

Temporal Trends in the Utilization of Echocardiography in Ontario, 2001 to 2009

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The purpose of this study was to examine utilization and growth in echocardiography among the general population of Ontario between 2001 and 2009. The age- and sex-adjusted rates of echocardiography grew from 39.1 per 1,000 persons in 2001 to 59.9 per 1,000 persons in 2009, for an annual rate of increase of 5.5%. Repeat echocardiograms increased at a rate of 10.6% per year and accounted for 25.3% of all procedures in 2009 as compared to 18.5% in 2002. While significant increases in echocardiography utilization were observed, opportunities may exist to improve the clinical utility of the echocardiograms performed in Ontario.

The rapid increase in utilization of imaging procedures has received substantial attention from both researchers and policymakers (1). In particular, the utilization of echocardiography has grown at an extremely high rate in both the United States and Canada (2–6). Recent studies of utilization using claims from the United States Veteran's Administration and Medicare plans have attributed the majority of the growth in echocardiography to increased enrollment in their health

plans and variations in disease prevalence. Nonetheless, there has been ongoing concern that increases in utilization may also be influenced by a number of nonclinical or system-related factors, such as fee for service incentives (7,8), increased availability (3,8), duplicate imaging (1), and increased physician reliance on technology (9). In response to such concerns of overuse, the American College of Cardiology Foundation (ACCF), in conjunction with the American Society of Echocardiography and

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other societies, published appropriate use criteria (AUC) for echocardiography, which are currently being evaluated for usability (10–13).

The province of Ontario provides universal coverage for health care to its residents, so is less subject to the enrollment shifts of large U.S. insurers. Furthermore, the prevalence of cardiovascular disease has remained relatively stable over the past decade in Canada (14). The purpose of this study was to examine the utilization of echocardiography and frequency of repeat studies among the general population of Ontario. We hypothesized that there would be significant growth in echocardiography utilization between 2001 and 2009 despite a relatively stable rate of cardiovascular disease during this period (14,15). We explored factors that might influence utilization including indication, geography, and physician supply.

Methods

Study design and data sources. We conducted a population-based, repeated cross-sectional study of all outpatient echocardiograms performed in Ontario between 2001 and 2009. Our primary data source was the Ontario Health Insurance Plan (OHIP) administrative database. The OHIP database contains claims submitted for all outpatient services, including echocardiography, covered by the Ontario Ministry of Health and Long-Term Care (2). The Registered Persons Database was used to obtain demographic information including age, sex, and geographic location. Patients' postal codes of residence from the Registered Persons Database were linked to the Census Area Profile using the Postal Code Conversion File to obtain median neighborhood income and urban density. Hospitalizations were determined using the Canadian Institutes for Health Information database. Physician specialty was assessed using the Ontario Physician Human Resource Data Center database.

Echocardiography utilization assessment. We included transthoracic echocardiograms billed to OHIP between January 2001 and December 2009. Echocardiography utilization was assessed by the technical component of the billing codes for 1- and 2-dimensional transthoracic echocardiograms (G560, G566, G570, G574) (2,16). Before 2006, echocardiography was covered under the global hospital budget for inpatients and was not available in the OHIP database (6). For this reason, we only included outpatient echocardiography in this study. Other exclusion criteria included echocardiography billed after the beneficiary was deceased; echocardiography with an associated claim to OHIP that was not reimbursed; and echocardiography performed on persons <18 years of age. We did not include transesophageal echocardiography as these are invasive tests. To avoid duplicate claims, only 1 echocardiogram was counted per patient in a given day.

An echocardiogram was considered to be a repeat test if another test had been performed in the 365 days before the index test. Because we considered studies starting on January 1, 2001, we examined the frequency of repeat studies beginning in 2002.

Demographic information. Individual demographic information was obtained at the time of echocardiogram. Average neighborhood income was based on census tract and categorized into quintiles. Urban density was categorized as rural if the population was <10,000 (17). Regional variation was assessed using 14 geographically defined Local Health Integration Networks (LHINs) in Ontario (18). The LHINs were developed by the government to allow for local planning and funding of health care services to a population residing in a specific geographic region. These networks cover the entire province and vary in population size from 180,000 to 1.3 million.

For each subject, we assessed if a hospitalization occurred in the 30 days

before the time of echocardiography. In addition, we determined if a cardiology consultation took place either 30 days before or 30 days after the procedure, based on an OHIP claim from a physician encounter. Physician specialty in the Ontario Physician Human Resource Data Center database was based on the type of care that is primarily delivered by the physician (19). The specialty of the billing physician was dichotomized as cardiac specialist and other specialties. Non-cardiac specialists were then categorized as internal medicine, family physician or general practitioner, radiology, and other.

We determined the top 10 most common indications for echocardiography during the study period. Diagnosis codes for procedure claims submitted to OHIP are 3 digits and based on the International Classification of Diseases, Eighth Revision (ICD-8) coding system (20).

Statistical analysis. The number of echocardiograms performed in each calendar year was determined and characteristics compared across years using the chi-square test for categorical variables and analysis of variance for continuous variables. Rates of echocardiography were calculated by dividing the number of studies by the population of Ontario in a specific year and estimated per 1,000 persons. Rates were standardized with age- and sex-adjustment to the 2006 Ontario population using the direct standardization method. Average changes in echocardiography rates and repeat echocardiography rates in the population were calculated using a negative binomial regression model.

Change in number of echocardiograms by physician specialty during the period was calculated by dividing the number of studies performed in 2009 by the number of studies performed in 2001. We divided the change in number of echocardiograms for each specialty by the total provincial change in studies during this period to determine the amount of growth that was attrib-

utable to each physician specialty. Rates of echocardiography and repeat echocardiography by physician specialty were calculated by dividing the number of procedures performed by the number of physicians who had billed at least 1 claim. The annual change in number of physicians and number and rate of echocardiography by physician specialty were calculated using a negative binomial regression model.

We determined the age- and sex-adjusted rates for total and repeat echocardiography studies for each of the 14 LHINs. The difference across LHINs in a given year was determined by dividing the rate of echocardiography in the region with the highest rate in that year by the region with the lowest rate in that year to calculate an extremal quotient (21). We evaluated the average change in extremal quotient using linear regression with year as the independent variable.

A p value <0.05 was considered statistically significant, and all tests were 2-sided. Statistical analyses were performed using SAS version 9.2 (SAS Institute, Cary, North Carolina) and STATA 10 (StataCorp, College Station, Texas). The project was approved by the research ethics board at Sunnybrook Health Sciences Centre.

Results

Between 2001 and 2009, there were 4,844,483 outpatient OHIP claims for echocardiograms. After exclusion of claims with no reimbursement, children, repeat procedures on the same day, billing date after death date, or missing sex or postal code information, 4,234,166 echocardiograms were included in our study.

The mean age of Ontario patients at the time of an echocardiogram was 59.5 years, with a slight increase during the 9-year study period (Table 1). There was also an increase in the percent of echocardiograms performed on persons who were male and from urban regions. In most years, procedures were evenly distributed across strata of in-

come, our measure of socioeconomic status. The percentage of echocardiograms performed within 30 days of a hospitalization steadily declined from 4.6% in 2001 to 2.8% in 2009.

The number of echocardiograms increased in each consecutive year, rising from 345,767 in 2001 to 630,692 in 2009 (Table 1). This represented a growth of 82% in absolute number of studies performed during the period. The age- and sex-adjusted rates of echocardiography grew from 39.1 per 1,000 persons in 2001 to 59.9 per 1,000 persons in 2009 (Fig. 1). Overall growth in adjusted rate of tests was 53% during this period, with an annual rate of increase of 5.5% (Fig. 2). The age- and sex-adjusted percentage of the population who had an echocardiogram increased from 3.6% in 2001 to 5.2% in 2009. On average, 4.3% of people in Ontario (approximately 1 in every 25 adults) had an echocardiogram performed in a given year.

The rate of repeat echocardiography per 1,000 persons increased from 7.6 in 2002 to 15.1 in 2009, representing an annual increase of 10.6% per year. The percentage of all echocardiograms that represented repeat studies increased from 18.5 to 25.3% ($p < 0.001$) between 2002 and 2009 (Table 2). Additionally, the percentage of persons receiving at least 1 repeat test grew from 16.6% to 22.5% ($p < 0.001$) during the study period, with the increase observed among both persons who had 1 repeat test and those who had multiple repeat tests. About half of repeat tests were performed by the same physician (Table 2).

The majority of echocardiograms were performed by cardiac specialists throughout the study period, with significant growth taking place: cardiologists performed 87% more echocardiograms in 2009 in comparison to 2001, and this increase accounted for 81% of the overall growth in echocardiograms in the province. The average annual rate of change in number of cardiac

specialists performing echocardiograms in Ontario was 3.1%, whereas the volume of tests per cardiac specialist increased by 5.1% per year (Table 3). Among cardiologists, 34% of the growth in the rate of echocardiograms between 2002 and 2009 could be attributed to an increase in repeat echocardiography.

Non-cardiac specialists performed 23% of echocardiograms between 2001 and 2009. The number of noncardiologists who were performing echocardiography remained stable during the period; nonetheless, growth in the rate of echocardiograms performed by non-cardiologists was 6% per year due to an increase in the average volume performed per provider. Much of this increase in volume per provider was related to increases in repeat studies, as opposed to increased patient volume. Internal medicine physicians accounted for 44% of the procedures performed by non-cardiac specialists.

Rates of echocardiography varied by LHIN and the extent of regional variation increased over time. In 2001, the age- and sex-adjusted rates of echocardiography ranged from 24.1 to 53.9 per 1,000 persons across LHINs; in 2009, rates by LHIN ranged from 34.6 to 87.3 per 1,000 persons (Online Figs. 1 and 2). The rates in the highest utilizing LHIN were >2 times (range 2.23 to 2.68) that of the lowest LHIN in each year. We found the extremal quotient to increase at 0.05 per year (95% confidence interval: 0.03 to 0.07), implying a widening regional variation during the period. The extremal quotient for repeat studies increased from 3.26 in 2002 to 4.54 in 2009.

Of all echocardiography claims submitted during the study period, 73% were missing an indication diagnosis, although there was a slight improvement in reporting of diagnoses during the study period (Online Table 1). The most common non-missing diagnosis was code 785, representing "chest pain, tachycardia, syncope, shock, edema,

Table 1. Characteristics of Patients Receiving and Physicians Performing Echocardiograms in Ontario, 2001 to 2009

	2001 (n = 345,767)	2002 (n = 371,356)	2003 (n = 382,187)	2004 (n = 431,716)	2005 (n = 459,692)	2006 (n = 504,581)	2007 (n = 536,655)	2008 (n = 571,520)	2009 (n = 630,692)	Overall (n = 4,234,166)	P Trend
Age, yrs											
Mean ± SD	59.0 ± 16.4	59.1 ± 16.5	59.2 ± 16.4	59.4 ± 16.3	59.5 ± 16.4	59.5 ± 16.4	59.7 ± 16.3	59.9 ± 16.3	59.8 ± 16.3	59.5 ± 16.4	<0.001
18-49	27.8	27.9	27.5	27.2	27.0	26.9	26.5	25.9	26.0	26.8	
50-64	29.7	29.6	30.1	30.3	30.6	30.8	31.2	31.4	31.8	30.8	
65-74	23.4	23.1	22.6	22.4	22.2	21.7	21.6	21.6	21.4	22.1	
≥75	19.1	19.4	19.8	20.1	20.2	20.5	20.7	21.0	20.7	20.3	
Female	51.6	51.5	50.8	50.4	49.9	49.9	49.7	49.3	49.5	50.1	<0.001
Rural	11.4	11.4	11.2	10.4	10.3	9.9	9.9	9.8	9.7	10.3	<0.001
Income quintile											
1	19.6	19.3	19.1	20.3	20.1	20.1	19.9	19.7	19.6	19.8	
2	20.8	20.6	20.3	20.5	20.3	20.3	20.2	20.2	20.2	20.3	
3	19.9	20.0	20.0	19.4	19.8	19.6	19.7	19.7	19.8	19.8	
4	19.4	19.7	20.0	19.5	19.7	19.7	20.0	20.1	20.2	19.8	
5	20.3	20.5	20.6	20.2	20.1	20.2	20.3	20.3	20.1	20.3	
Hospitalization in prior 30 days	4.6	4.4	4.1	3.8	3.7	3.3	3.1	2.9	2.8	3.5	<0.001
Physician specialty											
Cardiology	76.0	75.8	76.0	75.6	75.5	77.1	78.5	77.9	78.1	76.9	<0.001
Noncardiology	24.0	24.2	24.0	24.4	24.5	22.9	21.5	22.1	21.9	23.1	
Family physician	1.7	2.0	2.2	2.6	1.9	2.0	1.9	2.1	1.7	2.0	
Internal medicine	10.9	11.2	10.2	10.4	11.8	9.8	9.0	9.6	10.0	10.2	
Radiology	8.5	7.8	8.1	7.1	6.2	6.1	5.7	5.4	5.2	6.5	
Other	2.9	3.2	3.5	4.3	5.2	5.0	4.9	5.0	4.9	4.5	
Cardiology consultation in 30 days	41.2	40.4	40.8	39.6	39.3	39.5	40.9	40.8	41.5	40.5	<0.001

Values are mean ± SD or %.

masses” and found in 7.0% of claims during the period of 2007 to 2009. The next most common indication for echocardiography was code 429, for “all other forms of heart disease.”

Discussion

On average, approximately 4% of the adult population of Ontario had at least 1 outpatient transthoracic echocardiogram in any given year from 2001 to 2009. The total cost of performing these echocardiograms was approximately \$130 million in Ontario in 2009. During this period, the total number of echocardiograms performed in the province of Ontario grew by 82%; after adjusting for age and sex, population standardized rates increased by 5.5% per annum. If adjusted rates of echocardiography had remained stable during the period, there would have been 215,000 fewer echocardiograms performed in 2009 as compared to the actual number performed. This differential would have resulted in saving the provincial health care system >\$44 million in annual costs, given current reimbursement rates for a complete echocardiogram (16).

The increase in age- and sex-adjusted rate in our study was similar to the annual increase observed in an earlier OHIP study, which evaluated diagnostic testing between 1992 and 2001 (2). This implies a continued growth of nearly 6% annually in the rate of echocardiograms performed in Ontario over a 19-year period, after accounting for both population growth and aging, both of which are major contributors to increased health care spending (22). Trends in our study were slightly below the 7.7% growth in rate of echocardiography in the United States Medicare population from the first part of the decade, although the Medicare numbers were unadjusted and included inpatient procedures (5). Conversely, a study from the Veterans Administration found a total rate of

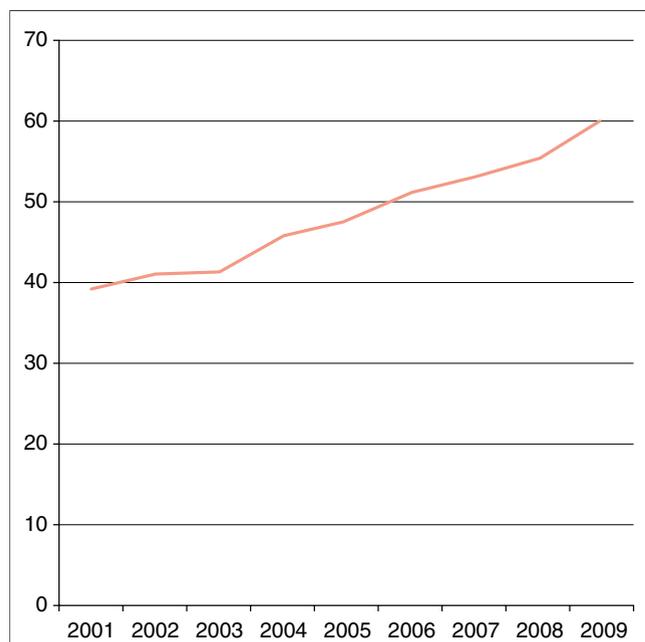


Figure 1. Growth in Rate of Echocardiography

Figure represents age- and sex-adjusted rate of echocardiography between 2001 and 2009. Rates are per 1,000 persons.

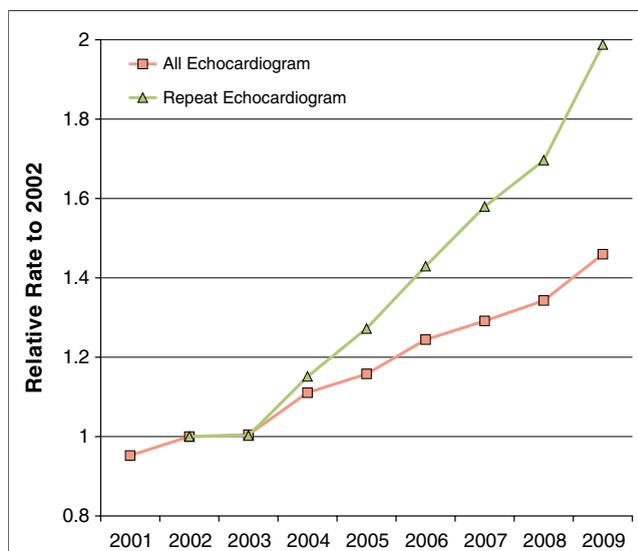


Figure 2. Annual Change in Relative Rate of Echocardiography and Repeat Echocardiography

Rates are relative to 2002 and adjusted for age and sex. Echocardiograms were considered repeat procedures (green line) if performed within 365 days of a prior procedure, resulting in a 1-year lag in rates for repeat echocardiography as compared to all echocardiography (orange line).

increase in echocardiography of <4% between 2000 and 2007. The authors of that study hypothesized that Veterans Administration policy changes to increase the number of veterans eligible for services without an immediate increase in procedural capacity may have resulted in stabilization of echocardiography rates (23). There were no such policy changes in Ontario during the period we examined. In our study, physicians appeared to be increasingly reliant on echocardiography to clinically manage patients.

The rate of repeat testing grew faster than the total rate of echocardiography; repeat testing accounted for 18% of all echocardiograms at the beginning of the study period and 25% of total tests by the end, representing a major driver in the increase in overall utilization of echocardiography. Previous studies have shown minimal growth in the rate of repeat echocardiography but were limited to evaluating only the number of repeat studies within the same calendar year (5,23). In our study, in which a repeat echocardiogram was defined as having occurred within 365 days of a

prior outpatient procedure, repeat testing increased by an average of 10% per year.

The ACCF AUC, first published in 2007 (10) and updated in 2011 (11), describe many appropriate indications for repeat echocardiography within 1 year, including symptoms of an acute cardiopulmonary event; changes in clinical status for an individual patient with pulmonary hypertension, valvular disease, or aortic disease; and evaluation for advanced therapies in heart failure (11). Nonetheless, most indications for repeat studies within 1 year are considered to be inappropriate for stable patients, and studies from single centers have demonstrated that repeat echocardiograms are frequently obtained for stable patients, particularly in the outpatient setting (24–26). We did not include hospitalized patients and found that the rates of tests performed within 30 days of hospitalization decreased during this period; these findings suggest that growth in echocardiography was not related to a higher prevalence of unstable patients.

Importantly, we observed that more than one-half of all repeat echocardiograms were performed by a different physician. We postulate that many of these repeat tests may be related to inefficiencies in the current health care system and/or medicolegal concerns. An inability to access prior echocardiographic images, or questions regarding the quality of either the acquisition or interpretation of previous studies by different physicians, may have led to many repeat procedures.

Given that multiple-laboratory image sharing for outpatient echocardiography has not been implemented in Ontario (27), improving accessibility of imaging across facilities through a common picture archiving and communications system may help to reduce unnecessary repeat procedures. Furthermore, certification of facilities that perform echocardiography and basic competency requirements for physicians who interpret echocardiograms may reduce concerns related to variations in quality and possibly re-

Table 2. Characteristics of Repeat Echocardiograms in Ontario

	2002	2003	2004	2005	2006	2007	2008	2009
Number of echocardiograms	371,356	382,187	431,716	459,692	504,581	536,655	571,520	630,692
Percent repeats	18.5	18.4	19.1	20.3	21.3	22.6	23.5	25.3
Adjusted rate of repeat (per 1,000 people)	7.6	7.6	8.7	9.7	10.9	12.0	12.9	15.1
Repeats (%) performed by same physician	43.4	45.3	46.3	45.6	48.0	47.6	46.5	46.5
Number of persons with echocardiogram	338,055	348,181	390,220	413,157	449,277	474,264	500,432	543,772
Percent of persons with repeat echocardiogram								
0 repeat	83.4	83.5	82.8	81.7	80.9	79.5	79.0	77.5
1 repeat	13.7	13.5	13.9	14.8	15.3	16.4	16.5	17.3
2 repeats	2.5	2.5	2.7	2.9	3.1	3.3	3.6	4.0
3 repeats	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.9
≥4 repeats	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3

sult in less repeat procedures. An organization such as the Intersocietal Commission for the Accreditation of Echocardiography Laboratories (28) may be able to provide such certification but there are only a few facilities in Ontario that are currently accredited (29).

We were limited in our ability to determine the indication for procedures as the majority of claims in this study had no associated diagnosis. Of the claims that did have a diagnosis code, the diagnosis was based on the ICD-8 classification system, which was updated decades ago because of lack of specificity (30). As exemplified in this study, the most common diagnosis listed (other than missing) was “chest pain, tachycardia, syncope, shock, edema, masses,” which represents 6 different symptoms, each of which may incorporate a number of actual diagnoses. Given such lack of specificity, we are significantly limited in our ability to assess the rationale for the minority of procedures that did have an associated diagnosis codes.

A number of other health care systems and payers require that a referral indication be included with outpatient procedures such as echocardiograms, thus allowing for potential tracking of procedure indications (23,31). Although procedure diagnoses have limitations in accuracy, they

may be helpful for improving appropriate utilization. Firstly, clinicians who are required to provide a diagnosis for referral may give additional consideration to the necessity for the procedure. Such consideration may lead to further education about appropriate use, which is 1 of the goals of the AUC (11,31). Secondly, required documentation of echocardiography indication could be used to track the appropriateness of procedures. To maximize the utility of such a tracking mechanism, the diagnosis coding system should be updated to a more specific system. The referral diagnosis could ideally be paired with expert recommendations on utilization, such as the ACCF AUC, to evaluate for best practice. Thirdly, the inclusion of indication on claims should be feasible. The Cardiac Care Network of Ontario recently issued a statement on the standards for performance of echocardiography, which included recommendations that laboratories should have mechanisms to ensure that an indication is included with each referral and to educate physicians on appropriate indications for referral (32). Therefore, a mechanism should be in development for recording an appropriate referral indication; tracking this information can be implemented with improvement of the system that records the diagnosis.

Study limitations. This study should be interpreted in the context of its limitations. Firstly, echocardiography is an extremely useful diagnostic test in many patients but whether a continuous rapid rise in utilization rates is clinically justified remains uncertain, particularly given the lack of rigor in OHIP diagnostic coding for procedures and our inability to determine trends and variations in the prevalence of such conditions as pulmonary hypertension, valvular heart disease, and outpatient heart failure. Secondly, our definition of physician specialty was based on analysis of the type of clinical care delivered rather than specialty certification and, therefore, may be subject to misclassification (19). Thirdly, due to the nature of claims data, we were unable to determine the proportion of echocardiograms that were attributable to self-referral as we did not have information on the referring physician. Fourthly, as claims data for inpatient echocardiography were unavailable for the majority of the study period, we are only able to evaluate trends in outpatient procedures. A shift in location of performance of echocardiography from hospital to the outpatient setting might have partially accounted for increases in rates. However, OHIP began to reimburse the professional component for inpatient echocardiography by 2007, in-

Table 3. Characteristics of Specialty of Physicians Performing Echocardiograms in Ontario, by Year

	2001	2002	2003	2004	2005	2006	2007	2008	2009	Annual Rate of Change (95% CI)	
Cardiology											
No. of physicians billing echo	304	305	328	330	335	361	361	363	395	3%	(3% to 4%)*
No. of echo	262,634	281,499	290,325	326,215	347,082	388,870	421,152	445,271	492,406	8%	(8% to 9%)*
Avg. echo per physician	864	923	885	989	1,036	1,077	1,167	1,227	1,247	5%	(4% to 6%)*
No. of repeat echo		56,679	58,693	68,745	76,630	89,799	101,782	109,964	128,829	13%	(12% to 14%)*
Avg. repeat echo per physician		186	179	208	229	249	282	303	326	9%	(7% to 12%)*
All Non-Cardiology											
No. of physicians billing echo	399	411	395	374	406	385	352	395	395	-1%	(-2% to 1%)
No. of echo	83,133	89,857	91,862	105,501	112,610	115,711	115,503	126,249	138,286	6%	(5% to 7%)*
Avg. echo per physician	208	219	233	282	277	301	328	320	350	7%	(5% to 8%)*
No. of repeat echo		11,852	11,605	13,859	16,806	17,638	19,713	24,148	30,619	15%	(12% to 17%)*
Avg. repeat echo per physician		29	29	37	41	46	56	61	78	16%	(11% to 21%)*
Internal Medicine											
No. of physicians billing echo	95	89	107	95	108	104	94	118	119	3%	(0% to 5%)‡
No. of echo	37,711	41,435	38,980	45,025	51,307	49,330	48,441	55,034	63,249	6%	(4% to 7%)*
Avg. echo per physician	397	466	364	474	475	474	515	466	532	3%	(1% to 5%)†
No. of repeat echo		6,215	5,108	5,826	7,701	7,280	8,297	10,593	11,065	11%	(8% to 14%)*
Avg. repeat echo per physician		70	48	61	71	70	88	90	93	8%	(4% to 11%)*
Family Practice/General Practitioner											
No. of physicians billing echo	62	74	74	70	79	59	66	64	60	-2%	(-5% to 1%)
No. of echo	5,785	7,591	8,574	11,339	8,920	10,314	10,441	11,737	10,911	7%	(4% to 10%)*
Avg. echo per physician	93	103	116	162	113	175	158	183	182	9%	(5% to 12%)*
No. of repeat echo		1,544	2,213	2,481	1,938	1,993	2,033	2,619	2,555	4%	(0% to 9%)‡
Avg. repeat echo per physician		21	30	35	25	34	31	41	43	8%	(2% to 14%)†
Radiology											
No. of physicians billing echo	139	147	133	121	119	115	92	89	95	-6%	(-8% to -4%)*
No. of echo	29,485	28,938	30,789	30,773	28,421	30,669	30,421	30,831	33,089	1%	(0% to 2%)‡
Avg. echo per physician	212	197	231	254	239	267	331	346	348	8%	(6% to 9%)*
No. of repeat echo		2,541	2,719	2,819	3,149	3,425	4,108	4,741	8,289	16%	(11% to 21%)*
Avg. repeat echo per physician		17	20	23	26	30	45	53	87	27%	(21% to 35%)*

*p < 0.001. †p < 0.01. ‡p < 0.05.
 Avg. = average; CI = confidence interval; echo = echocardiograms; No. = number.

creasing the financial incentive to perform tests in the hospital rather than moving the site of location of these studies from the hospital to the outpatient setting. Finally, our findings reflect patterns of echocardiography use in the province of Ontario and may not reflect trends in utilization in other provinces or health care systems.

Conclusions

We observed high rates of growth in the use of echocardiography and repeat echocardiography in the universal health care system of Ontario. There are clearly opportunities to address this rapid growth through basic measures such as required referral indication codes, particularly with an

improved coding system. The effect of the implementation of required coding on quality, efficiency, and patient outcomes should be evaluated.

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Key Words: cardiovascular imaging ■ echocardiography ■ resource utilization.

► APPENDIX

For supplementary Figures 1 and 2 and Table 1, please see the online version of this article.