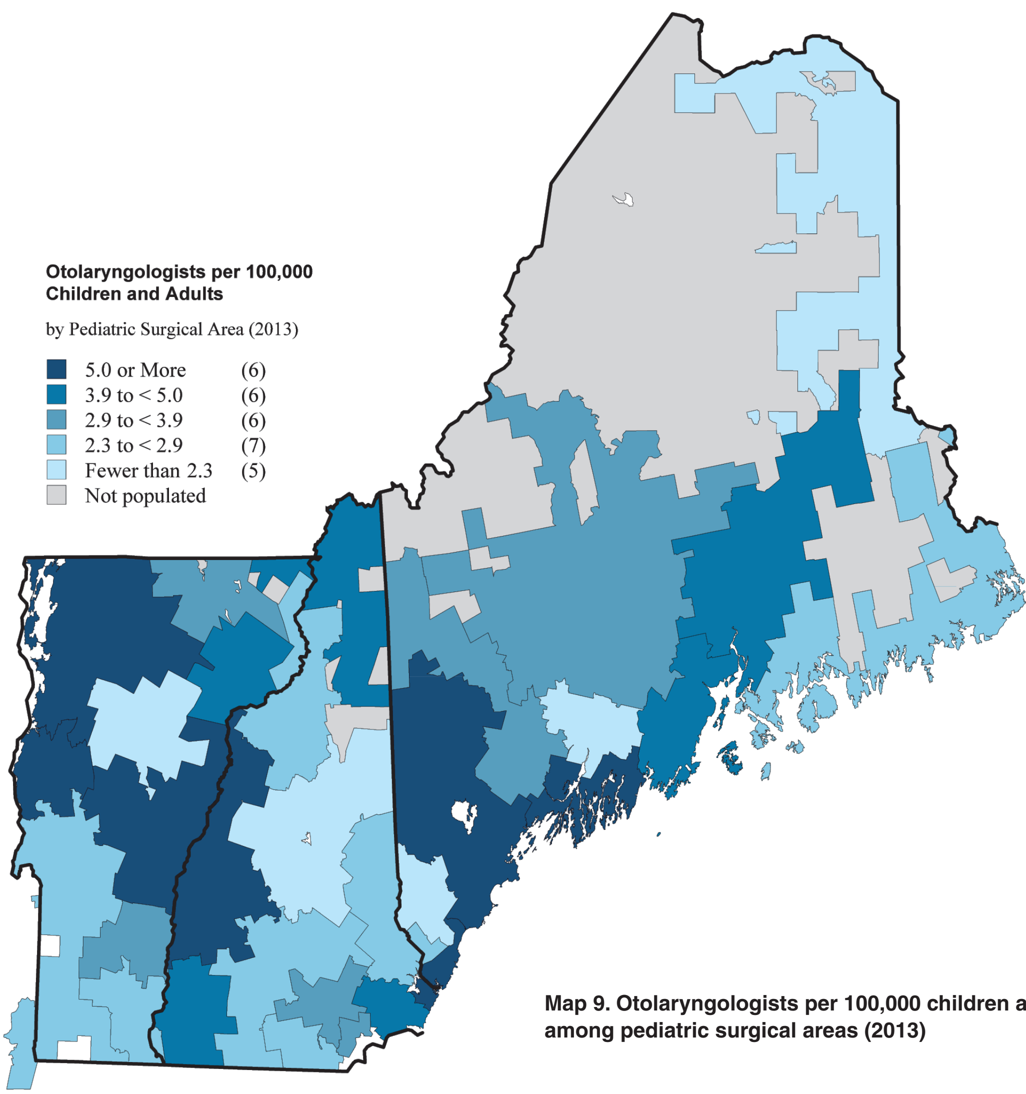
Child health physicians include general pediatricians and one quarter of the number of family physicians, or about 920 full-time equivalent physicians. This translates into a rate of about 134 physicians per 100,000 children. Nurse practitioners and physician assistants also provide primary care to children, but data about their location and specialty are not available for this report. The child health workforce varied in 2009 from fewer than 60 physicians per 100,000 children in Sanford, Maine (27.2), Rochester, New Hampshire (58.7), and Derry, New Hampshire (59.8) to more than 200 per 100,000 in Lebanon, New Hampshire (355.9), Middlebury, Vermont (271.2), and Burlington, Vermont (225.1).



Map 8. Child health physicians per 100,000 children among hospital service areas (2009)

Otolaryngologists

Otolaryngologists (ear, nose, and throat physicians) perform the most common pediatric surgical procedures: tonsillectomies, adenoidectomies, and tympanostomy tube insertion. There were about 125 otolaryngologists practicing in Northern New England in 2013. Across pediatric surgical areas, the otolaryngology workforce varied from 0.7 physicians per 100,000 children and adults in Augusta, Maine to 12.4 per 100,000 in York, Maine. Other areas with fewer than 2 otolaryngologists per 100,000 children and adults included Presque Isle, Maine (1.2), Berlin, Vermont (1.5), and Laconia, New Hampshire (1.8). Areas with more than 5 physicians per 100,000 included Lebanon, New Hampshire (6.5) and Portland, Maine (5.5).



Map 9. Otolaryngologists per 100,000 children and adults among pediatric surgical areas (2013)

Summing up

It is expected that the supply of physicians would vary in response to different health needs across Northern New England. Unfortunately, physicians responsible for the care of children tend to locate in areas with lower levels of pediatric health risk. This unwarranted variation in the child health workforce is seen in the correlations between the percent of children in each HSA in poverty and the number of physicians per capita (either per child or per total population) (Table 2).

Table 2. Correlations (r values) between the physician workforce and the percent of children living in poverty

	Correlation (r) with child poverty rate
Physicians per 100,000 children among HSAs	
Pediatricians	-0.39
Family physicians	0.11
Child health physicians*	-0.27
Physicians per 100,000 children and adults among PSAs	
Otolaryngologists	-0.26

*Composite of pediatricians and one quarter of family physicians

For more information about the r value, please see the section entitled “Utilization, variation, and association – how to interpret the measures.”

There was a negative correlation between the child poverty rate and the supply of pediatricians and child health physicians; they tended to practice in areas with higher household incomes. Family physicians were not more or less likely (i.e., there was no correlation) to practice in areas with greater poverty. Like pediatricians, otolaryngologists were more likely to practice in areas with greater affluence. These patterns of physician practice location are similar to national studies for a wide range of specialties;[21,23,34-36] in general, physicians are not found in higher numbers where patient needs are greater.

Table 3. The child health workforce in Northern New England states

	General pediatricians per 100,000 children (2009)	Family physicians per 100,000 children (2009)	Child health physicians per 100,000 children (2009)	Otolaryngologists per 100,000 children and adults (2013)
Maine	69.2	261.8	134.7	4.0
New Hampshire	78.1	183.3	123.9	3.8
Vermont	98.0	233.3	156.3	3.8
Northern New England	78.2	223.5	134.1	3.9

Tables containing data for all Northern New England HSAs and PSAs may be found in the Appendices.

Ambulatory Care

Most of the medical care received by infants and children is delivered in ambulatory care settings such as primary care physician offices, hospital clinics, and emergency rooms. The frequency of primary care office visits for children less than 15 years of age is higher than for any age except for those over 75,[37] constituting 67% of all ambulatory visits. Physician office and clinic visits are for preventive services, acute illness, sub-specialty consultations, and chronic disease management.

Emergency rooms provide a wide range of care beyond the diagnosis and treatment of emergent and life-threatening illness. Twenty-four hour availability of emergency care helps to fill the gap left by primary care practices that may have full schedules or limited evening and weekend hours. In many rural communities, the emergency room is the only source of medical care during non-business hours. All hospitals are required by law to treat patients regardless of insurance status, making emergency rooms the providers of last resort.

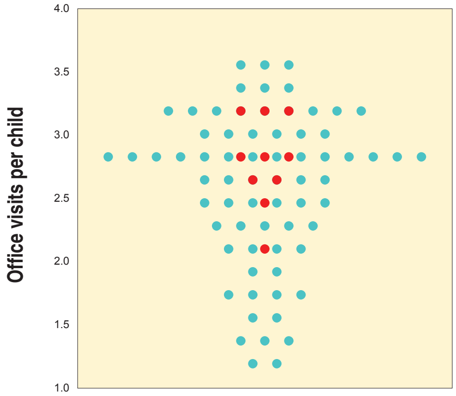
Office and clinic visits

Table 4. Top 20 office visit diagnoses		
Diagnosis*	Percent of visits	Cumulative percent
Health maintenance visits	20.9	20.9
Other upper respiratory infections	13.4	34.3
Otitis media and related conditions	8.6	42.9
Viral infection	3.4	46.3
Attention-deficit, conduct, and disruptive behavior disorders	2.9	49.2
Other skin disorders	2.7	51.9
Asthma	2.4	54.3
Allergic reactions	2.4	56.7
Other lower respiratory disease	1.9	58.6
Other ear and sense organ disorders	1.7	60.3
Other upper respiratory disease	1.6	61.9
Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease)	1.5	63.4
Other non-traumatic joint disorders	1.4	64.8
Superficial injury; contusion	1.4	66.1
Sprains and strains	1.3	67.4
Skin and subcutaneous tissue infections	1.2	68.6
Misc. office visits	1.1	69.8
Abdominal pain	1.1	70.9
Other gastrointestinal disorders	1.1	72.0
Other nutritional; endocrine; and metabolic disorders	1.1	73.1

* Clinical Classification System (AHRQ)

The most common office visits were for health maintenance (i.e., well-child care), upper respiratory infections, otitis media (middle ear infections and related problems), viral infections, and attention deficit disorders (Table 4).

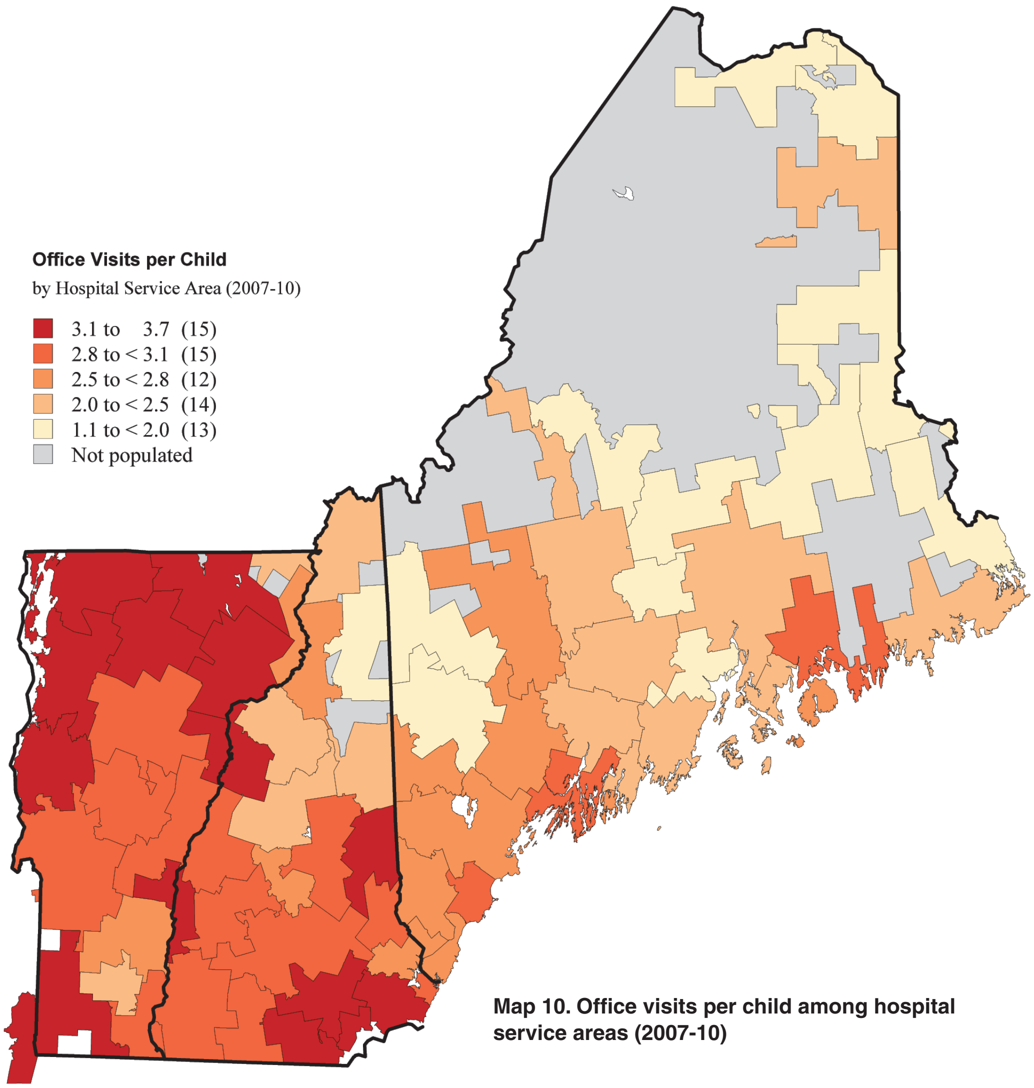
The average annual office visit rate (including primary care and subspecialty office and clinic visits) for children living in Northern New England hospital service areas during 2007-10 was 2.8 visits per child. Children with commercial insurance had slightly higher visit rates (2.83) than children with Medicaid (2.73). Office visits varied more than threefold across hospital service areas, from fewer than 1.5 visits per child in Houlton, Maine (1.2) and Dover-Foxcroft, Maine (1.3) to more than 3.5 per child in St. Albans, Vermont (3.6) and Bennington, Vermont (3.6). Among areas containing large medical centers and children's hospitals, visit rates were higher in Burlington, Vermont (3.2) and Manchester, New Hampshire (3.1) than in Bangor, Maine (2.0) and Augusta, Maine (2.4). The HSAs with higher rates of poverty generally had lower office visit rates (r = -0.60), but this was true for both the commercially insured (r = -0.57) and Medicaid beneficiaries (r = -0.45), indicating the importance of the local health care system in addition to patient characteristics.



Nashua, NH	3.2
Burlington, VT	3.2
Manchester, NH	3.1
Concord, NH	2.9
Lebanon, NH	2.8
Lewiston, ME	2.7
Dover, NH	2.7
Portland, ME	2.6
Augusta, ME	2.4
Bangor, ME	2.0

Figure 1. Office visits per child among hospital service areas (2007-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges. For more information about this graph, please see the section entitled "Utilization, variation, and association – how to interpret the measures."



Map 10. Office visits per child among hospital service areas (2007-10)

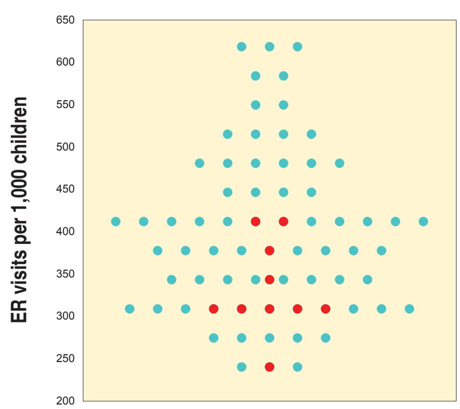
Table 5. Top 20 emergency room visit diagnoses		
Diagnosis*	Percent of visits	Cumulative percent
Other upper respiratory infections	9.6	9.6
Superficial injury; contusion	9.1	18.8
Sprains and strains	6.5	25.2
Otitis media and related conditions	5.9	31.2
Open wounds of head; neck; and trunk	5.9	37.0
Other injuries and conditions due to external causes	4.6	41.6
Fracture of upper limb	4.4	46.0
Open wounds of extremities	4.2	50.2
Fever of unknown origin	3.5	53.7
Abdominal pain	3.1	56.8
Viral infection	2.5	59.3
Allergic reactions	2.2	61.5
Nausea and vomiting	1.8	63.3
Other lower respiratory disease	1.6	64.8
Asthma	1.4	66.2
Fracture of lower limb	1.3	67.5
Skin and subcutaneous tissue infections	1.3	68.8
Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease)	1.2	70.0
Pneumonia (except that caused by tuberculosis or sexually transmitted disease)	1.2	71.3
Urinary tract infections	1.2	72.4

* Clinical Classification System (AHRQ)

Emergency room visits

The most common causes of emergency room visits were upper respiratory infections, minor injuries including contusions and sprains, otitis media (middle ear infections and related problems), and open wounds (Table 5).

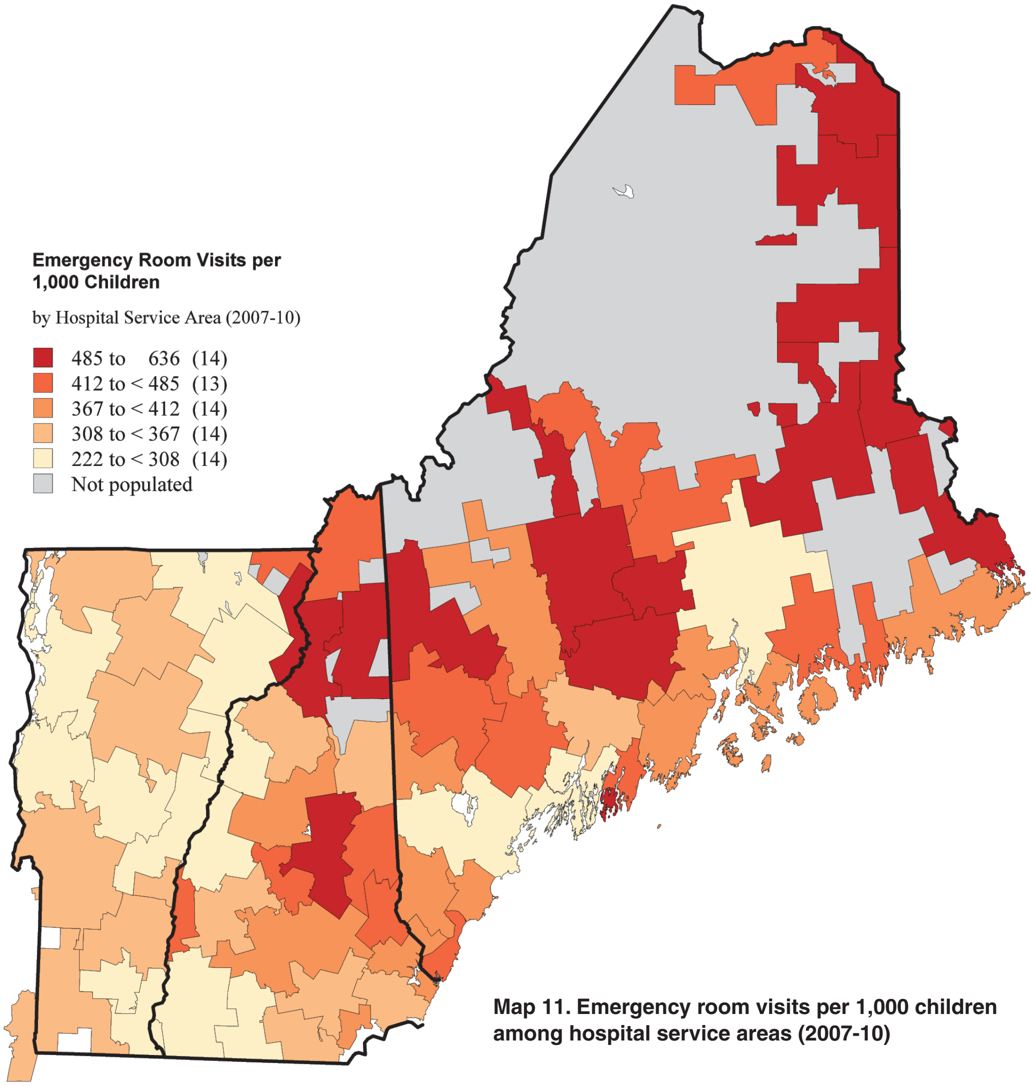
Across Northern New England hospital service areas, the annual emergency room visit rate during 2007-10 was 359 per 1,000 children. Children with Medicaid had much higher emergency room visit rates (560 per 1,000) than children with commercial insurance (225 per 1,000). Emergency room visit rates varied nearly threefold, from fewer than 250 visits per 1,000 children in Burlington, Vermont (223) and Brattleboro, Vermont (231) to more than 600 per 1,000 children in Houlton, Maine (635) and Skowhegan, Maine (622). Among HSAs with large hospitals, the rates in Lewiston, Maine (427) and Dover, New Hampshire (411) were nearly twice as high as the rate in Burlington. The HSAs with high poverty rates tended to be the areas with high emergency room visit rates (r = 0.57), and this was true for patients insured both with Medicaid (r = 0.58) and for those with commercial insurance (r = 0.48). As with office visits, where children live and receive care is an important factor in emergency room use in addition to their individual health characteristics.



Lewiston, ME	427
Dover, NH	411
Concord, NH	370
Augusta, ME	360
Nashua, NH	324
Manchester, NH	309
Portland, ME	302
Bangor, ME	295
Lebanon, NH	295
Burlington, VT	223

Figure 2. Emergency room visits per 1,000 children among hospital service areas (2007-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 11. Emergency room visits per 1,000 children among hospital service areas (2007-10)

Summing up

The variation in office visit rates across areas cannot be explained solely by socioeconomic differences. The rates were adjusted for the mix of children insured with Medicaid and with commercial insurance. The patterns of visits in areas with high (and low) poverty rates were similar for both Medicaid and commercially insured children. While population differences may explain some portion of the variation, the magnitude of the differences suggests that the structure and style of health care in different locales are contributing factors.

The supply of child health physicians is one structural factor, but it only partially explains the variation. There was a weak positive relationship between the number of child health physicians per 100,000 children and office visit rates per child (Figure 3). In contrast, there was a weak inverse association between child health physicians and emergency room visit rates (Figure 4). In general, in areas with more physicians, children had more office visits and fewer emergency room visits. The weakness of the relationships may be due, in part, to misclassification of physicians in the American Medical Association Masterfile, the source of physician supply data. The Masterfile does not always categorize part-time physicians accurately, and may lag in reporting physicians entering or leaving a practice location.

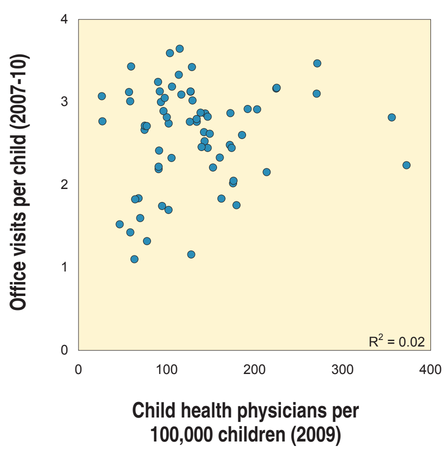


Figure 3. Relationship between the supply of child health physicians and office visit rates among hospital service areas.

For more information about the R^2 statistic, please see the section entitled "Utilization, variation, and association – how to interpret the measures."

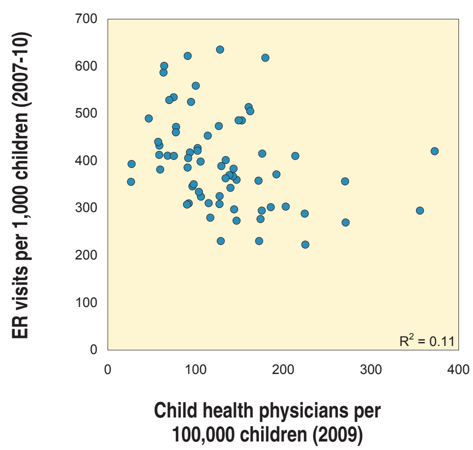


Figure 4. Relationship between the supply of child health physicians and emergency room visit rates among hospital service areas

There was a strong inverse relationship between office and emergency room visits rates (Figure 5). In HSAs with higher office visit rates, ER visit rates were much lower. This was almost entirely due to Medicaid patients. The apparent substitution of office visits for ER visits could be explained by a reduction in acute illness in areas where children receive more office care. Alternatively, in places with restricted availability of office services—particularly for children with Medicaid—families may turn to the local emergency room.

The above hypotheses encompass the principles of both effective care (i.e., more ambulatory visits leading to improved health) and supply-sensitive care (i.e., more physicians leading to more office visits, or conversely, less office availability leading to greater ER use). Understanding the causes of the patterns of ambulatory use in each community could lead to more effective and less costly health care.

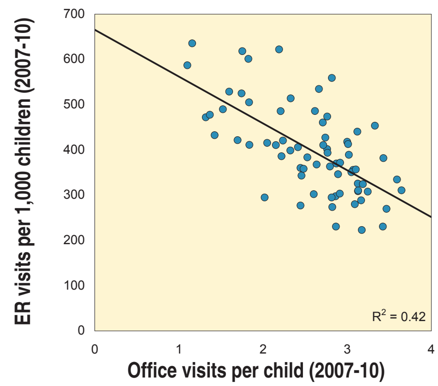


Figure 5. Relationship between office visit rates and emergency room visit rates among hospital service areas

Table 6. Ambulatory care visits in Northern New England states (2007-10)	Office visits per child	Emergency room visits per 1,000 children
Maine		
Overall	2.4	418.2
Commercially insured	2.5	246.4
Medicaid	2.3	678.7
New Hampshire		
Overall	3.0	374.3
Commercially insured	3.2	248.8
Medicaid	2.7	568.8
Vermont		
Overall	3.2	301.8
Commercially insured	3.0	201.3
Medicaid	3.4	458.5
Northern New England		
Overall	2.8	359.3
Commercially insured	2.8	225.2
Medicaid	2.7	560.0

Effective Care

Effective care refers to medical services of which the benefits far outweigh the side effects or risks of harm. Scientific advances in the past 150 years have led to the development of many well-understood diagnostic and treatment interventions proven to improve children's health and well-being. For effective care, there is agreement by clinicians and patients that the value of the medical intervention is the best of any alternative.

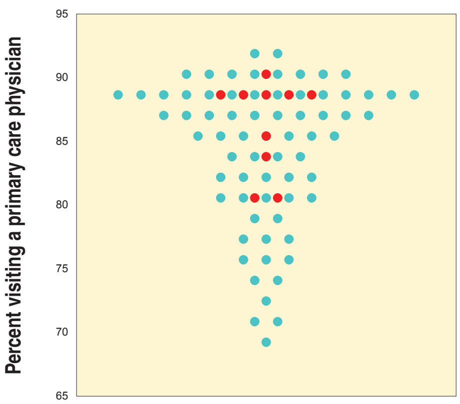
Childhood immunizations are an example of effective care. Although there are some common side effects (e.g., soreness at the injection site) and more serious side effects that occur rarely, the benefits are overwhelmingly positive. For example, pertussis (whooping cough) is a common infection in infants and children that requires hospitalization in about 50% of cases. Of those hospitalized, 1 to 2 out of 100 die of the illness. The pertussis vaccine prevents almost all cases of whooping cough, and serious reactions are estimated to occur in less than 1 per million children.[38] Clearly, the pertussis vaccine saves the lives of many infants and children every year.

Other types of effective care have less overwhelming benefit, but are still of high value in improving children's lives, with few tradeoffs. Health maintenance visits (i.e., well-child visits) are an example, as is screening for high blood lead levels in young children. For most types of effective care, the right rate is close to 100%.

This section provides the rates of pediatric effective care across the hospital service areas in Northern New England. We report measures from the Healthcare Effectiveness Data and Information Set (HEDIS) accredited by the National Committee for Quality Assurance (NCQA)[27] that can be calculated using medical claims data. We first present the variation in each individual measure across HSAs. Each map uses the same scale in order to demonstrate consistently the ranges in quality for each measure. We then present figures, called Quality Dartboards, for each HSA that summarize the overall quality of care received by the population of children residing in the area.

Access to primary care

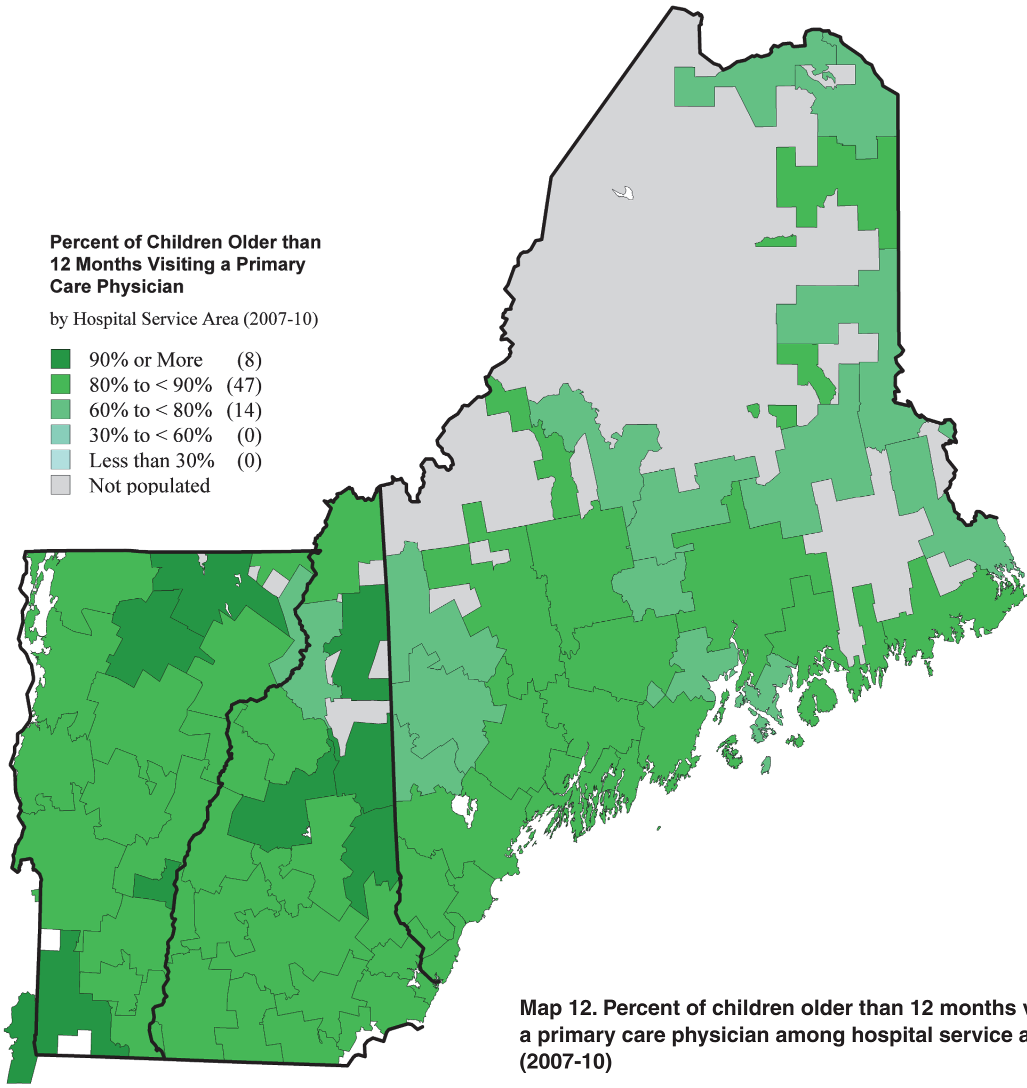
Primary care is the cornerstone of effective health care for children. This measure shows the percent of children older than 12 months who had at least one annual visit to a primary care physician during the period from 2007 to 2010. Overall, 86% of insured children in Northern New England had at least one primary care visit per year. This rate varied from less than 75% of children in several Maine hospital service areas, including Rumford (68%), Belfast (71%), and Calais (72%) to more than 90% in Berlin, New Hampshire (93%), Newport, Vermont (91%), and Bennington, Vermont (91%). Among HSAs containing children's hospitals, the rates in Lebanon, New Hampshire and Burlington, Vermont (both 89%) were somewhat higher than the rate in Portland, Maine (84%). No area had a rate below 60%.



Manchester, NH	90%
Lebanon, NH	89%
Burlington, VT	89%
Dover, NH	89%
Nashua, NH	88%
Concord, NH	88%
Augusta, ME	85%
Portland, ME	84%
Bangor, ME	80%
Lewiston, ME	80%

Figure 6. Percent of children older than 12 months visiting a primary care physician among hospital service areas (2007-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.

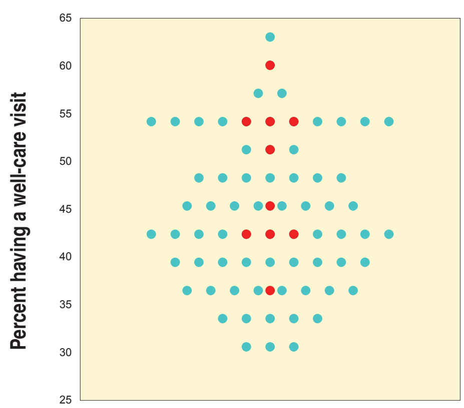


Map 12. Percent of children older than 12 months visiting a primary care physician among hospital service areas (2007-10)

Adolescent well-care visits

Well-care visits (also referred to as well-child visits or health maintenance visits) are effective for screening and for providing preventive services, such as immunizations and lifestyle counseling. This section displays well-care visits for adolescents, which tend to be the most underserved population in pediatrics. Well-child visits for children age 0 to 15 months and age 3 to 6 years are shown in the tables and are included in the Quality Dartboards.

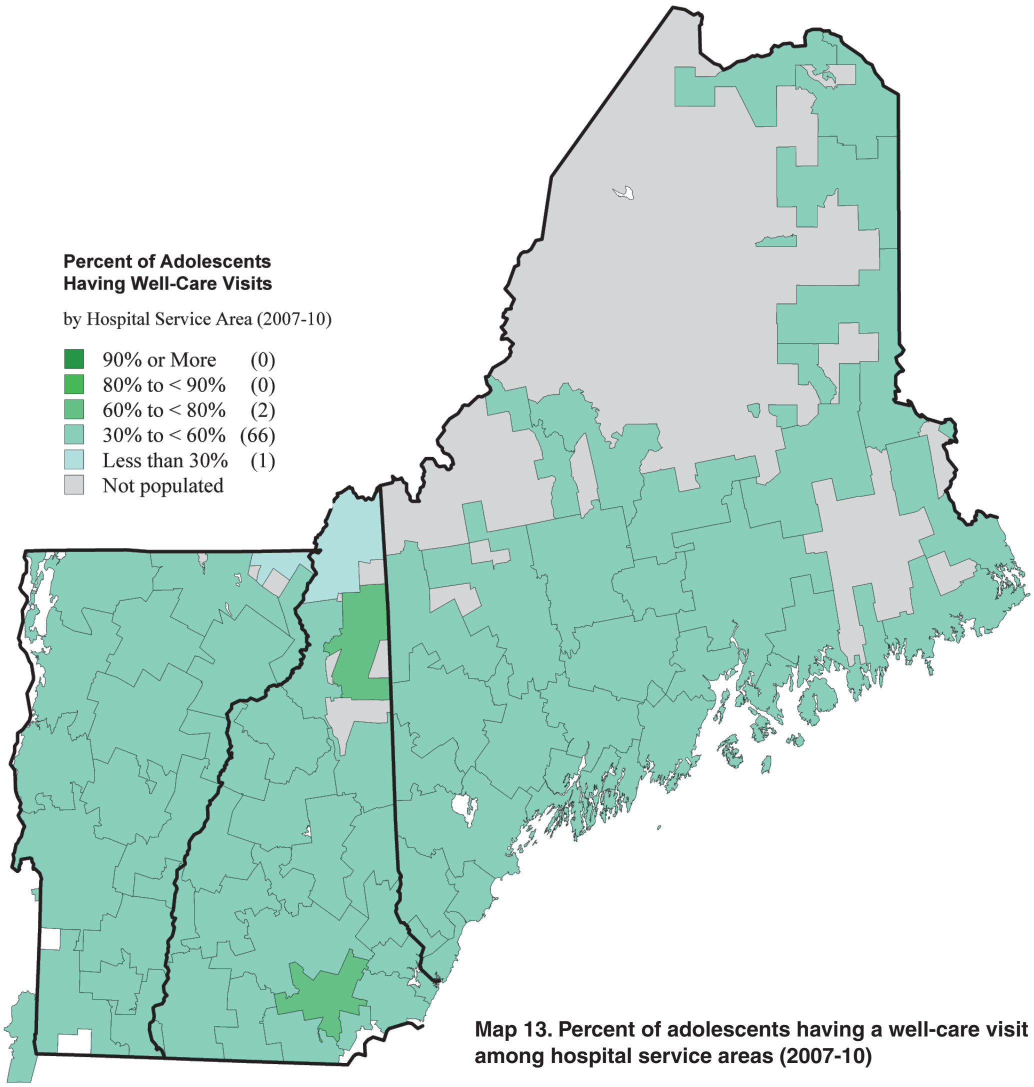
Overall, 47% of insured adolescents age 12 and over in Northern New England had an annual well-care visit during the period from 2007 to 2010. The rate varied more than twofold across hospital service areas, from about one third of adolescents in Colebrook, New Hampshire (29%), Pittsfield, Maine (32%), and Presque Isle, Maine (34%) to nearly two thirds in Berlin, New Hampshire (64%) and Manchester, New Hampshire (61%). The rate in Lebanon, New Hampshire was relatively high (55%) compared to the rates in Burlington, Vermont (46%) and Portland, Maine (44%). No area had a rate above 80%.



Manchester, NH	61%
Lebanon, NH	55%
Nashua, NH	54%
Dover, NH	54%
Concord, NH	50%
Burlington, VT	46%
Portland, ME	44%
Bangor, ME	44%
Lewiston, ME	43%
Augusta, ME	36%

Figure 7. Percent of adolescents having a well-care visit among hospital service areas (2007-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 13. Percent of adolescents having a well-care visit among hospital service areas (2007-10)

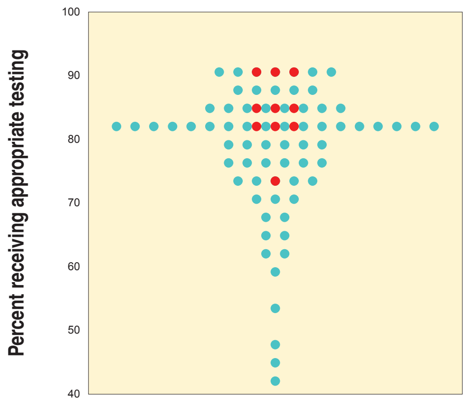
Appropriate testing

This section reports on two common types of ambulatory testing that are important for effective pediatric care: appropriate testing for pharyngitis and testing for elevated blood lead levels in those insured with Medicaid.

Appropriate testing for pharyngitis

Children with streptococcal pharyngitis should receive antibiotics. Children are commonly prescribed antibiotics when they have a viral infection or when a throat strep test has not been to done to determine whether the infection is caused by streptococcus. This measure represents the average annual percent of children diagnosed with pharyngitis and prescribed an antibiotic who had a throat strep test.

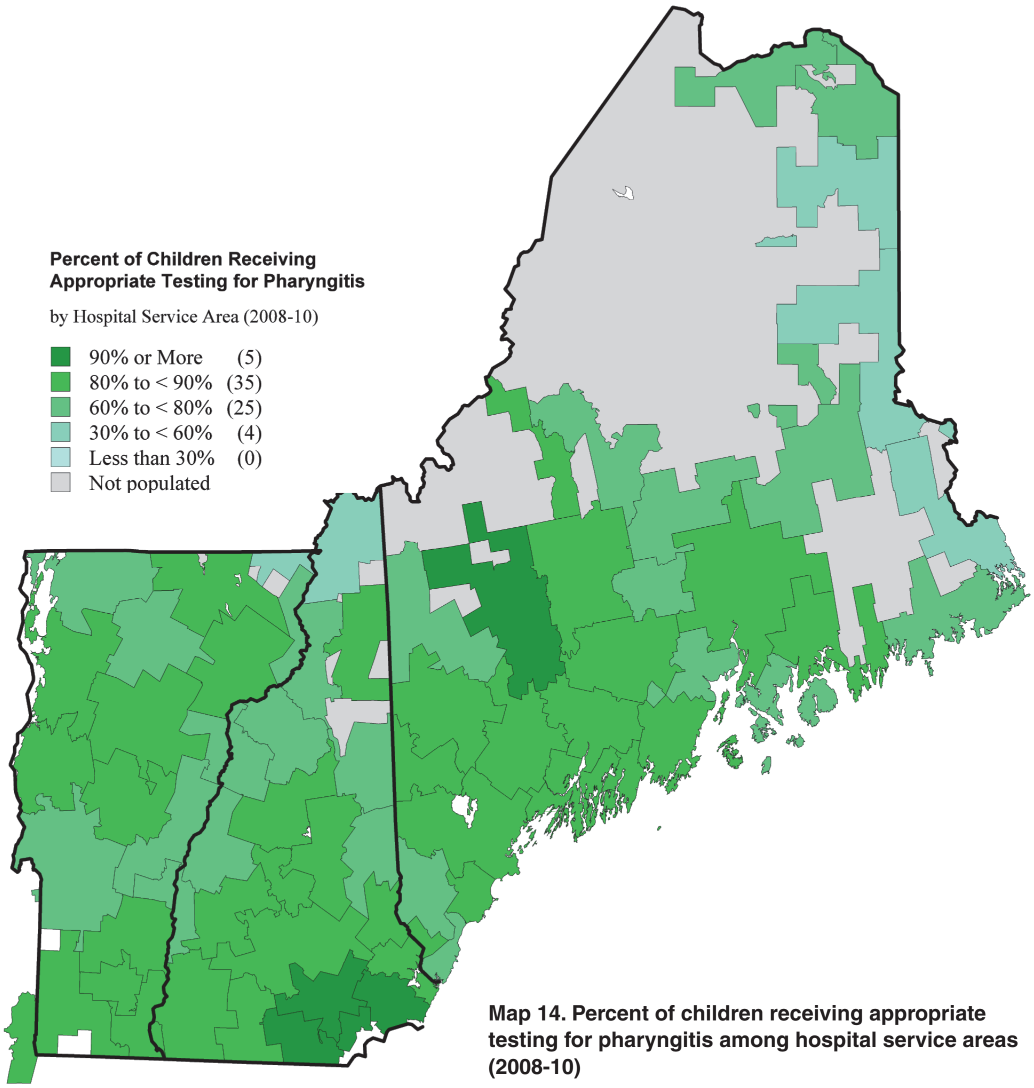
Across Northern New England, 83% of children received appropriate testing for pharyngitis. The rate varied from less than half of children in Calais, Maine (41%), Presque Isle, Maine (46%), and Houlton, Maine (47%) to more than 90% in Exeter, New Hampshire (92%) and Derry, New Hampshire (91%). The rate was also above the regional average in Burlington, Vermont (86%). In Portland, Maine (83%), the rate equaled the regional average; the rate in Lebanon, New Hampshire was well below average (72%). No area had a rate below 30%.



Nashua, NH	90%
Manchester, NH	90%
Augusta, ME	90%
Lewiston, ME	86%
Burlington, VT	86%
Concord, NH	84%
Dover, NH	83%
Portland, ME	83%
Bangor, ME	83%
Lebanon, NH	72%

Figure 8. Percent of children receiving appropriate testing for pharyngitis among hospital service areas (2008-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.

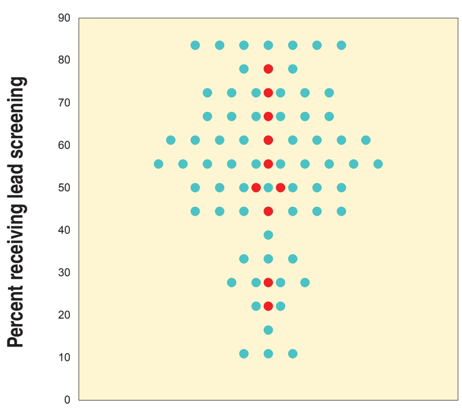


Map 14. Percent of children receiving appropriate testing for pharyngitis among hospital service areas (2008-10)

Lead screening in children under 2

Children receiving Medicaid insurance are from low-income families and are more likely to reside in poorer quality housing where they may be exposed to lead paint. This measure represents the percent of 2 year olds insured by Medicaid who had a test before their 2nd birthday to determine if their blood lead levels were high.

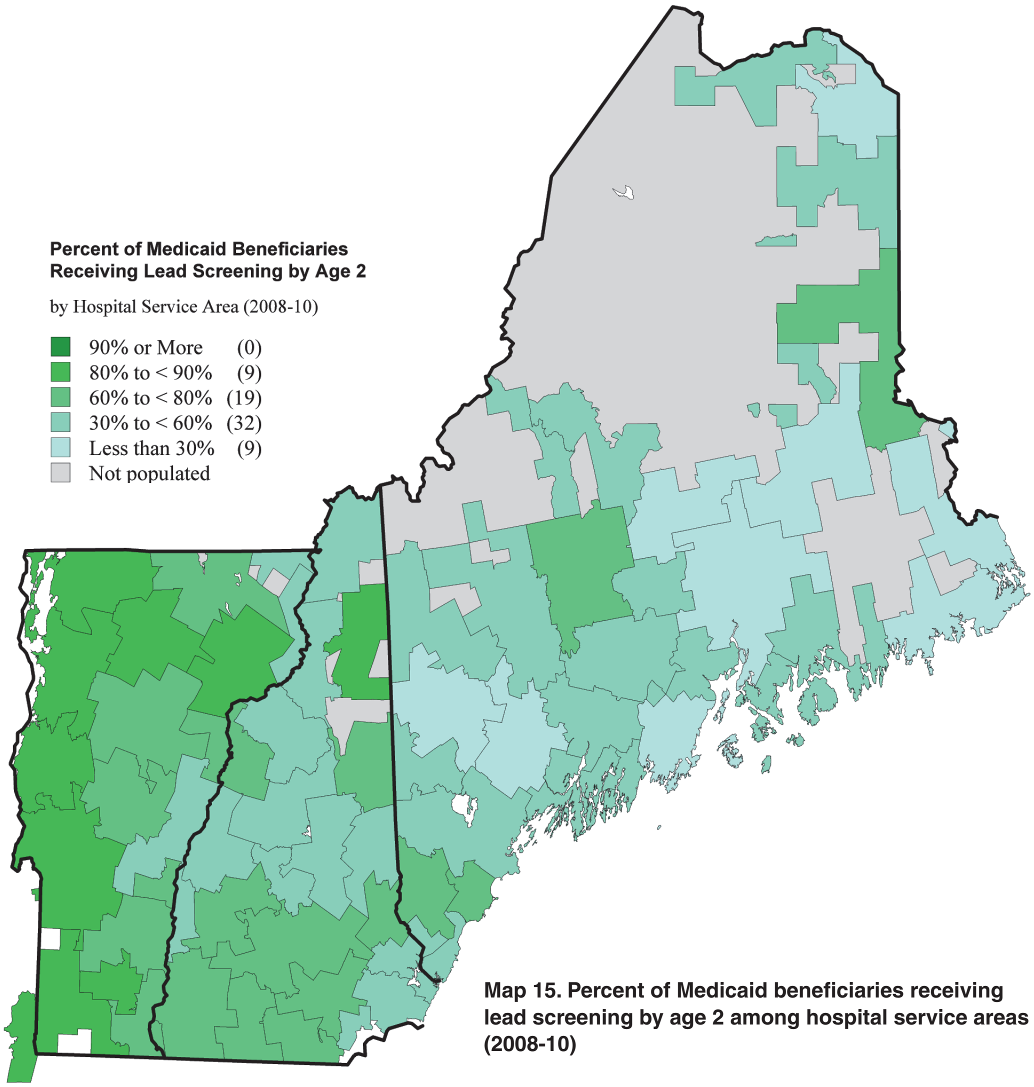
Among children insured by Medicaid in Northern New England, 59% received testing for their lead levels by age 2 during the period from 2008 to 2010. The rate of lead screening varied more than tenfold, from 8% in Dover-Foxcroft, Maine to 86% in Berlin, New Hampshire. Other areas where rates of lead screening were low included Calais, Maine (9%), Lincoln, Maine (12%), and Rockland, Maine (15%). Rates were much higher in nearly all Vermont areas, including St. Albans (84%), Rutland (81%), and Burlington (80%). The rates in Lebanon, New Hampshire (55%) and Portland, Maine (49%) were much lower than the rates in Burlington.



Burlington, VT	80%
Manchester, NH	72%
Concord, NH	65%
Nashua, NH	63%
Lebanon, NH	55%
Dover, NH	50%
Portland, ME	49%
Augusta, ME	43%
Lewiston, ME	29%
Bangor, ME	19%

Figure 9. Percent of Medicaid beneficiaries receiving lead screening by age 2 among hospital service areas (2008-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 15. Percent of Medicaid beneficiaries receiving lead screening by age 2 among hospital service areas (2008-10)

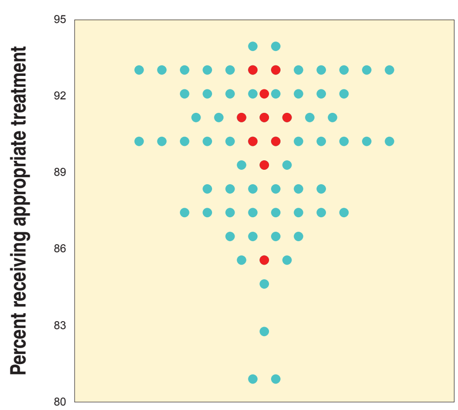
Appropriate medication use

This section reports on four measures of appropriate medication use: for upper respiratory infections, for asthma, and for initial and continuing treatment of attention deficit hyperactivity disorder (ADHD).

Appropriate treatment for children with upper respiratory infections

Almost all childhood upper respiratory infections (URIs) are caused by viruses and are not helped by antibiotics. The use of antibiotics when not needed places children at risk for drug allergies and the development of antibiotic-resistant infections. This measure reflects the percent of children annually who were determined to have simple URIs who did not receive antibiotics.

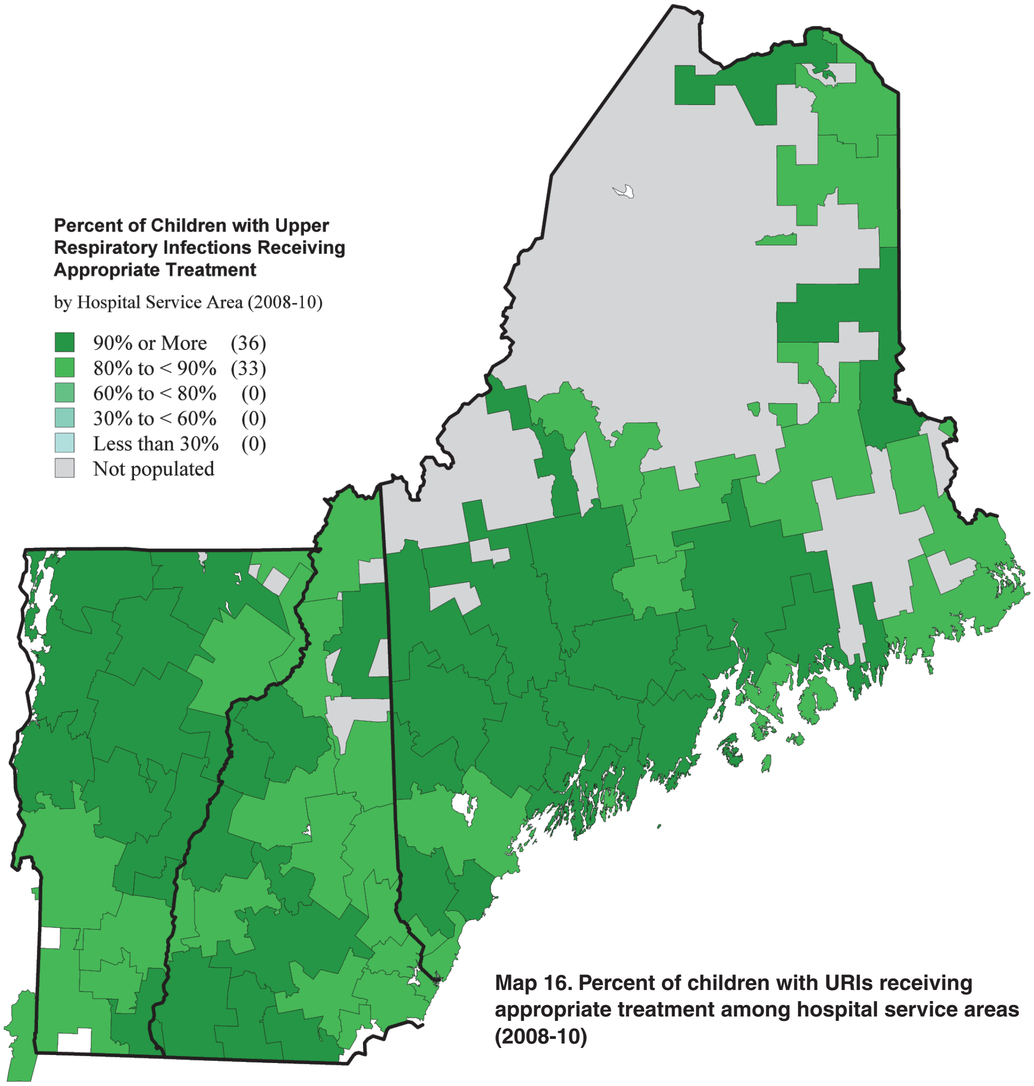
Overall, 90% of insured children in Northern New England received appropriate treatment for their upper respiratory infections during 2008-10. Rates of appropriate treatment were somewhat lower in Portsmouth, New Hampshire (80%) and Rutland, Vermont (85%) than in Brattleboro, Vermont (94%) and Waterville, Maine (93%). Rates in Burlington, Vermont and Lebanon New Hampshire (both 93%) were higher than rates in Portland, Maine (89%). No area had a rate below 80%.



Burlington, VT	93%
Lebanon, NH	93%
Lewiston, ME	92%
Bangor, ME	91%
Augusta, ME	91%
Nashua, NH	91%
Concord, NH	90%
Manchester, NH	90%
Portland, ME	89%
Dover, NH	86%

Figure 10. Percent of children with URIs receiving appropriate treatment among hospital service areas (2008-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 16. Percent of children with URIs receiving appropriate treatment among hospital service areas (2008-10)

Appropriate medication for children with asthma

Asthma is a common chronic respiratory condition that affects 9.5% of children.[39] About 1 in 3 children with asthma has a more severe type called "persistent" asthma. These children should be treated with a controller medication (e.g., inhaled corticosteroid, leukotriene receptor antagonist) to reduce symptoms, improve exercise tolerance, and decrease the chances of hospitalization. This measure represents the percent of children age 5-17 years with persistent asthma who received at least one prescription for a controller medication during 2008-10.

Ninety-three percent of insured children with asthma in Northern New England received appropriate medications annually during 2008-10. No area had a rate below 80%. The percent of children with asthma receiving appropriate medication ranged from 83% in Portsmouth, New Hampshire to 100% in Boothbay Harbor, Maine and Millinocket, Maine. The rates in the three HSAs containing children's hospitals were high: Burlington, Vermont (97%), Portland, Maine (96%), and Lebanon, New Hampshire (95%).

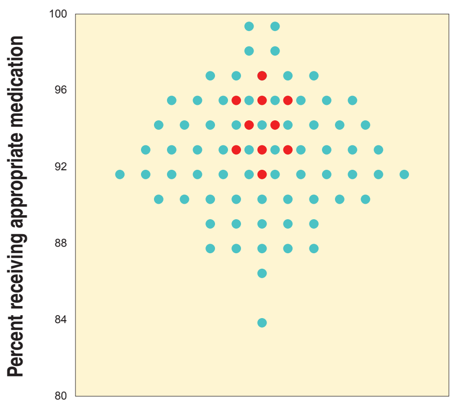
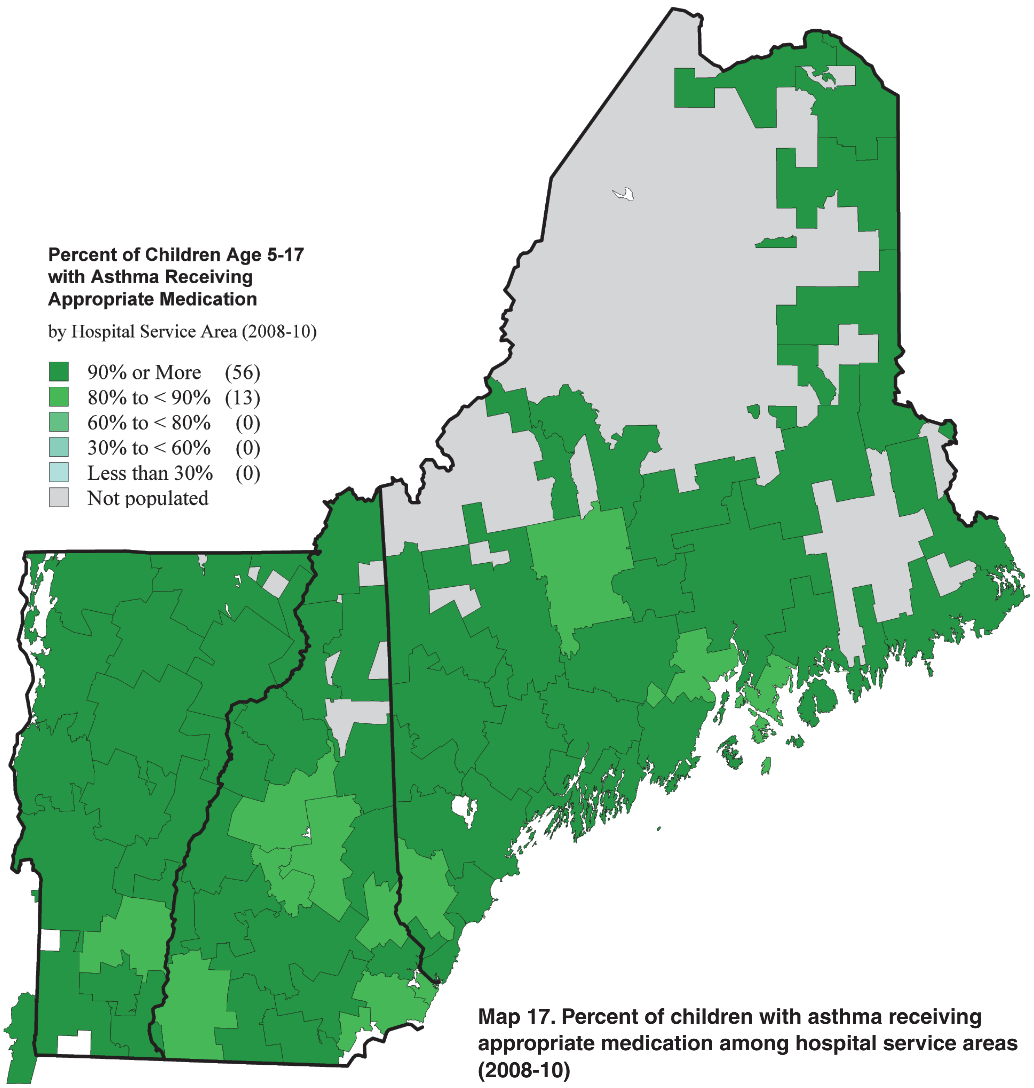


Figure 11. Percent of children with asthma receiving appropriate medication among hospital service areas (2008-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.

Burlington, VT	97%
Portland, ME	96%
Dover, NH	96%
Augusta, ME	95%
Lebanon, NH	95%
Lewiston, ME	95%
Bangor, ME	93%
Nashua, NH	93%
Concord, NH	93%
Manchester, NH	92%



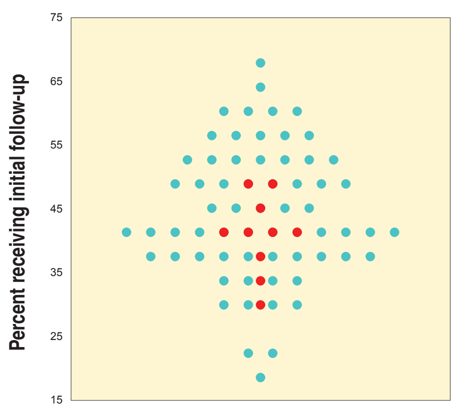
Map 17. Percent of children with asthma receiving appropriate medication among hospital service areas (2008-10)

Follow up care for children prescribed ADHD medication

One effective treatment for children with attention deficit hyperactivity disorder is the use of stimulant medication. Children with ADHD have a chronic condition and need ongoing medical supervision that is often lacking. The first measure shows the percent of children with an initial prescription for ADHD medication who had an office visit within 30 days; the second measure shows the percent who had an initial follow-up visit and two additional visits in the next period of 31 to 300 days.

Initiation phase

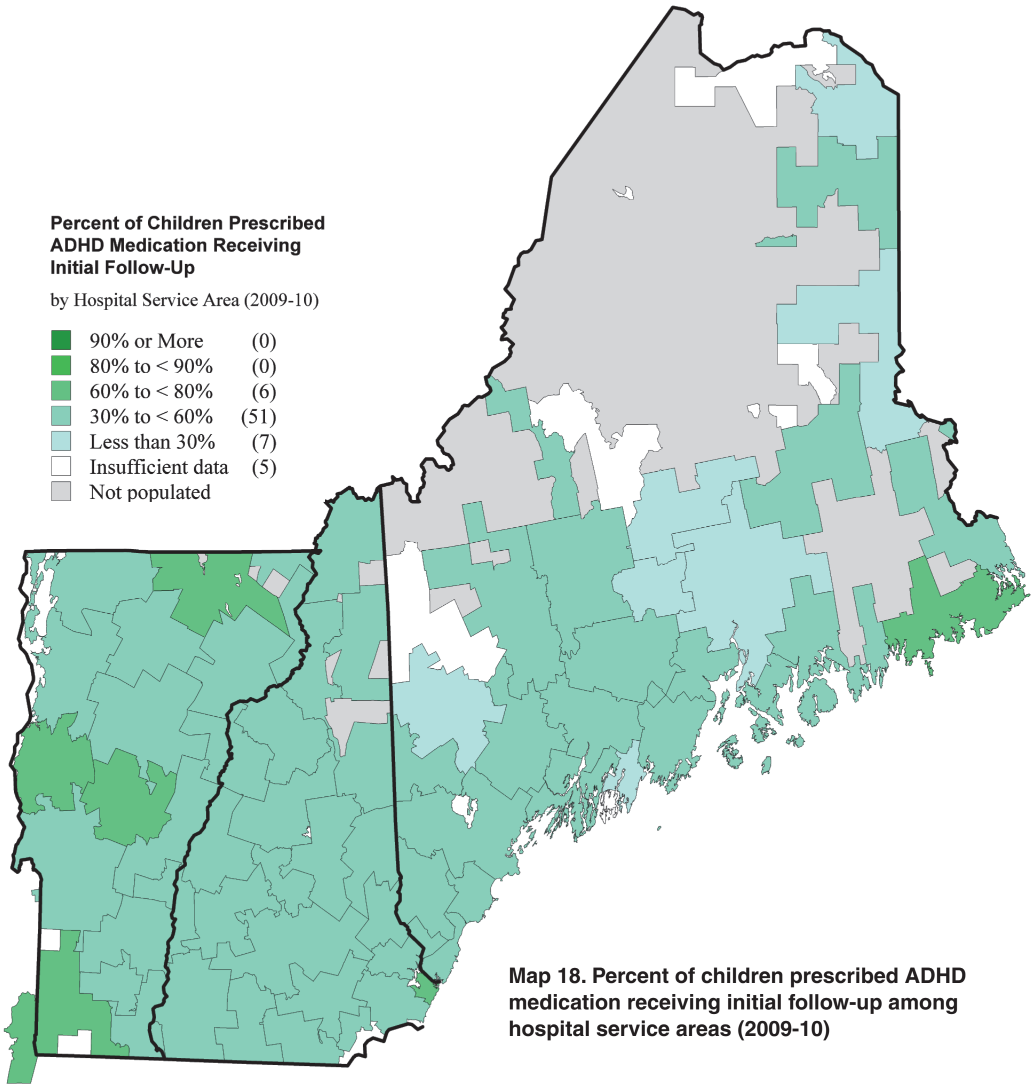
Across Northern New England hospital service areas, 43% of children prescribed ADHD medication had a follow-up visit within 30 days of the initial prescription. This rate varied from less than 25% of children in Pittsfield, Maine (17%), Dover-Foxcroft, Maine (21%), and Houlton, Maine (22%) to more than 60% of children in Newport, Vermont (70%), Portsmouth, New Hampshire (63%), and Middlebury, Vermont (62%). No area had a rate above 80%. Among the HSAs containing children's hospitals, the rates ranged from 37% in Portland, Maine to 51% in Lebanon, New Hampshire. The rate in Burlington, Vermont was 48%.



Lebanon, NH	51%
Burlington, VT	48%
Augusta, ME	46%
Dover, NH	43%
Manchester, NH	41%
Concord, NH	41%
Nashua, NH	40%
Portland, ME	37%
Lewiston, ME	35%
Bangor, ME	30%

Figure 12. Percent of children prescribed ADHD medication receiving initial follow-up among hospital service areas (2009-10)

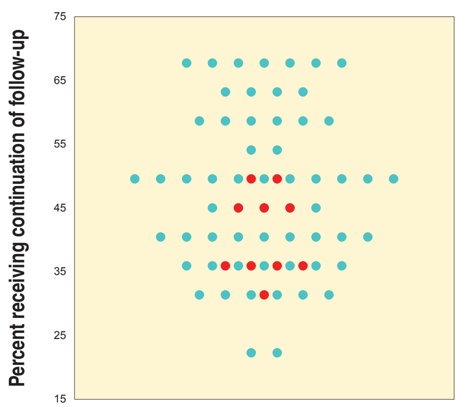
Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 18. Percent of children prescribed ADHD medication receiving initial follow-up among hospital service areas (2009-10)

Continuation and maintenance phase

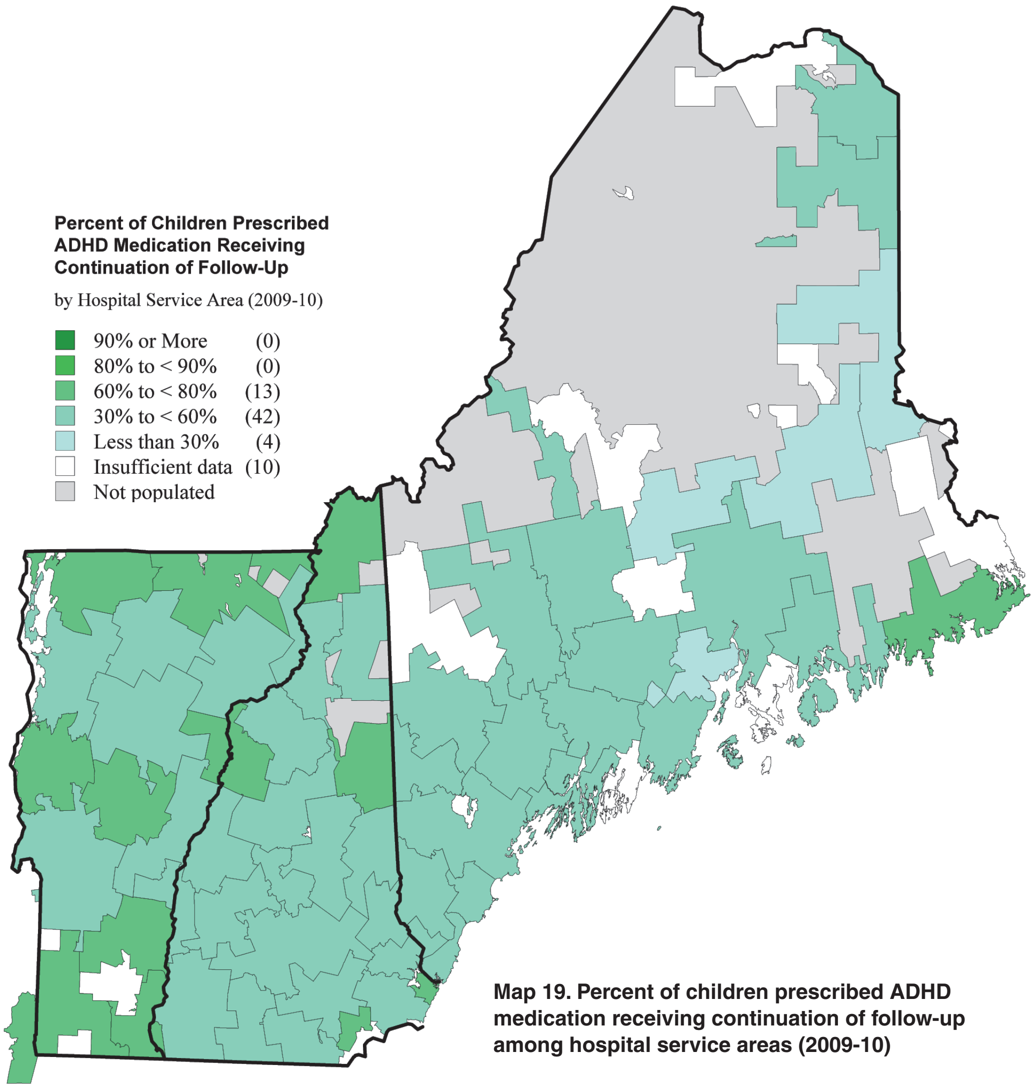
Overall, 45% of children who were prescribed ADHD medication received two additional follow-up office visits in the 31 to 300 days following the initiation of medication. Less than 35% of children received continuing follow-up in Belfast, Maine (30%), Laconia, New Hampshire (31%), and Bangor, Maine (34%). The rate was more than twice as high in Colebrook, New Hampshire, where 70% of children received continuing follow-up visits. Rates were also relatively high in Newport, Vermont (69%) and Machias, Maine (68%). Fifty percent of children in Burlington, Vermont received continuing follow-up visits, as did 45% of children in Lebanon, New Hampshire and 38% of children in Portland, Maine. No area had a rate above 80%.



Burlington, VT	50%
Augusta, ME	48%
Lebanon, NH	45%
Manchester, NH	44%
Dover, NH	43%
Nashua, NH	38%
Portland, ME	38%
Lewiston, ME	37%
Concord, NH	36%
Bangor, ME	34%

Figure 13. Percent of children prescribed ADHD medication receiving continuation of follow-up among hospital service areas (2009-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 19. Percent of children prescribed ADHD medication receiving continuation of follow-up among hospital service areas (2009-10)

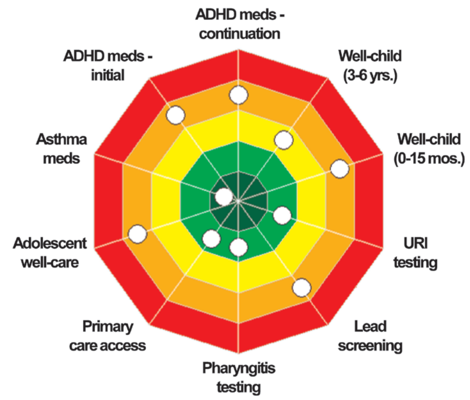
Quality Dartboards

The Quality Dartboards were developed by the Management and Health Laboratory at the Management Institute, Scuola Superiore Sant'Anna, Pisa, Italy. The Quality Dartboard shows the performance of each hospital service area's health care providers on the pediatric effective care measures in the Healthcare Effectiveness Data and Information Set (HEDIS). The closer the dot is to the center "target," the better the area's providers performed. The 12 HSAs with the largest populations and those with children's hospitals are shown here; Quality Dartboards for the other Northern New England HSAs may be found in the Appendices.

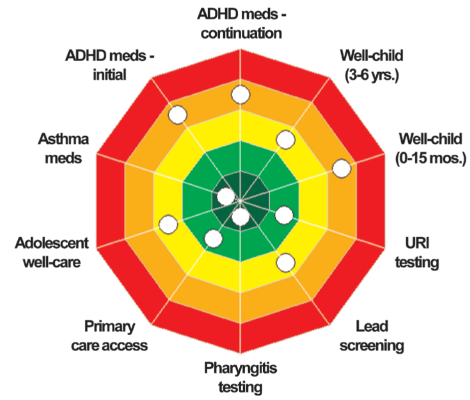
The measures are labeled as follows:

Well-child (3-6 yrs.)	Percent of children age 3-6 having well-care visits
Well-child (0-15 mos.)	Percent of children having at least 6 well-care visits in the first 15 months of life
URI testing	Percent of children with URIs receiving appropriate treatment
Lead screening	Percent of Medicaid beneficiaries receiving lead screening by age 2
Pharyngitis testing	Percent of children receiving appropriate testing for pharyngitis
Primary care access	Percent of children older than 12 months visiting a primary care physician
Adol. well-care	Percent of adolescents having well-care visits
Asthma meds	Percent of children age 5-17 with asthma receiving appropriate medication
ADHD meds – initial	Percent of children prescribed ADHD medication receiving initial follow-up
ADHD meds – continuation	Percent of children prescribed ADHD medication receiving continuation of follow-up

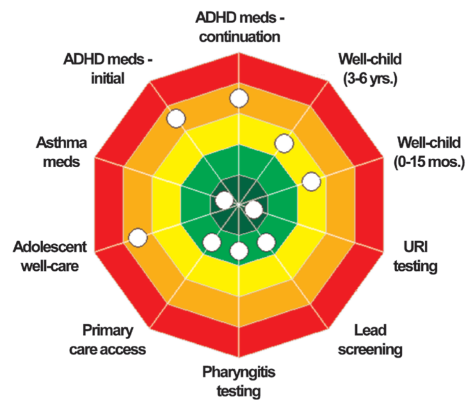
Portland, ME



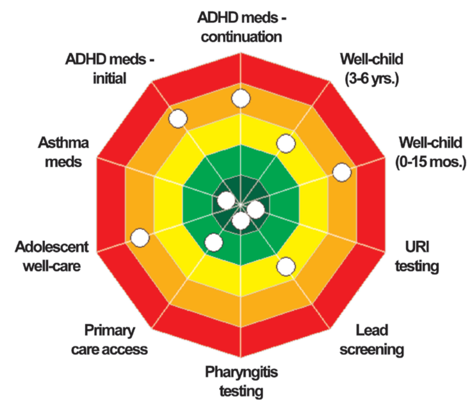
Manchester, NH



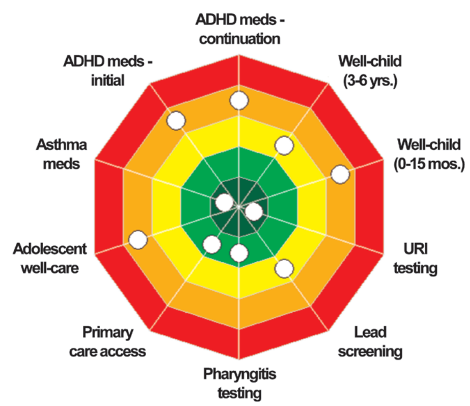
Burlington, VT



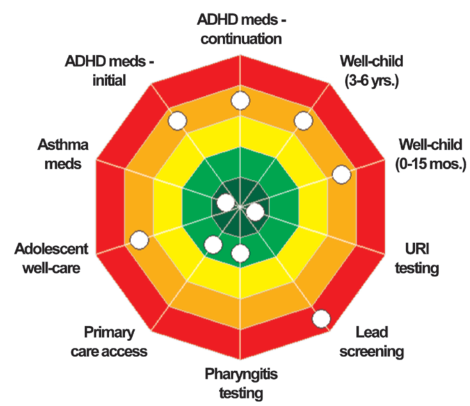
Nashua, NH



Concord, NH



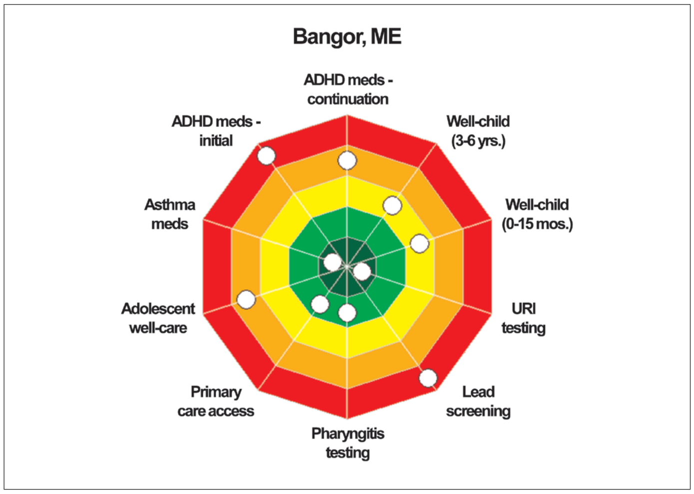
Lewiston, ME

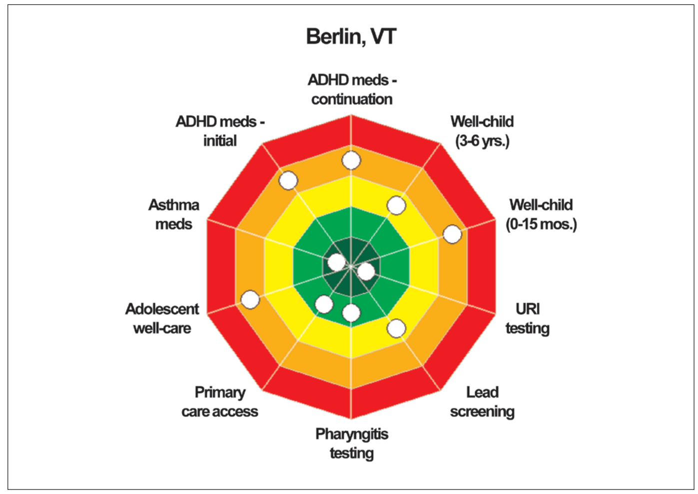


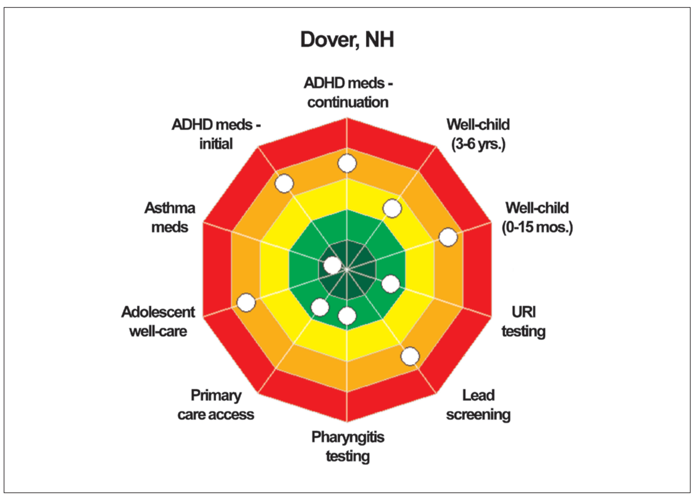
Percent of appropriate patients receiving service

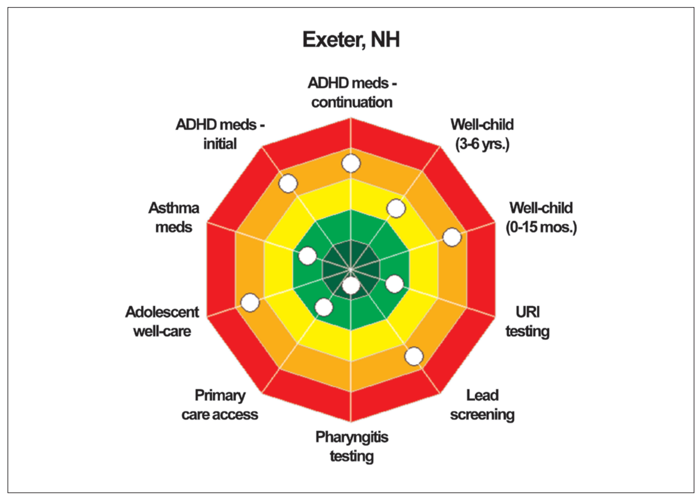
- 90-100%
- 80-90%
- 60-80%
- 30-60%
- 0-30%

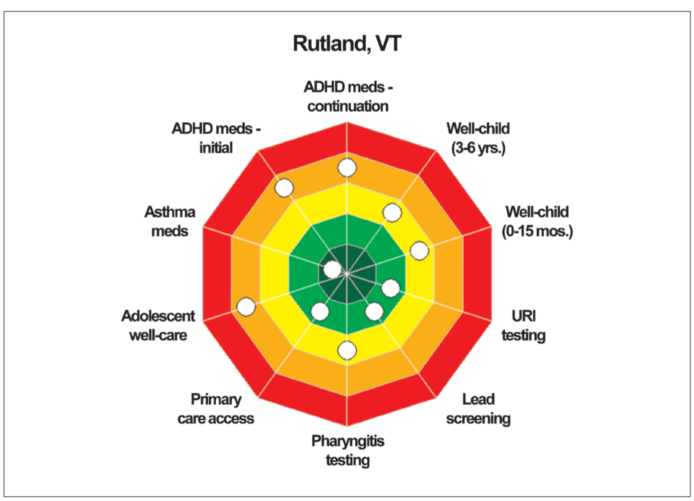
The dartboard shows the performance of each hospital service area's health care providers on recommended measures in the Healthcare Effectiveness Data and Information Set (HEDIS). The closer the dot is to the center, the better the area's providers performed.

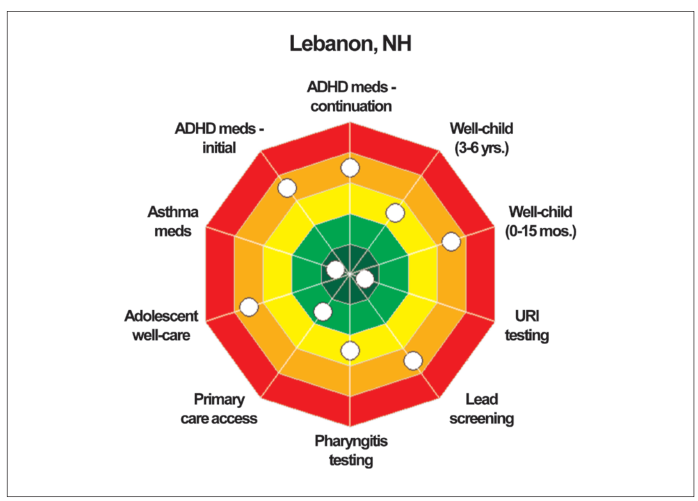












The dartboard graphs were powered thanks to a collaboration with Management and Health Laboratory, Management Institute, Scuola Superiore Sant'Anna, Pisa. http://www.meslab.sssup.it/en/

Summing up

According to the NCQA measures, the rates of effective care are relatively high in Northern New England hospital service areas, with the exception of well-care visits and follow-up after prescription of ADHD medications. The pattern of effective care is not uniform; some HSAs have relatively high rates for all measures, and others need to improve the quality care of care in several areas.

It should be noted that these NCQA measures fail to capture many important aspects of effective pediatric care. Many types of effective care cannot be measured with administrative claims data, and in other instances, the NCQA metric falls short of more important but harder to achieve standards. For example, persistent asthma does not require only one controller prescription fill to improve a child's health, but continual treatment for many months or years.

For most of these effective measures, areas with high poverty had lower measures of quality (Table 7). This was generally true for both the Medicaid and commercially insured. The relative supply of child health physicians was not strongly associated with higher levels of effective care. It is notable that there was a consistent relationship between more office visits to child health physicians and effective care; more ambulatory care appears to be associated with more effective care. This beneficial care may or may not be associated with overuse. However, measurement of ambulatory care overuse is beyond the scope of this report.

Table 7. Correlations (r values) between measures of effective care and hospital service area characteristics

	HSA poverty rate	HSA child health physician supply	HSA office visit rates
Primary care access	-0.62	0.29	0.77
Well-child visits (0-15 mos.)	-0.22	0.06	0.32
Well-child visits (3-6 yrs.)	-0.61	0.12	0.54
Adolescent well-care	-0.58	0.20	0.51
Pharyngitis testing	-0.42	0.04	0.53
Lead screening	-0.43	0.15	0.60
URI treatment	-0.04	0.26	0.07
Asthma medications	-0.02	0.20	0.02
ADHD meds – initial	-0.18	0.33	0.37
ADHD meds – continuation	-0.48	0.13	0.66

For more information about the r value, please see the section entitled "Utilization, variation, and association – how to interpret the measures."

Table 8. Effective care measures in Northern New England states

	Percent of children older than 12 months visiting a primary care physician (2007-10)	Percent of children having at least 6 well-care visits in the first 15 months of life (2009-10)	Percent of children age 3-6 having well-care visits (2007-10)	Percent of adolescents having well-care visits (2007-10)	Percent of children receiving appropriate testing for pharyngitis (2008-10)	Percent of Medicaid beneficiaries receiving lead screening by age 2 (2008-10)	Percent of children with URIs receiving appropriate treatment (2008-10)	Percent of children age 5-17 with asthma receiving appropriate medication (2008-10)	Percent of children prescribed ADHD medication receiving initial follow-up (2009-10)	Percent of children prescribed ADHD medication receiving continuation of follow-up (2009-10)
Maine										
Overall	81%	52%	60%	41%	82%	n/a	91%	94%	37%	38%
Commercially insured	83%	52%	64%	43%	82%	n/a	91%	95%	40%	41%
Medicaid	79%	51%	54%	37%	82%	41%	90%	92%	34%	36%
New Hampshire										
Overall	88%	57%	73%	53%	85%	n/a	89%	92%	44%	44%
Commercially insured	88%	54%	77%	55%	87%	n/a	89%	94%	37%	39%
Medicaid	89%	60%	68%	50%	83%	61%	89%	91%	47%	46%
Vermont										
Overall	89%	69%	68%	46%	82%	n/a	91%	94%	54%	57%
Commercially insured	86%	73%	69%	46%	83%	n/a	91%	95%	36%	36%
Medicaid	91%	66%	67%	46%	81%	79%	91%	93%	65%	67%
Northern New England										
Overall	86%	58%	67%	47%	83%	n/a	90%	93%	43%	45%
Commercially insured	86%	57%	70%	48%	84%	n/a	91%	95%	38%	39%
Medicaid	86%	59%	62%	44%	82%	59%	90%	92%	47%	48%

Hospitalization

It is unusual for an infant or child to be hospitalized after the newborn period. In the past two decades, hospitalization rates have decreased substantially, while the complexity has risen for pediatric inpatients.[40] Hospitalizations are often necessary to diagnose and treat acute and chronic pediatric conditions that range from acute asthma to mental illness to cancer. However, hospitals can also be uncomfortable and frightening to children, and they have their own health hazards, such as hospital-acquired infections and medication errors.[41] Hospital care is also very expensive. Judicious use of inpatient care can improve children's health and save lives, but excessive stays in the hospital can be traumatic and unsafe for children and waste health care dollars.

Considering the value of and need for judicious use of pediatric hospital care, the magnitude of variation in hospitalization rates is remarkable. This is not a new observation; it was reported in several papers in the 1980s and 1990s.[19,42-46] There has been relatively little scrutiny in recent years and even less research on the causes and consequences of the variation.[7]

Three reasons are usually offered for variation in hospitalization rates for children. The first is that the rates reflect differences in health status and/or socioeconomic circumstances.[47,48] Children who come from poor or less educated families are more likely to be hospitalized, although regional variation in hospitalization rates occurs irrespective of families' economic circumstances. The second is that hospitalization rates reflect the availability and quality of ambulatory care.[47,48] Good primary care can help keep children well and can often offer outpatient treatment as an alternative to hospital care, particularly for less severe illness. While this is true, it is not clear whether higher pediatric hospitalization rates reflect lower use of primary care services or poorer ambulatory care quality. Finally, there is some evidence that higher hospitalization rates are associated with higher availability of hospital beds for children in an area, and that this leads to a lower threshold for admission.[19] This concept is better established in the Medicare[49] than in the pediatric population, where much less research has been conducted.

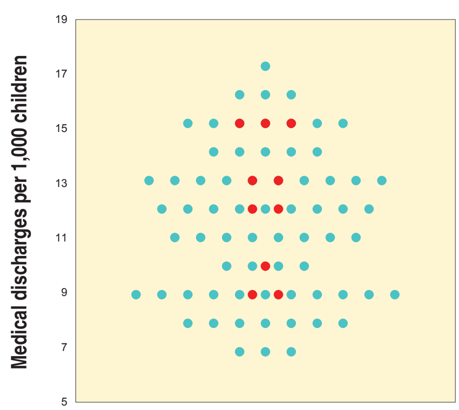
Medical discharges

Table 9. Top 20 medical hospitalization diagnoses		
Diagnosis*	Percent of discharges	Cumula-tive percent
Pneumonia	9.0	9.0
Acute bronchitis	7.4	16.4
Asthma	6.1	22.4
Epilepsy; convulsions	4.7	27.1
Fluid and electrolyte disorders	4.6	31.7
Maintenance chemotherapy; radiotherapy	3.3	35.0
Skin and subcutaneous tissue infections	3.1	38.0
Urinary tract infections	2.7	40.7
Other upper respiratory infections	2.6	43.3
Intestinal infection	2.2	45.5
Viral infection	2.0	47.6
Diabetes mellitus with complications	2.0	49.6
Poisoning by other medications and drugs	1.6	51.1
Other perinatal conditions	1.5	52.6
Cystic fibrosis	1.5	54.1
Intracranial injury	1.4	55.5
Other nutritional; endocrine; and metabolic disorders	1.4	56.9
Complications of surgical procedures or medical care	1.4	58.3
Other gastrointestinal disorders	1.3	59.6
Fever of unknown origin	1.2	60.9

* Clinical Classification System (AHRQ)

Medical discharges include hospitalization for a wide variety of non-surgical causes, reflecting both acute illness and chronic conditions. In Northern New England, the most common medical causes of children's hospitalization (excluding mental health) are pneumonia, acute bronchitis, asthma, convulsions, and fluid and electrolyte disorders (Table 9). Some of these patients are otherwise healthy, while many others have underlying cardiopulmonary or neurologic disorders.

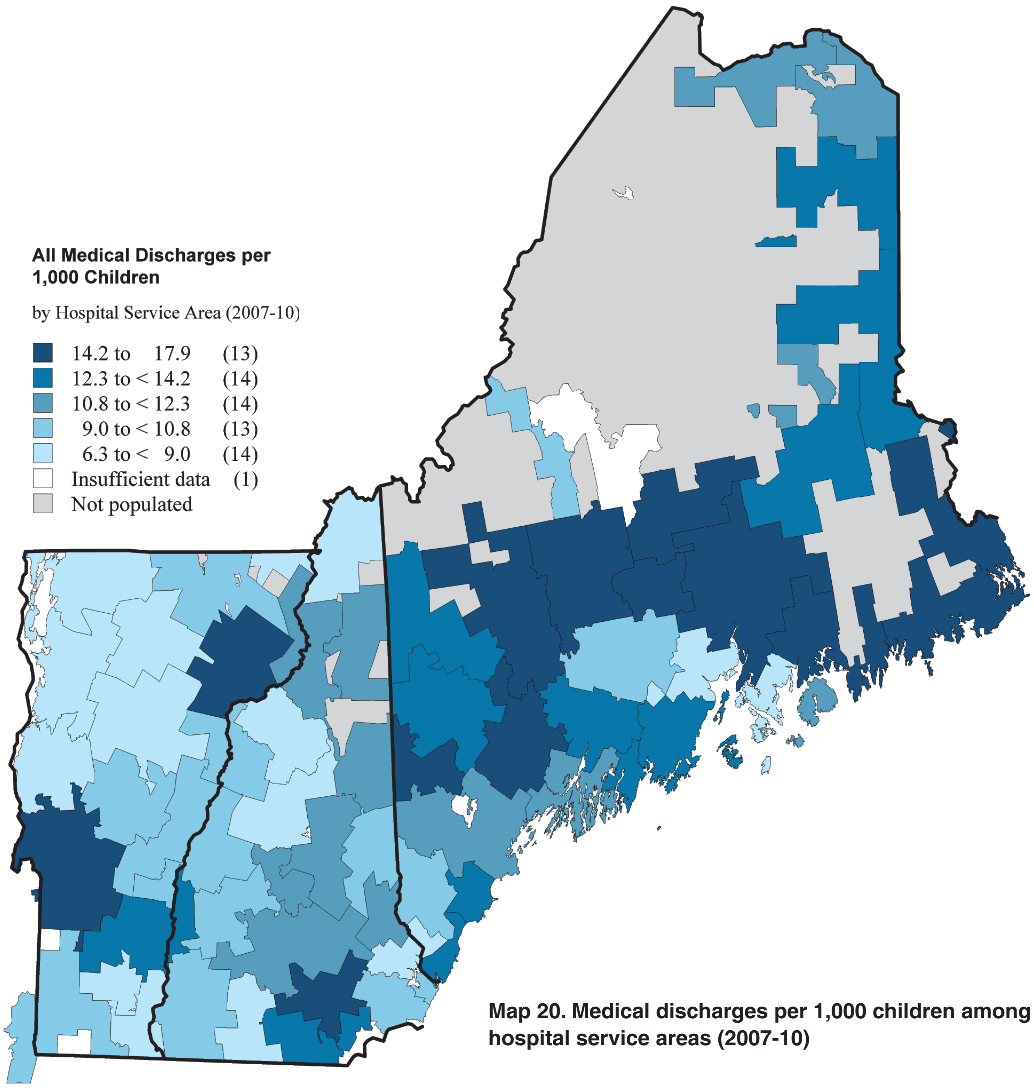
Overall, there were 11.7 medical discharges annually per 1,000 insured children living in Northern New England during 2007-10. The discharge rate varied more than twofold, from fewer than 8 discharges per 1,000 children in Brattleboro, Vermont (6.3), St. Albans, Vermont (7.1), and Peterborough, New Hampshire (7.3) to more than 16 per 1,000 in Pittsfield, Maine (17.8) and Farmington, Maine (16.7). Among the hospital service areas containing large hospitals, medical discharge rates were much lower in Burlington, Vermont (8.7) and Dover, New Hampshire (8.8) than in Manchester, New Hampshire (15.1) and Lewiston, Maine (14.7).



Manchester, NH	15.1
Lewiston, ME	14.7
Bangor, ME	14.7
Nashua, NH	12.7
Augusta, ME	12.6
Concord, NH	11.9
Portland, ME	11.7
Lebanon, NH	9.9
Dover, NH	8.8
Burlington, VT	8.7

Figure 14. Medical discharges per 1,000 children among hospital service areas (2007-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 20. Medical discharges per 1,000 children among hospital service areas (2007-10)

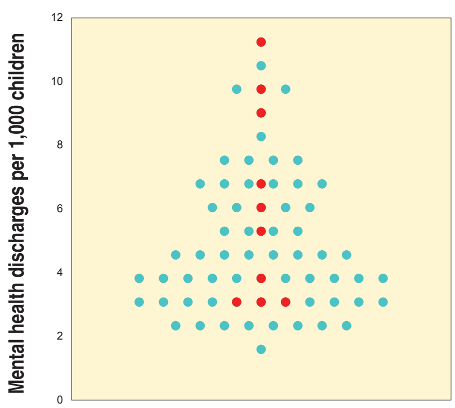
Table 10. Top 15 mental health diagnoses		
Diagnosis*	Percent of discharges	Cumulative percent
Mood disorders	62.4	62.4
Attention-deficit, conduct, and disruptive behavior disorders	10.8	73.2
Anxiety disorders	8.1	81.3
Misc. disorders usually diagnosed in childhood	5.3	86.6
Schizophrenia and other psychotic disorders	3.5	90.1
Adjustment disorders	3.2	93.3
Substance-related disorders	2.4	95.7
Miscellaneous disorders	2.1	97.8
Alcohol-related disorders	0.8	98.6
Impulse control disorders, NEC	0.6	99.1
Personality disorders	0.2	99.4
Delirium, dementia, and amnestic and other cognitive disorders	0.2	99.6
Screening and history of mental health and substance abuse codes	0.2	99.8
Developmental disorders	0.2	99.9
Suicide and intentional self-inflicted injury	0.1	100.0

* Clinical Classification System (AHRQ)

Mental health discharges

Hospitalizations for mental illness are relatively common, occurring in almost 1 in 200 patients under age 17 each year. The most common diagnoses associated with these admissions are mood disorders, attention-deficit, conduct, and disruptive behavior disorders, anxiety disorders, miscellaneous disorders usually diagnosed in childhood, and schizophrenia and other psychotic disorders (Table 10).

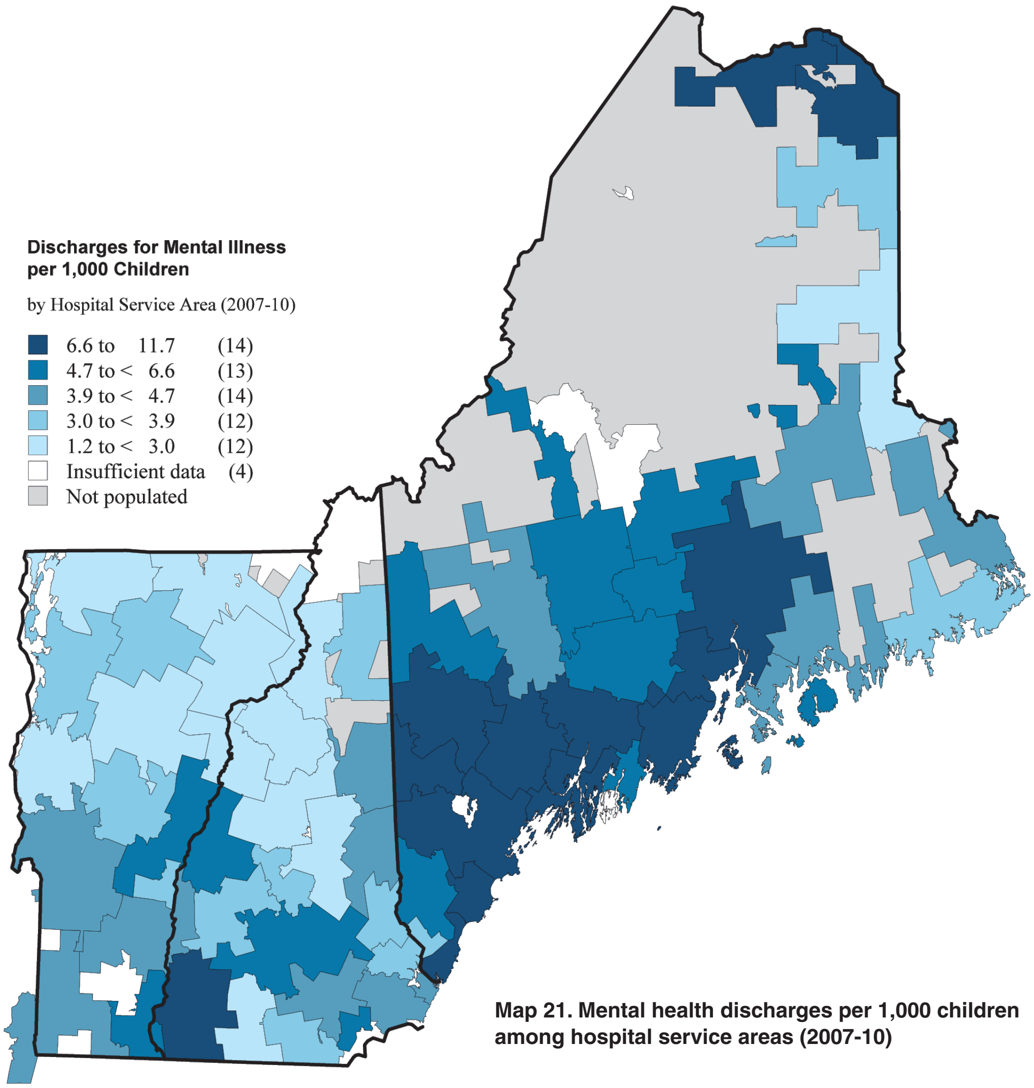
Among insured children living in Northern New England hospital service areas, the overall mental health discharge rate was 5.2 per 1,000 per year. The rate varied more than fourfold, from fewer than 2.5 per 1,000 children in several Vermont HSAs, including Newport (1.2), St. Johnsbury (2.0), and Berlin (2.4), to at least 10 per 1,000 in the Maine HSAs of Lewiston (11.6), Caribou (10.4), Fort Kent (10.1), and Augusta (10.0). Rates were generally lower than average in the New Hampshire HSAs containing large hospitals, including Dover (3.4), Nashua (3.4), and Manchester (4.1).



Lewiston, ME	11.6
Augusta, ME	10.0
Bangor, ME	9.2
Portland, ME	6.9
Concord, NH	6.2
Lebanon, NH	4.9
Manchester, NH	4.1
Nashua, NH	3.4
Burlington, VT	3.4
Dover, NH	3.4

Figure 15. Mental health discharges per 1,000 children among hospital service areas (2007-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 21. Mental health discharges per 1,000 children among hospital service areas (2007-10)

Summing up

The use of hospitals varied markedly across Northern New England hospital service areas. It is unlikely that most of this variation can be explained by population differences, for three reasons. First, these rates were adjusted for differences in age, sex, and insurance type among the children; having Medicaid is a good indication of lower socioeconomic status and higher health risk. Second, the regions that had higher discharge rates for commercially insured children were also often the regions with higher discharge rates for those with Medicaid (Figures 16 and 17). Finally, only about 22% of the variation in medical discharge rates was explained by the child poverty rate (Figure 18).

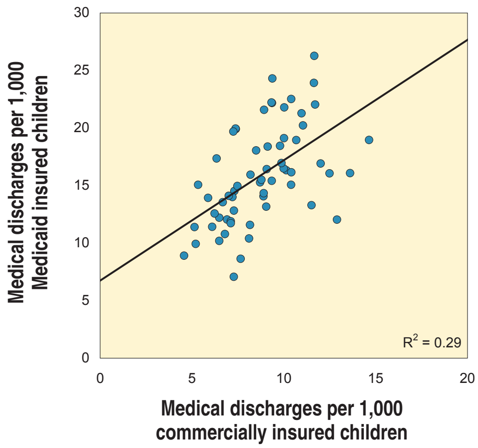


Figure 16. Relationship between medical discharges among children with commercial insurance and Medicaid among hospital service areas (2007-10)

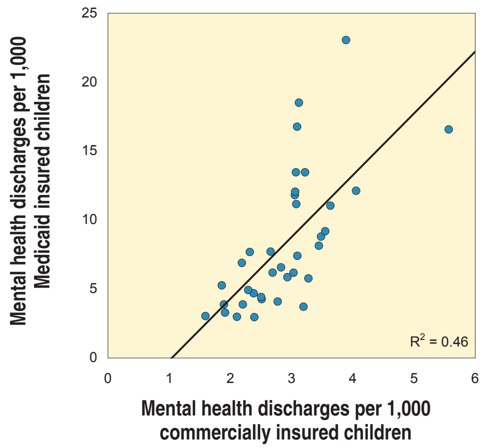


Figure 17. Relationship between mental health discharges among children with commercial insurance and Medicaid among hospital service areas (2007-10)

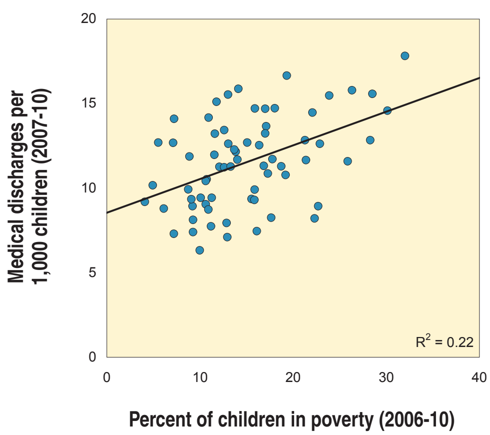


Figure 18. Relationship between poverty rates and medical discharges among hospital service areas

While population health status may not explain the different medical discharge rates, neither does the frequency of office visits. Areas with higher office visit rates did not have lower rates of hospitalization. This suggests that the availability of office-based care does not reduce hospitalization rates in the region. Because data is not available for the bed supply available specifically for pediatric hospitalizations, this report cannot examine the association between hospital bed capacity (bed supply) and hospital use.

Table 11. Hospital discharges in Northern New England states (2007-10)

	All medical discharges per 1,000 children	Mental health discharges per 1,000 children
Maine		
Overall	13.0	7.5
Commercially insured	9.0	3.5
Medicaid	18.9	13.6
New Hampshire		
Overall	11.6	4.1
Commercially insured	8.9	2.7
Medicaid	15.7	6.3
Vermont		
Overall	9.8	3.2
Commercially insured	6.9	2.4
Medicaid	14.0	4.6
Northern New England		
Overall	11.7	5.2
Commercially insured	8.6	2.9
Medicaid	16.5	8.6

Tables containing data for all Northern New England HSAs may be found in the Appendices.

Common Surgical Procedures

The most common surgical procedures of childhood (not including circumcision) are those related to the ear, nose, and throat: tonsillectomies, adenoidectomies, and tympanostomy tube placement, all usually performed by otolaryngologists (i.e., ENT doctors). The next most common surgical procedure is appendectomy, but the rate of this procedure is only one fifth of the rate of tonsillectomy and will not be presented in this report.

These procedures share some common features. They rarely need to be performed for emergent or urgent reasons. There are alternatives to surgery for the illnesses treated by the procedures, including watchful waiting. All of the procedures have been topics of debate in the pediatric and surgical community regarding their indications, benefits, and risks. Finally, studies on their efficacy and effectiveness are incomplete, with many procedures performed for indications or age ranges which have not been systematically studied. Given these shared characteristics, it is no surprise that the procedure rates vary markedly across the pediatric surgical areas of Northern New England.

Tympanostomy tube placement

Otitis media is the most common childhood diagnosis and the second most common diagnosis in medicine.[52-56] Broadly defined as middle ear inflammation, otitis media comprises two clinically distinct diagnoses. Acute otitis media is the rapid onset of inflammation in the middle ear that is usually accompanied by infection. The second form, otitis media with effusion, is the presence of fluid in the middle ear without acute inflammation.[55,56] The natural course of otitis media is persistent fluid in the middle ear for weeks to several months.

Tympanostomy (PE) tube insertion is considered for recurrent episodes of acute otitis media or for hearing loss from otitis media with effusion.[55,56] While otitis media spontaneously resolves for most children, a proportion suffers recurrent episodes that may cause hearing loss and, in some children, affect educational performance, language development, or behavior.[52,56] Insertion of tympanostomy tubes is the most common pediatric procedure in Northern New England and the U.S., accounting for more than 20% of all ambulatory surgery, with annual associated costs exceeding $5 billion nationally.[52]

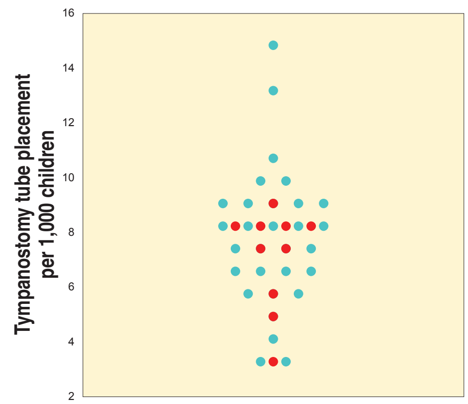
It is not well understood which patients will benefit from tympanostomy tubes.[57-62] Existing evidence corroborates that tympanostomy tube placement reliably improves short-term hearing loss. Long-term benefits of surgery for otitis media with effusion are inconclusive compared to watchful waiting, particularly with regard to improved hearing or language and cognitive development.[55,56]

The treatments for otitis media also have risks. Tube insertion can cause chronic perforation, persistent discharge, and scarring of the tympanic membrane, which itself may cause hearing loss. Neurodevelopmental consequences of anesthesia in childhood are also increasingly reported. Treatment for acute otitis media almost always involves antibiotics, despite controversy over their use and the growing rate of antibiotic resistance.[57-59]

Even with consensus guidelines based on the available evidence,[57,58] a significant majority of tympanostomy tube insertions have been found to be inappropriate; variations in care practices have also been well documented in other countries such as the United Kingdom.[63-66] While many children may receive unnecessary care (i.e., overuse of treatment), there is concern that other children may meet the criteria for tympanostomy tubes but not receive them (i.e., underuse of treatment). Potential under-and over-utilization of surgical treatment for otitis media has not been adequately investigated in the U.S.

There is a role for shared decision-making between a physician and caregiver when deciding on the treatment for otitis media.[17,67-69] Shared decision-making provides balanced information on treatment choices, often through the use of decision aids, and assists patients and families in clarifying values and treatment goals. Through this practice, patients and caregivers are brought more fully into the decision-making process.

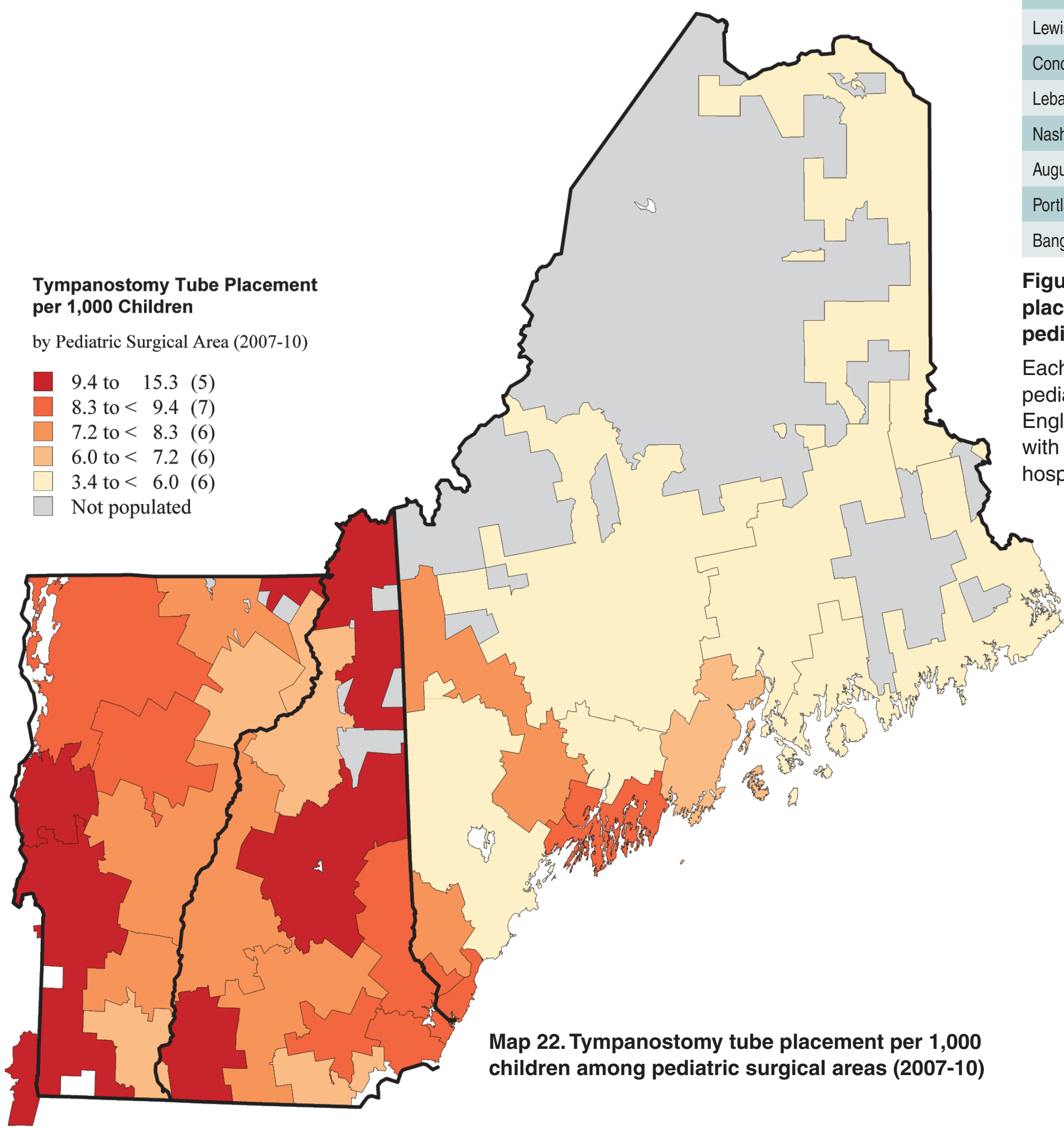
Overall, there were 7.4 tympanostomy tube insertion procedures per 1,000 children annually in Northern New England during 2007-10. The rate varied more than fourfold across the 30 pediatric surgical areas, from fewer than 4 per 1,000 in Bangor, Maine (3.4), Presque Isle, Maine (3.7), and Ellsworth, Maine (3.9) to more than 12 per 1,000 in Middlebury, Vermont (15.2) and Berlin, New Hampshire (13.1). Among PSAs containing large and children's hospitals, rates were generally higher in New Hampshire than in Maine; the rates in Dover (9.2) and Manchester (8.4) were much higher than those in Bangor (3.4) and Portland (5.0).



Dover, NH	9.2
Manchester, NH	8.4
Burlington, VT	8.3
Lewiston, ME	7.9
Concord, NH	7.9
Lebanon, NH	7.4
Nashua, NH	7.1
Augusta, ME	5.9
Portland, ME	5.0
Bangor, ME	3.4

Figure 19. Tympanostomy tube placement per 1,000 children among pediatric surgical areas (2007-10)

Each blue dot represents one of 30 pediatric surgical areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



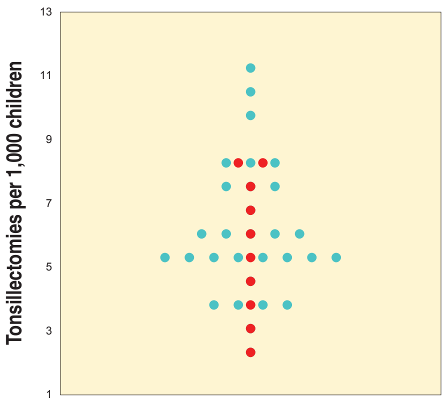
Map 22. Tympanostomy tube placement per 1,000 children among pediatric surgical areas (2007-10)

Tonsillectomies (including tonsillectomies with adenoidectomies)

Tonsillectomies are the most common surgical procedures requiring general anesthesia performed on children. Tonsillectomy rates declined from relatively high levels in the 1960s and reached their nadir in the 1980s, but they have recently increased.[70,71] Between 1996 and 2006, the ambulatory surgery rate (less than 10% are done in an inpatient setting) for U.S. children under 15 years rose from 4.97 to 8.7 per 1,000, representing an additional 243,000 procedures per year.[72,73] Currently, the most common indications are obstructive sleep apnea and recurrent throat infections.[70,74] There are few high-quality outcome studies.

For recurrent throat infections, randomized clinical trials show a modest benefit for those with stringent clinical criteria indicating more severe symptoms,[75] but little or no benefit for less frequent or milder illness.[76-79] It is likely that many tonsillectomies are done for children who fall into this milder group. For obstructive sleep apnea, current practices are poorly supported by research. Accurate diagnosis is often unreliable without a sleep study done in a sleep lab (i.e., polysomnography),[80] and it is doubtful that most children have had this test. For those with well-documented apnea, studies conducted without comparison groups suggest that tonsillectomies often provide immediate improvement but not resolution.[71,81,82] But even these results are questionable, given the absence of adequate comparison groups. A recent randomized clinical trial of children 5 to 9 years of age with obstructive sleep apnea did not show a difference in the primary outcome of attention and executive functioning.[83] Behavioral, quality-of-life, and sleep study findings, as well as symptoms, were more improved in the tonsillectomy group, although a relatively high number of the children with watchful waiting also improved. Importantly, in 2010 in Northern New England, tonsillectomies were most commonly done in children less than 5 years of age. Clearly, there remain many uncertainties as to the value of this procedure for children.

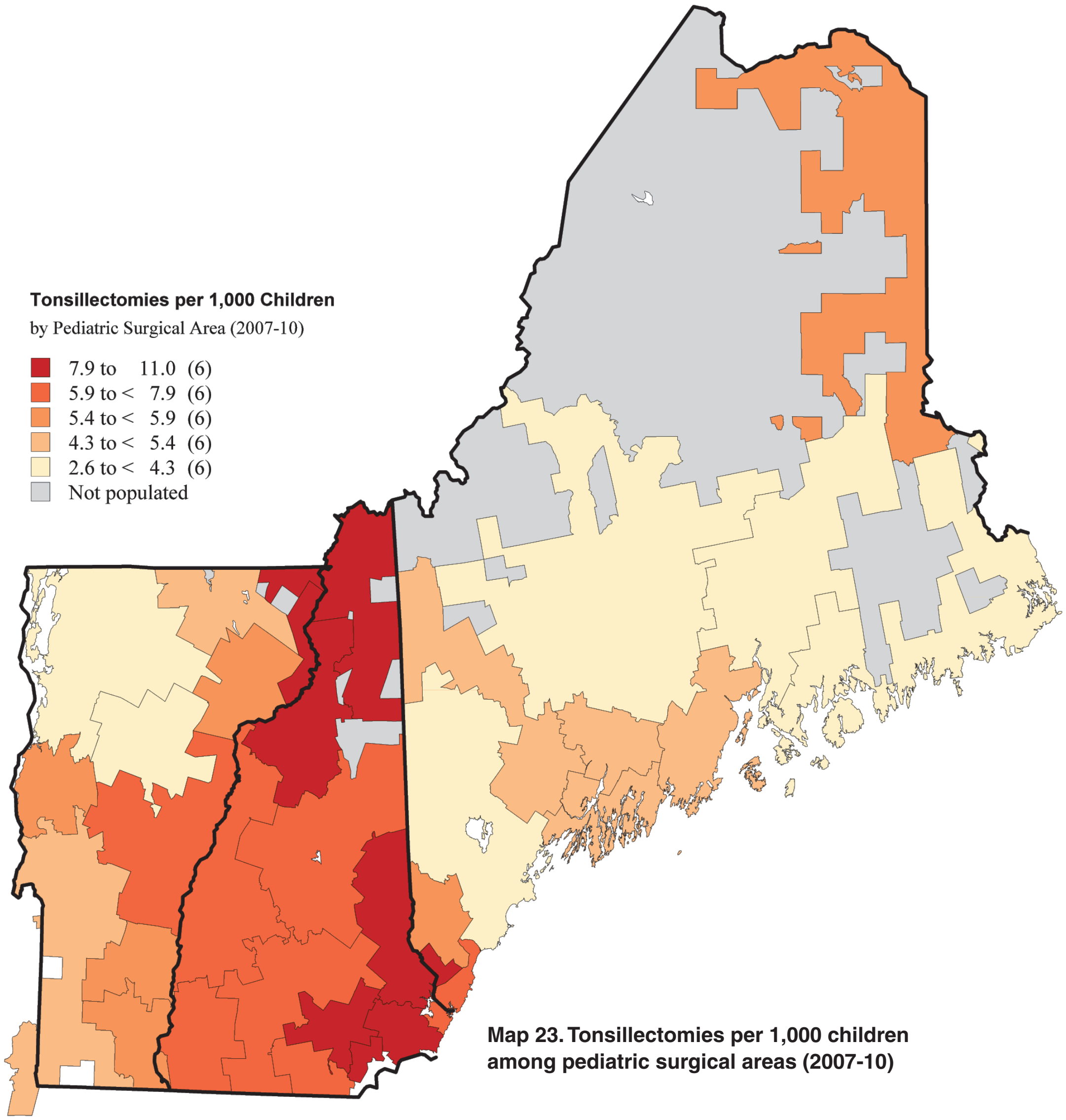
Across Northern New England pediatric surgical areas, there were 5.5 tonsillectomies performed annually per 1,000 children during 2007-10. Rates were lowest in Bangor, Maine (2.7) and Burlington, Vermont (2.9), both regions with large hospitals. The rates were more than twice as high in Lebanon, New Hampshire (7.9) and Manchester, New Hampshire (8.1), and more than three times higher in Berlin, New Hampshire (10.4) and Littleton, New Hampshire (10.9).



Manchester, NH	8.1
Dover, NH	8.1
Lebanon, NH	7.9
Nashua, NH	6.5
Concord, NH	5.9
Lewiston, ME	5.2
Augusta, ME	4.3
Portland, ME	4.0
Burlington, VT	2.9
Bangor, ME	2.7

Figure 20. Tonsillectomies per 1,000 children among pediatric surgical areas (2007-10)

Each blue dot represents one of 30 pediatric surgical areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 23. Tonsillectomies per 1,000 children among pediatric surgical areas (2007-10)

Tonsillectomy, Medical Opinion, and Public Health

No surgical procedure illustrates the role of medical opinion in determining the rate of surgery better than tonsillectomy. It was J. Alison Glover who first brought this to light in the 1930s,[50] when he challenged the theory that widespread use tonsillectomy prevented ear infections, hearing loss, absenteeism, and developmental problems. He documented the controversies over theory and fact and pointed out the harms: 444 British schoolchildren had died following surgery between 1931 and 1935.

Using the health records of English school districts, he uncovered striking variation in the incidence of tonsillectomy among children in British school districts. He ruled out such factors as illness, environment, and wealth or poverty as likely causes of the variation. He then traced what he called "the bare strange fact of incidence" to differences in medical opinion among local medical officers who were responsible for referring children for operations. His best evidence came from a natural experiment that occurred in the Hornsey Borough school district, when a tonsillectomy skeptic, Dr. R. Garrow, became the local health officer, replacing an unnamed believer in the preventive theory. The rate of tonsillectomy dropped dramatically and remained less than 10% of what it had been previously.

Glover did more than just monitor this change. In what was the first example of the use of administrative data to study outcomes, he followed the Hornsey Borough children for up to eight years to examine whether the abrupt decline in surgery led to increased ear infections and poor school attendance. To quote Glover: "judging by [the incidence of ear infections] nothing harmful but rather the reverse has happened by the substitution, in all but the most carefully selected fraction of cases, of conservative methods for operation." Glover concluded that widespread use caused harm with no evidence of benefit.

Glover's work stood as a major challenge to public health advocates on both sides of the Atlantic who believed that tonsillectomy was a required public health intervention in the fight to reduce hearing loss and other developmental problems in children. In the 1930s, the American Child Health Association took it upon itself to ensure that no child in New York City who needed this operation had been overlooked.[51] To measure unmet need, they conducted a study in which 1,000 New York schoolchildren were randomly selected for examination by school physicians to determine whether they needed surgery. Sixty percent of the sampled children were found to have already had the operation; among the 40% who hadn't had surgery, the physicians conducting the exams determined that almost half needed surgery. But to make sure that the examining physicians hadn't missed anyone, the Association arranged for those not selected for tonsillectomy in the first exam to undergo a second exam by different physicians. The second exam resulted in 40% of *these* children receiving recommendations for surgery. And just to make sure, a third exam was conducted on those who had so far survived without a diagnosis of need for surgery. Again, about 40% were now diagnosed as in need! By the end of this three-exam process, only 65 children of the original 1,000 emerged without a recommendation for surgery. The inevitable conclusion? The need for tonsillectomy didn't depend on the condition of the patient.

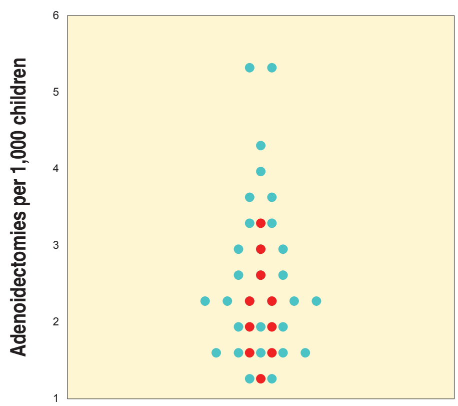
Taken together, the work of Glover and the American Child Health Association calls into question the conventional wisdom concerning medical need and the role of medical opinion in determining utilization of children's health care. The lessons would seem to be clear: to avoid harm and waste, medical theories need to be closely evaluated concerning the outcomes of care. But it is hard to find evidence that this is happening today; utilization rates for tonsillectomy remain highly variable, and new, controversial theories concerning its value in treating sleep apnea have emerged. Glover's incredible strange fact of incidence continues to impugn our assumption that clinical science and patient preferences drive medical use.

John E. Wennberg, MD, MPH

Adenoidectomies (without tonsillectomies)

Adenoidectomy as an independent surgical procedure is about half as common as tonsillectomy. The usual indication is for obstruction of the nasal passage, often in conjunction with tympanostomy tube placement for otitis media. In recent Cochrane Collaboration Reviews, there was no evidence of the benefit of adenoidectomy for nasal obstruction, and only weak evidence to support its use for otitis media.[84,85]

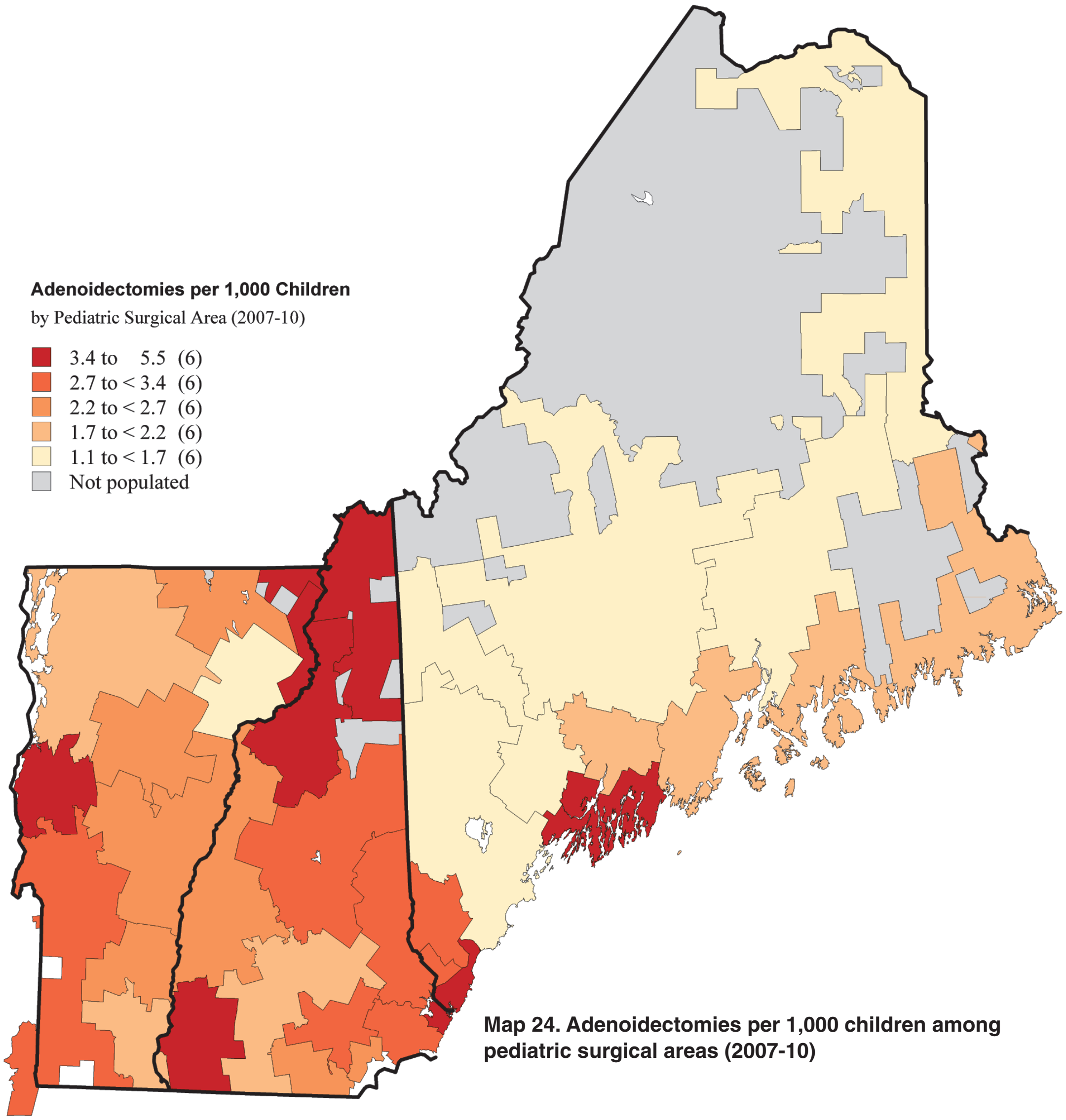
Among Northern New England pediatric surgical areas, the overall annual rate of adenoidectomies during 2007-10 was 2.4 procedures per 1,000 children. The rates varied more than fourfold across PSAs, from fewer than 1.5 per 1,000 in Bangor, Maine (1.2) and Waterville, Maine (1.4) to more than 5 per 1,000 in Berlin, New Hampshire (5.5) and Middlebury, Vermont (5.2). Among PSAs with large hospitals, rates were more than twice as high in the New Hampshire areas of Manchester (3.1), Dover (3.1), and Lebanon (2.6) as in Bangor.



Manchester, NH	3.1
Dover, NH	3.1
Lebanon, NH	2.6
Nashua, NH	2.2
Burlington, VT	2.2
Concord, NH	2.0
Augusta, ME	1.9
Portland, ME	1.7
Lewiston, ME	1.6
Bangor, ME	1.2

Figure 21. Adenoidectomies per 1,000 children among pediatric surgical areas (2007-10)

Each blue dot represents one of 30 pediatric surgical areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 24. Adenoidectomies per 1,000 children among pediatric surgical areas (2007-10)

Summing up

Some may suggest that population differences explain the variation in surgery across pediatric surgical areas. Perhaps, in some areas, the children have more ear, nose, and throat disease. This possibility is unlikely to explain the observed variation. These rates were adjusted for differences in age, sex, and in the proportion of children insured with Medicaid across areas. In addition, correlation of the procedure rates with the percent of children in poverty showed only a weak inverse relationship; areas with higher poverty rates had lower rates of the procedures, but the associations were not strong (Figures 22-24).

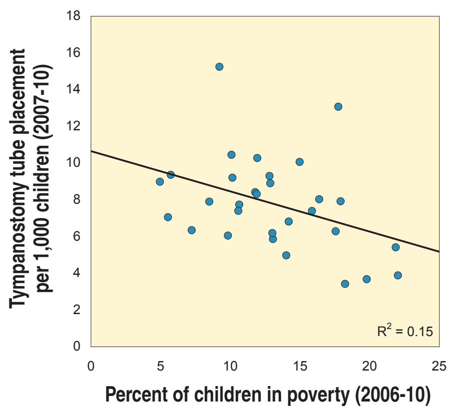


Figure 22. Relationship between the percent of children in poverty and tympanostomy tube insertion among pediatric surgical areas

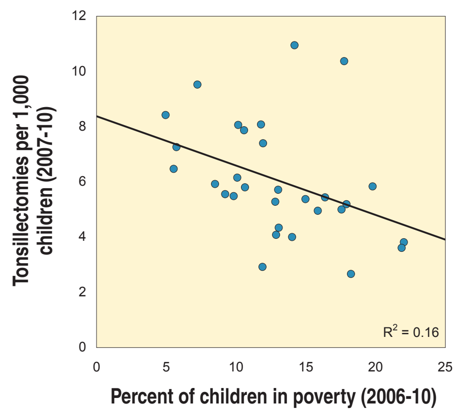


Figure 23. Relationship between the percent of children in poverty and tonsillectomy among pediatric surgical areas

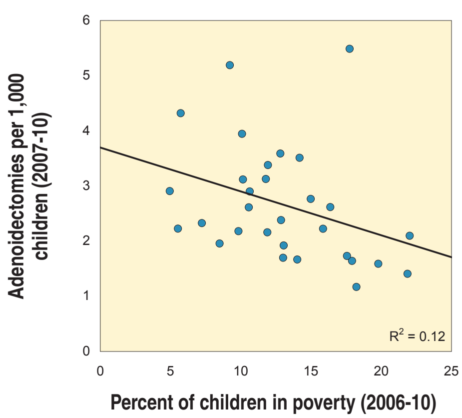


Figure 24. Relationship between the percent of children in poverty and adenoidectomy among pediatric surgical areas

Others may be curious as to whether the supply of otolaryngologists is associated with higher procedure rates. There was only a weak positive association between otolaryngology supply and rates of pediatric surgical procedures. This is not surprising, considering that these procedures comprise only a proportion of the total clinical effort for children and adults provided by otolaryngologists.

The evidence of benefit for the surgical procedures presented in this report remains incomplete, and in some instances (e.g., tonsillectomy for obstructive sleep apnea), it is unlikely that children in the region are accurately diagnosed. The tradeoffs of known benefits and risks mean that the most reasonable way to classify these procedures is as preference-sensitive care; that is, the decision to treat medically—including with watchful waiting—or surgically should reflect the preferences of informed families, rather than the local theories and practice styles of primary care physicians and otolaryngologists. Shared decision-making and the use of decision aids remains under-studied and under-implemented in children's health care.

Table 12. Pediatric surgical procedures in Northern New England states (2007-10)

	Tympanostomy (PE) tube placement per 1,000 children	Tonsillectomies per 1,000 children	Adenoidectomies per 1,000 children
Maine			
Overall	5.7	4.3	1.8
Commercially insured	5.1	4.1	1.9
Medicaid	6.4	4.7	1.8
New Hampshire			
Overall	8.4	7.6	2.9
Commercially insured	7.4	7.1	2.7
Medicaid	10.1	8.3	3.2
Vermont			
Overall	8.7	4.3	2.5
Commercially insured	6.4	3.2	2.1
Medicaid	11.9	5.7	3.0
Northern New England			
Overall	7.4	5.5	2.4
Commercially insured	6.2	5.0	2.2
Medicaid	9.1	6.3	2.6

Tables containing data for all Northern New England HSAs may be found in the Appendices.

Diagnostic Imaging

New imaging technologies, such as computerized tomography (CT) scanning and magnetic resonance imaging (MRI) have provided important tools for the diagnosis and management of childhood illness, leading to growth in the use and cost of diagnostic imaging over the past several decades.[86] Estimates of frequency of imaging exposure in children are now as high as 410 imaging procedures per 1,000 children annually, with only a recent leveling off.[87,88] This leveling off of the growth rate of imaging may be due to the recognition that radiation exposure from certain imaging modalities, primarily CT scanning, leads to a tangible cancer risk.[89]

The concern about cancer is particularly acute for children, who have a longer life expectancy from the time of exposure and higher radiation sensitivity due to their growth rate. While the magnitude of the risk is still debated, current evidence has prompted the Image Gently (IG) campaign, a project of the Alliance for Radiation Safety in Pediatric Imaging.[90] The Image Gently campaign is focused on decreasing the dosage of radiation delivered to children, particularly during high-radiation procedures like CT scans and fluoroscopy, and has achieved widespread professional awareness and uptake. Nevertheless, this approach merely mitigates the intrinsic risk of imaging; it does not question the value of the overall number of procedures.

Inherent in any consideration of the value of imaging is the need to examine the benefits. Concerns about pediatric radiation risk have prompted research studies intended to investigate the benefits, which have demonstrated that imaging is not as useful as some might believe. The use of abdominal CTs to rule out appendicitis and the use of head CTs after head trauma are two examples of areas where high utilization has not produced a commensurate clinical benefit. Abdominal CT scanning in children has failed to reduce significantly the rate of either removal of a normal appendix or the rate of ruptured appendix above that which can be achieved with ultrasound (a radiation-free technology) or by a skilled pediatric surgeon with a physical exam.[91] In the case of head injury, clinical decision rules have been developed and tested on large populations, and these simple algorithms could reduce the use of CT scanning for minor head injury dramatically.[92] Furthermore, such studies demonstrate indirectly that most of our current head CT scanning is unnecessary by showing very low rates of serious pathology over very large populations exposed to minor head trauma. Consideration of the value of imaging also needs to take into account the costs of CT and MRI scanning, which are very high.

How should physicians and nurses communicate what we know about the risks and benefits of imaging in pediatrics? The answer is that we do not know precisely, but it is clear that we should use some imaging sparingly. The Choosing Wisely campaign, a project of the American Board of Internal Medicine that has now been expanded to include pediatrics, is a first foray into this topic.[93] The project is intended to sensitize patients to the large number of routine tests and treatments that have low value and to prompt patients to discuss the issue with their doctors. As a starting point, each specialty created “top five” lists of unnecessary tests and treatments. The pediatric list features examples of low-value imaging prominently, including recommendations against head CT for minor head trauma, neuroimaging for febrile seizure, and routine abdominal CT for abdominal pain.[94] Furthermore, it has been demonstrated that when parents understand that most imaging is not risk-free, regardless of its benefits, many reconsider their consent.[95]

While most of the recent attention to imaging has concerned studies of high radiation exposure (CT scans) or cost (CT scans and MRI scans), the issues of benefit, future cancer risk, and cost also need to be considered for the more frequently used “plain films,” such as chest and abdominal x-ray studies. Shared decision-making is an important tool for helping patients and families understand medical choices and reach a decision that reflects their values. Shared decision-making has been used primarily in adult medicine. Although it has received some attention in children’s health care,[16,17,96,97] there are no reports of its use in pediatric imaging. Clearly, the time is ripe to investigate further the benefits and risks of pediatric imaging and to improve the decision quality surrounding its use.

CT scans

Head CT scans are valuable for diagnosing serious intracranial (i.e., inside the skull) disease processes. These include bleeding or fractures from trauma, tumors, infection, and congenital malformations. Abdominal and chest CT scans can be useful for identifying similar problems. The radiation exposure from a CT scan is high, equivalent to more than 200 chest x-rays. The lifetime risk that a single CT scan will cause cancer ranges from 1 cancer in 500 scans to 1 cancer in 1,000 scans, depending on the dose used and the site of the scan.[98]

For head CT scans, the most common diagnoses listed in insurance claims for children residing in Northern New England are head injury and headache (Table 13). For chest or abdominal CT scans, the most common diagnosis is abdominal pain (Table 14).

Table 13. Top 5 head CT scan diagnoses

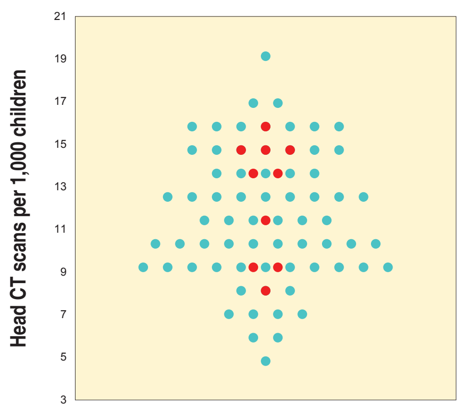
Diagnosis	Percent of scans	Cumulative percent
Head injury	22.5	22.5
Headache	21.2	43.7
Convulsions	4.7	48.4
Intracranial injury	4.1	52.6
Contusion face/scalp/neck	2.3	54.9

Table 14. Top 5 chest or abdominal CT scan diagnoses

Diagnosis	Percent of scans	Cumulative percent
Abdominal pain	37.2	37.2
Headache	1.8	39.0
Head injury	1.7	40.7
Injury of abdomen	1.5	42.2
Observation following accident	1.5	43.6

Head CT scans

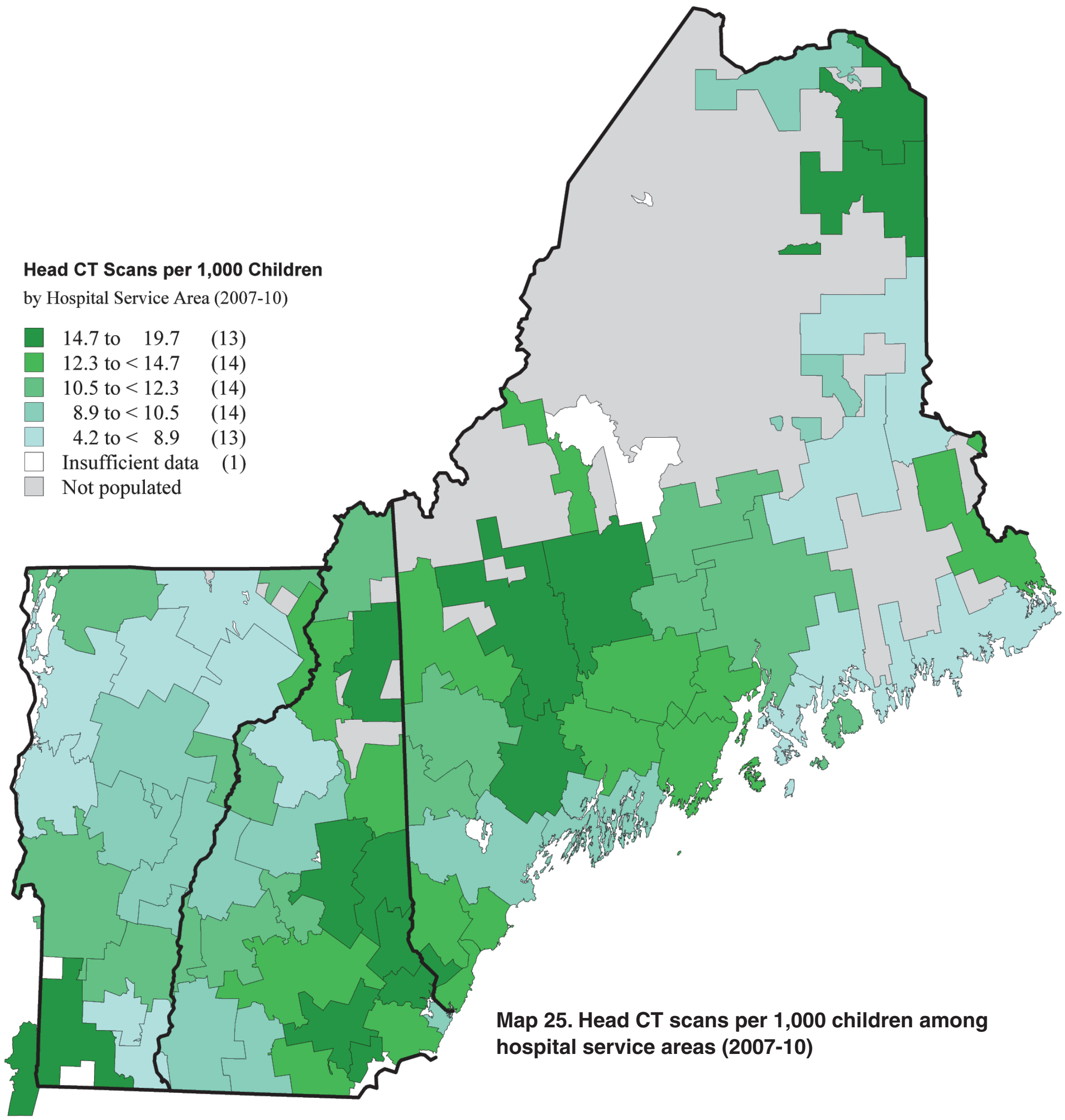
During the period from 2007 to 2010, there were 12 head CT scans per 1,000 insured children annually across Northern New England. The rate was less than half the regional average in the hospital service areas of Machias, Maine (4.3), Houlton, Maine (5.8), and Morrisville, Vermont (5.9); by contrast, there were more than 15 head CT scans per 1,000 children in Presque Isle, Maine (19.7), Wolfeboro, New Hampshire (17.0), and Skowhegan, Maine (16.4). Among areas with large hospitals, rates were lowest in the three HSAs containing children's hospitals: Burlington, Vermont (8.4), Lebanon, New Hampshire (8.9), and Portland, Maine (9.7). The rates of head CT scanning were considerably higher in Lewiston, Maine (15.5), Manchester, New Hampshire (14.8), and Dover, New Hampshire (14.8).



Lewiston, ME	15.5
Manchester, NH	14.8
Dover, NH	14.8
Augusta, ME	14.3
Concord, NH	14.1
Nashua, NH	13.9
Bangor, ME	11.1
Portland, ME	9.7
Lebanon, NH	8.9
Burlington, VT	8.4

Figure 25. Head CT scans per 1,000 children among hospital service areas (2007-10)

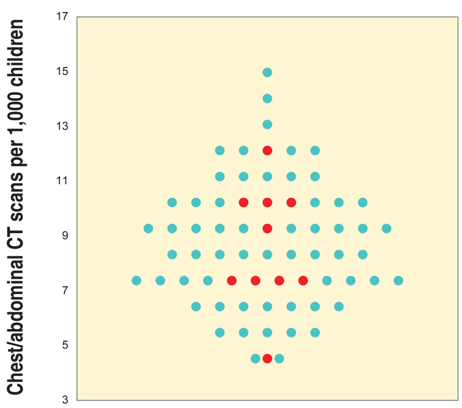
Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 25. Head CT scans per 1,000 children among hospital service areas (2007-10)

Chest or abdominal CT scans

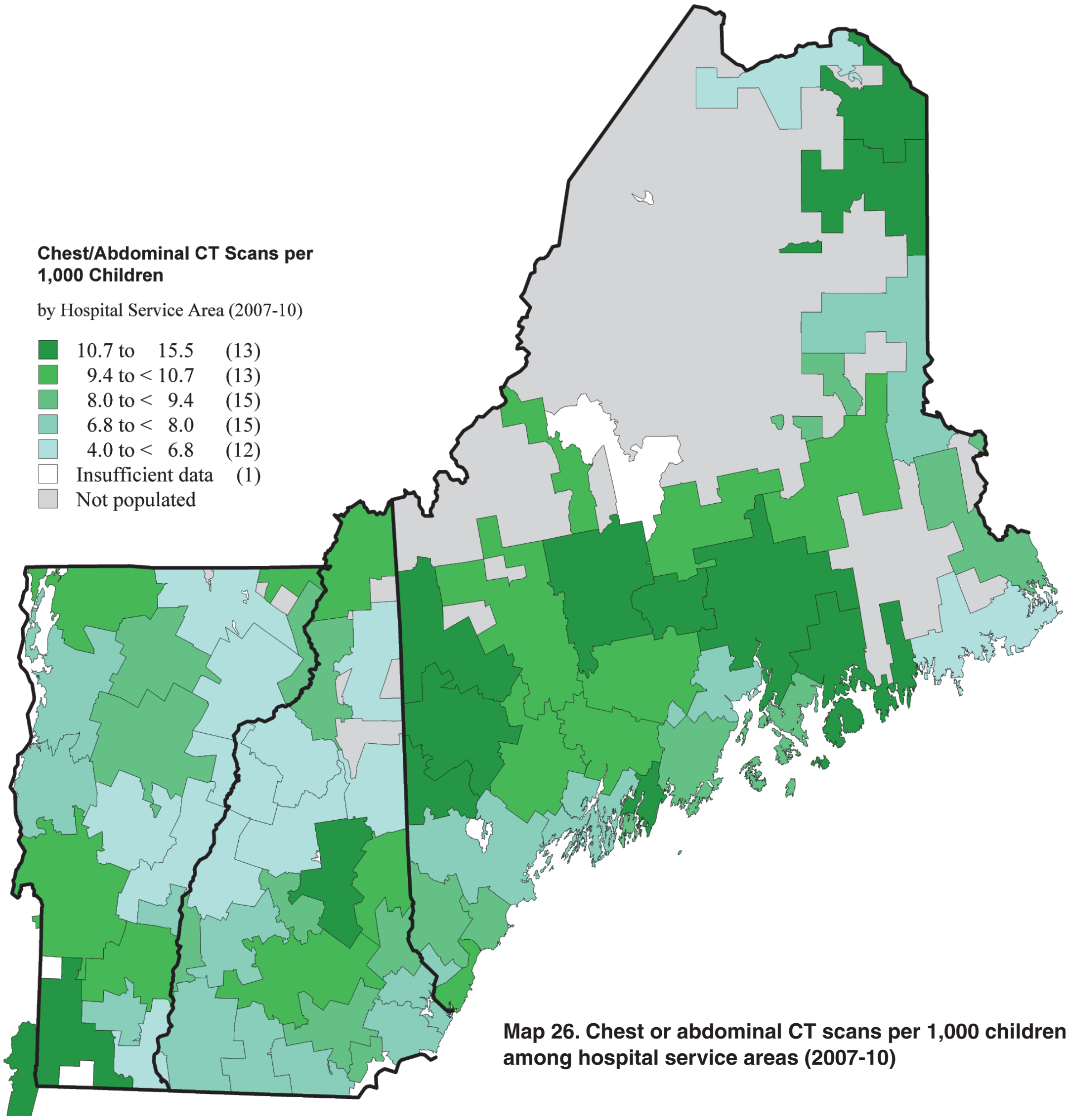
Overall, there were 8.8 chest or abdominal CT scans per 1,000 children each year in Northern New England during 2007-10. The rate varied more than three-fold across HSAs, from 4.0 per 1,000 children in Machias, Maine to 15.4 per 1,000 in Bennington, Vermont. Other HSAs with low rates included Lebanon, New Hampshire (4.7), Brattleboro, Vermont (5.1), and St. Johnsbury, Vermont (5.8). Rates of chest or abdominal CT scanning were more than two times higher in Bar Harbor, Maine (13.9) and Skowhegan, Maine (13.1). Among HSAs with large hospitals, the rate in Bangor, Maine (11.7) was more than twice the rate in Lebanon. The two other HSAs with children's hospitals also had relatively low rates: Burlington, Vermont (7.1) and Portland, Maine (7.6).



Bangor, ME	11.7
Augusta, ME	10.6
Lewiston, ME	9.9
Concord, NH	9.8
Manchester, NH	9.1
Portland, ME	7.6
Nashua, NH	7.6
Dover, NH	7.4
Burlington, VT	7.1
Lebanon, NH	4.7

Figure 26. Chest or abdominal CT scans per 1,000 children among hospital service areas (2007-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 26. Chest or abdominal CT scans per 1,000 children among hospital service areas (2007-10)

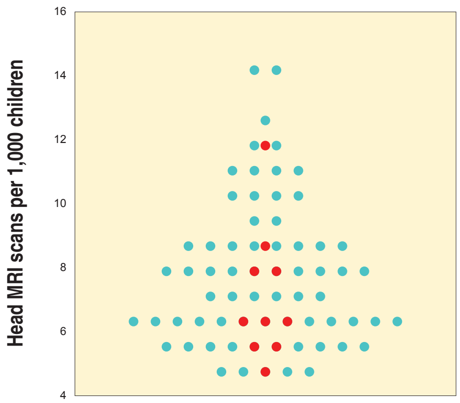
Head MRI scans

Head MRI scanning provides very high-resolution images for the diagnosis of serious abnormalities of the brain. MRIs do not expose the patient to radiation and are generally safe. In order for infants and young children to lie still for the prolonged time required, sedation provided by an anesthesiologist is often necessary. Sedation has its own small but definite risks. MRI scanning is also very expensive; a reporter in Massachusetts found costs ranging from $2,000 to $5,000 per scan, although insurance companies often negotiate lower prices.[99] This does not include the cost of sedation. The most common diagnoses associated with head MRI scans are headache and convulsions (Table 15).

Table 15. Top 5 head MRI scan diagnoses

Diagnosis	Percent of scans	Cumulative percent
Headache	17.0	17.0
Convulsions	6.0	22.9
Abnormal finding skull/head	2.9	25.9
Cerebral cysts	2.0	27.9
Migraine	1.8	29.6

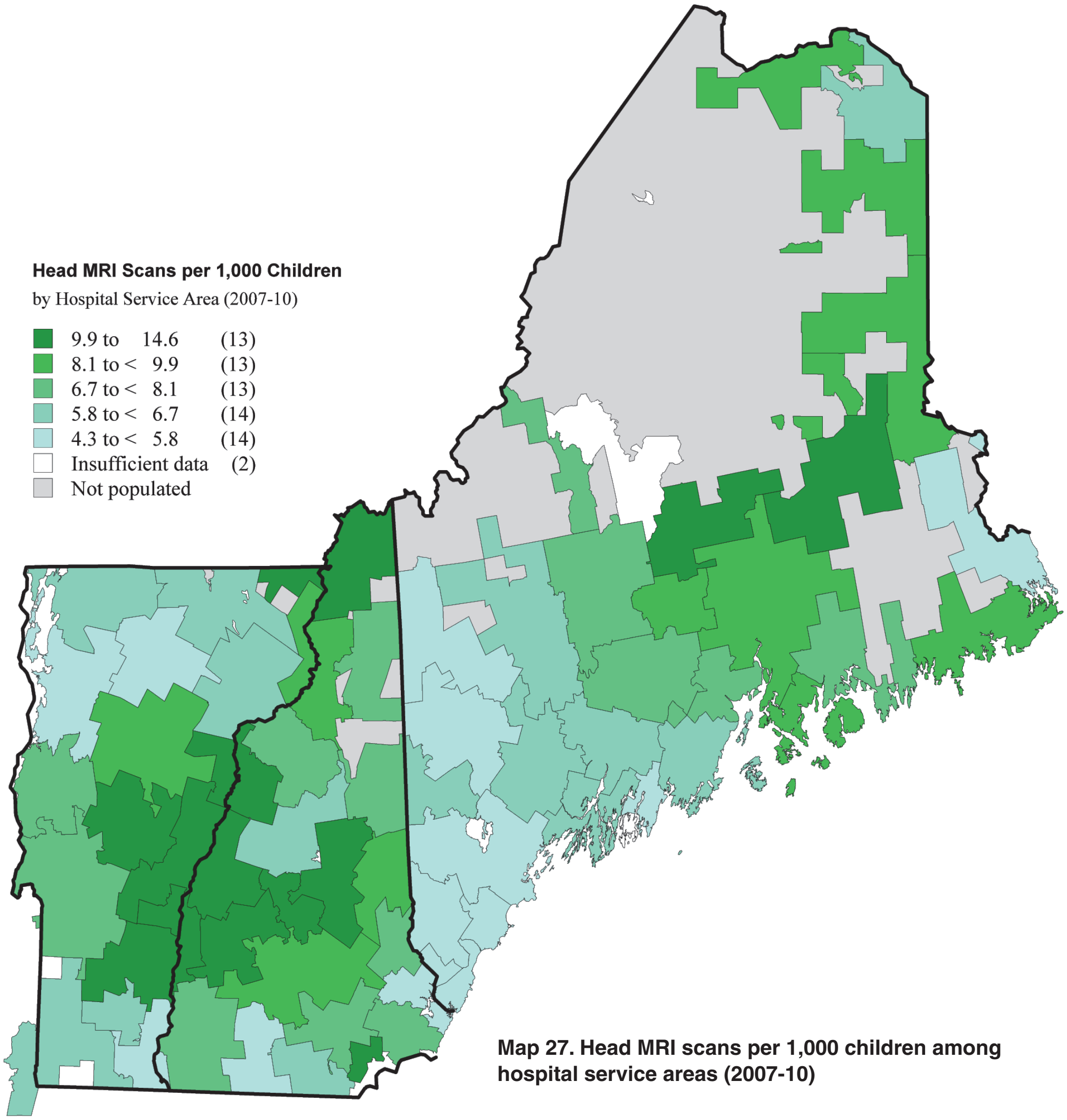
Among insured children in Northern New England, there were 7.1 head MRI scans per 1,000 annually during 2007-10. Across HSAs, rates of head MRI varied more than threefold, from fewer than 5 scans per 1,000 children in Portland, Maine (4.4), Rumford, Maine (4.6), and Peterborough, New Hampshire (4.9) to more than 14 per 1,000 in Windsor, Vermont (14.6) and Claremont, New Hampshire (14.2). Among HSAs containing children's hospitals, the rate of head MRI in Lebanon, New Hampshire (11.7) was more than twice the rate in Portland.



Lebanon, NH	11.7
Concord, NH	8.6
Bangor, ME	8.2
Manchester, NH	7.6
Nashua, NH	6.6
Augusta, ME	6.1
Lewiston, ME	6.0
Dover, NH	5.5
Burlington, VT	5.4
Portland, ME	4.4

Figure 27. Head MRI scans per 1,000 children among hospital service areas (2007-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 27. Head MRI scans per 1,000 children among hospital service areas (2007-10)

Chest and abdominal diagnostic x-rays

"Plain films" of the chest and abdomen are the most common type of imaging used in pediatrics. Compared to CT and MRI scans, they involve low doses of radiation and are much less expensive. They provide less detailed images, but remain very useful for diagnosing many childhood illnesses. They also have the potential for overuse.

The most common diagnoses associated with insurance claims for chest x-rays are cough, chest pain, and pneumonia (Table 16). The most common diagnoses associated with abdominal films are abdominal pain and constipation (Table 17).

Table 16. Top 5 chest x-ray diagnoses

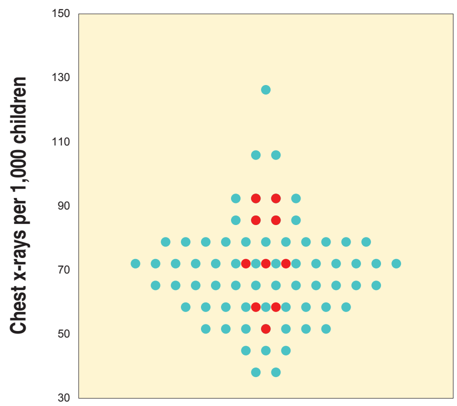
Diagnosis	Percent of x-rays	Cumulative percent
Cough	23.6	23.6
Chest pain	5.4	29.0
Pneumonia	4.7	33.8
Fever	9.0	42.8
Respiratory abnormality	4.2	47.0

Table 17. Top 5 abdominal x-ray diagnoses

Diagnosis	Percent of x-rays	Cumulative percent
Abdominal pain	23.3	23.3
Constipation	19.1	42.3
Flatulence/gas pain	3.8	46.2
Vomiting	3.1	49.3
Fitting/adjust catheter	2.7	52.0

Chest x-rays

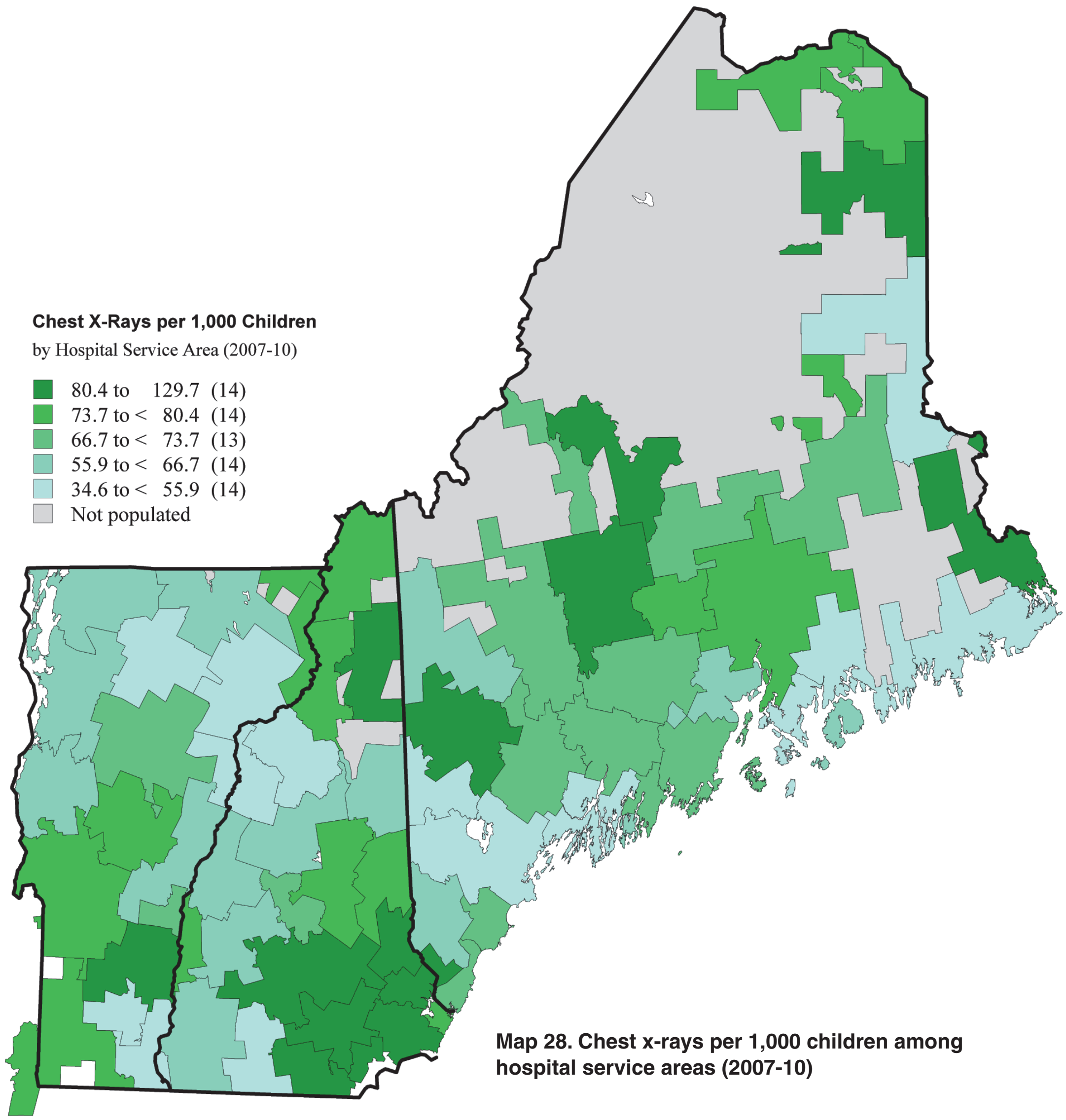
Overall, there were 71.5 chest x-rays per 1,000 insured children in Northern New England each year during 2007-10. Across HSAs, the rate varied more than threefold, from fewer than 45 chest x-rays per 1,000 children in Machias, Maine (34.7), Littleton, New Hampshire (40.9), and Townshend, Vermont (41.5) to more than 100 per 1,000 in Calais, Maine (129.7), Derry, New Hampshire (105.1), and Rochester, New Hampshire (103.3). There was considerable variation among the HSAs containing large hospitals, from 54.8 chest x-rays per 1,000 children in Portland, Maine to 93.2 per 1,000 in Manchester, New Hampshire.



Manchester, NH	93.2
Concord, NH	90.9
Nashua, NH	84.1
Dover, NH	83.9
Bangor, ME	73.7
Augusta, ME	72.7
Lewiston, ME	71.4
Lebanon, NH	58.9
Burlington, VT	57.5
Portland, ME	54.8

Figure 28. Chest x-rays per 1,000 children among hospital service areas (2007-10)

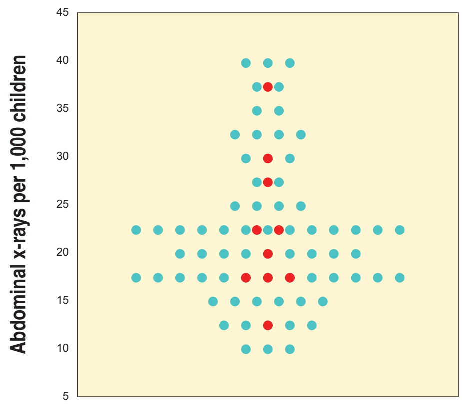
Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 28. Chest x-rays per 1,000 children among hospital service areas (2007-10)

Abdominal x-rays

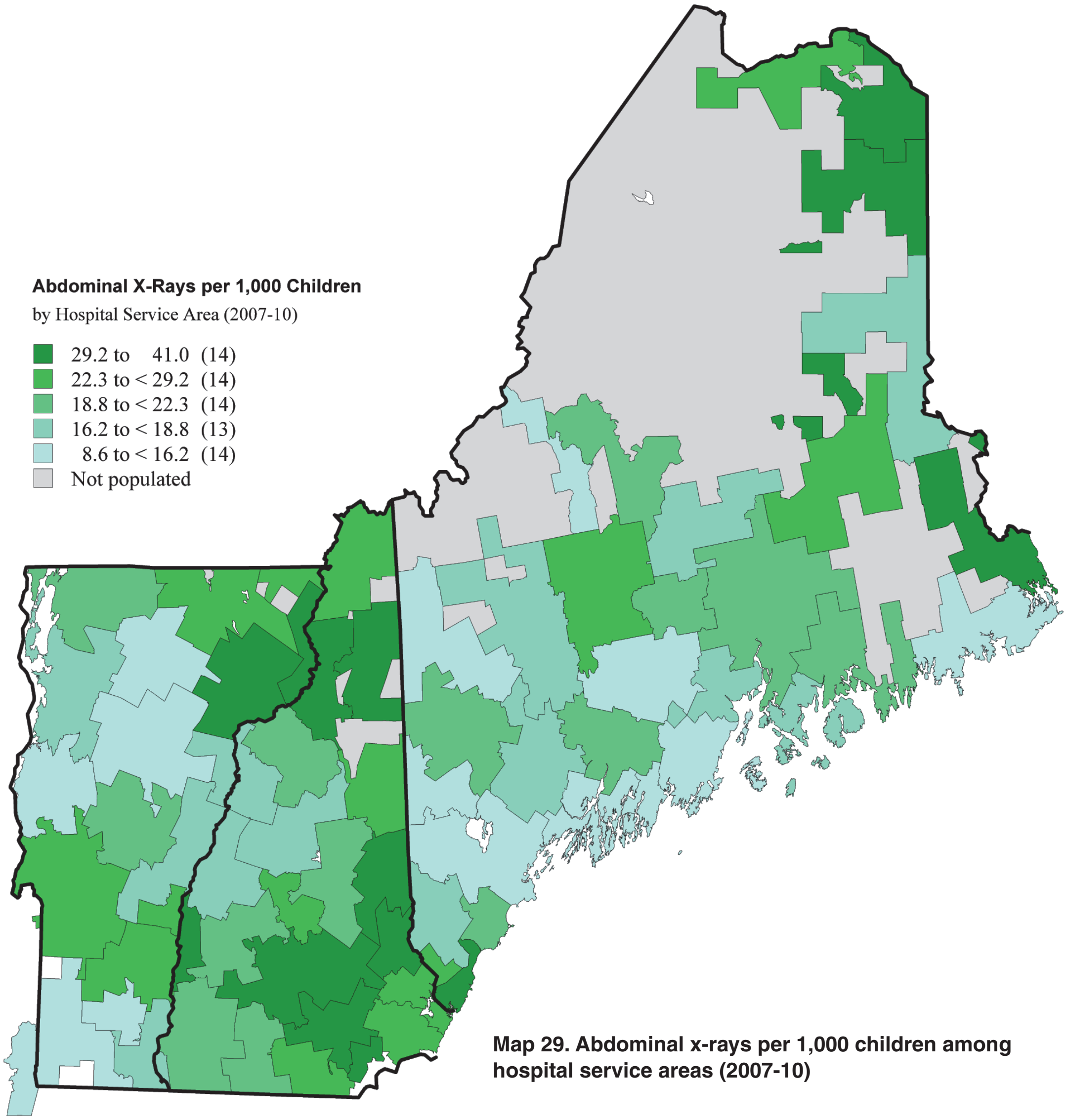
Across Northern New England, there were 22.2 abdominal x-rays per 1,000 insured children annually during 2007-10. Rates ranged from fewer than 10 x-rays per 1,000 in Townshend, Vermont (8.7) and Damariscotta, Maine (9.7) to more than 40 per 1,000 in Derry, New Hampshire (41.0) and Millinocket, Maine (40.4), a more than fourfold variation. There was nearly threefold variation among the HSAs with the largest hospitals, from 13.2 per 1,000 in Portland, Maine to 38.0 per 1,000 in Manchester, New Hampshire. In addition to Portland, rates were relatively low in the other two HSAs containing children's hospitals: Burlington, Vermont (17.8) and Lebanon, New Hampshire (17.9).



Manchester, NH	38.0
Concord, NH	30.6
Nashua, NH	28.1
Dover, NH	23.3
Bangor, ME	22.0
Augusta, ME	21.0
Lebanon, NH	17.9
Burlington, VT	17.8
Lewiston, ME	16.2
Portland, ME	13.2

Figure 29. Abdominal x-rays per 1,000 children among hospital service areas (2007-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 29. Abdominal x-rays per 1,000 children among hospital service areas (2007-10)

Summing up

Table 18. Correlations (r values) between the percent of children in poverty (2006-10) and rates of imaging per 1,000 children (2007-10)	
	HSA poverty rate
Head CT scan	0.03
Chest/abdominal CT scan	0.28
Head MRI scan	0.11
Chest x-ray	0.04
Abdominal x-ray	-0.01

The striking variations in the use of CT scans, head MRIs, and plain films are unlikely to be explained by differences in health status. The HSAs with high imaging rates for children with commercial insurance are often the same areas with high rates for the Medicaid insured (Figures 30-34). In addition, there was no meaningful relationship between overall imaging rates—which were adjusted for the proportion of children insured by Medicaid—and childhood poverty rates (Table 18).

Where children live affects their chances of receiving an imaging study and being exposed to the associated radiation. Families also bear the costs of the irrational and, at times, unnecessary use of imaging procedures. While the right rates are unknown, the extent of the variation, the lack of association with markers of illness (e.g., poverty), and the national studies indicating overuse mean than many children in Northern New England are likely to receive unnecessary imaging studies.

Table 19. Imaging among children in Northern New England states (2007-10)

	Head CT scans per 1,000 children	Chest/abdominal CT scans per 1,000 children	Head MRIs per 1,000 children	Chest x-rays per 1,000 children	Abdominal x-rays per 1,000 children
Maine					
Overall	12.2	9.5	6.2	65.9	18.2
Commercially insured	9.8	8.1	5.5	45.7	13.2
Medicaid	15.9	11.7	7.4	97.0	25.8
New Hampshire					
Overall	13.3	8.2	8.2	80.9	28.2
Commercially insured	12.5	8.1	8.1	63.5	23.8
Medicaid	14.6	8.3	8.3	107.0	34.8
Vermont					
Overall	9.5	8.5	6.8	65.6	19.3
Commercially insured	8.4	7.9	5.9	51.5	14.5
Medicaid	11.2	9.4	8.1	87.4	26.2
Northern New England					
Overall	12.0	8.8	7.1	71.5	22.2
Commercially insured	10.5	8.1	6.5	53.5	17.5
Medicaid	14.3	9.9	7.9	98.4	29.3

Tables containing data for all Northern New England HSAs may be found in the Appendices.

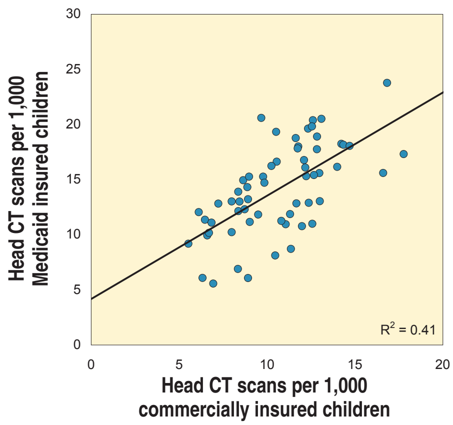


Figure 30. Relationship between head CT scans among children with commercial insurance and Medicaid among hospital service areas (2007-10)

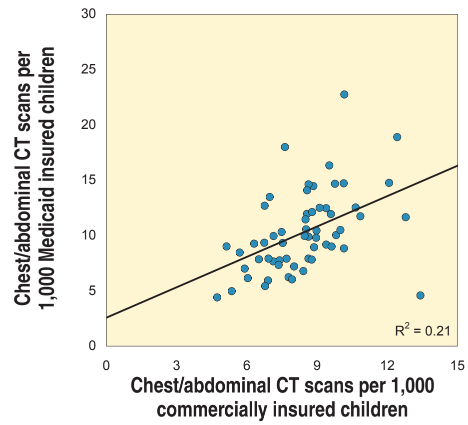


Figure 31. Relationship between chest or abdominal CT scans among children with commercial insurance and Medicaid among hospital service areas (2007-10)

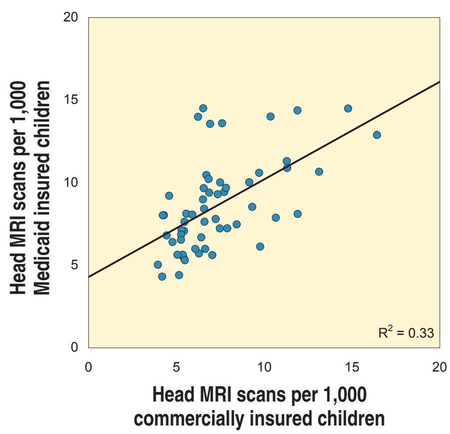


Figure 32. Relationship between head MRI scans among children with commercial insurance and Medicaid among hospital service areas (2007-10)

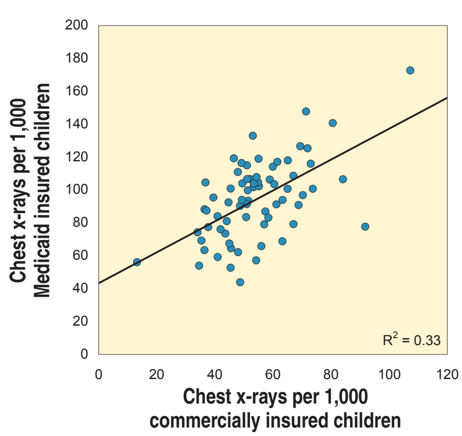


Figure 33. Relationship between chest x-rays among children with commercial insurance and Medicaid among hospital service areas (2007-10)

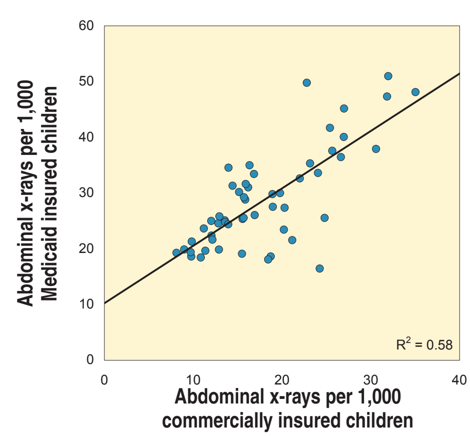


Figure 34. Relationship between abdominal x-rays among children with commercial insurance and Medicaid among hospital service areas (2007-10)

Prescription Drug Use

Prescription drugs play an important role in the health care of children. Despite this, there have been few studies of their use at the population level, and analysis of small area variation has been infrequently reported.[100] Past studies have described differences in pediatric drug use broadly, across large U.S. regions or by payer type (Medicaid versus commercial), and narrowly, among sub-populations defined by disease state or by ethnicity and race.[101-104] For example, it has been shown that, on average, children insured by Medicaid use more prescription medications than commercially insured children, especially psychiatric medications.[101,102] However, the reasons—likely complex and numerous—are poorly understood, and no research has yet satisfactorily explained why the use of medications varies substantially by region among children with similar levels of poverty and low social capital.[101,102,104,105] The variation suggests practice patterns and culture as potential explanations and highlights the need for detailed analyses at the level of the prescriber, clinician group, or region to more fully reveal the determinants of pediatric prescribing variation.

Compared to adult prescribing, the use of medications for children may be subject to greater uncertainty because of the relatively smaller number of clinical trials, especially long-term trials, that reflect real-world medication use for chronic conditions.[106,107] Although guidelines are in place to promote a uniform approach to some medication use decisions—for example, antibiotics for specific infections, treatment of attention deficit hyperactivity disorder, and management of adolescent depression—guidelines are lacking and/or dissemination and uptake have been slow for many clinical situations.[108-115] This combination of relatively limited evidence for many clinical scenarios and a narrow range of prescribing guidelines may increase the roles of practice style, patient preferences, and local practice norms in pediatric prescribing.

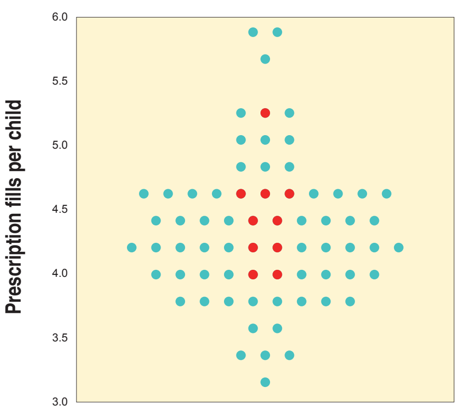
While prescription use among U.S. children often reflects prescribing decisions based on available evidence and good intentions, a scarcity of specific pharmacotherapy quality measures limits the ability to readily apply the Dartmouth Atlas conceptual framework (variation in effective care, preference-sensitive care, and supply-sensitive care) to a study of pediatric prescribing. The recent publication of an Atlas of prescription drug use among Medicare beneficiaries illustrates another approach to understanding patterns of medication use.[116] Even though the number of useful indicators of prescribing quality for elderly adults was small, the measures were sufficient to permit an assessment of both good and bad variation in prescribing quality. In pediatrics, measures of effective pharmacotherapy and harmful pharmacotherapy are not as numerous, as clearly defined, as broadly accepted, or as easily analyzed. This makes the current undertaking, the examination of pediatric prescription drug use patterns, inherently more descriptive and more reliant on measures of volume or intensity rather than clear indicators of high and low quality.

This analysis of prescription use among children in Northern New England will quantify, overall and across hospital service areas, variation in overall prescription volume (all drugs), use of two of the most commonly prescribed non-psychiatric drug groups (antibiotics and gastric acid suppressants), and use of three commonly prescribed psychiatric medication groups (antidepressants, attention deficit hyperactivity disorder (ADHD) treatments, and antipsychotics). Correlations in use between distinct drug groups, as well as between drug use and the use of non-prescription services presented in other sections of this report, will also be examined.

This section presents the intensity of prescription drug use using two complementary measures: (1) average annual prescription fills per 100 children (estimated based on person-years), and (2) the average annual proportion of the pediatric population with any use of a particular medication type. Together, these measures reveal how many prescription fills were received by the population and the proportion of the population over which the observed fills were distributed.

Overall prescription use volume

The average annual number of prescription drug fills for all types of medication received by children during the period from 2007 to 2010 was 435 per 100 children, or 4.4 fills per child per year. Across HSAs, the overall rate of prescription drug use varied nearly twofold, from 3.0 fills per child in Townshend, Vermont to 6.0 fills per child in Caribou, Maine. The observed variation does not appear to be a function of state-specific prescribing patterns; variations within states were similar in magnitude to variation across the entire region. Hospital service areas with relatively low rates of prescription fills per child included Rumford, Maine (3.4), Newport, Vermont (3.5), and Peterborough, New Hampshire (3.5). Rates were relatively high in Franklin, New Hampshire (5.9), Millinocket, Maine (5.7), and Bennington, Vermont (5.3). Among HSAs containing children's hospitals, prescription fill rates were somewhat lower in Burlington, Vermont (4.0) and Portland, Maine (4.1) than in Lebanon, New Hampshire (4.7).

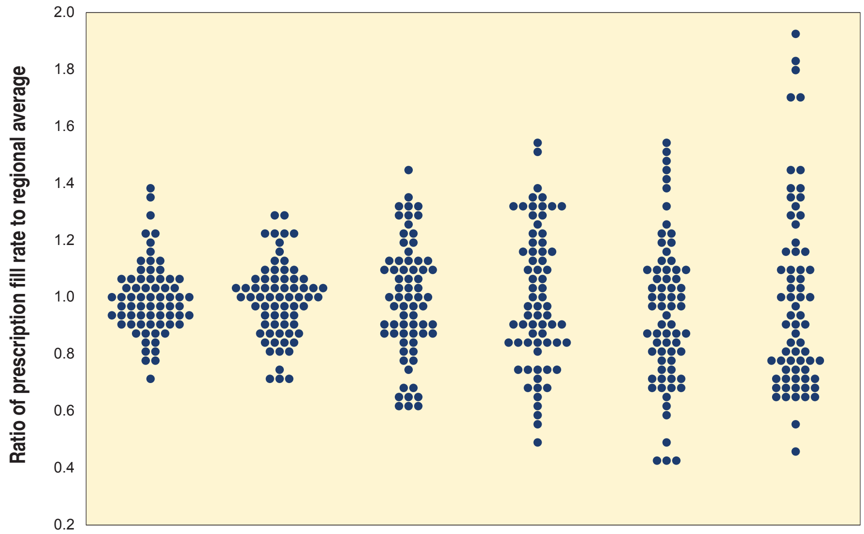


Bangor, ME	5.2
Manchester, NH	4.7
Lebanon, NH	4.7
Nashua, NH	4.5
Concord, NH	4.5
Augusta, ME	4.4
Lewiston, ME	4.3
Dover, NH	4.2
Portland, ME	4.1
Burlington, VT	4.0

Figure 35. Overall prescription fills per child among hospital service areas (2007-10)

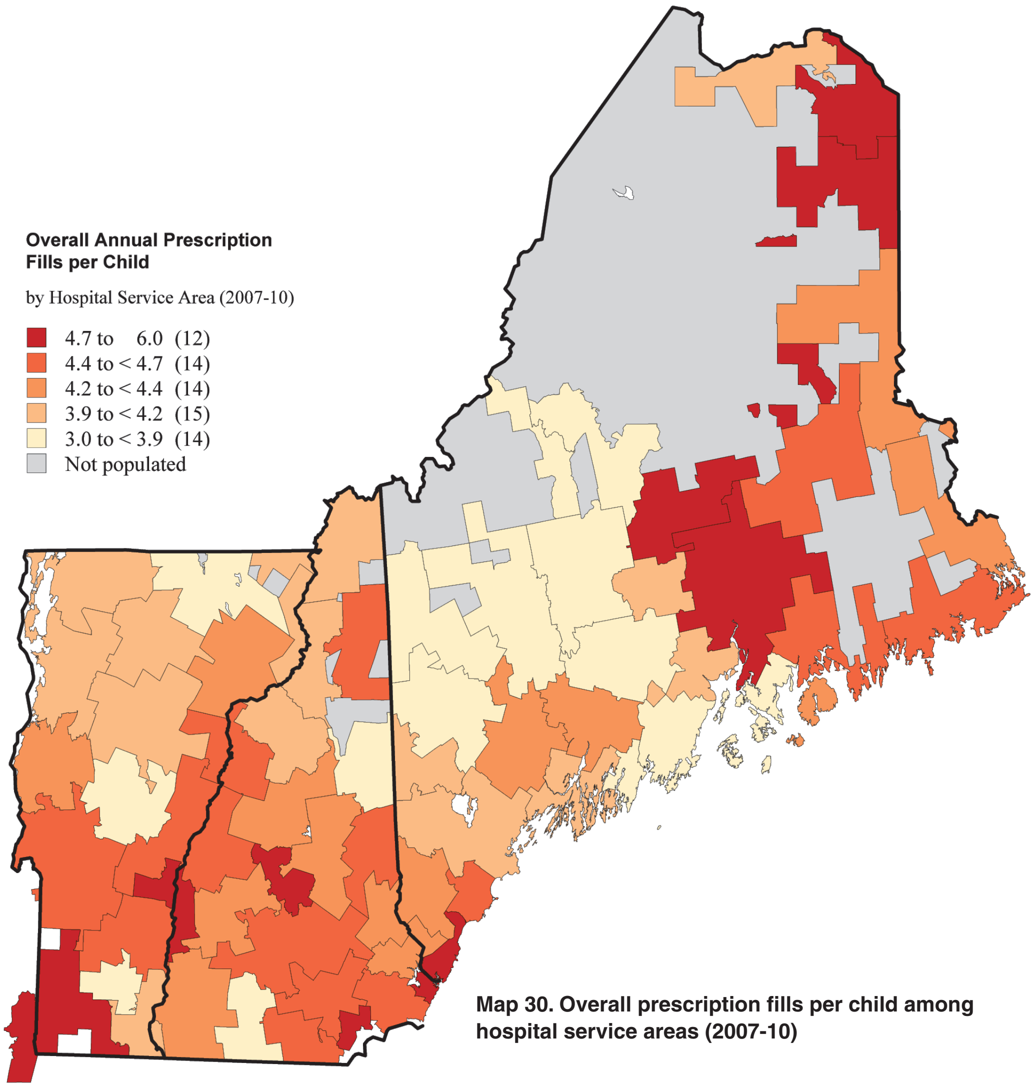
Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.

The variation in the use of individual prescription drugs differs greatly according to the type of medication. While antibiotic use varied modestly—by a factor of 1.8—the use of antipsychotics varied more than fourfold (Figure 36). The extremal ratio demonstrates the overall magnitude of variation for each drug type, while the interquartile ratio shows the variation between the HSAs at the 75th and 25th percentile. The coefficient of variation, which reflects the relative variability of each measure, is twice as high for acid suppressants and antipsychotic drugs as for overall fills and antibiotics.



	Overall fills	Antibiotics	ADHD medications	Anti-depressants	Acid suppressants	Anti-psychotics
Extremal ratio	1.96	1.81	2.40	3.25	3.75	4.35
Interquartile ratio	1.16	1.17	1.28	1.43	1.39	1.60
Coefficient of variation	12.9	13.6	20.3	24.5	27.3	33.2

Figure 36. Patterns of variation in prescription fills among hospital service areas (2007-10)



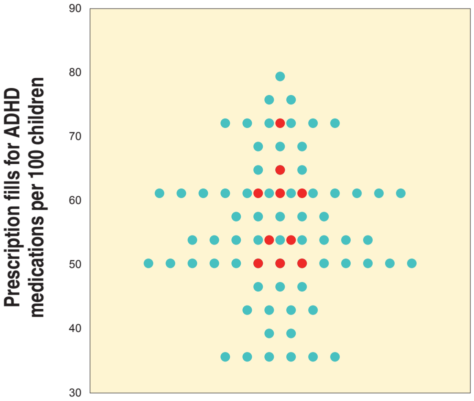
Map 30. Overall prescription fills per child among hospital service areas (2007-10)

Commonly used psychiatric medications

An estimated 13% to 20% of children in the U.S. experience mental illness each year and the rate is increasing.[117] The use of psychiatric medications parallels this trend in illness, and these medications are now among the most commonly prescribed drugs for children. While use of some psychiatric drugs, like anxiolytics, is declining, prescribing rates for other psychiatric medications have increased steadily in recent decades, especially drugs used for ADHD, antidepressants, and antipsychotics.[101,102,104,118] These trends reflect the use of psychiatric medications by a growing proportion of all children, as well as an increase in the tendency to use psychiatric medications in combination.[104,117-121] While sound evidence supports their use in clearly defined clinical situations,[111,112,117] there is also ample utilization in situations of diagnostic and therapeutic uncertainty.[122-124] Uncertainty arises from the relatively subjective nature of psychiatric diagnoses (compared to physical illnesses commonly diagnosed by exam findings, laboratory tests, and imaging studies), as well as a dearth of evidence on how best to manage complex pediatric psychiatric diseases and behaviors.[123,124]

Attention deficit hyperactivity disorder medications

Attention deficit hyperactivity disorder (ADHD) drugs are the most commonly prescribed psychiatric medications in children, and their use is growing, especially among adolescents.[105,106,118,125] The effective use of these medications requires complex information and decision-making; it is supported by good evidence in some patients, but accurate diagnosis of ADHD can be difficult. ADHD can also occur with other mental and physical illness, complicating both diagnosis and treatment.[115,119] Despite proven effectiveness in carefully selected patients, optimal use of this medication class remains widely debated. At the state level, substantial geographic variation has been documented, overall and among patients with ADHD diagnosis.[105,125] Many have called for more research to identify both the best application of these medications and the long-term effects of chronic use.[103,125,126] The complexity surrounding the use of these treatments is magnified by the fact that all but one ADHD-specific medication is regulated by the Drug Enforcement Administration due to the high potential for abuse and addiction. This reflects the risk of misuse, not only among patients receiving prescriptions, but also across the population as a result of drug diversion (medications being used by people other than those for whom they were prescribed).[127] The importance of close clinical follow-up of patients using ADHD medication is illustrated by the HEDIS measure of health care quality that specifically evaluates the timing and frequency of visits for children prescribed these medications (see the Effective Care section).[103]

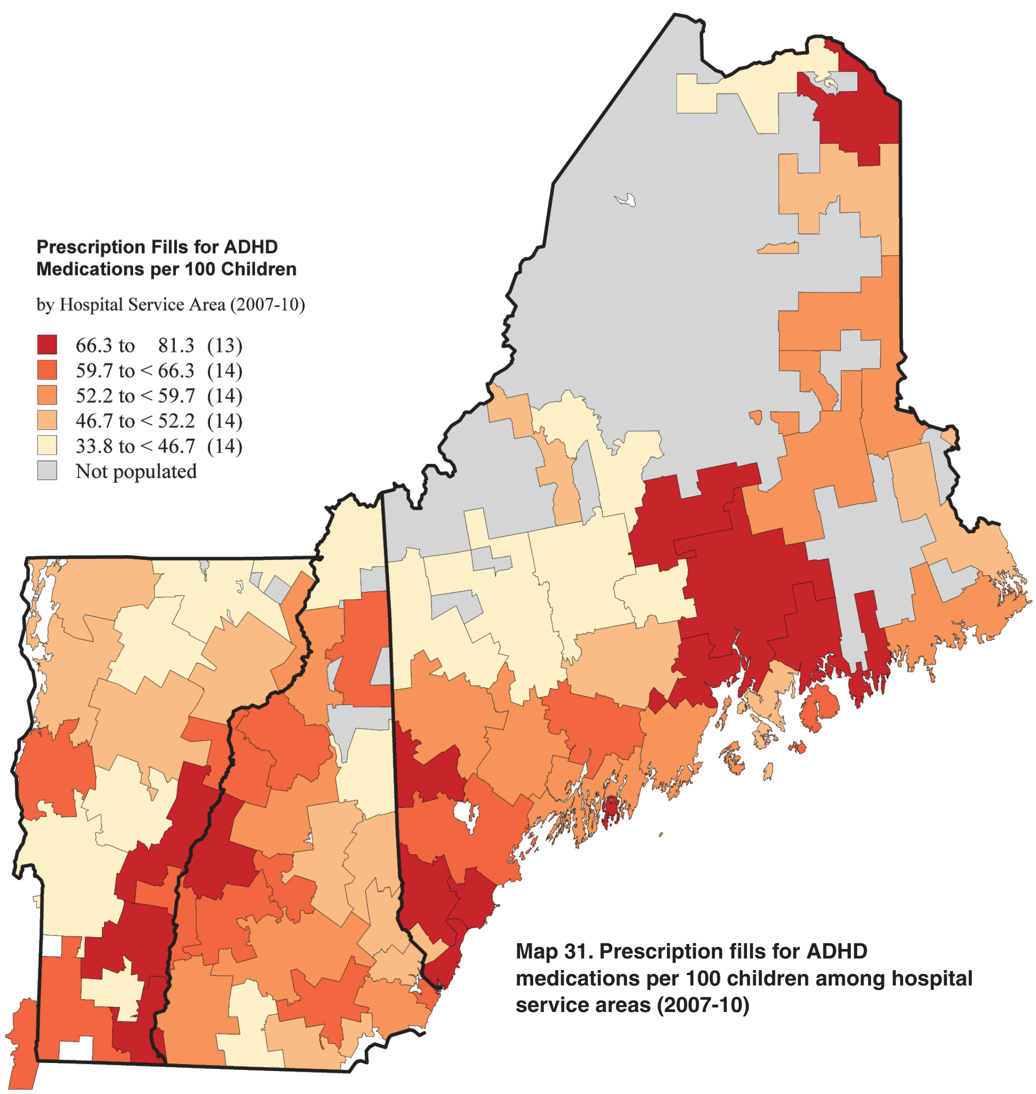


Bangor, ME	70.3
Lebanon, NH	66.3
Portland, ME	62.3
Manchester, NH	61.1
Augusta, ME	60.1
Concord, NH	54.6
Lewiston, ME	54.1
Dover, NH	51.1
Nashua, NH	50.0
Burlington, VT	49.7

Figure 37. Prescription fills for ADHD medications per 100 children among hospital service areas (2007-10)

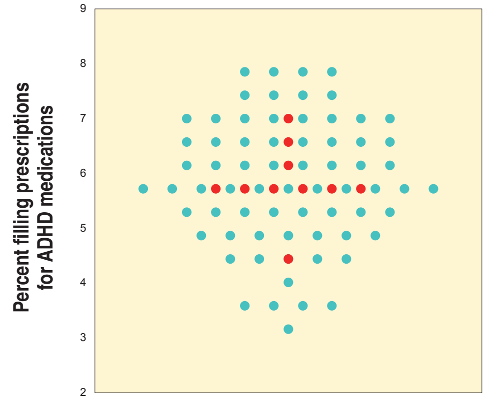
Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.

In Northern New England overall, there were 55.7 prescription fills for ADHD medications per 100 children per year during 2007-10. The rates varied more than twofold across hospital service areas, from fewer than 35 fills per 100 children in Greenville, Maine (33.8) and Newport, Vermont (34.8) to more than 75 per 100 in Caribou, Maine (81.2) and Biddeford, Maine (76.0). Among HSAs containing children's hospitals, the number of fills per 100 children was much lower in Burlington, Vermont (49.7) than in Lebanon, New Hampshire (66.3) and Portland, Maine (62.3).



Map 31. Prescription fills for ADHD medications per 100 children among hospital service areas (2007-10)

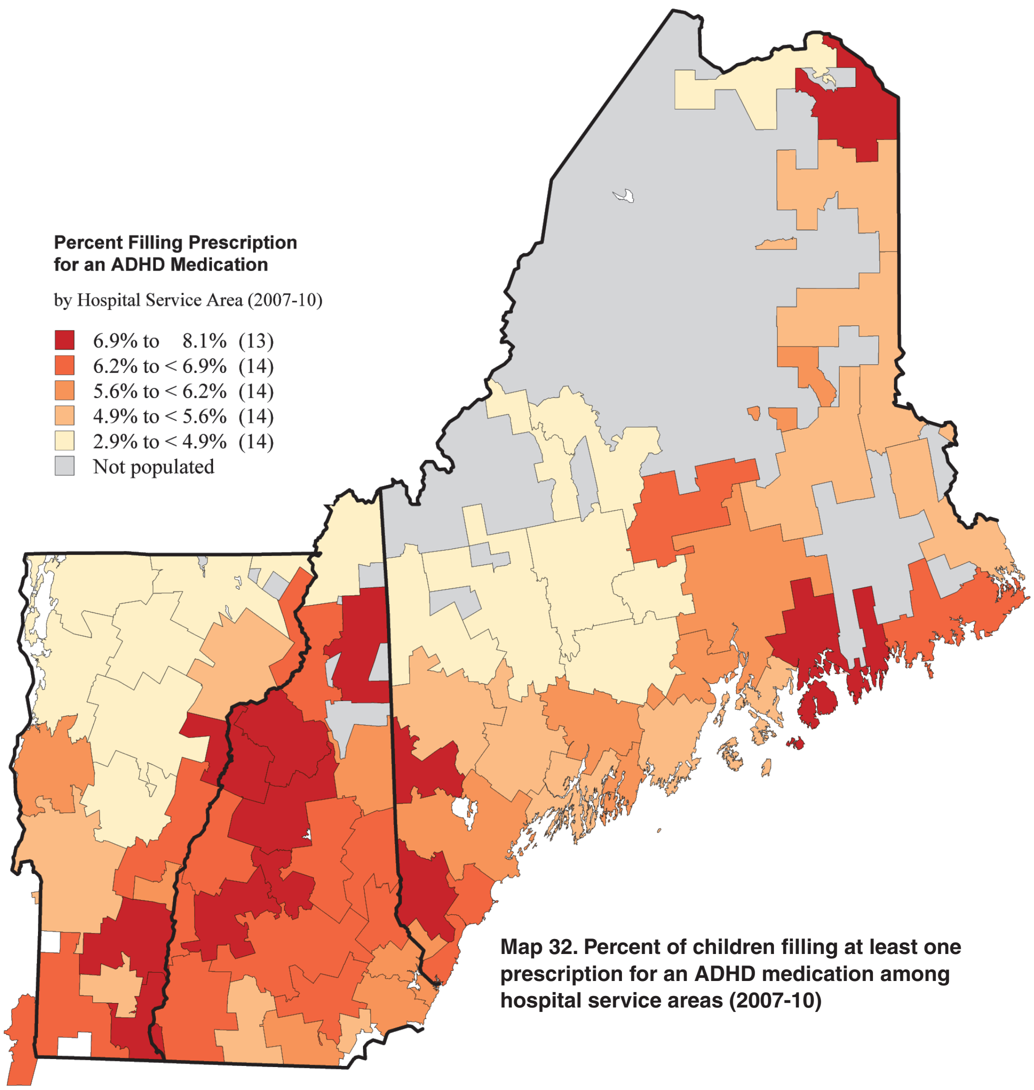
Across the Northern New England region, 5.8% of children filled at least one prescription for an ADHD medication annually during 2007-10. Less than 4% of children used ADHD drugs in five Maine HSAs, including Fort Kent (2.9%), Pittsfield (3.6%), and Farmington (3.6%). About 8% of children used ADHD drugs in Ellsworth, Maine (8.1%) and Brattleboro, Vermont (7.8%). Among HSAs with large hospitals, the rate in Burlington, Vermont (4.3%) was much lower than the rates in Manchester, New Hampshire (6.8%), Lebanon, New Hampshire (6.5%), and Concord, New Hampshire (6.3%).



Manchester, NH	6.8%
Lebanon, NH	6.5%
Concord, NH	6.3%
Bangor, ME	5.9%
Portland, ME	5.8%
Nashua, NH	5.8%
Augusta, ME	5.7%
Dover, NH	5.7%
Lewiston, ME	5.5%
Burlington, VT	4.3%

Figure 38. Percent of children filling at least one prescription for an ADHD medication among hospital service areas (2007-10)

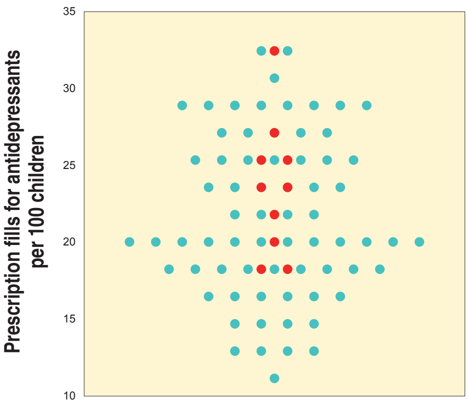
Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 32. Percent of children filling at least one prescription for an ADHD medication among hospital service areas (2007-10)

Antidepressants

Antidepressants are the second most commonly used psychiatric medications among children in Northern New England and nationally.[121] Like ADHD treatments, guidelines exist to direct the use of these medications for children, especially for adolescents.[112] Among teens, antidepressant use is made more complex by concerns about the potential for some of these medications to induce or increase thoughts of suicide. This concern must be balanced with the risk of not treating clinical depression.[111,112,128] Use of these medications requires careful decision-making and ongoing monitoring for effectiveness and side effects.

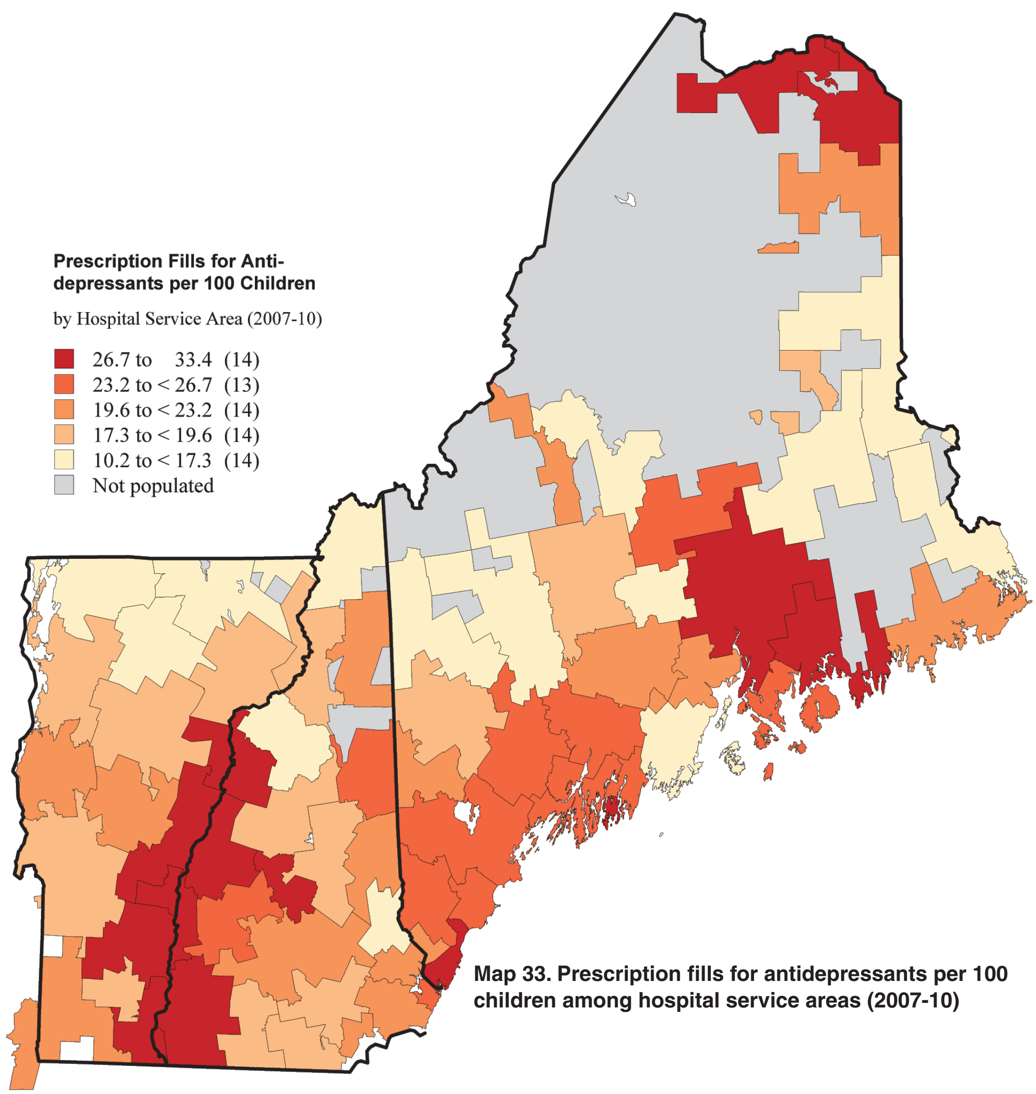


Lebanon, NH	32.5
Bangor, ME	26.7
Augusta, ME	25.5
Portland, ME	25.3
Lewiston, ME	23.3
Concord, NH	22.8
Dover, NH	21.4
Manchester, NH	19.5
Nashua, NH	17.8
Burlington, VT	17.8

Figure 39. Prescription fills for antidepressants per 100 children among hospital service areas (2007-10)

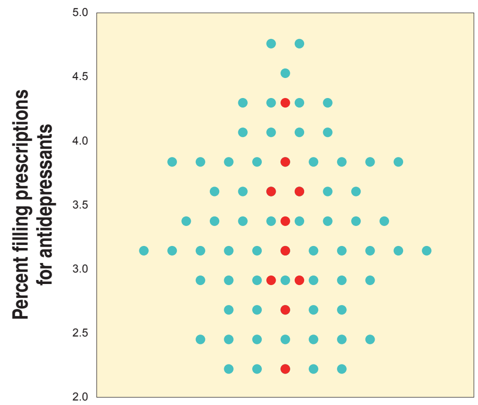
Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.

Overall, there were 21.5 annual prescription fills for antidepressants per 100 children in Northern New England during 2007-10. The fill rate varied more than threefold across HSAs, from 10.3 fills per 100 children in Colebrook, New Hampshire to 33.3 fills per 100 in York, Maine. Other HSAs with rates below 15 fills per 100 included Rumford, Maine (12.2), Newport, Vermont (13.3), and Rochester, New Hampshire (14.8). The rates were about 30 fills per 100 children in Lebanon, New Hampshire (32.5) and Claremont, New Hampshire (30.0). Lebanon had the highest rate among the HSAs with large hospitals; rates in Burlington, Vermont (17.8) and Nashua, New Hampshire (17.8) were much lower.



Map 33. Prescription fills for antidepressants per 100 children among hospital service areas (2007-10)

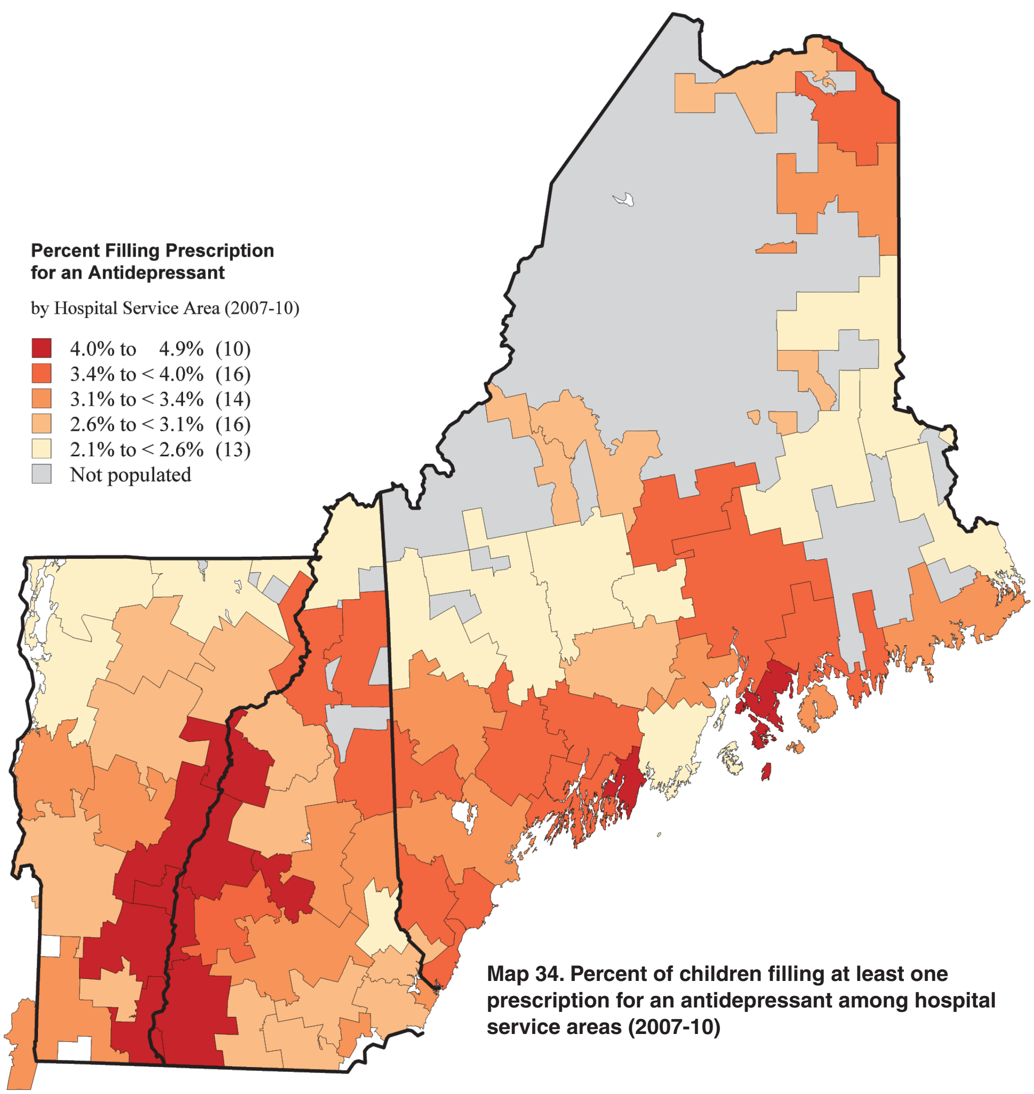
During 2007-10, 3.2% of children in Northern New England filled at least one prescription for an antidepressant. Relatively few children used antidepressants in Rumford, Maine (2.1%), Burlington, Vermont (2.3%), and Colebrook, New Hampshire (2.3%). Rates of antidepressant use each year approached 5% in Claremont, New Hampshire (4.9%) and Woodsville, New Hampshire (4.7%). Among HSAs containing children's hospitals, the percent of children using antidepressants was nearly twice as high in Lebanon, New Hampshire (4.4%) as in Burlington. The rate in Portland, Maine was close to the regional average (3.3%).



Lebanon, NH	4.4%
Augusta, ME	3.8%
Lewiston, ME	3.5%
Bangor, ME	3.5%
Portland, ME	3.3%
Concord, NH	3.2%
Dover, NH	3.0%
Manchester, NH	2.9%
Nashua, NH	2.7%
Burlington, VT	2.3%

Figure 40. Percent of children filling at least one prescription for an antidepressant among hospital service areas (2007-10)

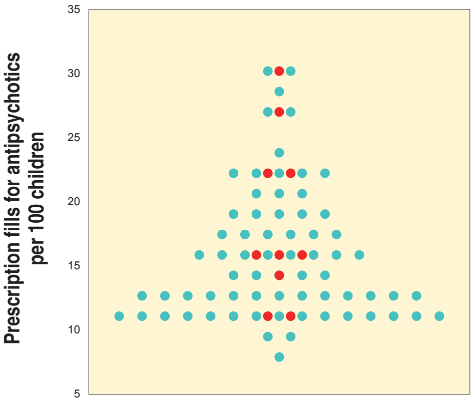
Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 34. Percent of children filling at least one prescription for an antidepressant among hospital service areas (2007-10)

Antipsychotics

Antipsychotics are the third most commonly used psychiatric medication among children in Northern New England. In general, these medications are reserved for use in patients with very serious mental illness and for behavior management in people with genetic or structural brain abnormalities that result in violent or uncontrollable disruptive behavior.[129-131] They are also increasingly used for a broader range of diagnoses and symptoms and in combination with other psychiatric medications.[120,121,129,130] In children, these medications are most commonly prescribed by psychiatrists and behavioral or developmental specialists, but general pediatricians and family physicians are not restricted in any way from prescribing these drugs, and they do prescribe them.[129] While proven effective in certain clinical situations, such as schizophrenia, Tourette's syndrome, and autism, their role in the treatment of children is not as well understood as it is among adults.[129] The newer drugs in this medication class, called "second-generation antipsychotics," are the ones used most often in children and are associated in adults with a risk of high blood sugar, diabetes, and elevated cholesterol.[129,130,132] These metabolic side effects have also been noted in studies of children, but less research in this age group exists, so uncertainty about near- and especially long-term adverse effects persists.[133] As with all medications, the potential side effects of these drugs must be weighed carefully against the severity of symptoms and desired therapeutic effects, with consideration of treatment alternatives. Careful monitoring is needed not only for symptom and behavior response but also for metabolic changes in the blood that may signal increased risk of diabetes or heart disease in the future.

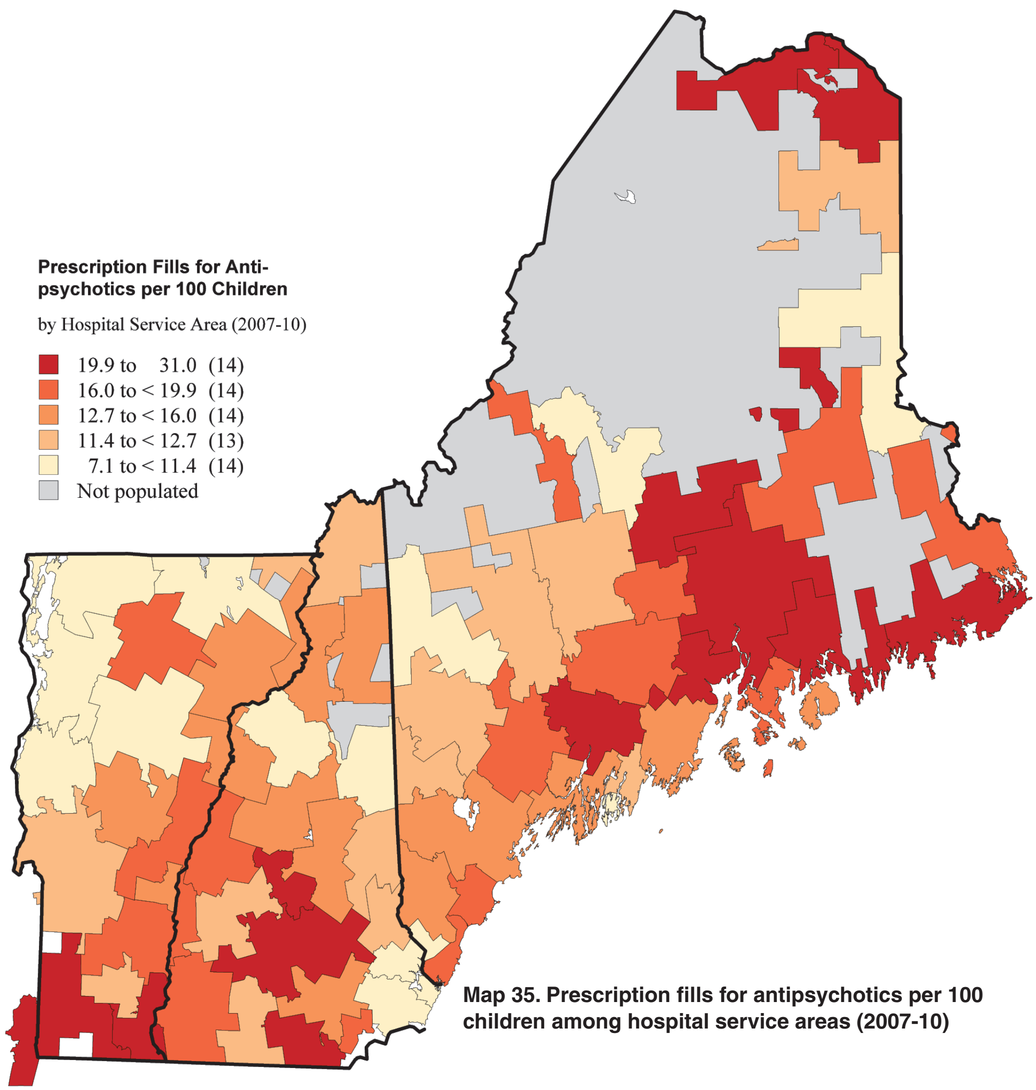


Bangor, ME	29.4
Augusta, ME	27.1
Concord, NH	22.2
Nashua, NH	21.7
Lewiston, ME	16.4
Lebanon, NH	16.3
Manchester, NH	15.6
Portland, ME	14.2
Burlington, VT	10.6
Dover, NH	10.6

Figure 41. Prescription fills for antipsychotics per 100 children among hospital service areas (2007-10)

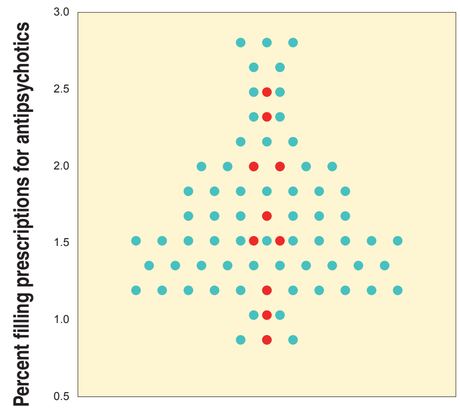
Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.

Across Northern New England, there were 16 prescription fills for antipsychotics per 100 children annually during 2007-10. The rates varied more than fourfold across HSAs, from fewer than 10 fills per 100 children in Newport, Vermont (7.1) and Rumford, Maine (9.0) to more than 28 fills per 100 in Ellsworth, Maine (31.0), Bangor, Maine (29.4), and Franklin, New Hampshire (28.9). In addition to Bangor, among HSAs with large hospitals, rates in Augusta, Maine (27.1) and Concord, New Hampshire (22.2) were more than twice as high as rates in Dover, New Hampshire (10.6) and Burlington, Vermont (10.6).



Map 35. Prescription fills for antipsychotics per 100 children among hospital service areas (2007-10)

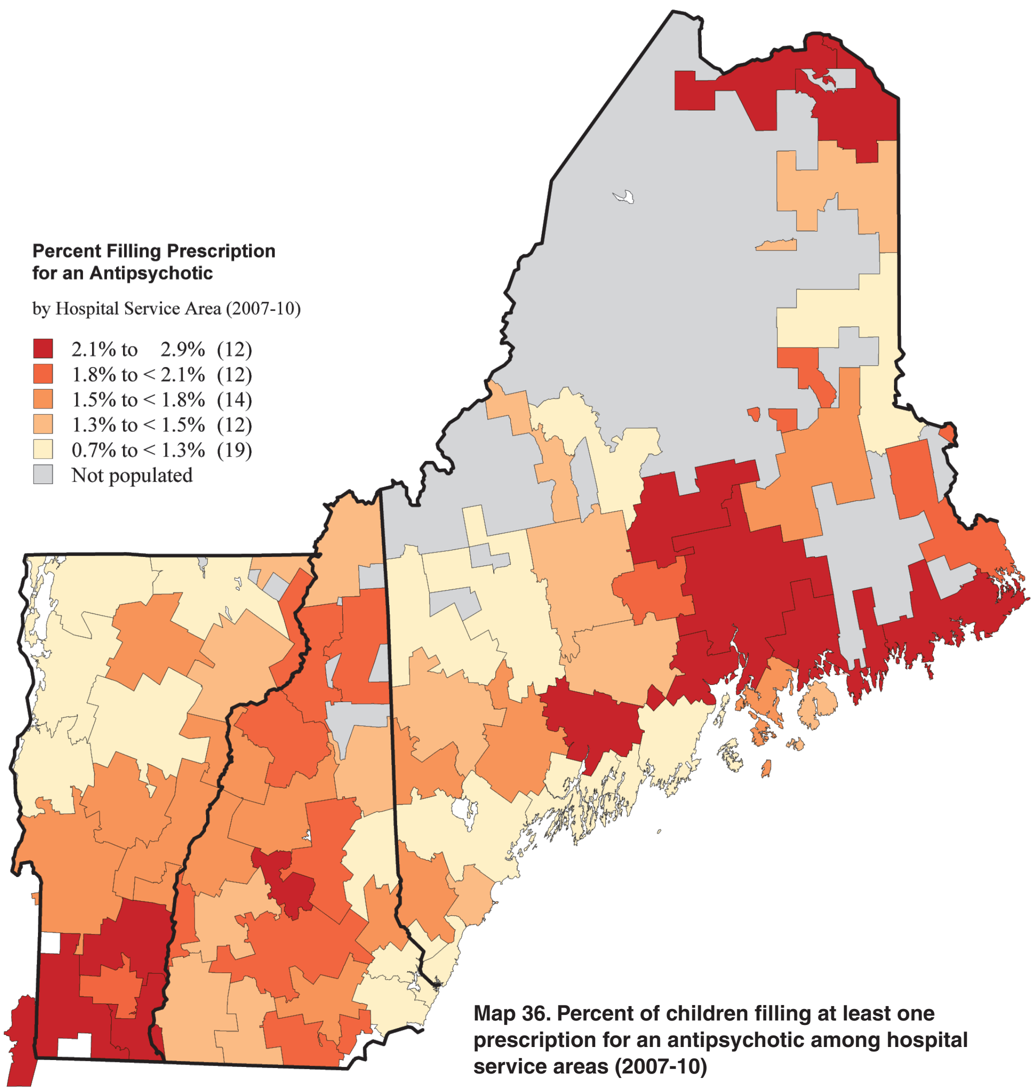
Overall, 1.6% of children used antipsychotics annually during 2007-10. The percent using antipsychotics ranged from less than 1% in Boothbay Harbor, Maine (0.8%), Burlington, Vermont (0.9%), and St. Albans, Vermont (0.9%) to more than 2.5% in Ellsworth, Maine (2.9%), Caribou, Maine (2.8%), and Bennington, Vermont (2.7%). Among HSAs containing large hospitals, rates were much higher in Bangor, Maine (2.5%) than in the three HSAs with children's hospitals.



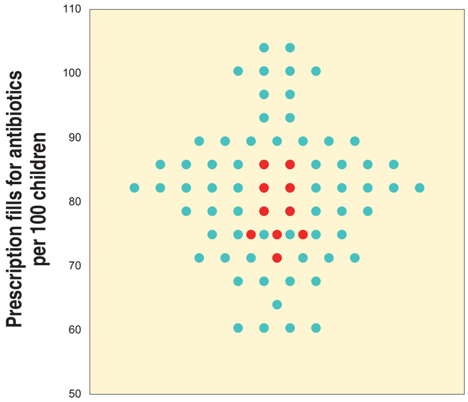
Bangor, ME	2.5%
Augusta, ME	2.4%
Concord, NH	2.0%
Nashua, NH	1.9%
Lewiston, ME	1.7%
Lebanon, NH	1.6%
Manchester, NH	1.5%
Dover, NH	1.2%
Portland, ME	1.1%
Burlington, VT	0.9%

Figure 42. Percent of children filling at least one prescription for an antipsychotic among hospital service areas (2007-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 36. Percent of children filling at least one prescription for an antipsychotic among hospital service areas (2007-10)



Dover, NH	86.3
Nashua, NH	85.7
Bangor, ME	83.2
Manchester, NH	80.8
Concord, NH	79.5
Burlington, VT	77.9
Lewiston, ME	75.5
Lebanon, NH	75.4
Portland, ME	74.6
Augusta, ME	71.0

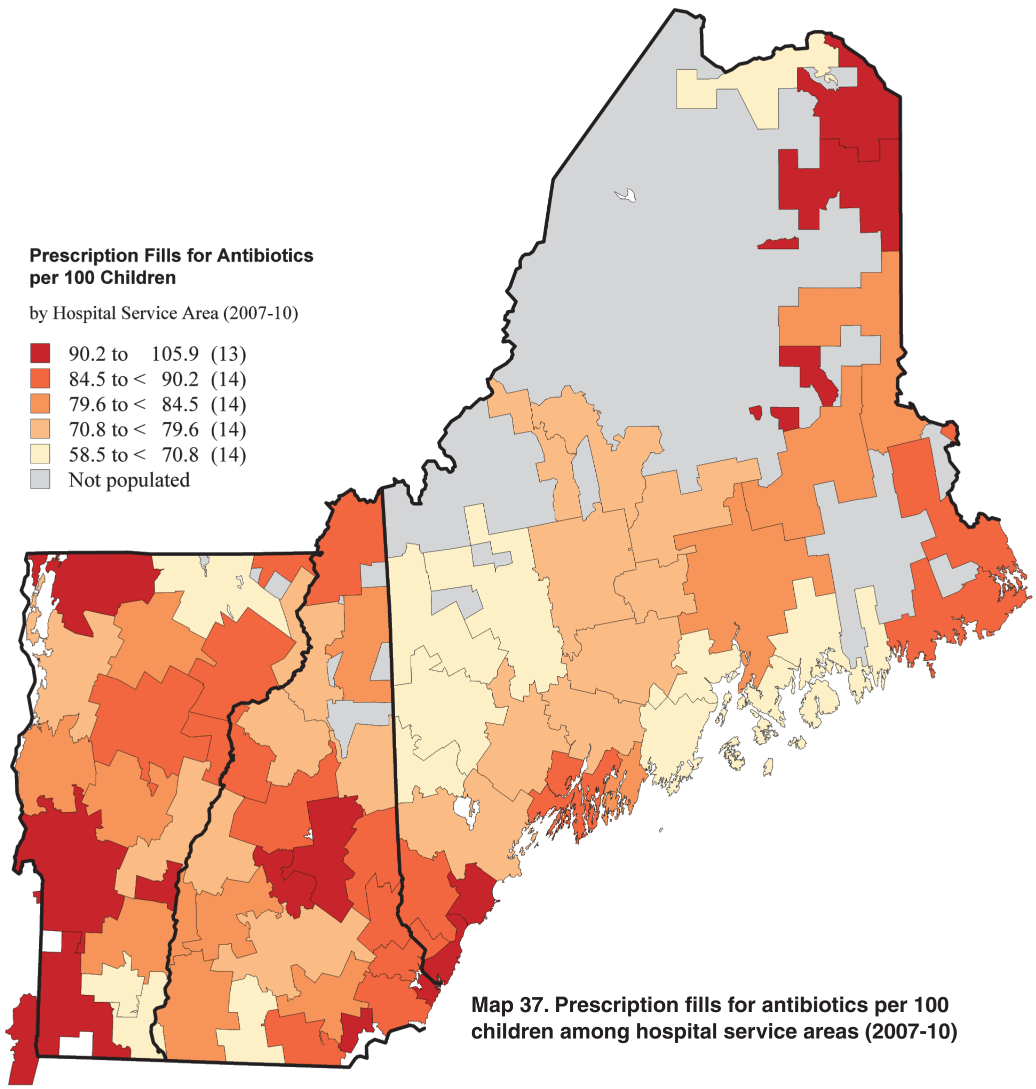
Figure 43. Prescription fills for antibiotics per 100 children among hospital service areas (2007-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.

Commonly used non-psychiatric medications

Antibiotics

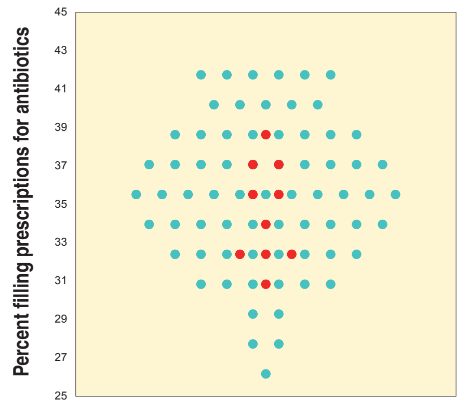
While pediatric antibiotic use has decreased substantially in recent decades, this group of medications remains the most commonly prescribed drug type in children nationally and in Northern New England.[103,134,135] Antibiotics have long been the subject of treatment guidelines covering common pediatric infections, and these guidelines are routinely updated to reflect evolving understanding of the most optimal antibiotic use.[108] Perhaps as a result of such guidance, use of these medications varies the least of all the medications examined in this report among children in Northern New England.



Map 37. Prescription fills for antibiotics per 100 children among hospital service areas (2007-10)

In Northern New England, there were 81.8 prescription fills for antibiotics per 100 children annually during 2007-10. This rate varied by a factor of 1.8, from fewer than 60 fills per 100 children in Townshend, Vermont (58.5) and in three Maine HSAs—Norway (58.5), Rumford (59.3), and Blue Hill (59.7)—to more than 100 in York, Maine (100.9) and in three Vermont HSAs—Rutland (101.2), Bennington (105.7), and St. Albans (105.8). There was little variation among the HSAs containing large hospitals, where the rates ranged from 71.0 fills per 100 children in Augusta, Maine to 86.3 fills per 100 in Dover, New Hampshire.

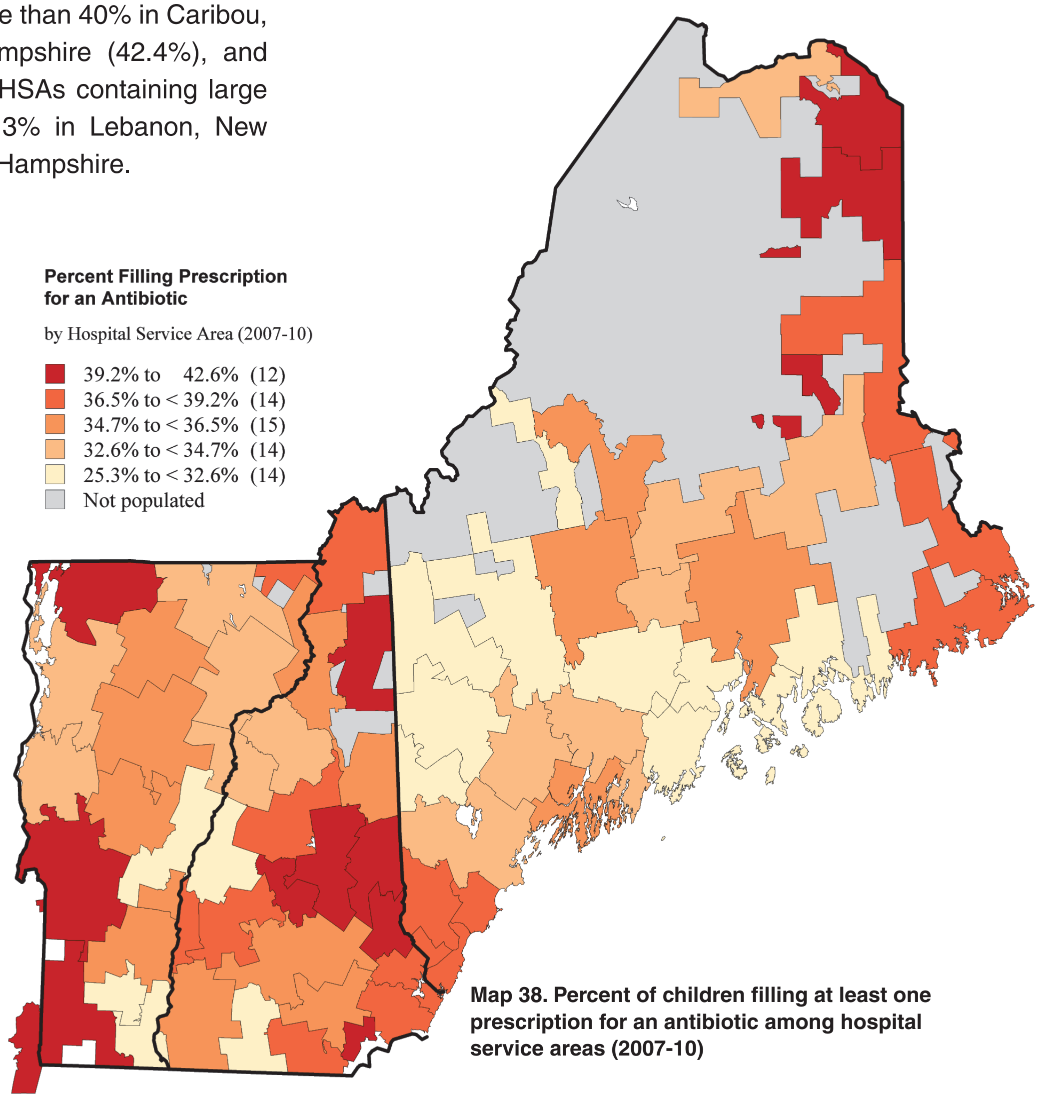
Overall, 35.7% of children in Northern New England filled a prescription for an antibiotic annually during 2007-10. The rate of antibiotic use varied from less than 30% of children in Rumford, Maine (25.4%), Norway, Maine (27.9%), and Brattleboro, Vermont (29.4%) to more than 40% in Caribou, Maine (42.5%), Franklin, New Hampshire (42.4%), and Rutland, Vermont (42.2%). Among HSAs containing large hospitals, the rate varied from 31.3% in Lebanon, New Hampshire to 39.0% in Dover, New Hampshire.



Dover, NH	39.0%
Nashua, NH	37.4%
Bangor, ME	36.5%
Manchester, NH	36.1%
Concord, NH	35.8%
Burlington, VT	33.8%
Augusta, ME	33.0%
Portland, ME	32.7%
Lewiston, ME	32.6%
Lebanon, NH	31.3%

Figure 44. Percent of children filling at least one prescription for an antibiotic among hospital service areas (2007-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.

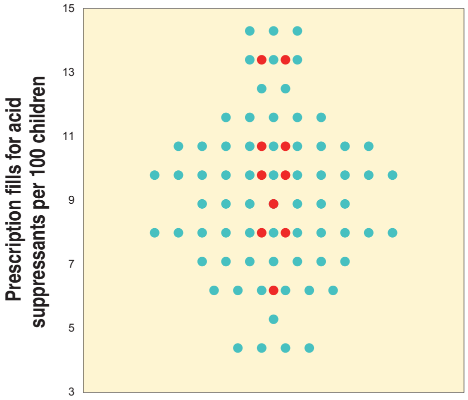


Map 38. Percent of children filling at least one prescription for an antibiotic among hospital service areas (2007-10)

Gastric acid suppressing medications

Acid suppressing medications are among the prescription drugs most commonly prescribed for children. For examination of these medications, this reports combines two drug classes: the commonly used and highly advertised proton pump inhibitors (PPIs) (e.g., esomeprazole, sold under the brand name Nexium), and an older group of similar but less potent medications known as histamine two receptor blockers (H2RAs) (e.g., famotidine, sold under the brand name Pepcid). In general, these two classes of medications treat the same conditions: heartburn (also known as gastroesophageal reflux) and gastritis (inflammation of the stomach). Ideally, patients needing such treatment are tried first on an H2RA and offered a PPI only if the H2RA is not sufficient to control the symptoms or disease. The two drug classes are considered collectively here; overall, PPIs make up 55% of all antacid prescriptions fills in the dataset.

Little evidence supports the use of acid suppressing drugs for children, especially the very young—infants under age one—for whom they are used most commonly.[136-138] A growing body of literature documents rapidly increasing use of these drugs in the pediatric population.[137,139] This growth is occurring despite increasing evidence of adverse effects of PPIs in adults and persistent uncertainty about the safety and side effects associated with short- and long-term use of these drugs by children.[140-144]

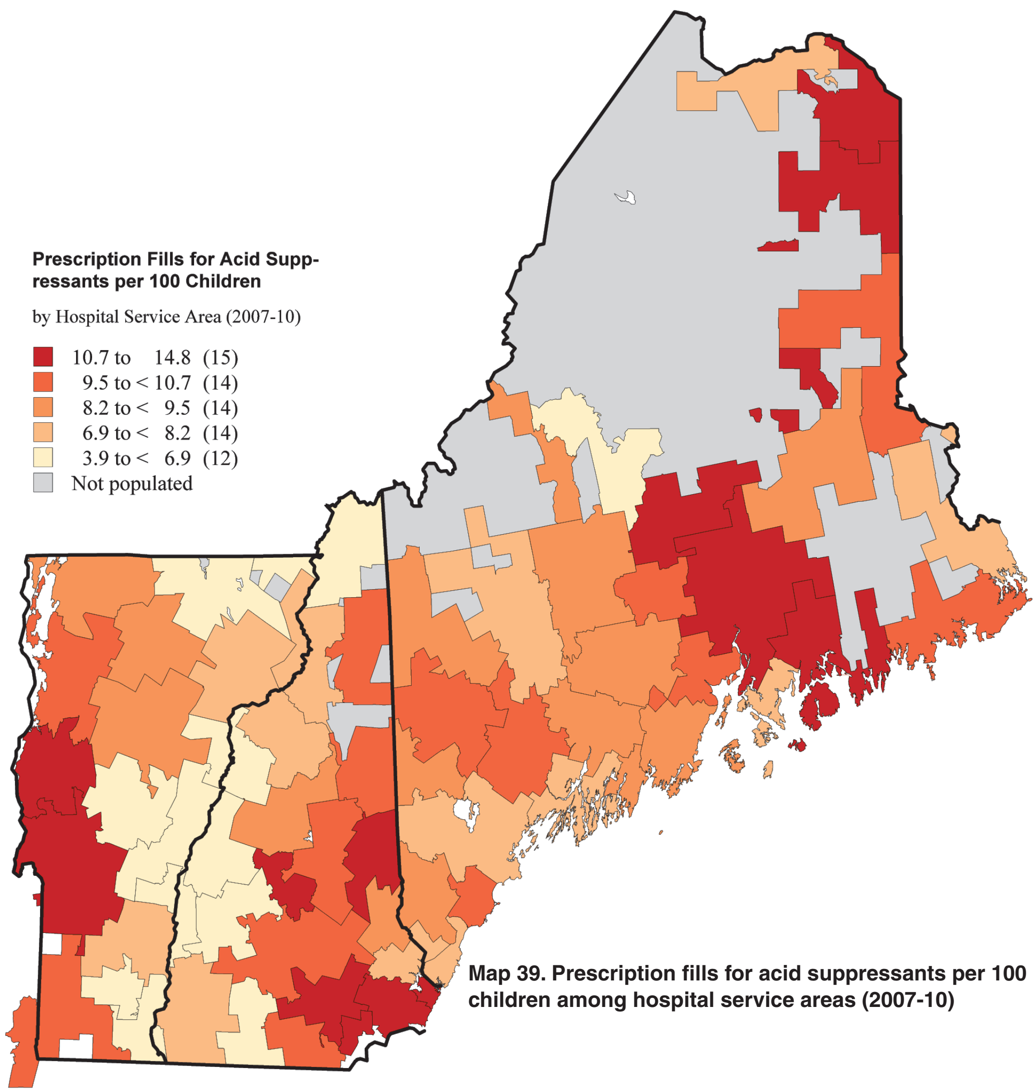


Bangor, ME	13.8
Manchester, NH	13.1
Burlington, VT	10.4
Nashua, NH	10.3
Concord, NH	10.1
Lewiston, ME	10.0
Augusta, ME	9.2
Portland, ME	8.0
Dover, NH	7.6
Lebanon, NH	6.4

Figure 45. Prescription fills for acid suppressants per 100 children among hospital service areas (2007-10)

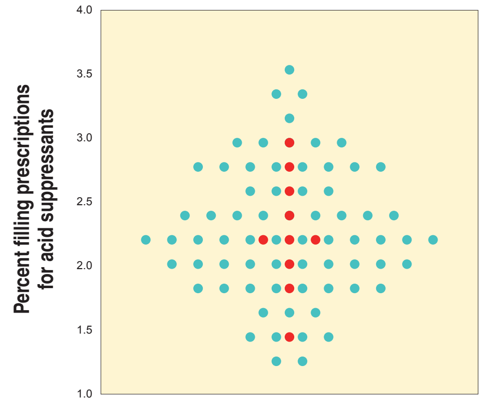
Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.

Annually, across Northern New England, there were 9.6 prescription fills for acid suppressants per 100 children during 2007-10. There was more than a threefold variation in the rates, from fewer than 5 fills per 100 children in Colebrook, New Hampshire (3.9), Brattleboro, Vermont (4.2), and New London, New Hampshire (4.8) to more than 14 per 100 in Presque Isle, Maine (14.8), Millinocket, Maine (14.6), and Derry, New Hampshire (14.1). The rate varied more than twofold across HSAs containing large hospitals, from 6.4 fills per 100 children in Lebanon, New Hampshire to 13.8 per 100 in Bangor, Maine.



Map 39. Prescription fills for acid suppressants per 100 children among hospital service areas (2007-10)

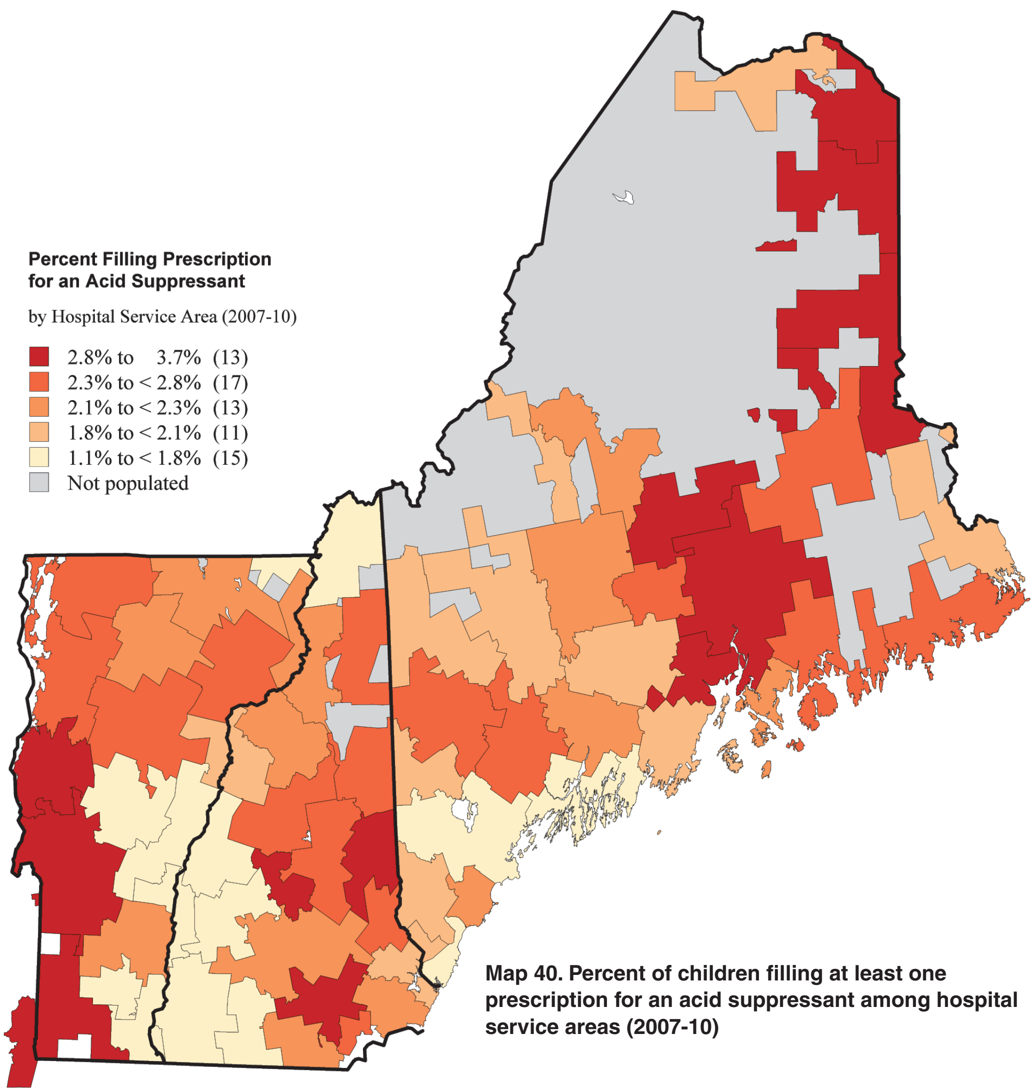
Overall, 2.3% of children filled prescriptions for acid suppressants annually in Northern New England during 2007-10. The percent using acid suppressants varied threefold across HSAs, from less than 1.5% in Brattleboro, Vermont (1.2%), Randolph, Vermont (1.3%), and Peterborough, New Hampshire (1.4%) to more than 3% in Presque Isle, Maine (3.6%), Caribou, Maine (3.4%), and Franklin, New Hampshire (3.3%). Among HSAs with large hospitals, the rate in Bangor, Maine (3.0%) was more than twice the rate in Lebanon, New Hampshire (1.4%).



Bangor, ME	3.0%
Manchester, NH	2.9%
Lewiston, ME	2.5%
Burlington, VT	2.3%
Augusta, ME	2.2%
Concord, NH	2.1%
Nashua, NH	2.1%
Dover, NH	2.0%
Portland, ME	1.7%
Lebanon, NH	1.4%

Figure 46. Percent of children filling at least one prescription for an acid suppressant among hospital service areas (2007-10)

Each blue dot represents one of 69 hospital service areas in Northern New England. Red dots indicate the 10 HSAs with the largest number of acute care hospital discharges.



Map 40. Percent of children filling at least one prescription for an acid suppressant among hospital service areas (2007-10)

How does the use of one drug type relate to use of others?

Correlations, or relationships between the use of one type of medication and another, contribute to the understanding of the determinants of medication use in general in important ways. Correlations can support the understanding of what drives prescription use, or they can reveal unexpected relationships that suggest a need to rethink the assumptions about drug use determinants.

Figures 47 and 48 show positive relationships between antidepressant use and ADHD medication use within HSAs: $R^2 = 0.48$ for rate of use (fills per 100) and $R^2 = 0.44$ for the percent with any use. One might expect these correlations, assuming that clinicians with a tendency to prescribe more or less of one psychiatric medication are likely to demonstrate similar tendencies for other psychiatric

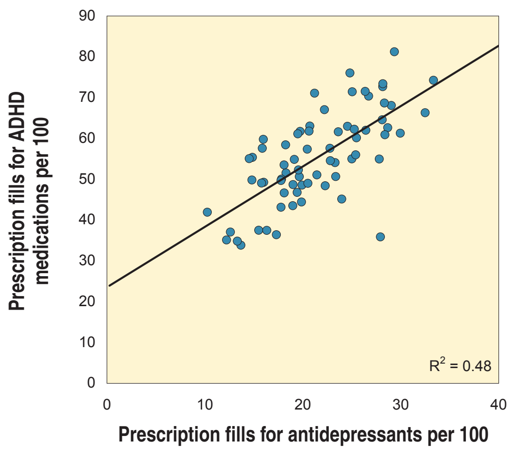


Figure 47. Relationship between prescription fills for antidepressants and ADHD medications among hospital service areas (2007-10)

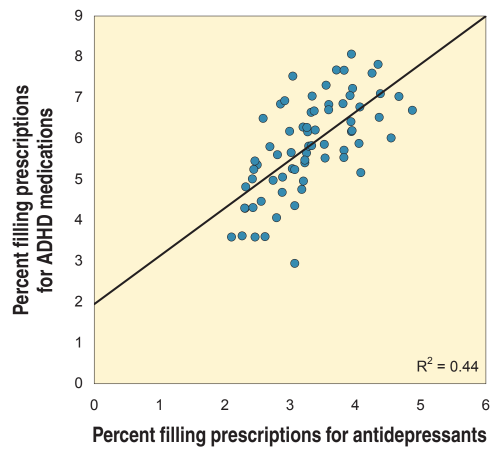


Figure 48. Relationship between the percent of children filling at least one prescription for antidepressants and ADHD medications among hospital service areas (2007-10)

medications. Some correlation in use could also be explained by the propensity of some children to suffer both depression and ADHD; the co-occurrence of these two conditions in individual patients is estimated to be between 12% and 50%, which would explain some, perhaps much, of the observed association.[145-147]

The relationship between the use of antidepressants and acid suppressants was also examined. Figures 49 and 50 show that there was no correlation between these two distinct drug groups (R^2 = 0.00 for rate of use and R^2 = 0.02 for the percent with any use), demonstrating no relationship between the tendency to prescribe antidepressants and the likelihood of prescribing acid suppressants. This suggests that prescribing is selective. Depression and gastrointestinal symptoms are not clinically related, so more—or less—use of antidepressants should not logically be associated with more acid suppressant use, unless utilization is largely driven by overall prescribing tendencies rather than patient needs.

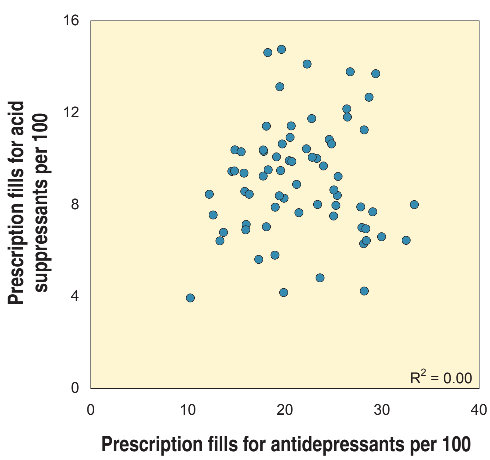


Figure 49. Relationship between prescription fills for antidepressants and acid suppressants among hospital service areas (2007-10)

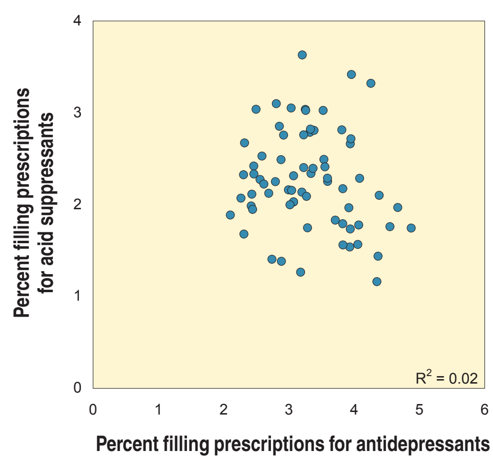


Figure 50. Relationship between the percent of children filling at least one prescription for antidepressants and acid suppressants among hospital service areas (2007-10)

How does prescription use relate to the use of non-prescription services?

Two of the effective care measures described earlier in this report demonstrated variation in high-quality clinical follow-up of children treated with ADHD medications (see the Effective Care section). How does performance on these quality measures relate to the overall use of ADHD medications? One might expect clinicians in areas with high ADHD medication use to have operationalized a systematic approach to clinical follow-up of treated children and thus to perform better on these measures of quality. This would result in a high correlation. Conversely, greater use of ADHD medications means that more children need the recommended clinical follow-up, making sufficient follow-up more demanding in terms of visit volume and tracking; in this case, higher use could result in lower performance on these quality measures. Figures 51 and 52 show that the measures were unrelated: R^2 = 0.00 between the percent of children using ADHD medications and follow-up during the initiation phase (within 30 days of the initial prescription) and R^2 = 0.00 between the percent using ADHD medications and continuing follow-up (31-300 days following the initiation of medication), demonstrating no relationship between the tendency to prescribe ADHD medications and performance on the HEDIS quality measures of appropriate clinical monitoring of children pharmacologically treated for ADHD.

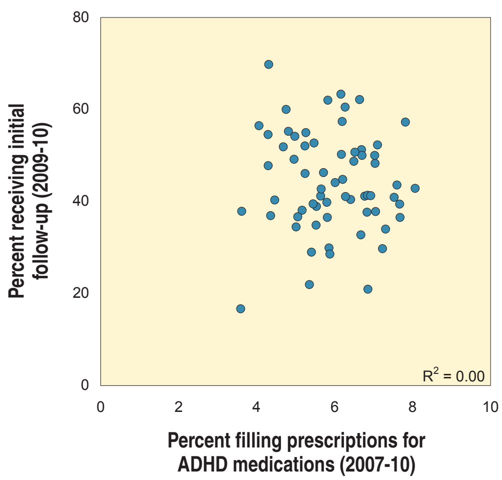


Figure 51. Relationship between the percent of children filling at least one prescription for ADHD medications and the percent receiving initial follow-up among hospital service areas

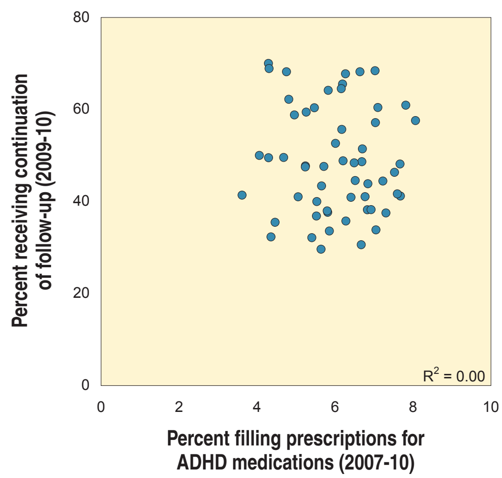


Figure 52. Relationship between the percent of children filling at least one prescription for ADHD medications and the percent receiving continuation of follow-up among hospital service areas

Summing up

This section demonstrates substantial variation in the use of medications among children. These analyses were adjusted for differences across HSAs in population age, sex, and the proportion insured by Medicaid versus commercial insurance. The wide range of prescription intensity, similar to other services examined, suggests a lack of consensus regarding the optimal approach to medication use for children and the likely influence of clinician practice style.

The report describes the landscape of pediatric prescribing in Northern New England. While we cannot identify specific instances of good or bad prescribing practice at the HSA level, there is likely both underuse and overuse given the extent of the variation, the uncertainty in diagnosis, and the lack of evidence to support many of the common current uses of these medications. This suggests that there are two important steps to improving care. The first is more research into the effectiveness of these medications for childhood illness. This need has been recognized by past legislation, such as the Best Pharmaceuticals for Children Act of 2002 (BPCA), which mandated the federal government (i.e., the National Institutes of Health) to sponsor pediatric studies of drugs approved for use in the U.S. but lacking evaluation in the pediatric population.[148-150] The need for pediatric drug research has also been acknowledged recently by legislators through the Patient Protection and Affordable Care Act of 2010, which includes a Program for Pediatric Study of Drugs.[151] While history suggests that the fruits of these efforts will be slow to emerge, in part due to slow dissemination and uptake of evidence by physicians, these efforts hold promise for the advancement of pediatric drug effectiveness evidence.[152,153]

A second important step to improving pediatric prescribing practice is clearer communication of drug benefits and risks and greater implementation of shared decision-making. Shared decision-making more fully informs patients and families of the expected outcomes of treatment choices, including the uncertainty of the evidence, and assists them in clarifying their health goals to arrive at a decision that reflects their informed preferences. Shared decision-making has been used to improve decision quality for otitis media and attention deficit hyperactivity disorder, but its application is much less developed in pediatrics than in adult medicine.[13,14,16] Better evidence and an emphasis on a collaborative approach to decision making, especially in situations of diagnostic and therapeutic uncertainty, should improve prescribing practice and ultimately reduce variation to that which is driven by true differences in patient and family preferences.

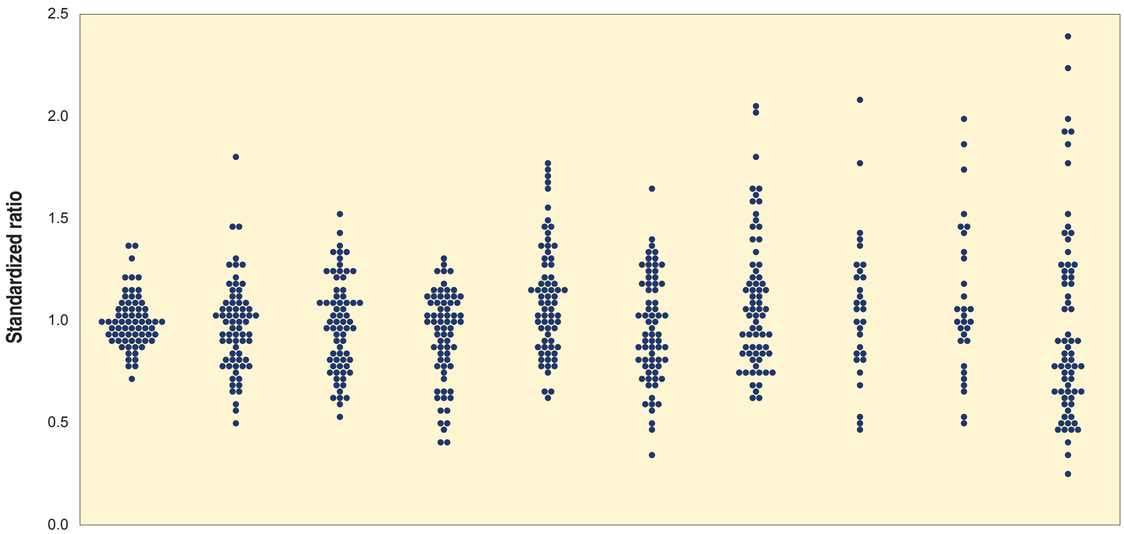
Table 20. Prescription drug use among children in Northern New England states (2007-10)

	Total prescription fills per 100 children	ADHD medications		Antidepressants		Antipsychotics		Antibiotics		Acid suppressants	
		Fills per 100	% with fill	Fills per 100	% with fill	Fills per 100	% with fill	Fills per 100	% with fill	Fills per 100	% with fill
Maine											
Overall	429.9	59.5	5.7%	23.0	3.3%	17.8	1.6%	77.3	33.9%	9.6	2.2%
Commercially insured	322.4	35.4	4.3%	18.5	2.9%	6.6	0.7%	72.4	32.8%	6.9	1.7%
Medicaid	559.6	88.5	8.2%	28.4	4.1%	31.1	3.2%	83.2	35.3%	12.9	3.0%
New Hampshire											
Overall	451.4	55.4	6.3%	21.7	3.2%	16.2	1.6%	83.8	36.7%	10.0	2.2%
Commercially insured	356.8	39.4	4.7%	18.9	2.8%	6.5	0.8%	78.7	33.8%	7.5	1.6%
Medicaid	562.6	74.7	7.9%	25.1	3.6%	27.7	2.5%	89.8	39.2%	12.9	2.8%
Vermont											
Overall	418.9	51.0	5.0%	19.2	2.9%	13.2	1.4%	85.8	36.0%	9.0	2.4%
Commercially insured	347.0	31.5	3.3%	15.2	2.1%	5.3	0.5%	82.6	33.5%	8.1	1.9%
Medicaid	505.9	73.5	6.5%	23.7	3.4%	22.4	2.1%	89.8	36.8%	10.3	2.7%
Northern New England											
Overall	435.0	55.7	5.8%	21.5	3.2%	16.0	1.6%	81.8	35.7%	9.6	2.3%
Commercially insured	339.9	35.9	4.2%	17.8	2.7%	6.2	0.7%	76.9	33.3%	7.4	1.7%
Medicaid	546.3	79.0	7.7%	25.8	3.8%	27.4	2.6%	87.6	37.9%	12.2	2.9%

Tables containing data for all Northern New England HSAs may be found in the Appendices.

A Path Forward

Where children live in Northern New England has a powerful effect on the quality and quantity of the health care they receive. The variation across small health care areas is striking for both effective care and for utilization measures. Whether the care is lead screening, tonsillectomies, mental health hospital admissions, or prescriptions for psychotropic medications, health care depends a great deal on where children live and receive their care (Figure 53).



	Overall prescrip-tion fills per child	Chest x-rays per 1,000	All medical discharges per 1,000	Office visits per child	ER visits per 1,000	Head CT scans per 1,000	Head MRIs per 1,000	PE tube placement per 1,000	Tonsillec-tomy per 1,000	Mental illness discharges per 1,000
Regional average	4.4	71.5	11.7	2.8	359.3	12.0	7.1	7.4	5.5	5.2
Extremal ratio	1.96	3.74	2.82	3.31	2.85	4.61	3.35	4.45	4.11	9.54
Interquartile ratio	1.16	1.35	1.42	1.38	1.42	1.50	1.49	1.47	1.48	1.92
Coefficient of variation	12.9	23.2	23.3	24.1	24.8	26.9	30.3	33.0	34.1	46.2

Figure 53. Patterns of variation in measures of children's health care among Northern New England areas

This examination of children's health care raises important questions about where care is better. Why do the children of Dover, New Hampshire (whether insured by Medicaid or commercial plans) have almost twice as many emergency room visits as those living in Burlington, Vermont? Why do children in Berlin, New Hampshire or Newport, Vermont have medical hospitalization rates almost half those in Rutland, Vermont or Manchester, New Hampshire? Is hospital care rationed in Berlin and Newport, or are some of the hospital stays in Rutland and Manchester preventable? Do the children of Lebanon, New Hampshire benefit from tonsillectomy rates 90% higher than Berlin, Vermont and 170% higher than

Burlington, Vermont? What value do the children of Manchester, New Hampshire, St. Albans, Vermont, or Lewiston, Maine receive from high rates of head CT scans and the accompanying radiation exposure? Are they better off than children in the areas served by the three major children's hospitals—Portland, Maine, Lebanon, New Hampshire, and Burlington, Vermont—where children receive at least 20% fewer scans?

The variations presented in this report are largely unwarranted; that is, they are only partially explained by differences in population characteristics or health risk. The variations, instead, are primarily the result of differences in the way physicians, hospitals, and clinics provide care.[8] These practice styles evolve slowly and invisibly over time, reflecting area differences in investments in hospital-based resources (e.g., beds, CT scanners, and MRI scanners) and in physician supply. Practice styles are also shaped by where physicians train and their practice experience. The patterns of pediatric care observed across the regions of Northern New England are the sum of thousands of well-intentioned decisions by doctors and nurses, but they do not all represent "best care."

What is the right rate? For effective care, the answer is generally the highest rate. With few exceptions, all children should receive care for which the evidence of benefit outweighs potential harms. HEDIS measures and quality metrics endorsed by the National Quality Forum and other national organizations[154] can identify some of the improvements needed in quality. Unfortunately, meaningful quality measures in pediatrics are few and far between.[155]

The right rate for most kinds of pediatric care is less certain, but is unlikely to be the highest rate. For many illnesses in children, commonly used treatments (e.g., hospitalization, tonsillectomy, or CT scans) are either not well supported by clinical studies, or there is substantial evidence of overuse and potential harm. Areas with low rates, adjusted for population characteristics, demonstrate what is achievable, whether by circumstance or by planned improvements in care. These rates should challenge health care providers in other areas to examine their approach to children's health care. Similarly, the relatively high use of CT scans and other imaging tests for the children of Northern New England raises questions about the value of current practices. With the evidence that imaging procedures infrequently inform treatment decisions, high rates likely represent many instances of overuse, conferring more risk than benefit.

In clinical situations where the benefits and risks are more balanced, there are often alternatives. For imaging procedures, these include studies with lower radiation doses or costs, or a period of active surveillance to better assess the need for testing. For decisions where there is more than one reasonable option, reliance on each clinician to make their own recommendation leads to as many different area rates as there are physician opinions about the "right" test or treatment.

The ethical and clinically effective approach is to provide balanced information to families and then more fully engage them to participate in the decision. This is termed shared decision-making.[156,157]

The need for shared decision-making is especially acute in the treatment of common ear, nose, and throat diseases. Seventy-five years after Glover's paper[50] (see the Common Surgical Procedures section) questioned the value of tonsillectomies in English schoolchildren, the best that can be said is that some patients experience short-term benefit, while many other children do just as well without the procedure. This dilemma cannot be addressed by clinical guidelines; it instead requires high-grade decision aids to improve decision quality through shared decision-making. In most cases, decision aids are not available for pediatric illness. These are two areas in need of further investment: improving the understanding of the effectiveness of common pediatric interventions and improving decision quality through shared decision-making.

Whatever the causes and consequences of the variations presented in this report, these findings should challenge the idea that children's health care only needs more resources. More resources are needed in some domains of children's health care, but they will not address the irrational care patterns that are evident today. Curiosity, inquiry, and better use of existing resources by local health care systems are equally important. At the same time, investment in health care surveillance is necessary for pediatric care to evolve and improve. How can health care systems improve if they lack information about the quality and efficiency of the care they provide today?

Nationally, children's health care is a black box. Provider accountability is elusive without adequate data, measures, and public reporting. Pediatric care processes and outcomes are usually only available for the nation as a whole, or for populations too large to be attributed to particular providers. In other instances, the data show dramatic differences in quality across providers—affecting survival chances or quality of life—but the names of the responsible hospitals or care units are not publicly available. While difficult to accomplish,[158] the value of public reporting is twofold. First, it leads to faster change compared to confidential feedback to providers.[159] Second, when there is information about the quality and outcomes of care that would alter parents' decisions for their children, it is ethically appropriate and just to make that information available.

The depth and breadth of both public reporting and the use of care measures to understand and improve quality is most fully developed for the elderly population insured by Medicare. While still not perfect, information in administrative databases, clinical record systems, and surveys, reported for regions, small areas, and specific providers, is broad and deep. The availability of this information has permitted research about care that has no parallel in any other population in the

U.S.,[160] or in any other country.[161] Today, the evaluation of children's health care is a pale semblance of that conducted in the elderly.[155]

The scarcity of data available for research and evaluation of children's health care has slowed our pace of improvement. The recent development of All Payer Claims Datasets by a growing number of states[32] is an important advancement. As shown in this report, these data allow measurement across virtually the entire population for all types of care. While these data lack the clinical details available in some pediatric disease registries and provider collaboratives, they are often available for research and/or public reporting efforts. Expanding these data to additional states and making them available are essential to clinicians, policy makers, and administrators seeking to improve care, to researchers who aim to understand care, and to families who want to choose the best care possible for their children.

How to Interpret the Measures: Utilization, Variation, and Association

What is a rate?

A rate measures how often something happens in a defined population. In health care, a rate is usually expressed as the number of events (physician visits, procedures, prescription fills, etc.) that occur in a given group of people over a given period of time (the numerator), divided by the total number of members of the group (the denominator) during that period. For example, if there are 100 children in a group, and 15 of them fill a prescription for an antibiotic in one year, the rate of antibiotic use is 15 per 100 for that year. This can also be expressed as a rate of 15%. In this report, the rates are conveyed in several different ways. Some represent the number of events (visits, procedures, etc.) occurring among children with commercial insurance or Medicaid divided by the total number of insured children living in a given geographic area. These rates are expressed as the number of events per child, per 100 children, or per 1,000 children. Others represent the number of children experiencing one or more of a specific kind of event, including effective care services. These rates are expressed as the percent of children (number of children per 100) receiving at least one service. Most are averaged over a four-year period, 2007 to 2010.

These rates (with the exception of those for physician supply and effective care) have been adjusted for age, sex, and the proportion of children insured by Medicaid. This means that patient characteristics that might affect how commonly an event occurs have been taken into account. For example, in communities where a higher proportion of children is insured by Medicaid, there may be a higher incidence of emergency room use, because these children are more likely to have emergency room visits. That could affect the rate of observed ER use. Adjusting reported rates for insurance type makes it unlikely that the variation we see in rates of ER use in different communities is due to the different mix of insurance in the population. Adjusting for age similarly makes it unlikely that observed differences across areas are explained by different areas having more younger—or older—children. In essence, these adjustments make the results what they would be if there were no age, sex, or insurance differences between areas.

Knowing the rate at which a particular event occurs among communities is a way to compare the average chance of receiving that treatment, depending on where one lives. For example, during the period from 2007 to 2010, the average rate of tonsillectomy among children living in Littleton, New Hampshire was 10.9 per 1,000. The rate in Bangor, Maine was 2.7 per 1,000, less than one quarter of Littleton's rate. That means that a child in Littleton was more than four times as likely to get a tonsillectomy as a child in Bangor. Another way to judge the chance of receiving a service is to compare the rate in a given community against the regional average. The rate of tonsillectomy in Littleton was nearly twice the Northern New England average.

Measures of variation and association

The distribution graph

The distribution graphs used in the Atlas provide a simple way to show the dispersion in particular rates of health care, in this case across the 69 hospital service areas and 30 pediatric surgical areas in Northern New England. For example, Figure 15 shows the distribution of hospitalization for mental illness across the 69 HSAs. The vertical axis shows the rates of mental health discharges per 1,000 children. Lewiston, Maine, which had the highest rate of use, is represented by the highest point on the graph. Newport, Vermont, which had a rate of 1.2, is represented by the lowest point on the graph. Areas with very similar rates are arrayed on a single line because their rates fall into a "bin" between two values.

This chart summarizes two features of the data. The first is a measure of dispersion; if the rate of mental health discharges per 1,000 insured children (or whatever measure is on the vertical axis) for the highest HSA is two or three times higher than the rate per 1,000 insured children in the lowest HSA, it suggests substantial variation. Second, the distribution graph shows whether the variation is caused by just a few outliers—HSAs that, for various reasons, are very different from the rest of the region—or whether the variation is pervasive and widespread across the region. In the above example, there was widespread dispersion across Northern New England; no one area stands apart from all other areas, as displayed in Figure 15.

R^2 and regression lines

In this Atlas, we often suggest that some factors may be related in a systematic way to other factors. For example, in the Hospitalization section, we show that areas with high rates of hospitalization for mental illness among commercially insured children also had high rates for children insured by Medicaid. To capture the degree and extent of the association between mental health discharges among children with commercial insurance and Medicaid, in Figure 17, we plotted mental health discharge rates per 1,000 commercially insured children on the horizontal axis and discharge rates per 1,000 children with Medicaid on the vertical axis, and placed a point on the graph for each of the 69 HSAs. If mental health discharge rates among children with commercial insurance and Medicaid were negatively correlated, so that areas with higher rates among commercially insured children had lower rates among those with Medicaid, then we would see a cloud of points tilted downward, running from northwest to southeast. Conversely, if they were positively correlated—as they in fact were—the cloud of points runs from southwest to northeast on the graph, as seen in Figure 17.

It is sometimes difficult to discern from a cloud of points in a figure the strength of the relationship between two variables. A linear regression line estimates the best fit of the data and summarizes the relationships between them. A measure of the "goodness of fit," or the extent to which mental health discharges among commercially insured children predict discharges among those with Medicaid, is the R^2 (from Pearson's correlation), which is defined as the proportion of total variation in the vertical axis (discharges among children with Medicaid) that is explained by variation in the horizontal axis (discharges among commercially insured children). It ranges from 0 to 1, where 1 is perfect correlation and 0 means that the two variables are completely unrelated. In Figure 17, the R^2 for the relationship between mental health discharges among the two populations of children is 0.46, which means that the two are strongly related; 46% of the variation among children with Medicaid was explained by the variation among commercially insured children. In contrast, Figure 18 shows that the rate of medical discharges is only weakly related to the percent of children in poverty. In this case, the R^2 value is 0.22, which means that only 22% of the variation in medical discharge rates was explained by the child poverty rate.

R values

While the R^2 value is informative and lets readers understand how much use of one service is related to another as a percent (see example above), we also present r values (not squared) from Spearman correlation tests. The r values presented in tables are similar to the R^2 values; they tell readers how one measure relates to another measure. The value of the r falls between +1 and –1. An r value of +1 represents a perfect positive correlation; as one measure increases, the other measure increases (or moves in the same direction) a predictable amount. An r value of zero means there is no correlation; the measures move independently, and change in one measure results in no predictable change in the other measure. An r value of –1 is a perfect negative correlation; as one measure increases, the other decreases (or moves in the opposite direction) a predictable amount. The r value lets readers assess how two measures relate. Table 7 shows a weak negative relationship between the percent of children receiving initial follow-up visits after being prescribed medication for ADHD and the child poverty rate in the region. The r value is -0.18. This means regions with higher rates of child poverty tended to have modestly lower rates of appropriate follow-up following the initiation of ADHD medication. An opposite relationship is seen between this effective care measure and the supply of child health physicians: the r value is 0.33, meaning HSAs with higher rates on this effective care measure tended to be HSAs with more child health physicians.

Methods

Files used in the Atlas

This Atlas report depends on the integrated use of databases provided by numerous sources, which are listed in Table 21.

Table 21. Data files used in analysis

Type	Source	Description and Use in Analyses
All Payer Claims Datasets		
Maine	Maine Health Data Organization	Enrollment and medical claims for the commercially and Medicaid insured residing in Maine, 2007-2010. Medicaid data for Maine in 2010 was not available in time for this report.
New Hampshire	Bureau of Data & Systems Management, Office of Medicaid Business & Policy, NH Department of Health and Human Services	Enrollment and medical claims for the commercially and Medicaid insured residing in New Hampshire, 2007-2010.
Vermont	Vermont Department of Banking, Insurance, Securities, and Health Care Administration	Enrollment and medical claims for the commercially and Medicaid insured residing in Vermont, 2007-2010.
Resource Files		
AMA Masterfile 2009	American Medical Association	Includes one record for each allopathic/osteopathic physician with practice ZIP code, self-designated specialty, major professional activities, and federal/non-federal status. Used to determine specialty-specific counts of physicians in each health care market.
Other Files		
Population files 2010	U.S. Bureau of the Census	Data from the U.S. Bureau of the Census 2010 and American Community Survey: 2006-2010 estimated counts of residents by Census tract. These were used (1) as denominators for physician supply, (2) to estimate child poverty in each health care market.
ZIP code boundary files through 2009	TomTom, Lebanon, NH	Includes records for each ZIP code with the coordinates of the boundary precisely specified. Used as the basis for mapping HSAs and HRRs and for assigning ZIP codes appropriately.
ZIP code centroid file 2010	Maponics, White River Junction, VT	Includes records for each ZIP code with the population-weighted coordinates precisely specified. Used for assigning 2010 ZIP codes to HSAs appropriately.

The geography of health care in the United States

Defining hospital service areas

Hospital service areas (HSAs) represent local health care markets for community-based inpatient care. The definitions of HSAs used in the original edition of the Atlas have been retained in subsequent editions in order to provide continuity of the market areas. HSAs were originally defined in three steps using 1993 provider files and 1992-93 utilization data. First, all acute care hospitals in the 50 states and the District of Columbia were identified from the American Hospital Association Annual Survey of Hospitals and the Medicare Provider of Services files and assigned to a location within a town or city. The list of towns or cities with at least one acute care hospital (N=3,953) defined the maximum number of possible HSAs. Second, all 1992 and 1993 acute care hospitalizations of the Medicare population were analyzed according to ZIP code to determine the proportion of residents' hospital stays that occurred in each of the 3,953 candidate HSAs. ZIP codes were initially assigned to the HSA where the greatest proportion (plurality) of residents was hospitalized. Approximately 500 of the candidate HSAs did not qualify as independent HSAs because the plurality of patients living in those cities was hospitalized in other cities.

The third step required visual examination of the ZIP codes used to define each HSA. Maps of ZIP code boundaries were made using files obtained from Geographic Data Technologies (GDT) (now TomTom) and each HSA's component ZIP codes were examined. In order to achieve contiguity of the component ZIP codes for each HSA, "island" ZIP codes were reassigned to the enclosing HSA, and/or HSAs were grouped into larger HSAs (for an illustration, please see the Appendix on the Geography of Health Care in the United States at www.dartmouthatlas.org/downloads/methods/geogappdx.pdf). Certain ZIP codes used in the Medicare files were restricted in their use to specific institutions (e.g., a nursing home) or a post office. These "point ZIPs" were assigned to their enclosing ZIP code based on the ZIP code boundary map.

This process resulted in the identification of 3,436 HSAs in the U.S. and 69 in Northern New England. In most HSAs, the majority of Medicare hospitalizations occurred in a hospital or hospitals located within the HSA.

In the communities of Northern New England, primary care and common types of hospital-based care for children usually occur in the same local hospitals that provide services to Medicare beneficiaries. The extent to which care occurs locally is shown through "localization indices" for many of the utilization events presented in the report (Table 22). These are calculated as the percent of the events (e.g., office visits, CT scans) for the children residing in the HSA that were done by providers within the HSA. Generally, for medical care (in contrast to surgery), these indices are at least as high for children as for the Medicare population. The localization indices vary by event and by area. HSAs that do not have the capacity to care for a wide range of pediatric problems have lower indices than the HSAs with children's hospitals. Localization indices for imaging tend to underestimate the local provision of care in some small rural hospitals with radiologists who serve more than one hospital, or when there is an affiliation with a larger hospital radiology practice.

Table 22. Localization indices for selected events among Northern New England hospital service areas

HSA Name	State	Percent localization				
		Office visits	ER visits	Medical discharges	CT & MRI scans	Chest & abdominal x-rays
Augusta	ME	67.9%	47.7%	26.8%	51.7%	70.2%
Bangor	ME	83.6%	76.0%	85.9%	78.7%	74.9%
Bar Harbor	ME	56.6%	66.7%	20.9%	30.2%	30.5%
Belfast	ME	73.5%	82.4%	23.2%	51.6%	48.2%
Biddeford	ME	61.5%	75.8%	32.0%	52.9%	57.8%
Blue Hill	ME	42.4%	72.0%	21.3%	30.8%	21.6%
Boothbay Harbor	ME	35.1%	76.4%	17.0%	11.3%	17.3%
Bridgton	ME	60.3%	63.1%	22.9%	13.2%	16.7%
Brunswick	ME	71.1%	76.2%	41.4%	21.0%	29.6%
Calais	ME	59.3%	89.5%	46.1%	69.3%	84.2%
Caribou	ME	52.2%	83.8%	40.9%	9.5%	15.4%
Damariscotta	ME	59.3%	74.2%	27.1%	25.0%	27.2%
Dover-Foxcroft	ME	48.8%	72.7%	26.4%	32.4%	35.4%
Ellsworth	ME	75.2%	79.1%	46.0%	48.6%	45.0%
Farmington	ME	70.3%	78.1%	57.8%	43.4%	43.0%
Fort Kent	ME	69.5%	89.7%	55.7%	72.1%	77.5%
Greenville	ME	40.8%	62.7%	22.2%	16.0%	31.0%
Houlton	ME	56.7%	89.7%	37.8%	53.6%	41.5%
Lewiston	ME	69.6%	84.1%	58.0%	50.2%	50.8%
Lincoln	ME	56.7%	77.3%	28.8%	26.2%	35.6%
Machias	ME	68.8%	75.4%	33.5%	4.1%	0.7%
Millinocket	ME	56.7%	82.0%	18.1%	45.7%	60.4%
Norway	ME	46.1%	75.9%	33.8%	55.5%	71.1%
Pittsfield	ME	27.4%	70.4%	19.2%	2.5%	0.2%
Portland	ME	85.7%	81.3%	94.1%	74.9%	72.3%
Presque Isle	ME	65.4%	76.2%	42.1%	51.8%	49.2%
Rockland	ME	74.7%	61.6%	50.1%	46.9%	60.4%
Rumford	ME	30.1%	75.3%	19.3%	10.7%	11.0%
Sanford	ME	32.7%	59.4%	19.6%	7.0%	7.7%
Skowhegan	ME	35.0%	77.5%	28.1%	48.3%	59.8%
Waterville	ME	67.6%	43.0%	29.1%	30.0%	29.7%
York	ME	65.6%	78.6%	43.4%	50.7%	55.7%
Berlin	NH	77.1%	88.3%	40.0%	51.5%	66.6%
Claremont	NH	47.6%	71.5%	7.5%	34.9%	35.7%
Colebrook	NH	39.0%	75.0%	15.2%	17.0%	2.3%
Concord	NH	70.9%	79.2%	49.5%	60.6%	61.4%
Derry	NH	39.7%	65.8%	34.0%	6.6%	6.3%
Dover	NH	49.9%	68.5%	47.9%	3.0%	12.4%
Exeter	NH	62.3%	57.3%	37.6%	57.3%	53.2%
Franklin	NH	42.3%	44.4%	5.3%	0.0%	0.0%

Table 22. Localization indices for selected events among Northern New England hospital service areas

HSA Name	State	Percent localization				
		Office visits	ER visits	Medical discharges	CT & MRI scans	Chest & abdominal x-rays
Keene	NH	74.1%	83.3%	36.2%	57.0%	64.0%
Laconia	NH	62.4%	80.1%	44.0%	60.7%	51.3%
Lancaster	NH	54.2%	71.2%	26.2%	20.4%	27.2%
Lebanon	NH	80.6%	79.2%	94.5%	84.4%	77.2%
Littleton	NH	72.0%	76.3%	35.7%	28.4%	50.8%
Manchester	NH	81.6%	79.5%	72.7%	72.3%	81.4%
Nashua	NH	75.9%	87.0%	68.4%	75.0%	76.7%
New London	NH	40.8%	44.1%	7.9%	0.0%	0.1%
North Conway	NH	83.9%	90.9%	48.8%	33.7%	40.0%
Peterborough	NH	71.8%	74.1%	24.9%	1.4%	0.5%
Plymouth	NH	68.4%	80.8%	36.9%	0.4%	0.8%
Portsmouth	NH	68.7%	65.4%	44.8%	55.1%	65.0%
Rochester	NH	51.9%	69.4%	45.9%	66.0%	64.8%
Wolfeboro	NH	56.2%	68.1%	38.1%	47.7%	51.6%
Woodsville	NH	61.4%	64.3%	16.7%	24.7%	18.3%
Bennington	VT	87.3%	87.0%	44.4%	79.3%	82.0%
Berlin	VT	68.1%	82.8%	30.6%	39.3%	38.1%
Brattleboro	VT	67.1%	71.6%	35.6%	50.1%	54.5%
Burlington	VT	90.9%	73.4%	90.4%	86.3%	89.7%
Middlebury	VT	74.4%	83.3%	20.2%	40.3%	51.3%
Morrisville	VT	65.8%	64.6%	28.3%	0.2%	3.9%
Newport	VT	75.3%	66.9%	29.2%	45.7%	54.2%
Randolph	VT	65.9%	49.2%	31.9%	2.5%	2.6%
Rutland	VT	79.4%	82.5%	52.9%	67.4%	59.9%
Springfield	VT	65.5%	76.8%	38.0%	48.8%	64.6%
St. Albans	VT	70.9%	88.5%	22.7%	51.7%	42.3%
St. Johnsbury	VT	81.4%	57.8%	59.7%	18.1%	18.2%
Townshend	VT	38.6%	60.8%	0.0%	0.0%	1.0%
Windsor	VT	40.9%	52.2%	14.5%	7.5%	8.8%

Defining pediatric surgical areas

The provision of common surgical procedures for children is more regionalized than for medical care. In order to define geographic markets for pediatric surgery, we aggregated hospital service areas based on children's travel for common ENT procedures and appendectomies. This resulted in 30 pediatric surgical areas (PSAs).

Table 23. Localization indices for selected events among Northern New England pediatric surgical areas

PSA Name	State	Percent localization	
		ENT procedures	Appendectomy
Augusta	ME	25.1%	62.7%
Bangor	ME	33.5%	69.1%
Brunswick	ME	84.2%	72.9%
Ellsworth	ME	32.1%	60.5%
Lewiston	ME	32.1%	70.2%
Portland	ME	88.7%	89.5%
Presque Isle	ME	24.1%	89.8%
Rockland	ME	81.2%	73.7%
Sanford	ME	31.0%	29.4%
Waterville	ME	69.2%	68.2%
York	ME	66.8%	81.4%
Berlin	NH	74.4%	61.5%
Concord	NH	66.3%	77.0%
Derry	NH	48.8%	69.0%
Dover	NH	69.8%	70.9%
Exeter	NH	60.2%	81.1%
Keene	NH	56.8%	68.3%
Laconia	NH	63.6%	74.8%
Lebanon	NH	81.5%	86.2%
Littleton	NH	55.6%	65.5%
Manchester	NH	86.0%	68.2%
Nashua	NH	59.9%	69.6%
Berlin	VT	44.7%	72.0%
Brattleboro	VT	74.3%	83.3%
Burlington	VT	87.7%	95.1%
Middlebury	VT	76.9%	71.0%
Newport	VT	53.2%	73.0%
Rutland	VT	57.2%	83.6%
Springfield	VT	42.9%	53.1%
St. Johnsbury	VT	38.7%	61.3%

Populations of HSAs and PSAs

The population was limited to those under 18 years of age. The Medicaid study population includes all children insured by Medicaid for each of the three states, with the exception of Maine 2010 data, which was not released in time for this report. The commercially insured study population varied by state, reflecting differences in which plans were required to report claims. As a result, the proportion of the total pediatric population included in the study differed. The proportion was higher than 90% for Maine and Vermont (with the exception of Maine in 2010), but ranged between 66% and 77% for New Hampshire (Table 24).

Table 24. Study population (person-years)

	2010 Census	2007	2008	2009	2010	Total
Maine						
Commercial		142,327	139,493	134,962	131,631	548,414
Medicaid		108,259	107,952	111,275	-	327,486
Total	274,533	250,586	247,445	246,237	131,631	875,900
Percent of 2010 Census population		91%	90%	90%	48%	
New Hampshire						
Commercial		119,377	112,979	119,899	134,587	486,842
Medicaid		74,550	76,911	82,016	86,429	319,906
Total	287,234	193,927	189,891	201,915	221,016	806,748
Percent of 2010 Census population		68%	66%	70%	77%	
Vermont						
Commercial		68,282	67,179	63,576	60,351	259,388
Medicaid		51,771	52,845	55,385	56,929	216,929
Total	129,233	120,053	120,024	118,961	117,280	476,318
Percent of 2010 Census population		93%	93%	92%	91%	
Northern New England region						
Commercial		329,986	319,651	318,438	326,569	1,294,644
Medicaid		234,580	237,708	248,675	143,359	864,322
Total	691,000	564,566	557,359	567,113	469,928	2,158,966
Percent of 2010 Census population		82%	81%	82%	68%	

Physician workforce rates

The source of information on physicians was the American Medical Association Physician Masterfile for 2009. This file has been used extensively to study physician supply and is the only comprehensive data available on physician location, specialty, and level of effort devoted to clinical practice. The physician file classifies physicians according to self-reported level of effort devoted to clinical practice. In this study, we excluded physicians who reported that they worked the majority of the time in medical teaching, administration, or research, and part-time physicians working fewer than 20 hours per week in clinical practice. The file also lists ZIP code fields indicating the physician's primary place of practice. When this information is not available, we use the physician's preferred professional address to indicate location.

Because the number of otolaryngologists is small and, therefore, more subject to error, we verified the location of every clinically active physician through the web pages of practices and hospital medical staffs. Unless there was information to the contrary, we assigned physicians with multiple locations to the largest hospital.

Physician specialties

The AMA Masterfile includes the physician's primary self-designated specialty from a list of 243 specialties. We grouped these into the categories listed in Table 25.

Table 25. Categories of clinically active physicians

Dartmouth-designated specialty	AMA codes
Pediatricians	PD
Family physicians	FP, FM, FSM, GP, AMF, FMP
Child health physicians	PD and FP, FM, FSM, GP, AMF, FMP
Otolaryngologists	OT, OTO, LAR, RHI, PDO, NO, OMF, PSO, SMO

Clinically active physician rates

Clinically active physicians were assigned to the HSA of their primary place of practice or preferred professional address. The rates for pediatricians and family physicians were calculated as the number of physicians divided by the 2010 Census population less than 18 years, multiplied by 100,000. For child health physicians, the number of physicians for the rate numerator was the number of pediatricians plus 25% of the number of family physicians. For otolaryngologists, the denominator was the total population.

Healthcare Effectiveness Data and Information Set (HEDIS) measures

Table 26 describes the HEDIS measures and available years. Detailed specifications can be found at the National Committee for Quality Assurance web site at www.ncqa.org/HEDISQualityMeasurement/HEDISMeasures.aspx

Table 26. HEDIS measures

Measure abbreviation and name		Measurement years			
		2007	2008	2009	2010
CAP	Children and adolescents' access to primary care practitioners	X	X	X	X
W15	At least 6 well-child visits in the first 15 months of life			X	X
W34	Well-child visits age 3-6	X	X	X	X
AWC	Adolescent well-care visits	X	X	X	X
CWP	Appropriate testing for children with pharyngitis		X	X	X
LSC	Lead screening in children under age 2 (Medicaid only)		X	X	X
URI	Appropriate testing and treatment for children with upper respiratory infections		X	X	X
ASM	Use of appropriate medications for children age 5-17 with asthma		X	X	X
ADDIN	Follow-up care for children prescribed ADHD medication – Initiation phase			X	X
ADDCT	Follow-up care for children prescribed ADHD medication – Continuation phase			X	X

Hospitalization, visits, and procedure rates

Medical event rates represent counts of the number of events that occurred in a defined time period (the numerator) for a specific population (the denominator). The counts of events are the rate numerators. The denominator is the corresponding enrolled insurance population (calculated using person-months) for a particular year and insurance type residing in each HSA (based on enrollment file ZIP codes). S-CHIP is categorized as Medicaid.

Procedures and conditions examined in the Atlas

The specific medical events and the codes used to identify the events in the claims files are given in Table 27.

Table 27. Codes used to define conditions and procedures

Event	Definition
Hospital Discharges	
Medical discharges	All medical DRGs, excluding mental and perinatal discharges
Mental health discharges	Clinical Classification System: 5. Mental illness
Ambulatory Care	
Office visits	CPT codes 99202–99205, 99212–99215, 99382–99384, 99392–99394
ER visits	CPT codes 99281–99285, or revenue center code 0981
Surgery	
Tonsillectomies	CPT codes 42820, 42821, 42825, 42826
Adenoidectomies without tonsillectomies	CPT codes 42830, 42831, 42835, 42836, and not 42820, 42821, 42825, 42826
Tympanostomy tube placement	CPT codes 69433, 69436
Imaging	
Head CT scan	CPT codes 70450, 70460, 70470
Chest and abdominal CT scan	CPT codes 74150, 74160, 74170, 74175, 71250, 71260, 71270, 71275
Head MRI scan	CPT codes 70544, 70545, 70546, 70551, 70552, 70553
Chest x-ray	CPT codes 71010, 71020, 71030
Abdominal x-ray	CPT codes 74000, 74010, 74020, 74022

Selection of codes was based on review of the literature and/or consultation with clinical experts. Some rates were suppressed for reasons of data confidentiality. Suppression rules meet the requirements of the data sources (generally < 5 children experiencing the event). Rates with fewer than 26 expected events may lack statistical precision and are shown in parentheses in the appendix tables.

Adjusted utilization rates

Utilization rates were adjusted using the indirect method for age (age categories 0-2, 3-4, 5-9, 10-14, and 15-17), sex, and insurance type (Medicaid or commercial plan) using the regional population as the standard. HEDIS measures and physician workforce measures were not adjusted.

Prescription drug rates

Prescription drug use was measured for the entire population of children included in the all payer dataset. Two distinct measures were employed for reporting rates and variation in prescription use: 1) prescription fill rates and 2) percent of children receiving one or more prescriptions for a specific drug type. Each measure begins with identification and counting of prescription fill records that reflect the receipt of a prescription from an outpatient pharmacy, including mail-order pharmacies.

Prescription fill rates

The first measure of prescription use is the rate of fill events per observed person-year. A person-year in this case is equal to 12 months of enrollment in an insurance plan included in the dataset. One person-year of observation could reflect two unique children enrolled for 6 months each, or one child enrolled for 12 full months. To calculate prescription fills per person-year, the total number of prescriptions filled was divided by the total number of person-years overall or in the HSA. For example, as seen in Figure 35, overall prescription use in this population was 4.4 fills per person-year. This can be thought of as, on average, 4.4 prescription fills per child per year.

In children, drug use can be relatively rare, especially for select drug groups. As a consequence, calculating fills per person-year can sometimes result in very small numbers, numbers far less than one. When this occurs, rates are reported as fills per 100 person-years, so that values appear as integers. A rate of 0.051 fills per person-year would thus be reported as 5.1 fills per 100 person-years, or per 100 children.

Percent of children receiving one or more prescriptions for a specific drug type

The second measure of prescription use aims to communicate to readers the proportion of all children over which total prescription fills were distributed. This measured is defined as the number of children receiving a prescription of interest divided by the total number of children in the dataset. These measurements were weighted for the amount of time that a child was present in the dataset. For example, a child in the dataset for 6 months contributed only half as much observation time as a child in the dataset for 12 months. The child with only 6 months of observation had half as much time as the child with 12 months of observed time to see a clinician and receive a prescription. In calculating the percent of children with any use of a specific drug type, the child observed for 6 months was "weighted," or counted slightly less than the child with 12 full months of enrollment, to adjust for this shorter observation time.

The two measures of prescription use are intended to be complementary. The first reveals the overall prescription use across the population. The second reveals what proportion of the population is responsible for the total observed prescription use. An illustrative example is found in the comparison of antibiotic use and ADHD medication use. The rate of antibiotic use for the full population was 82 fills per 100 person years; the rate of ADHD medication use was 56 fills per 100 person years. On average for each year during the study period, 35.7% of all children studied received at least one antibiotic, while 5.8% of all children received at least one prescription fill for an ADHD medication. The antibiotic use was distributed across a much larger proportion of the population than the ADHD medication use.

Medications not studied

In the measurement of overall prescription use, we excluded fluoride prescription fills because fluoride use is driven by regional differences in tap water fluoridation and thus is inappropriate for this study of variation in prescribing practices. Asthma medications are commonly prescribed pediatric drugs, but because their use is often intermittent or "as needed," their use was not included.

Validity of prescription fills as a unit of measure

Prescription fills were used as the units for drug use calculations. To test the validity of the prescription fill count as a stable measure of prescription use, mean and median payer and year-specific days supply per prescription fill were calculated for comparison by payer, state, and year (Table 28).

Table 28: Days supply per prescription fill statistics by payer, by year

Payer	2007			2008			2009			2010		
	Mean	Standard deviation	Median	Mean	Standard deviation	Median	Mean	Standard deviation	Median	Mean	Standard deviation	Median
Maine Overall	24.4	17.1	30.0	24.6	17.2	30.0	24.8	17.7	30.0	26.4	21.9	30.0
Maine Commercial	25.7	21.2	30.0	25.8	21.5	28.0	26.2	22.1	30.0	26.4	21.9	30.0
Maine Medicaid	23.7	14.1	30.0	23.9	14.4	30.0	24.0	14.7	30.0	-	-	-
New Hampshire Overall	22.9	17.5	30.0	22.9	17.4	30.0	22.9	17.6	29.0	23.5	17.7	30.0
New Hampshire Commercial	22.6	18.5	28.0	22.7	18.6	28.0	22.7	18.9	28.0	23.7	19.1	28.0
New Hampshire Medicaid	23.0	16.7	30.0	22.9	16.6	30.0	22.9	16.8	30.0	23.5	16.7	30.0
Vermont Overall	22.8	17.5	28.0	23.3	17.9	28.0	24.3	19.5	30.0	25.9	21.8	30.0
Vermont Commercial	22.6	18.5	28.0	23.0	19.1	28.0	23.3	19.5	28.0	24.3	20.2	28.0
Vermont Medicaid	23.0	16.6	30.0	23.6	16.9	30.0	25.0	19.6	30.0	26.9	22.7	30.0

All medication use measures were based on prescription event fill records for the entire time period and the entire population. The Lexi-Data Basic database (Lexicomp) was used to obtain the drug name and active ingredient according to the National Drug Code (NDC).[162]

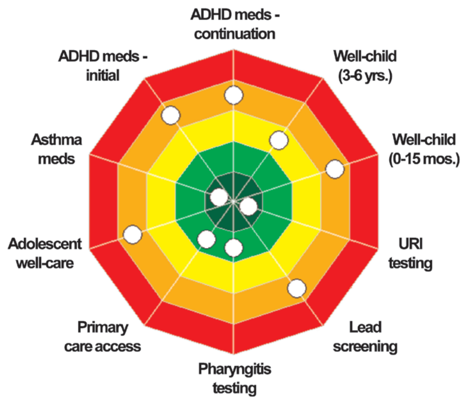
Quality Dartboards

The Quality Dartboards were developed by the Management and Health Laboratory at the Management Institute, Scuola Superiore Sant'Anna, Pisa, Italy. The Quality Dartboard shows the performance of each hospital service area's health care providers on the pediatric effective care measures in the Healthcare Effectiveness Data and Information Set (HEDIS). The closer the dot is to the center "target," the better the area's providers performed.

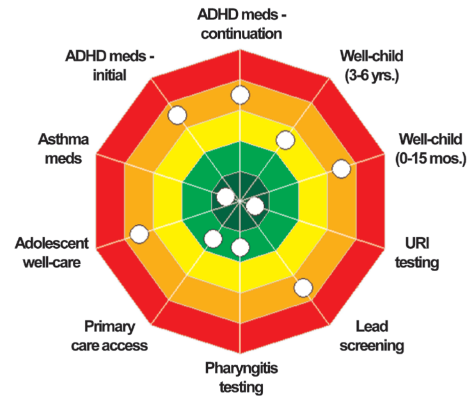
The measures are labeled as follows:

Well-child (3-6 yrs.)	Percent of children age 3-6 having well-care visits
Well-child (0-15 mos.)	Percent of children having at least 6 well-care visits in the first 15 months of life
URI testing	Percent of children with URIs receiving appropriate treatment
Lead screening	Percent of Medicaid beneficiaries receiving lead screening by age 2
Pharyngitis testing	Percent of children receiving appropriate testing for pharyngitis
Primary care access	Percent of children older than 12 months visiting a primary care physician
Adol. well-care	Percent of adolescents having well-care visits
Asthma meds	Percent of children age 5-17 with asthma receiving appropriate medication
ADHD meds – initial	Percent of children prescribed ADHD medication receiving initial follow-up
ADHD meds – continuation	Percent of children prescribed ADHD medication receiving continuation of follow-up

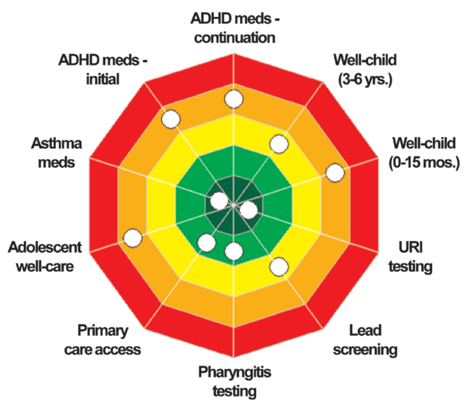
Augusta, ME



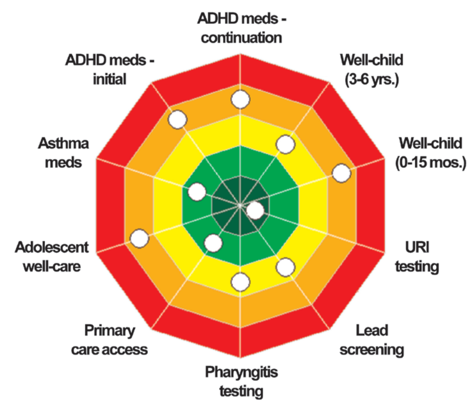
Waterville, ME



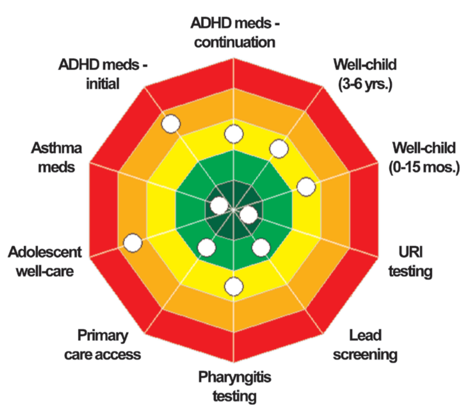
Biddeford, ME



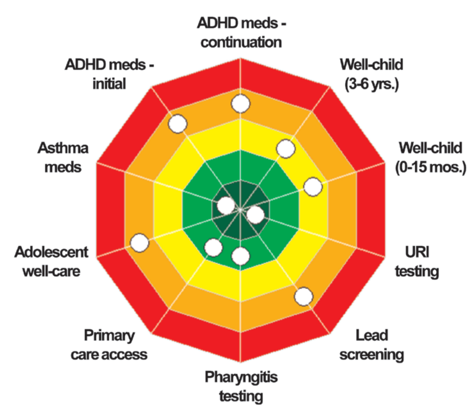
Sanford, ME



St. Albans, VT



Brunswick, ME



Percent of appropriate patients receiving service
- 90-100%
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- 30-60%
- 0-30%

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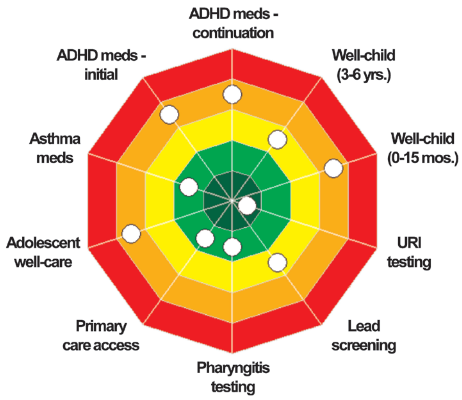
Keene, NH



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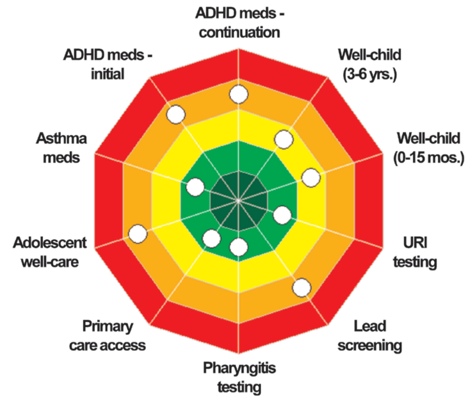

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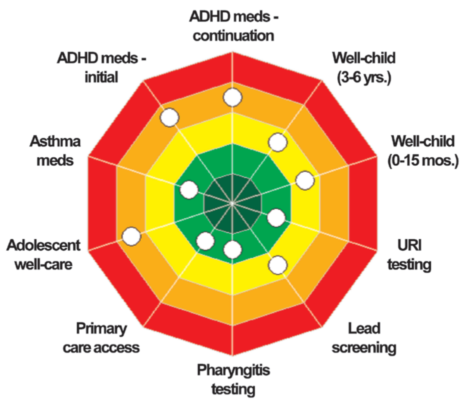

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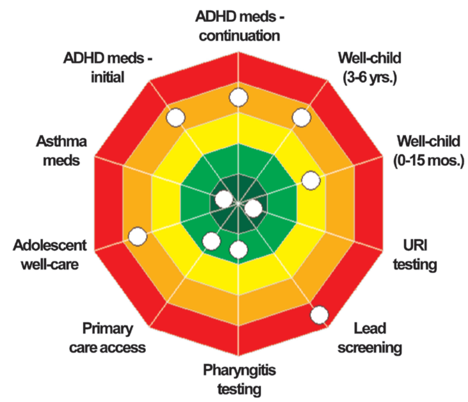

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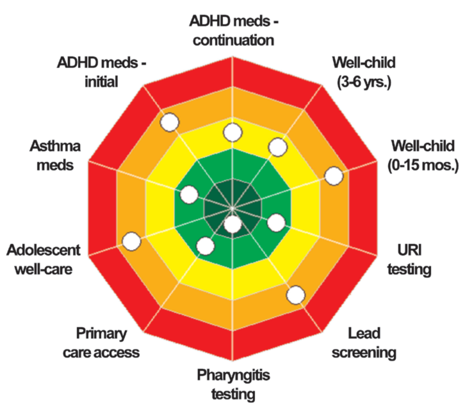

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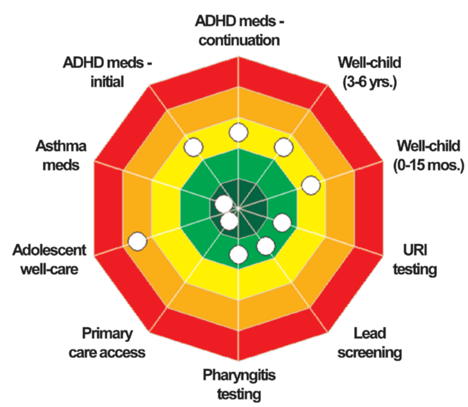

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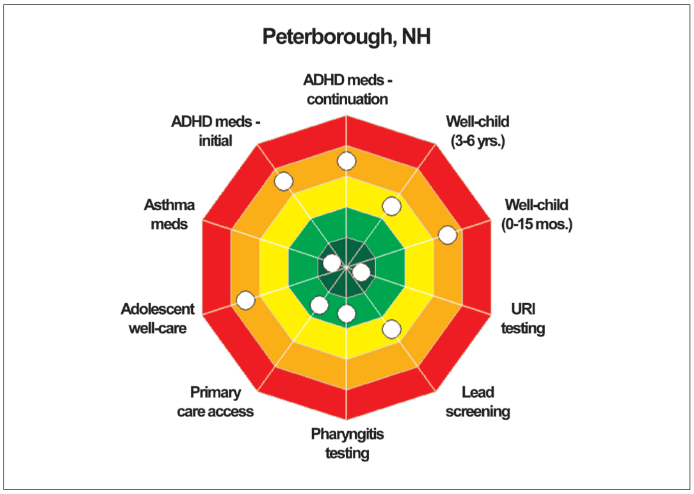

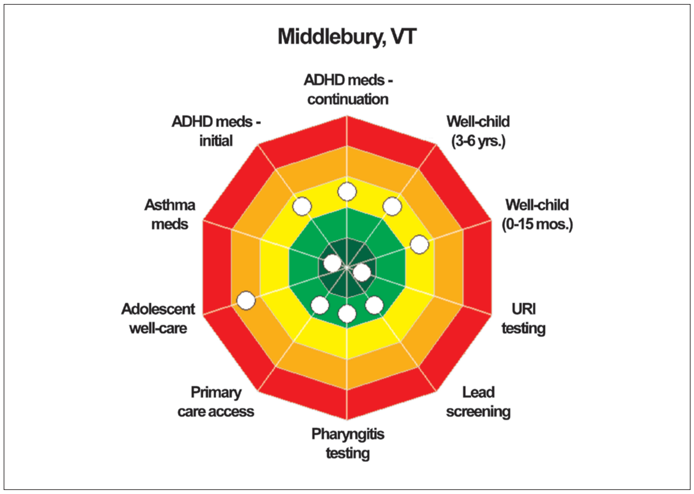

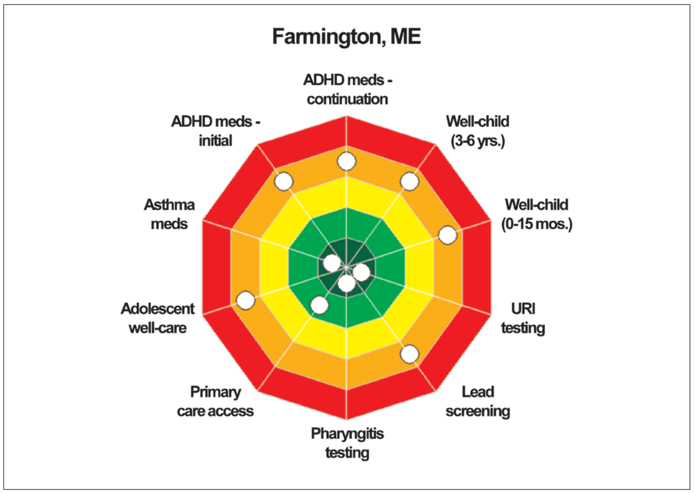

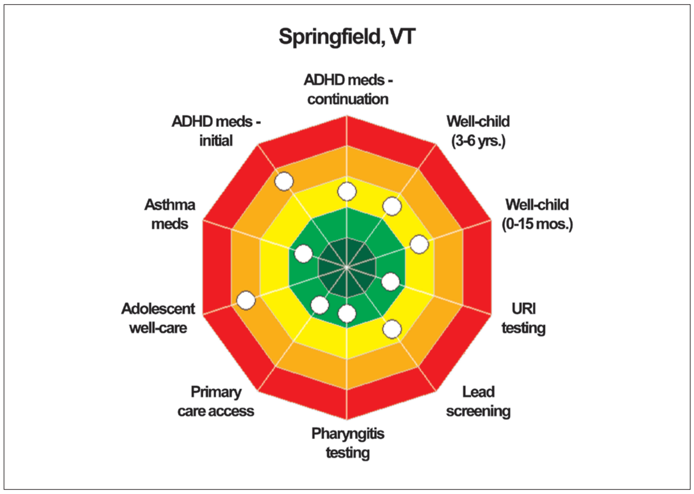

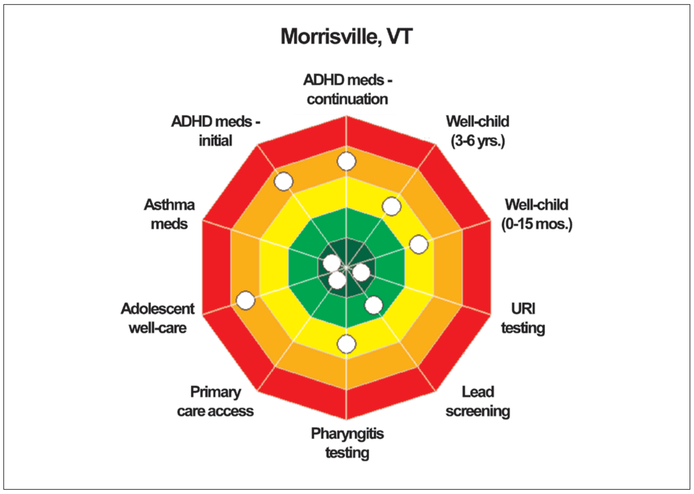

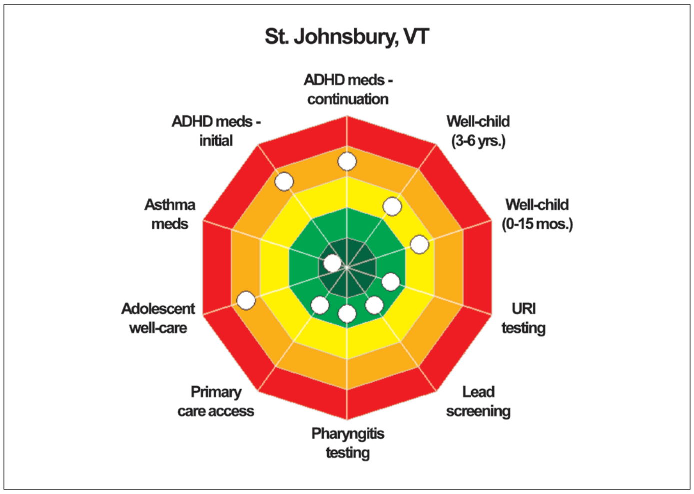

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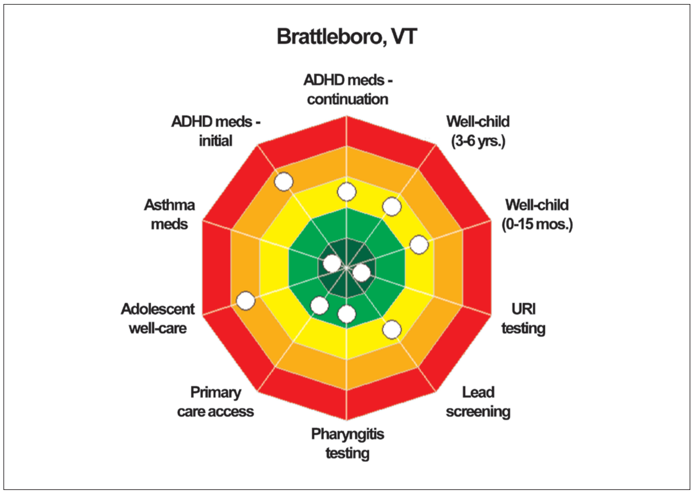

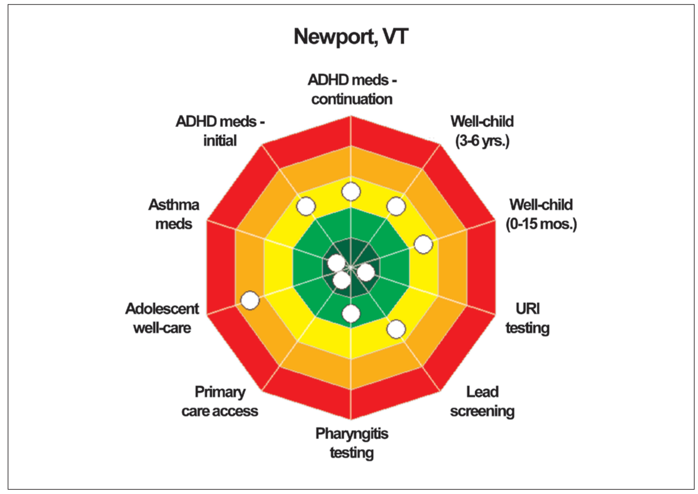

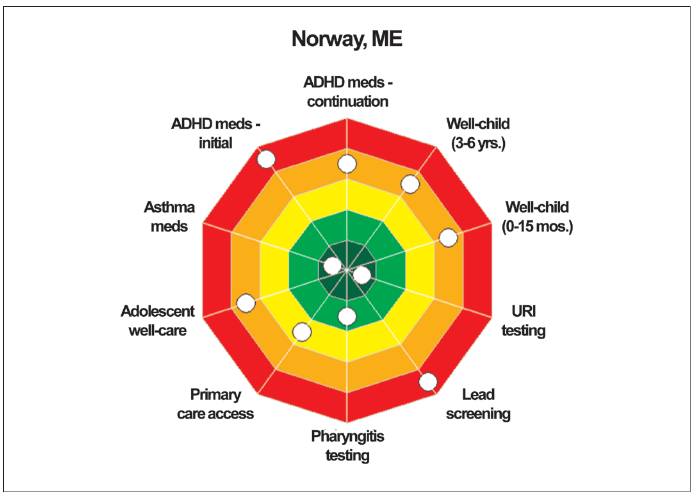

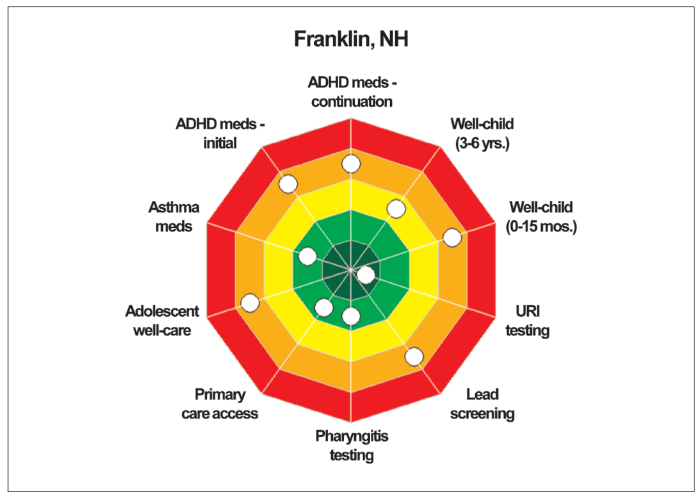

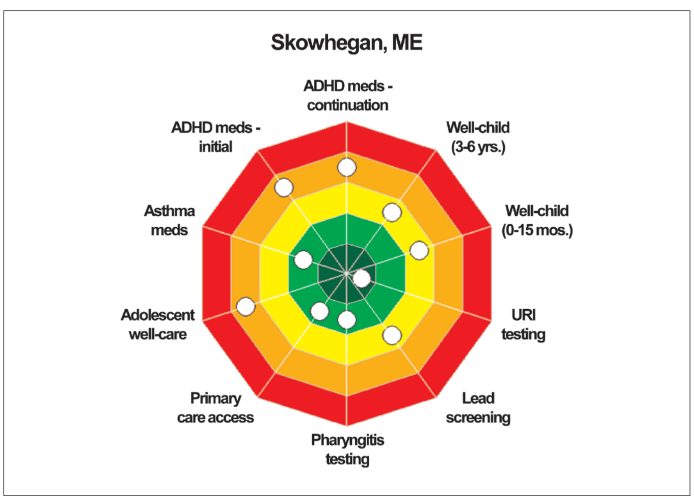

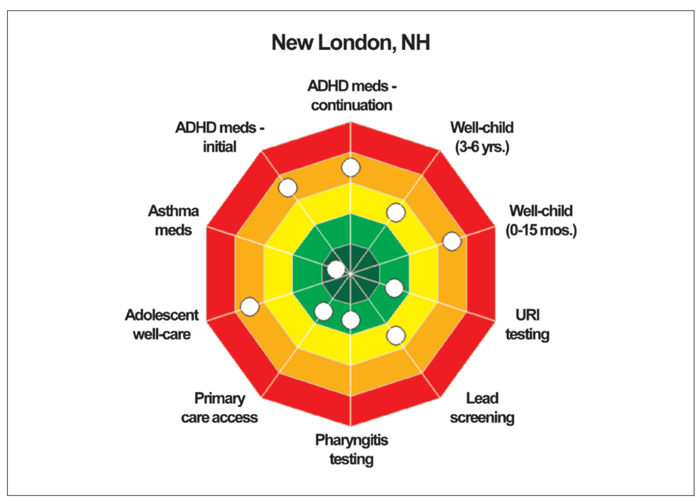

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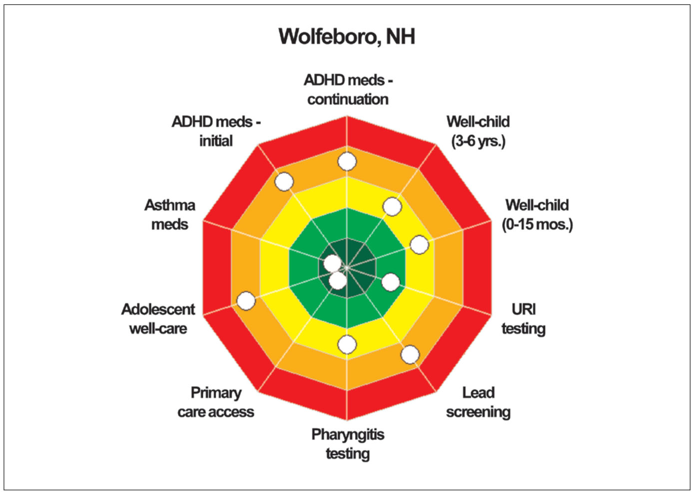

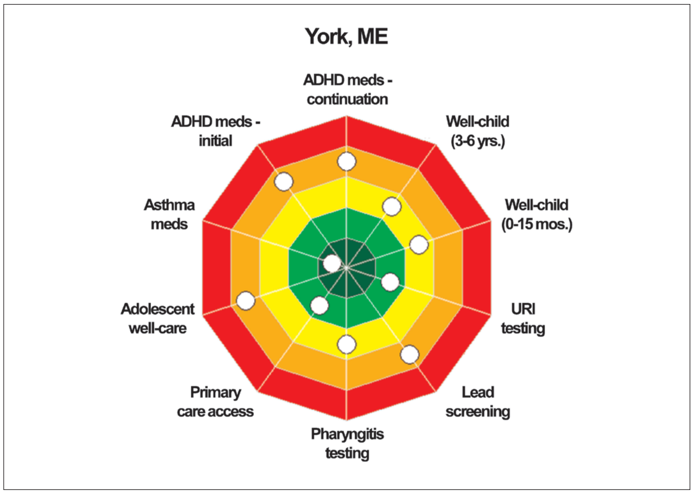

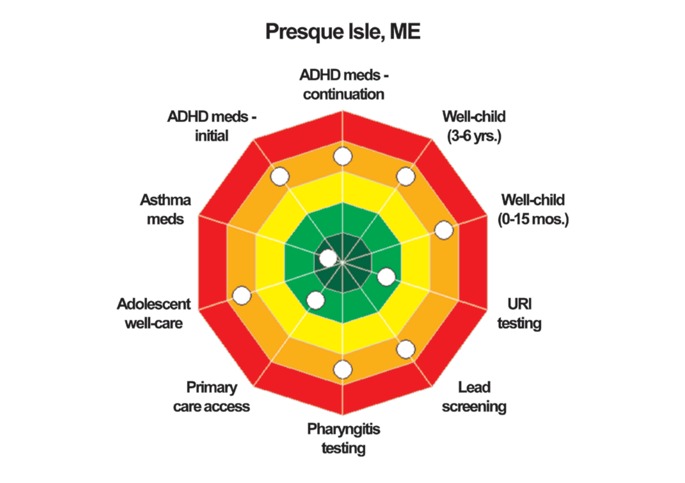

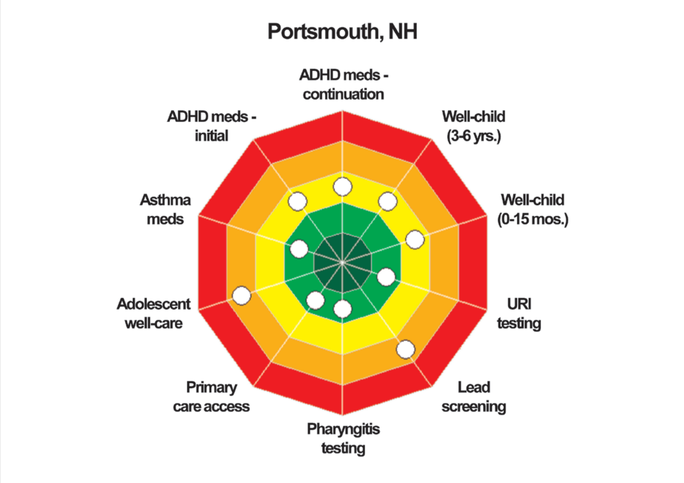

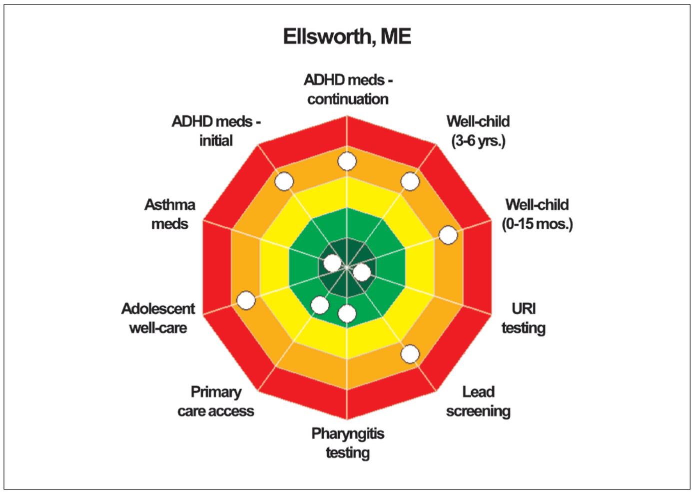

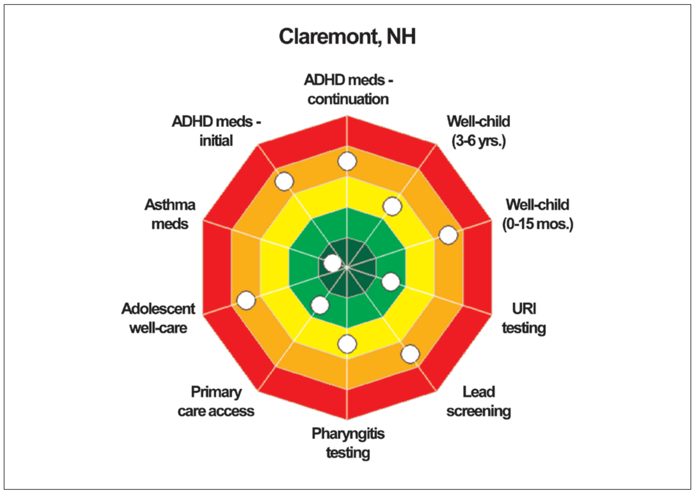

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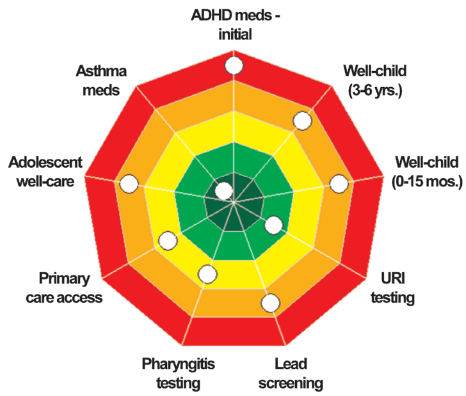
Pittsfield, ME



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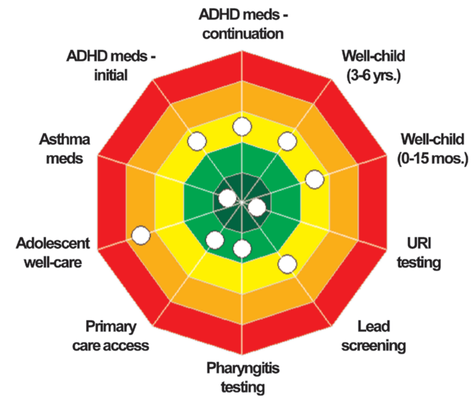

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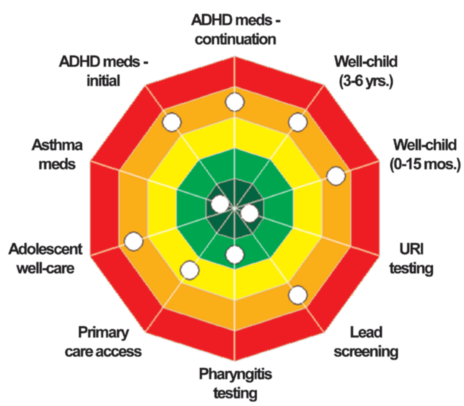

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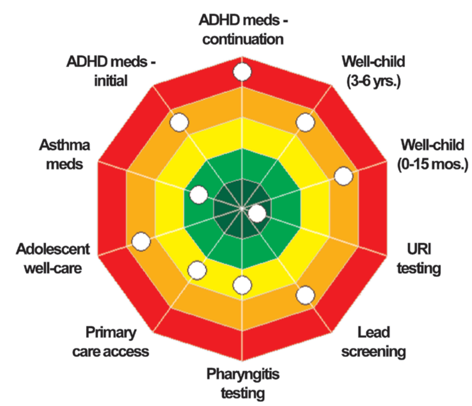

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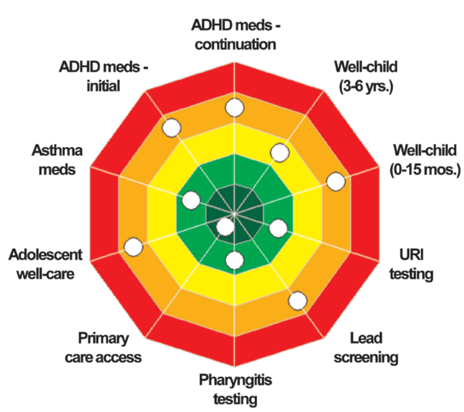
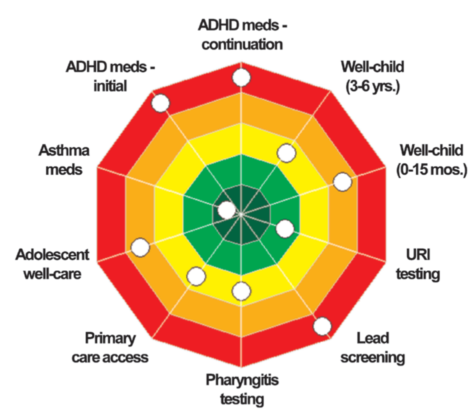


Dover-Foxcroft, ME



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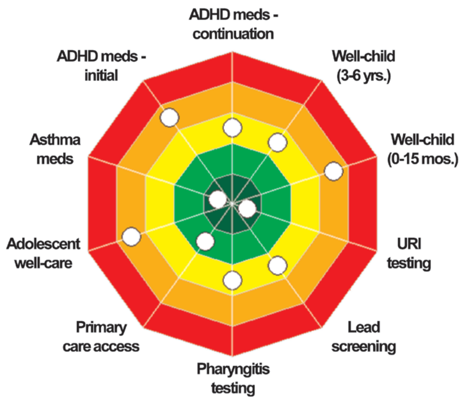

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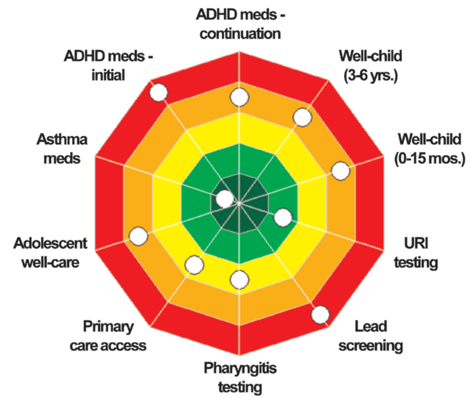

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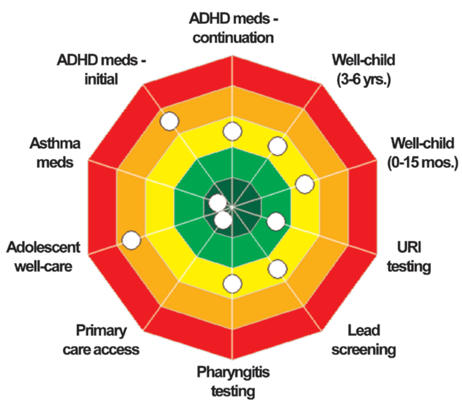
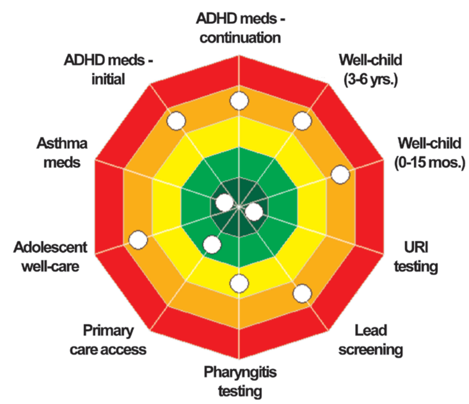


Littleton, NH



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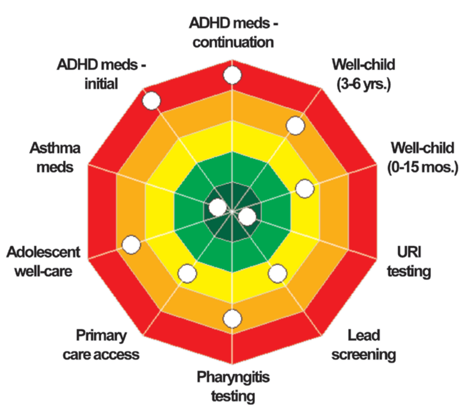

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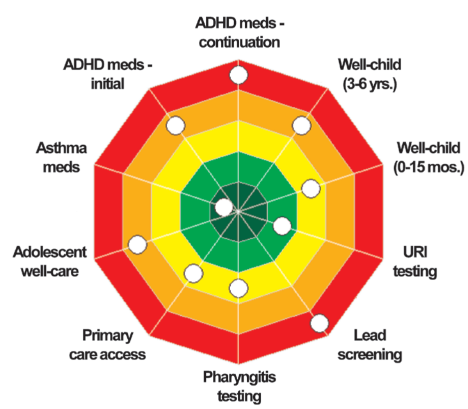

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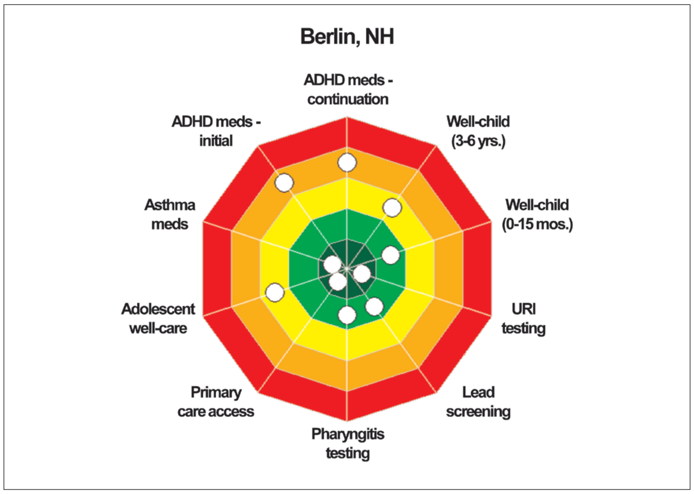

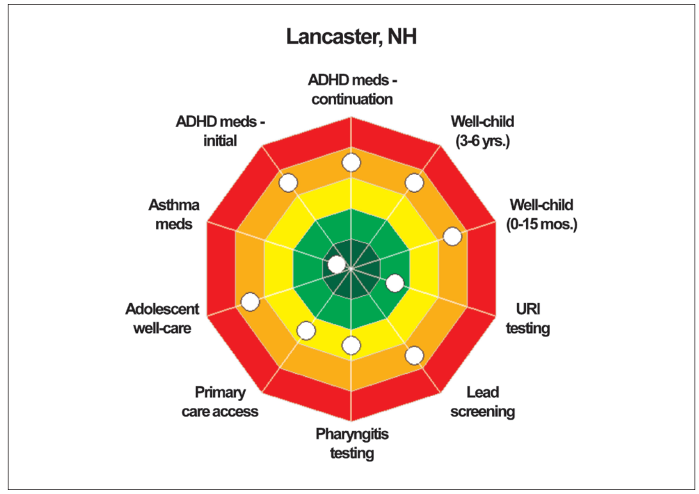

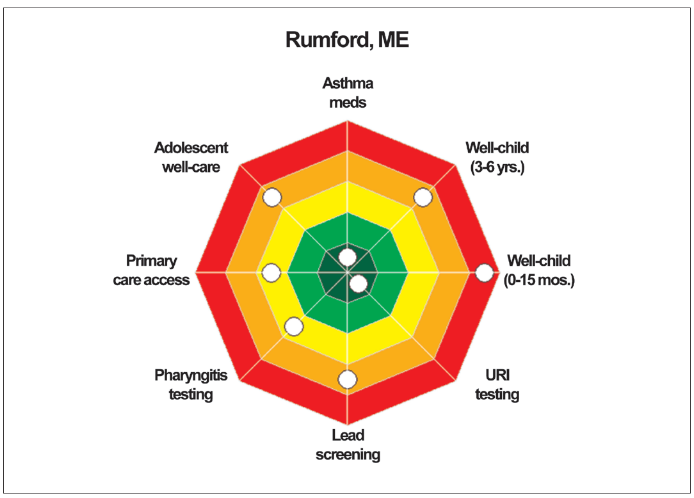

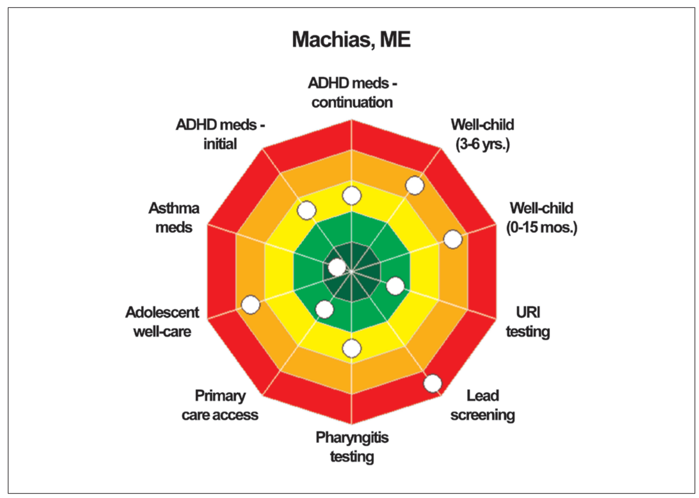

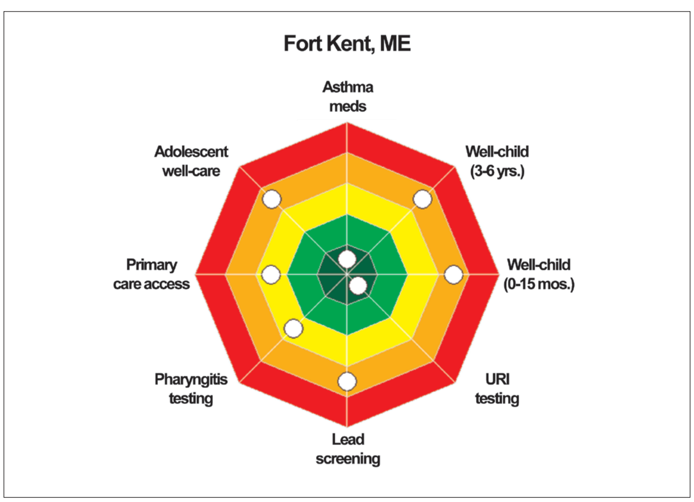

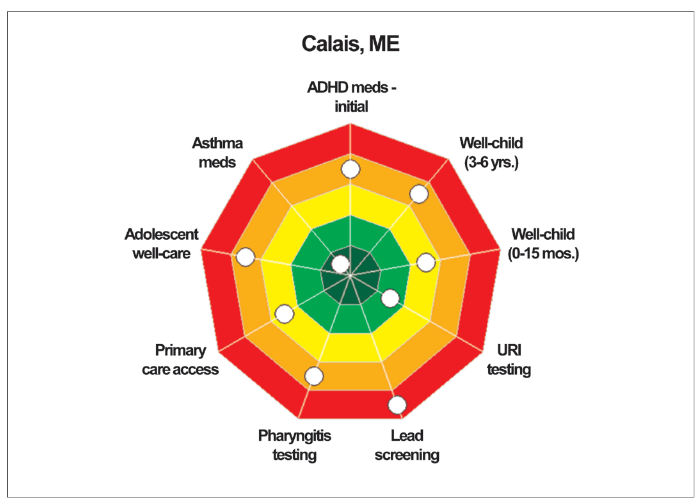

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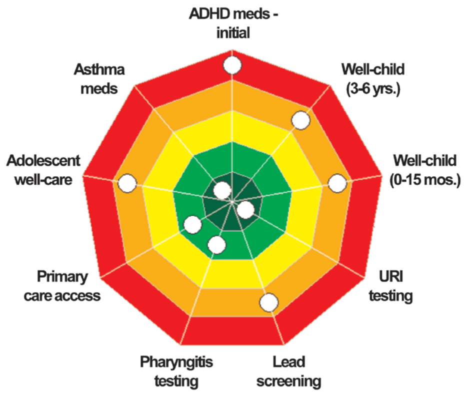
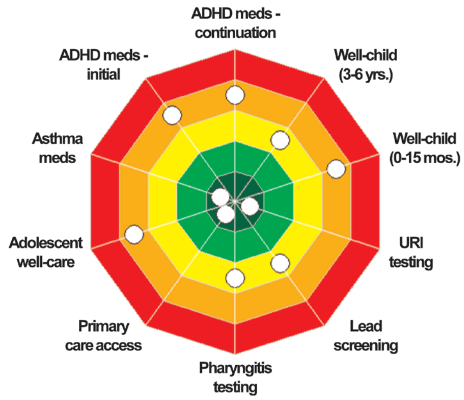
Damariscotta, ME



Windsor, VT



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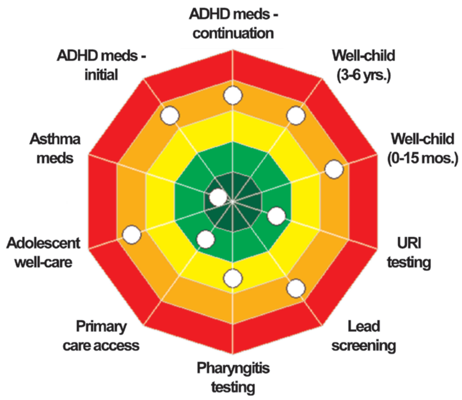
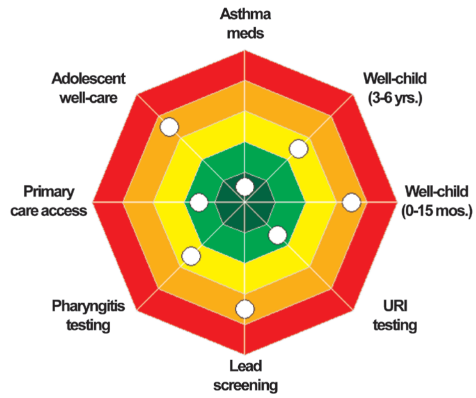


Millinocket, ME



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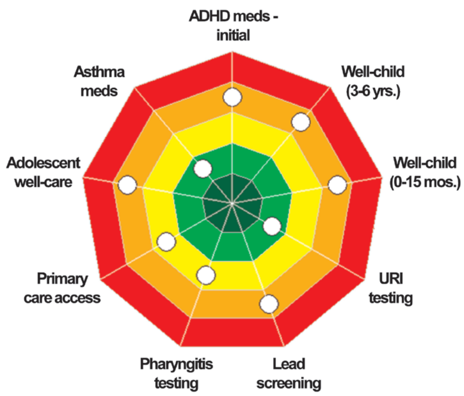
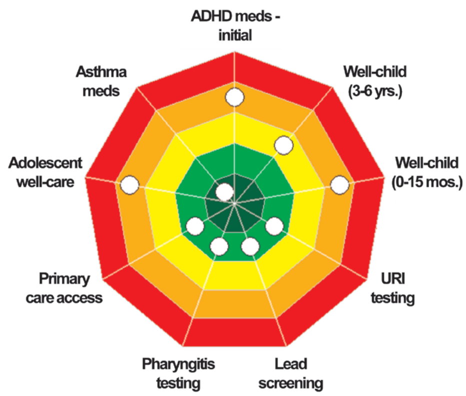


Townshend, VT



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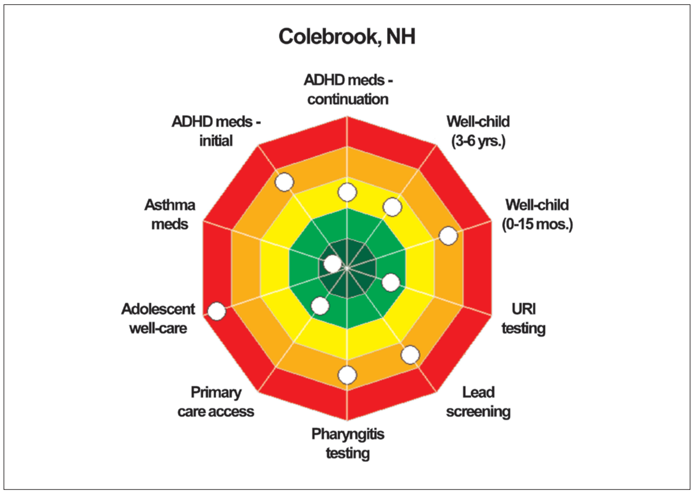

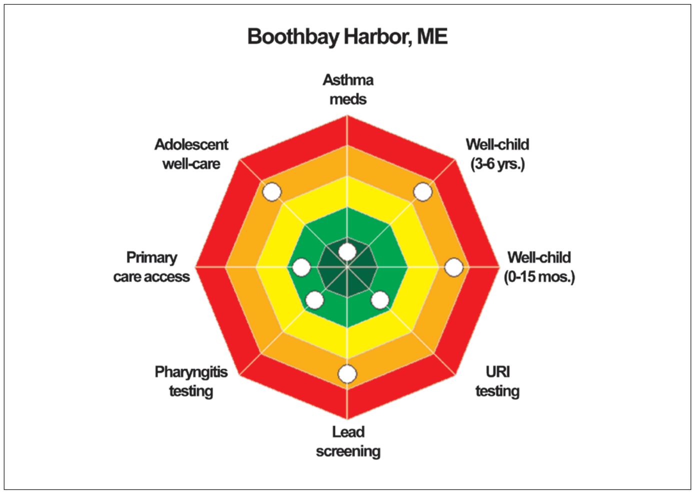

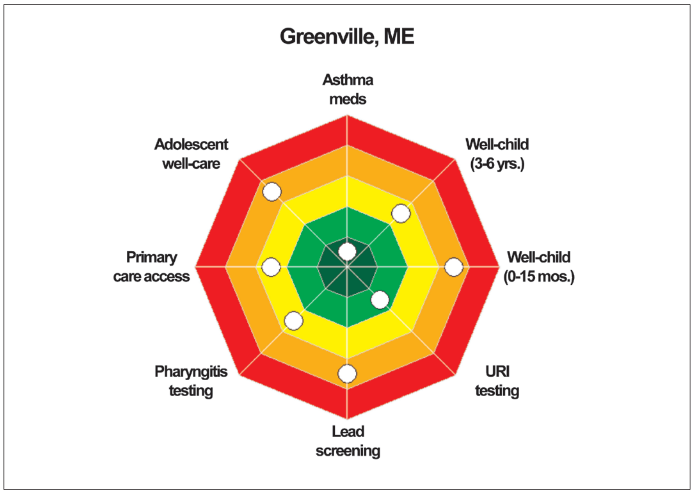

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Appendix Tables

Appendix Table 1a. Demographic data for Northern New England hospital service areas

HSA Name	State	Number of children in study population under age 18 (2009)	Percent of children in poverty (2006-10)	Percent of children insured by Medicaid (2007-10)
Augusta	ME	13,859	13.1	44.3
Bangor	ME	23,439	17.0	42.1
Bar Harbor	ME	1,684	13.9	31.4
Belfast	ME	3,544	22.3	51.9
Biddeford	ME	12,778	10.9	32.9
Blue Hill	ME	1,511	22.7	46.7
Boothbay Harbor	ME	790	25.9	39.7
Bridgton	ME	3,580	22.1	45.2
Brunswick	ME	11,565	12.1	33.2
Calais	ME	2,345	28.5	64.3
Caribou	ME	3,125	16.8	58.2
Damariscotta	ME	1,844	11.6	36.8
Dover-Foxcroft	ME	3,387	26.3	61.2
Ellsworth	ME	4,320	15.9	50.4
Farmington	ME	6,902	19.3	50.9
Fort Kent	ME	2,281	13.7	40.7
Greenville	ME	508	17.0	52.3
Houlton	ME	3,157	21.3	61.1
Lewiston	ME	24,541	18.0	45.0
Lincoln	ME	2,935	28.3	56.2
Machias	ME	2,619	30.2	63.2
Millinocket	ME	1,608	21.4	57.7
Norway	ME	5,799	17.1	48.1
Pittsfield	ME	4,055	32.0	54.9
Portland	ME	51,661	14.0	28.3
Presque Isle	ME	4,520	22.9	49.9
Rockland	ME	9,037	15.1	43.9
Rumford	ME	2,942	17.0	48.4
Sanford	ME	12,761	10.6	37.2
Skowhegan	ME	5,562	23.9	58.8
Waterville	ME	13,326	19.2	45.6
York	ME	4,255	7.1	21.9
Berlin	NH	2,482	17.8	56.4
Claremont	NH	3,683	12.6	49.0
Colebrook	NH	920	17.7	60.0
Concord	NH	22,900	8.9	34.7
Derry	NH	7,811	7.2	29.8
Dover	NH	13,384	6.1	33.8
Exeter	NH	12,886	4.9	29.9
Franklin	NH	4,815	12.6	47.5
Keene	NH	9,151	10.1	39.7
Laconia	NH	8,816	11.6	42.9
Lancaster	NH	2,488	18.7	58.2
Lebanon	NH	11,889	8.7	27.2

Appendix Table 1a. Demographic data for Northern New England hospital service areas

HSA Name	State	Number of children in study population under age 18 (2009)	Percent of children in poverty (2006-10)	Percent of children insured by Medicaid (2007-10)
Littleton	NH	2,641	9.3	54.7
Manchester	NH	34,835	11.8	37.7
Nashua	NH	27,723	5.5	31.6
New London	NH	4,498	11.3	37.9
North Conway	NH	2,617	13.3	53.5
Peterborough	NH	6,134	7.2	36.1
Plymouth	NH	3,000	11.2	48.6
Portsmouth	NH	3,745	4.1	28.2
Rochester	NH	8,460	17.3	48.1
Wolfeboro	NH	4,197	10.7	48.9
Woodsville	NH	2,843	15.5	52.9
Bennington	VT	7,473	15.9	46.8
Berlin	VT	13,684	12.9	38.7
Brattleboro	VT	5,543	10.0	45.4
Burlington	VT	34,038	10.9	29.4
Middlebury	VT	6,092	9.2	38.5
Morrisville	VT	5,738	16.1	49.8
Newport	VT	5,377	15.9	62.1
Randolph	VT	3,164	10.6	44.7
Rutland	VT	12,572	14.1	46.0
Springfield	VT	5,974	16.4	47.7
St. Albans	VT	10,985	13.0	45.3
St. Johnsbury	VT	5,664	13.0	50.2
Townshend	VT	1,042	9.3	46.2
Windsor	VT	1,616	9.1	39.2
Northern New England average		567,113	12.7	39.5

The number of children was estimated using the number of person-months represented in each claims database.

Appendix Table 1b. Demographic data for Northern New England pediatric surgical areas				
HSA Name	State	Number of children in study population under age 18 (2009)	Percent of children in poverty (2006-10)	Percent of children insured by Medicaid (2007-10)
Augusta	ME	13,859	13.1	48.6
Bangor	ME	26,374	18.2	45.9
Brunswick	ME	14,199	12.8	35.0
Ellsworth	ME	12,479	22.0	51.5
Lewiston	ME	27,482	17.9	44.8
Portland	ME	73,818	14.0	31.5
Presque Isle	ME	14,691	19.8	52.8
Rockland	ME	12,581	17.6	45.2
Sanford	ME	12,761	10.6	36.1
Waterville	ME	33,739	21.9	50.3
York	ME	8,000	5.7	23.6
Berlin	NH	3,402	17.7	58.9
Concord	NH	29,034	8.5	36.6
Derry	NH	7,811	7.2	31.4
Dover	NH	26,041	10.2	40.0
Exeter	NH	12,886	4.9	29.9
Keene	NH	9,151	10.1	40.4
Laconia	NH	19,247	11.9	46.0
Lebanon	NH	27,692	10.6	37.0
Littleton	NH	5,129	14.2	56.1
Manchester	NH	34,835	11.8	36.8
Nashua	NH	27,723	5.5	30.7
Berlin	VT	13,684	12.9	38.6
Brattleboro	VT	6,584	9.8	45.1
Burlington	VT	50,761	11.9	35.1
Middlebury	VT	6,092	9.2	38.6
Newport	VT	5,377	15.9	62.1
Rutland	VT	20,045	15.0	46.3
Springfield	VT	5,974	16.4	47.4
St. Johnsbury	VT	5,664	13.0	50.2
Northern New England average		567,113	12.7	39.5

The number of children was estimated using the number of person-months represented in each claims database.

Appendix Table 2. The child health workforce among Northern New England hospital service areas (2009)

HSA Name	State	Number of children living in HSA	General pediatricians per 100,000 children	Family physicians per 100,000 children	Child health physicians per 100,000 children
Augusta	ME	14,984	40.0	427.1	146.8
Bangor	ME	26,480	105.7	279.5	175.6
Bar Harbor	ME	2,046		537.7	134.4
Belfast	ME	4,395	22.8	182.0	68.3
Biddeford	ME	15,250	72.1	229.5	129.5
Blue Hill	ME	1,754		855.2	213.8
Boothbay Harbor	ME	998		300.7	75.2
Bridgton	ME	3,680	81.5	244.6	142.7
Brunswick	ME	15,961	81.5	250.6	144.1
Calais	ME	2,752	36.3	109.0	63.6
Caribou	ME	3,480	114.9	258.6	179.6
Damariscotta	ME	1,945	205.6	668.3	372.7
Dover-Foxcroft	ME	3,532	28.3	198.2	77.9
Ellsworth	ME	5,072	19.7	295.8	93.7
Farmington	ME	7,500	66.7	306.7	143.3
Fort Kent	ME	2,549		235.4	58.9
Greenville	ME	669			
Houlton	ME	3,319	60.3	271.1	128.0
Lewiston	ME	26,125	45.9	225.8	102.4
Lincoln	ME	2,896	34.5	241.7	95.0
Machias	ME	3,000		366.6	91.7
Millinocket	ME	1,942	51.5	51.5	64.4
Norway	ME	5,861	68.2	136.5	102.4
Pittsfield	ME	4,281	23.4	186.9	70.1
Portland	ME	53,681	121.1	258.9	185.8
Presque Isle	ME	4,826	82.9	310.8	160.6
Rockland	ME	9,926	60.4	181.3	105.8
Rumford	ME	3,206		187.1	46.8
Sanford	ME	13,780	7.3	79.8	27.2
Skowhegan	ME	6,311	31.7	237.7	91.1
Waterville	ME	14,560	54.9	391.5	152.8
York	ME	6,322	63.3	253.1	126.5
Berlin	NH	2,771	36.1	505.3	162.4
Claremont	NH	4,608	43.4	282.1	113.9
Colebrook	NH	1,136	88.0	352.1	176.1
Concord	NH	29,200	71.9	267.1	138.7
Derry	NH	15,476	25.8	135.7	59.8
Dover	NH	19,243	31.2	176.7	75.4
Exeter	NH	22,945	87.2	161.3	127.5
Franklin	NH	5,801	34.5	172.4	77.6
Keene	NH	11,764	51.0	263.5	116.9
Laconia	NH	10,465	76.4	95.6	100.3
Lancaster	NH	2,850	70.2	315.8	149.1
Lebanon	NH	13,910	280.4	302.0	355.9

Appendix Table 2. The child health workforce among Northern New England hospital service areas (2009)

HSA Name	State	Number of children living in HSA	General pediatricians per 100,000 children	Family physicians per 100,000 children	Child health physicians per 100,000 children
Littleton	NH	3,054	98.2	294.7	171.9
Manchester	NH	51,032	98.0	117.6	127.4
Nashua	NH	48,231	68.4	151.4	106.3
New London	NH	5,647		106.3	26.6
North Conway	NH	3,217	62.2	310.9	139.9
Peterborough	NH	9,364	106.8	160.2	146.8
Plymouth	NH	3,845	52.0	156.0	91.0
Portsmouth	NH	5,462	91.5	402.8	192.2
Rochester	NH	12,352	32.4	105.2	58.7
Wolfeboro	NH	5,221	19.2	153.2	57.5
Woodsville	NH	3,117	160.4	256.7	224.6
Bennington	VT	10,428	47.9	268.5	115.1
Berlin	VT	13,461	44.6	208.0	96.6
Brattleboro	VT	5,649	123.9	194.7	172.6
Burlington	VT	35,754	156.6	274.1	225.1
Middlebury	VT	6,269	175.5	382.9	271.2
Morrisville	VT	6,226	16.1	305.2	92.4
Newport	VT	5,532	36.2	216.9	90.4
Randolph	VT	3,573	168.0	140.0	202.9
Rutland	VT	13,011	46.1	207.5	98.0
Springfield	VT	5,957	83.9	201.4	134.3
St. Albans	VT	11,554	77.9	103.9	103.9
St. Johnsbury	VT	5,432	73.6	220.9	128.9
Townshend	VT	1,149	87.0	348.2	174.1
Windsor	VT	1,571	254.7	63.7	270.6
Northern New England average		689,357	78.2	223.5	134.1

Rates are unadjusted. The denominator includes all children under age 18 living in the area and was extrapolated from the 2010 Census.
Blank cells indicate that there were no physicians of the specialty practicing in the area.

Appendix Table 3. Utilization of ambulatory and hospital care among insured children in Northern New England hospital service areas (2007-10)

HSA Name	State	Office visits per 1,000 children	Emergency room visits per 1,000 children	All medical discharges per 1,000 children	Mental health discharges per 1,000 children
Augusta	ME	2,446.0	360.1	12.6	10.0
Bangor	ME	2,018.9	294.9	14.7	9.2
Bar Harbor	ME	2,762.1	401.7	12.2	4.7
Belfast	ME	1,837.7	411.0	8.2	9.8
Biddeford	ME	3,020.2	389.1	14.2	8.0
Blue Hill	ME	2,153.4	410.7	8.9	4.7
Boothbay Harbor	ME	2,664.7	534.7	11.6	(12.5)
Bridgton	ME	2,636.7	367.8	14.5	7.4
Brunswick	ME	2,862.0	297.4	11.3	7.3
Calais	ME	1,101.0	587.0	15.6	4.1
Caribou	ME	1,754.3	618.1	11.3	10.4
Damariscotta	ME	2,237.0	420.6	13.2	6.4
Dover-Foxcroft	ME	1,320.2	471.9	15.8	6.5
Ellsworth	ME	2,999.8	418.0	14.7	4.7
Farmington	ME	2,526.8	383.6	16.7	4.7
Fort Kent	ME	1,425.4	432.4	12.3	10.1
Greenville	ME	1,367.9	477.5	(9.9)	
Houlton	ME	1,158.1	635.5	12.8	2.9
Lewiston	ME	2,741.0	427.2	14.7	11.6
Lincoln	ME	1,745.0	524.8	12.8	4.6
Machias	ME	2,414.7	406.0	14.6	3.4
Millinocket	ME	1,825.7	601.0	11.7	6.2
Norway	ME	1,697.6	421.4	13.7	7.4
Pittsfield	ME	1,598.1	528.8	17.8	6.3
Portland	ME	2,602.3	302.1	11.7	6.9
Presque Isle	ME	2,329.2	513.9	12.6	3.8
Rockland	ME	2,324.6	398.7	12.7	6.6
Rumford	ME	1,522.5	489.7	13.2	5.5
Sanford	ME	2,767.4	393.5	9.0	5.7
Skowhegan	ME	2,190.7	622.1	15.5	6.2
Waterville	ME	2,209.9	485.5	10.8	6.6
York	ME	2,762.8	473.7	12.7	7.6
Berlin	NH	1,833.4	505.1	11.7	3.7
Claremont	NH	3,329.9	453.4	13.4	4.1
Colebrook	NH	2,048.9	415.5	8.2	(1.8)
Concord	NH	2,871.6	369.9	11.9	6.2
Derry	NH	3,430.0	381.8	14.1	5.4
Dover	NH	2,715.5	410.6	8.8	3.4
Exeter	NH	3,125.9	325.6	10.2	4.4
Franklin	NH	2,710.9	460.5	11.2	3.2
Keene	NH	3,090.3	280.0	9.4	6.7
Laconia	NH	2,818.1	559.0	12.0	2.8
Lancaster	NH	2,617.3	485.7	11.3	2.4
Lebanon	NH	2,815.4	294.8	9.9	4.9
Littleton	NH	2,482.7	358.1	8.1	2.5

Appendix Table 3. Utilization of ambulatory and hospital care among insured children in Northern New England hospital service areas (2007-10)

HSA Name	State	Office visits per 1,000 children	Emergency room visits per 1,000 children	All medical discharges per 1,000 children	Mental health discharges per 1,000 children
Manchester	NH	3,128.6	308.8	15.1	4.1
Nashua	NH	3,187.0	324.4	12.7	3.4
New London	NH	3,071.5	355.7	9.4	3.5
North Conway	NH	2,457.2	343.2	11.3	4.0
Peterborough	NH	2,823.2	273.6	7.3	2.7
Plymouth	NH	2,219.4	386.0	7.7	2.6
Portsmouth	NH	2,916.3	371.5	9.2	4.4
Rochester	NH	3,010.2	412.7	10.9	3.1
Wolfeboro	NH	3,121.2	440.3	10.5	4.1
Woodsville	NH	3,165.1	288.4	9.4	2.6
Bennington	VT	3,645.1	310.7	9.9	4.2
Berlin	VT	2,891.3	346.3	7.9	2.4
Brattleboro	VT	2,867.1	230.6	6.3	5.8
Burlington	VT	3,173.1	222.9	8.7	3.4
Middlebury	VT	3,467.8	269.8	8.9	2.4
Morrisville	VT	3,130.1	310.1	7.4	3.1
Newport	VT	3,243.9	307.7	9.3	1.2
Randolph	VT	2,913.0	303.2	10.4	3.6
Rutland	VT	3,050.6	350.6	15.9	4.0
Springfield	VT	2,796.3	363.2	12.5	4.1
St. Albans	VT	3,591.7	334.5	7.1	2.4
St. Johnsbury	VT	3,423.9	230.4	15.5	2.0
Townshend	VT	2,445.6	276.9	7.4	(3.9)
Windsor	VT	3,102.6	356.6	9.3	3.2
Northern New England average		2,789.8	359.3	11.7	5.2

Rates are adjusted for age, sex, and payer (commercial insurer or Medicaid). Numbers in parentheses indicate a possible lack of statistical precision due to a small sample size. Blank cells indicate that the rate was suppressed due to a sample size smaller than 5 children.

Appendix Table 4. HEDIS measures of effective care for children among Northern New England hospital service areas

HSA Name	State	Percent of children and adolescents visiting primary care practitioners (2007-10)	Percent of children having at least 6 well-care visits in the first 15 months of life (2009-10)	Percent of children age 3-6 having well-care visits (2007-10)	Percent of adolescents having well-care visits (2007-10)	Percent of children receiving appropriate testing for pharyngitis (2008-10)	Percent of children with URIs receiving appropriate treatment (2008-10)	Percent of Medicaid beneficiaries receiving lead screening by age 2 (2008-10)	Percent of children 5-17 with asthma receiving appropriate medication (2008-10)	Percent of children prescribed ADHD medication receiving initial follow-up (2009-10)	Percent of children prescribed ADHD medication receiving continuation of follow-up (2009-10)
Augusta	ME	85%	50%	61%	36%	90%	91%	43%	95%	46%	48%
Bangor	ME	80%	61%	64%	44%	83%	91%	19%	93%	30%	34%
Bar Harbor	ME	85%	38%	57%	34%	71%	86%	45%	96%	48%	57%
Belfast	ME	71%	39%	52%	36%	78%	93%	43%	87%	41%	30%
Biddeford	ME	84%	51%	60%	45%	85%	91%	61%	93%	38%	38%
Blue Hill	ME	79%	36%	50%	41%	73%	90%	47%	87%	38%	
Boothbay Harbor	ME	86%	48%	57%	36%	80%	90%	52%	100%		
Bridgton	ME	76%	40%	45%	36%	83%	91%	58%	91%	37%	41%
Brunswick	ME	86%	69%	61%	44%	88%	92%	54%	96%	39%	40%
Calais	ME	72%	61%	48%	38%	41%	89%	9%	91%	34%	
Caribou	ME	79%	53%	57%	42%	64%	90%	28%	95%	30%	44%
Damariscotta	ME	84%	48%	59%	40%	82%	90%	45%	98%	29%	
Dover-Foxcroft	ME	75%	54%	62%	36%	76%	87%	8%	91%	21%	
Ellsworth	ME	83%	54%	60%	37%	83%	91%	55%	90%	43%	58%
Farmington	ME	81%	42%	54%	39%	90%	90%	59%	92%	38%	41%
Fort Kent	ME	70%	53%	50%	31%	62%	93%	51%	91%		
Houlton	ME	75%	60%	56%	43%	47%	93%	65%	93%	22%	
Lewiston	ME	80%	40%	55%	43%	86%	92%	29%	95%	35%	37%
Lincoln	ME	77%	62%	58%	38%	71%	87%	12%	92%	39%	
Machias	ME	82%	57%	59%	42%	75%	88%	26%	91%	62%	68%
Millinocket	ME	81%	56%	62%	45%	60%	83%	57%	100%		
Norway	ME	78%	46%	60%	43%	82%	92%	21%	95%	29%	32%
Pittsfield	ME	75%	55%	60%	32%	74%	88%	33%	95%	17%	
Portland	ME	84%	48%	62%	44%	83%	89%	49%	96%	37%	38%
Presque Isle	ME	81%	46%	51%	34%	46%	87%	53%	90%	49%	59%
Rockland	ME	80%	61%	58%	35%	83%	90%	15%	91%	46%	48%
Rumford	ME	68%	26%	42%	31%	78%	93%	57%	93%		
Sanford	ME	82%	59%	62%	39%	80%	91%	64%	89%	38%	34%
Skowhegan	ME	81%	63%	61%	40%	82%	92%	63%	89%	40%	35%
Waterville	ME	82%	51%	62%	36%	82%	93%	59%	92%	37%	32%
York	ME	86%	67%	71%	54%	64%	88%	45%	98%	40%	41%
Greenville	ME	77%	47%	62%	35%	69%	81%	46%	93%		
Berlin	NH	93%	82%	78%	64%	82%	93%	86%	91%	34%	38%
Claremont	NH	88%	59%	67%	45%	75%	86%	59%	97%	51%	49%
Colebrook	NH	86%	55%	62%	29%	54%	86%	34%	97%	55%	70%
Concord	NH	88%	50%	72%	50%	84%	90%	65%	93%	41%	36%
Derry	NH	86%	60%	74%	54%	91%	88%	55%	88%	53%	60%
Dover	NH	89%	57%	76%	54%	83%	86%	50%	96%	43%	43%
Exeter	NH	89%	60%	80%	58%	92%	87%	52%	90%	50%	56%
Franklin	NH	85%	53%	63%	49%	83%	90%	57%	90%	44%	42%
Keene	NH	87%	50%	73%	49%	84%	91%	68%	88%	41%	41%

Appendix Table 4. HEDIS measures of effective care for children among Northern New England hospital service areas											
HSA Name	State	Percent of children and adolescents visiting primary care practitioners (2007-10)	Percent of children having at least 6 well-care visits in the first 15 months of life (2009-10)	Percent of children age 3-6 having well-care visits (2007-10)	Percent of adolescents having well-care visits (2007-10)	Percent of children receiving appropriate testing for pharyngitis (2008-10)	Percent of children with URIs receiving appropriate treatment (2008-10)	Percent of Medicaid beneficiaries receiving lead screening by age 2 (2008-10)	Percent of children 5-17 with asthma receiving appropriate medication (2008-10)	Percent of children prescribed ADHD medication receiving initial follow-up (2009-10)	Percent of children prescribed ADHD medication receiving continuation of follow-up (2009-10)
Laconia	NH	87%	62%	67%	45%	83%	87%	55%	90%	33%	31%
Lancaster	NH	76%	40%	43%	38%	78%	88%	33%	91%	50%	51%
Lebanon	NH	89%	58%	72%	55%	72%	93%	55%	95%	51%	45%
Littleton	NH	87%	35%	58%	48%	75%	94%	37%	92%	41%	46%
Manchester	NH	90%	60%	76%	61%	90%	90%	72%	92%	41%	44%
Nashua	NH	88%	59%	75%	54%	90%	91%	63%	93%	40%	38%
New London	NH	88%	51%	69%	49%	83%	90%	61%	93%	39%	48%
North Conway	NH	91%	78%	75%	54%	61%	86%	70%	93%	57%	66%
Peterborough	NH	87%	53%	74%	56%	83%	93%	64%	90%	37%	41%
Plymouth	NH	91%	48%	69%	51%	83%	89%	30%	87%	41%	38%
Portsmouth	NH	90%	68%	79%	58%	88%	80%	52%	83%	63%	65%
Rochester	NH	88%	61%	73%	49%	89%	88%	62%	89%	49%	48%
Wolfeboro	NH	90%	69%	73%	54%	76%	88%	55%	96%	45%	49%
Woodsville	NH	89%	53%	69%	49%	67%	93%	69%	91%	50%	68%
Bennington	VT	91%	66%	69%	53%	82%	87%	83%	90%	61%	68%
Berlin	VT	88%	60%	64%	44%	84%	92%	74%	94%	52%	50%
Brattleboro	VT	86%	66%	64%	41%	83%	94%	74%	91%	57%	61%
Burlington	VT	89%	72%	73%	46%	86%	93%	80%	97%	48%	50%
Middlebury	VT	89%	74%	69%	47%	86%	92%	81%	96%	62%	64%
Morrisville	VT	90%	60%	65%	44%	74%	93%	83%	94%	56%	50%
Newport	VT	91%	71%	77%	54%	84%	92%	74%	94%	70%	69%
Randolph	VT	89%	65%	66%	53%	88%	93%	79%	96%	60%	68%
Rutland	VT	86%	72%	61%	43%	71%	85%	81%	92%	55%	59%
Springfield	VT	88%	69%	68%	46%	88%	90%	73%	88%	52%	60%
St. Albans	VT	89%	75%	68%	41%	76%	92%	84%	92%	55%	62%
St. Johnsbury	VT	88%	60%	66%	48%	80%	89%	81%	96%	52%	48%
Townshend	VT	87%	59%	65%	42%	84%	86%	83%	97%	54%	
Windsor	VT	90%	56%	74%	54%	75%	92%	68%	94%	44%	53%
Northern New England average		86%	58%	67%	47%	83%	90%	59%	93%	43%	45%

Measures were selected from the Healthcare Effectives Data and Information (HEDIS) dataset and are unadjusted.

Blank cells indicate that the rate was suppressed due to a sample size smaller than 5 children.

Appendix Table 5. The supply of otolaryngologists and rates of common surgical procedures among insured children in Northern New England pediatric surgical areas

PSA Name	State	Otolaryngologists per 100,000 children and adults (2013)	Tympanostomy (PE) tube placement per 1,000 children (2007-10)	Tonsillectomies per 1,000 children (2007-10)	Adenoidectomies per 1,000 children (2007-10)
Augusta	ME	0.7	5.9	4.3	1.9
Bangor	ME	3.9	3.4	2.7	1.2
Brunswick	ME	5.6	9.3	5.3	3.6
Ellsworth	ME	2.7	3.9	3.8	2.1
Lewiston	ME	3.9	7.9	5.2	1.6
Portland	ME	5.5	5.0	4.0	1.7
Presque Isle	ME	1.2	3.7	5.8	1.6
Rockland	ME	4.1	6.3	5.0	1.7
Sanford	ME	1.8	7.7	5.8	2.9
Waterville	ME	3.6	5.4	3.6	1.4
York	ME	12.4	9.4	7.3	4.3
Berlin	NH	4.9	13.1	10.4	5.5
Concord	NH	2.4	7.9	5.9	2.0
Derry	NH	3.5	6.3	9.5	2.3
Dover	NH	2.4	9.2	8.1	3.1
Exeter	NH	4.0	9.0	8.4	2.9
Keene	NH	4.9	10.5	6.2	3.9
Laconia	NH	1.8	10.3	7.4	3.4
Lebanon	NH	6.5	7.4	7.9	2.6
Littleton	NH	2.9	6.8	10.9	3.5
Manchester	NH	3.2	8.4	8.1	3.1
Nashua	NH	2.6	7.1	6.5	2.2
Berlin	VT	1.5	8.9	4.1	2.4
Brattleboro	VT	2.7	6.1	5.5	2.2
Burlington	VT	5.0	8.3	2.9	2.2
Middlebury	VT	5.4	15.2	5.6	5.2
Newport	VT	3.5	7.4	5.0	2.2
Rutland	VT	2.6	10.1	5.4	2.8
Springfield	VT	3.5	8.0	5.4	2.6
St. Johnsbury	VT	4.0	6.2	5.7	1.7
Northern New England average		3.9	7.4	5.5	2.4

Surgery rates are adjusted for age, sex, and payer (commercial insurer or Medicaid). The supply of otolaryngologists is unadjusted.

Appendix Table 6. Imaging among children in Northern New England hospital service areas (2007-10)						
HSA Name	State	Head CT scans per 1,000 children	Chest/ abdominal CT scans per 1,000 children	Head MRIs per 1,000 children	Chest x-rays per 1,000 children	Abdominal x-rays per 1,000 children
Augusta	ME	14.3	10.6	6.1	72.7	21.0
Bangor	ME	11.1	11.7	8.2	73.7	22.0
Bar Harbor	ME	10.6	13.9	9.0	56.8	16.4
Belfast	ME	14.6	6.9	6.8	58.5	17.5
Biddeford	ME	14.2	9.3	5.2	68.4	20.8
Blue Hill	ME	8.7	8.2	8.2	50.4	17.6
Boothbay Harbor	ME	9.4	8.7	(7.4)	65.3	13.1
Bridgton	ME	11.6	11.4	6.6	55.4	13.3
Brunswick	ME	9.8	7.3	5.9	48.5	14.6
Calais	ME	14.5	8.5	5.4	129.7	37.5
Caribou	ME	16.1	11.6	6.3	74.1	34.7
Damariscotta	ME	10.4	10.9	5.8	71.9	9.7
Dover-Foxcroft	ME	12.3	9.5	12.9	71.4	17.5
Ellsworth	ME	8.7	12.6	7.4	47.0	19.4
Farmington	ME	15.5	9.5	6.0	67.0	16.5
Fort Kent	ME	9.5	6.1	9.5	76.1	23.3
Houlton	ME	5.8	7.8	8.4	46.0	17.5
Lewiston	ME	15.5	9.9	6.0	71.4	16.2
Lincoln	ME	8.7	10.1	10.4	66.7	23.2
Machias	ME	4.3	4.0	8.5	34.7	10.5
Millinocket	ME	9.2	8.9	8.8	75.2	40.4
Norway	ME	11.9	11.1	5.4	81.8	20.5
Pittsfield	ME	11.3	12.2	8.4	78.3	21.8
Portland	ME	9.7	7.6	4.4	54.8	13.2
Presque Isle	ME	19.7	12.4	8.6	81.9	39.4
Rockland	ME	13.7	8.6	6.5	67.7	14.5
Rumford	ME	14.0	11.2	4.6	64.4	13.2
Sanford	ME	12.8	8.2	4.4	63.2	17.4
Skowhegan	ME	16.4	13.1	7.7	86.1	22.5
Waterville	ME	12.7	10.5	7.0	67.2	13.9
York	ME	13.0	9.8	4.9	72.6	29.2
Greenville	ME	(6.9)	(12.4)	(7.6)	90.1	19.1
Berlin	NH	15.2	5.1	8.1	80.3	33.4
Claremont	NH	10.9	8.1	14.2	74.3	32.2
Colebrook	NH	12.2	9.6	11.4	77.6	25.2
Concord	NH	14.1	9.8	8.6	90.9	30.6
Derry	NH	15.9	8.6	10.9	105.1	41.0
Dover	NH	14.8	7.4	5.5	83.9	23.3
Exeter	NH	12.4	7.9	7.5	83.4	24.1
Franklin	NH	11.2	9.2	11.6	71.5	27.7
Keene	NH	10.4	7.3	7.9	63.6	19.6
Laconia	NH	15.8	12.1	11.2	74.5	22.2
Lancaster	NH	13.2	9.0	9.9	76.6	31.4
Lebanon	NH	8.9	4.7	11.7	58.9	17.9

Appendix Table 6. Imaging among children in Northern New England hospital service areas (2007-10)

HSA Name	State	Head CT scans per 1,000 children	Chest/ abdominal CT scans per 1,000 children	Head MRIs per 1,000 children	Chest x-rays per 1,000 children	Abdominal x-rays per 1,000 children
Littleton	NH	6.9	5.1	6.9	40.9	18.6
Manchester	NH	14.8	9.1	7.6	93.2	38.0
Nashua	NH	13.9	7.6	6.6	84.1	28.1
New London	NH	12.0	7.7	11.2	55.9	18.9
North Conway	NH	12.4	6.7	7.5	60.2	23.2
Peterborough	NH	9.7	7.8	4.9	48.8	21.5
Plymouth	NH	9.7	6.3	6.2	57.4	17.3
Portsmouth	NH	10.1	7.5	5.3	73.7	23.0
Rochester	NH	15.9	8.4	7.2	103.3	29.8
Wolfeboro	NH	17.0	9.7	9.1	78.4	34.3
Woodsville	NH	10.5	6.6	10.3	55.5	18.2
Bennington	VT	15.4	15.4	6.0	76.5	13.5
Berlin	VT	9.9	9.3	8.1	68.9	16.0
Brattleboro	VT	7.4	5.1	5.8	51.6	16.4
Burlington	VT	8.4	7.1	5.4	57.5	17.8
Middlebury	VT	7.0	6.9	7.5	65.4	15.6
Morrisville	VT	5.9	9.0	5.2	52.4	13.2
Newport	VT	8.2	5.9	6.6	63.7	25.4
Randolph	VT	10.4	6.0	9.9	79.9	20.7
Rutland	VT	10.7	10.5	8.0	77.7	22.5
Springfield	VT	10.8	9.8	10.5	92.0	24.5
St. Albans	VT	12.2	10.0	5.9	66.6	21.4
St. Johnsbury	VT	8.2	5.8	6.2	54.5	31.4
Townshend	VT	7.2	6.9	6.5	41.5	8.7
Windsor	VT	8.9	6.8	14.6	73.6	22.3
Northern New England average		12.0	8.8	7.1	71.5	22.2

Rates are adjusted for age, sex, and payer (commercial insurer or Medicaid). Numbers in parentheses indicate a possible lack of statistical precision due to a small sample size.

Appendix Table 7. Prescription drug use among children in Northern New England hospital service areas (2007-10)

HSA Name	State	Total prescription fills per 100 children	ADHD medications		Antidepressants		Antipsychotics		Antibiotics		Acid suppressants	
			Fills per 100	% with fill	Fills per 100	% with fill	Fills per 100	% with fill	Fills per 100	% with fill	Fills per 100	% with fill
Augusta	ME	435.8	60.1	5.7	25.5	3.8	27.1	2.4	71.0	33.0	9.2	2.2
Bangor	ME	523.6	70.3	5.9	26.7	3.5	29.4	2.5	83.2	36.5	13.8	3.0
Bar Harbor	ME	424.8	63.0	7.0	24.6	3.3	15.2	1.5	67.9	30.8	10.8	2.3
Belfast	ME	410.5	67.0	5.6	22.2	3.3	20.5	2.3	66.7	32.4	10.4	3.0
Biddeford	ME	468.3	76.0	6.8	24.8	3.6	17.8	1.5	90.2	36.7	10.6	2.3
Blue Hill	ME	388.7	50.7	5.2	23.4	4.1	18.9	1.6	59.7	28.5	8.0	2.3
Boothbay Harbor	ME	418.0	68.1	6.2	29.0	3.9	10.4	0.8	83.0	35.7	7.7	1.7
Bridgton	ME	401.7	71.1	7.7	21.2	3.7	11.5	1.7	70.6	31.4	8.9	1.8
Brunswick	ME	413.4	55.0	5.5	25.0	3.8	16.0	1.3	84.6	35.5	7.5	1.8
Calais	ME	424.6	49.2	5.0	16.0	2.4	19.9	1.8	87.8	38.5	7.1	2.0
Caribou	ME	598.8	81.2	7.2	29.4	4.0	27.0	2.8	95.6	42.5	13.7	3.4
Damariscotta	ME	386.8	56.0	5.9	25.4	4.1	12.5	1.2	81.8	33.8	8.4	1.6
Dover-Foxcroft	ME	531.5	71.5	6.9	26.4	3.8	21.9	2.2	77.3	33.3	12.2	2.8
Ellsworth	ME	457.1	72.7	8.1	28.2	3.9	31.0	2.9	67.8	31.7	11.3	2.7
Farmington	ME	342.2	37.1	3.6	12.6	2.3	11.9	1.1	69.5	31.6	7.5	2.1
Fort Kent	ME	407.4	35.9	2.9	27.9	3.1	23.1	2.2	70.3	33.1	7.0	2.0
Greenville	ME	382.4	33.8	3.6	13.7	2.6	10.4	1.2	79.2	34.7	6.8	2.2
Houlton	ME	438.4	55.3	5.4	14.9	2.5	11.0	1.2	80.9	36.5	10.4	3.0
Lewiston	ME	427.3	54.1	5.5	23.3	3.5	16.4	1.7	75.5	32.6	10.0	2.5
Lincoln	ME	446.4	55.0	5.5	14.5	2.5	18.7	1.8	81.2	33.8	9.4	2.4
Machias	ME	453.8	57.4	6.6	20.5	3.3	20.5	2.5	85.5	37.0	9.9	2.8
Millinocket	ME	565.2	58.4	5.6	18.2	2.8	21.0	2.0	93.6	40.2	14.6	3.1
Norway	ME	381.2	54.8	5.4	19.1	3.2	12.4	1.3	58.5	27.9	10.1	2.4
Pittsfield	ME	415.5	37.5	3.6	15.5	2.5	17.2	1.8	74.6	34.5	10.3	2.3
Portland	ME	405.1	62.3	5.8	25.3	3.3	14.2	1.1	74.6	32.7	8.0	1.7
Presque Isle	ME	494.7	50.6	5.0	19.6	3.2	12.6	1.4	92.5	40.9	14.8	3.6
Rockland	ME	361.9	57.6	5.2	15.9	2.4	12.8	1.3	70.2	30.9	8.6	1.9
Rumford	ME	336.7	35.1	3.6	12.2	2.1	9.0	1.2	59.3	25.4	8.4	1.9
Sanford	ME	434.0	71.4	7.1	25.0	3.9	14.3	1.6	85.5	37.5	8.6	2.0
Skowhegan	ME	381.4	43.1	4.5	17.8	2.6	12.3	1.4	78.1	35.8	9.2	2.3
Waterville	ME	374.8	48.6	4.4	19.9	3.1	16.1	1.4	70.8	32.4	8.3	2.0
York	ME	498.1	74.3	6.4	33.3	3.9	17.4	1.1	100.9	38.2	8.0	1.5
Berlin	NH	465.9	61.7	7.3	19.7	3.6	14.2	2.1	82.0	39.5	10.6	2.4
Claremont	NH	491.4	61.3	6.7	30.0	4.9	17.3	2.0	83.5	37.9	6.6	1.7
Colebrook	NH	400.8	41.9	4.3	10.3	2.3	12.7	1.4	87.5	37.0	3.9	1.7
Concord	NH	451.5	54.6	6.3	22.8	3.2	22.2	2.0	79.5	35.8	10.1	2.1
Derry	NH	481.2	48.4	5.5	22.3	3.2	18.4	1.8	98.4	39.6	14.1	2.8
Dover	NH	424.0	51.1	5.7	21.4	3.0	10.6	1.2	86.3	39.0	7.6	2.0
Exeter	NH	462.4	57.6	6.2	22.8	3.0	10.2	1.1	88.3	37.0	11.7	2.2
Franklin	NH	588.2	62.6	7.6	28.7	4.3	28.9	2.6	99.4	42.4	12.7	3.3
Keene	NH	436.1	54.9	6.8	27.8	4.1	17.0	1.5	79.7	35.9	7.9	1.8
Laconia	NH	436.4	51.5	6.7	18.3	3.4	14.9	2.0	98.8	42.0	9.5	2.4
Lancaster	NH	409.1	53.5	6.7	18.1	3.6	15.9	1.8	78.6	35.2	7.0	2.3
Lebanon	NH	466.8	66.3	6.5	32.5	4.4	16.3	1.6	75.4	31.3	6.4	1.4

Appendix Table 7. Prescription drug use among children in Northern New England hospital service areas (2007-10)												
HSA Name	State	Total prescription fills per 100 children	ADHD medications		Antidepressants		Antipsychotics		Antibiotics		Acid suppressants	
			Fills per 100	% with fill	Fills per 100	% with fill	Fills per 100	% with fill	Fills per 100	% with fill	Fills per 100	% with fill
Littleton	NH	393.5	59.8	7.5	16.0	3.0	11.4	1.8	74.1	34.3	6.9	2.2
Manchester	NH	469.3	61.1	6.8	19.5	2.9	15.6	1.5	80.8	36.1	13.1	2.9
Nashua	NH	452.2	50.0	5.8	17.8	2.7	21.7	1.9	85.7	37.4	10.3	2.1
New London	NH	429.4	61.6	7.7	23.6	3.8	12.5	1.4	83.2	38.1	4.8	1.6
North Conway	NH	388.6	45.1	6.2	24.0	4.0	11.4	1.5	75.1	35.9	9.7	2.7
Peterborough	NH	348.9	43.5	5.1	19.0	2.9	12.3	1.3	66.4	31.5	5.8	1.4
Plymouth	NH	428.4	52.3	6.9	19.6	2.9	13.9	1.6	85.3	38.7	9.5	2.8
Portsmouth	NH	480.5	62.0	6.2	26.4	3.3	11.0	1.2	90.8	39.0	11.8	2.1
Rochester	NH	432.7	49.8	6.5	14.8	2.6	11.7	1.7	86.0	39.7	9.5	2.5
Wolfeboro	NH	452.8	49.0	6.2	20.5	3.4	11.5	1.3	90.0	39.3	10.9	2.8
Woodsville	NH	444.0	64.6	7.0	28.1	4.7	13.4	1.7	84.9	34.6	6.3	2.0
Bennington	VT	532.5	63.0	6.3	20.7	3.3	23.2	2.7	105.7	41.2	9.9	3.0
Berlin	VT	398.4	46.8	4.7	19.4	2.9	11.1	1.1	85.8	36.4	8.4	2.5
Brattleboro	VT	412.0	73.4	7.8	28.2	4.3	21.8	2.6	65.3	29.4	4.2	1.2
Burlington	VT	397.1	49.7	4.3	17.8	2.3	10.6	0.9	77.9	33.8	10.4	2.3
Middlebury	VT	439.3	61.8	5.8	20.6	3.3	10.7	1.3	79.7	33.4	11.4	2.8
Morrisville	VT	398.4	37.5	4.1	16.3	2.8	17.6	1.7	82.4	36.4	8.4	2.2
Newport	VT	345.5	34.8	4.3	13.3	2.4	7.1	1.0	69.6	32.8	6.4	2.1
Randolph	VT	371.5	44.4	4.8	19.9	3.2	13.5	1.6	81.4	35.4	4.2	1.3
Rutland	VT	459.2	46.7	5.3	18.1	3.0	12.0	1.5	101.2	42.2	11.4	3.1
Springfield	VT	470.0	68.7	7.1	28.3	4.4	18.7	2.2	81.5	35.2	6.9	2.1
St. Albans	VT	403.7	49.1	4.8	15.8	2.3	10.6	0.9	105.8	41.8	9.4	2.7
St. Johnsbury	VT	424.7	48.7	5.2	19.0	3.1	12.7	1.4	88.1	34.2	7.9	2.3
Townshend	VT	305.0	36.4	5.0	17.3	2.7	11.6	1.8	58.5	27.7	5.6	1.4
Windsor	VT	495.8	60.9	6.0	28.4	4.5	15.9	1.6	91.0	35.7	6.4	1.8
Northern New England average		435.0	55.7	5.8	21.5	3.2	16.0	1.6	81.8	35.7	9.6	2.3

Rates are adjusted for age, sex, and payer (commercial insurer or Medicaid). Two rates are given for the individual drug classes: the number of fills per 100 children, and the percent of children filling at least one prescription.

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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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