Laboratory Test Ordering at Physician Offices with and without On-Site Laboratories

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BACKGROUND: Physician self-referral, ordering a test or procedure or referring to a facility in which a physician has a financial interest, has been associated with increased utilization of health care services.

OBJECTIVE: To examine the association between on-site laboratories and laboratory test ordering among visits to group-practice physicians.

DESIGN: Cross-sectional study using data from the 2005 and 2006 National Ambulatory Medical Care Surveys.

STUDY POPULATION: Visits by adults to non-federally-funded, non-hospital-based group practices. Primary analyses focused on visits to physician owners; secondary analyses focused on visits to non-owners.

MAIN MEASURES: Ordering of five laboratory tests: complete blood count (CBC), electrolytes, glycosylated hemoglobin A1c (HbA1c), cholesterol, and prostate-specific antigen (PSA).

KEY RESULTS: There were 19,163 visits to group-practice owners with 51.9% to a practice with an on-site laboratory. Visits to primary care physicians were more likely to be to a practice with an on-site laboratory when compared with visits to specialists (64.4% vs. 34.0%, $p < 0.001$). Among visits to specialist group owners, all five tests were ordered more often if there was an on-site laboratory, even after accounting for patient and practice characteristics: CBC: adjusted odds ratio[OR]=8.01, 95% Confidence Interval [CI], 5.00–12.82, $p < 0.001$; electrolytes: aOR=3.51, 95% CI, 1.93–6.40, $p < 0.001$; HbA1c: aOR=4.91, 95% CI, 1.75–13.78, $p = 0.003$; cholesterol: aOR=3.32, 95% CI, 1.85–5.93, $p < 0.001$; and PSA: aOR=3.84, 95% CI, 1.93–7.65, $p < 0.001$. This association was not found among visits to primary care physician owners and all practice non-owners (both primary care and specialists). The estimated excess spending on these five tests by specialist owners with on-site laboratories was \$75 million per 100 million visits.

CONCLUSIONS: In a nationally representative sample of visits to physician-owned group practices, specialist owners with on-site laboratories were more likely to order five common laboratory tests, potentially resulting in millions in excess healthcare spending.

KEY WORDS: physician self-referral; reimbursement/incentive; laboratories/economics; laboratories/utilization.

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INTRODUCTION

Rising healthcare costs in the United States are a major concern for patients, policymakers, and the medical community.¹ In 2007, spending on health care was \$2.2 trillion or 16.2% of the U.S. gross domestic product (GDP). The Congressional Budget Office (CBO) predicts that healthcare spending will reach 25% of the GDP in 2025 if no legislation is enacted to curb spending.² Increased healthcare costs not only threaten the stability of publicly funded programs such as Medicare and Medicaid but also affect the privately insured who have seen increases in out-of-pocket expenses.³ This rapid growth in the cost of healthcare is a major focus of healthcare reform efforts.^{4,5}

There are many drivers of rising healthcare costs, including an aging population, increased chronic disease, and ready access to new technology.⁶ Physician self-referral, the referral of a patient for a diagnostic test or procedure or to a medical facility in which the referring physician has a financial interest, has also been cited as a driver of rising health care costs.^{7,8} Previous research on self-referral for laboratory testing has shown that physicians with an investment interest in a clinical laboratory order more tests.⁹ As a result of these findings and others, a series of three laws, known as the Stark legislation, were initiated in 1989. However, the legislation does not apply to in-office ancillary services performed by physician groups.¹⁰

Recent studies have found that self-referral for imaging is increasing^{11–14} with several studies showing that physicians who own diagnostic imaging equipment order more tests.^{15–19} There are no recent studies examining test ordering by physicians who maintain on-site laboratories.

Maintaining an on-site laboratory may provide a financial incentive to order more tests because physicians' practices are reimbursed for the testing, often at some profit. Utilization of on-site laboratories might also be driven by convenience for both the physician and the patient. Understanding whether physicians order more tests if they own diagnostic testing facilities can shed some light on the practice of self-referral and inform legislators who are attempting to control rising healthcare costs.

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We used the National Ambulatory Medical Care Survey (NAMCS) to determine whether common laboratory tests are ordered more frequently during visits to physicians in group practices that maintain a laboratory compared to those that do not. As a nationally representative sample of visits to ambulatory, community-based physicians, the NAMCS provides a unique opportunity to describe national physician self-referral practice patterns.

METHODS

Study Design

We performed a cross-sectional analysis using data from the 2005 and 2006 National Ambulatory Medical Care Survey (NAMCS). NAMCS is a nationally representative survey administered by the Center of Disease Control's National Center for Health Statistics (NCHS). NAMCS contains information about patient visits to non-federally funded, non-hospital-based offices throughout the United States. Physicians in the fields of anesthesiology, radiology, and pathology are excluded from the survey. Physicians who participate in the survey cannot participate again for at least three years.²⁰

NAMCS uses a three-stage sampling design. The first stage is based on geographic location, the second stage identifies offices in each geographic location, and the third stage samples visits within each office. The visits sampled take place during a one week period that is randomly assigned for each practice. Between 20% and 100% of the visits that week are sampled depending on the size of the practice. The NCHS weighs each visit so that the data can be used for national estimates. Each visit weight accounts for selection probability, adjusts for non-response, and accounts for other factors so that the national estimates properly reflect the scope of ambulatory visits in the U.S.

The survey collects patient and office demographics, and visit-specific clinical information. The information from each visit is recorded on a standardized survey form by the physician, office staff, or a US Census Bureau Representative. Because this study used publicly available data without respondent identifiers, it was exempted from review by the Mount Sinai Institutional Review Board.

Study Sample

We limited our analysis to visits by adult patients 18 years or older who saw physicians that were part of group practices. We only studied physicians within group practices because on-site laboratory testing was clearly defined only as part of group practice induction interviews (Personal Communication, Donald Cherry, National Center for Health Statistics, March 30, 2009). Because we were interested in testing the hypothesis that maintaining an on-site laboratory is associated with increased test ordering, theoretically by providing some financial incentive, we limited our initial analyses to visits to physicians who self-identified themselves as practice owners. We performed secondary analyses of visits to physicians who were non-owners.

Study Variables

The NAMCS collects data on the ordering of six specific blood tests: complete blood count (CBC), electrolytes, cholesterol,

glycosylated hemoglobin (HbA1c), glucose, and prostate-specific antigen (PSA); two specific urine tests: urinalysis and pregnancy testing; as well as an 'other' box to indicate that other blood or urines tests were ordered. We focused our analysis on CBC, electrolytes, cholesterol, HbA1c, and PSA blood tests because these laboratory tests are commonly performed, physicians with on-site laboratories are likely to have the equipment to perform these tests, and the ordering of these tests is systematically recorded in the NAMCS survey. We did not include blood glucose testing, urinalysis, or urine pregnancy testing because it was unclear whether these tests were point of care tests that could be performed with minimal equipment in a physician's office. All dependent variables were categorized dichotomously as ordered or not ordered during the patient's visit.

The primary predictor variable was the presence or absence of an on-site laboratory. In the NAMCS Physician Induction Interview the question is phrased "Does your practice have the ability to perform lab testing on-site?"²¹ We categorized the sample of visits by the following patient and physician characteristics: patient age, gender, race (black/white/other), ethnicity (Hispanic/non-Hispanic), insurance type (private/Medicare/Medicaid/other), number of chronic conditions (0/1-3/>3) major reason for visit (acute/chronic/preventative/other), physician specialty (primary care or specialist physician), presence of an electronic medical record (yes/partial/no), and practice location by census region and metropolitan statistical area. Primary care physicians included internal medicine, family practice, pediatrics, and obstetrics and gynecology physicians. Specialists included medical specialists, surgical specialists, neurologists, and psychiatrists.

Statistical Analysis

Our main analyses examined the association between presence of an on-site laboratory and the ordering of laboratory tests among visits to physician owners in group practices. We used the Chi-squared test to study the bivariate association and then tested these associations while adjusting for the patient, physician, and practice characteristics as outlined above using multivariable logistic regression analysis. All variables in our multivariable model were tested for multicollinearity using a correlation matrix. Variables with a correlation coefficient >0.9 or <-0.9 were excluded from the multivariable model.²² When developing our multivariable models, we identified a significant interaction between on-site laboratories and physician specialty for all five laboratory tests examined (p values <0.05). Therefore, we repeated these analyses stratified by physician specialty.

We repeated our analyses for visits to non-owner physicians in group practices to determine whether the observed relationships were consistent with associations observed in physician-owned group practices.

Finally, to estimate the excess cost of laboratory testing by specialty physician owners with on-site laboratories, we calculated the difference between the number of tests ordered per 100 million visits to specialists based on the weighted national estimates. We then multiplied this difference with the average reimbursement for each laboratory test based on the 2005 and 2006 Medicare fee schedule (CBC \$8.84, electrolytes \$9.37, HbA1c \$13.37, cholesterol \$6.07, and PSA \$25.54).²³

All analyses accounted for the complex survey and weighted sampling design of the NAMCS and were performed using

Stata statistical software, version 9.0 (Stata Corp., College Station, TX). Because we repeated our analyses for multiple outcomes, we used the Bonferroni correction and deemed a $p < 0.01$ to be significant.²⁴

RESULTS

Visit Characteristics

In the 2005 and 2006 NAMCS, there were 45,026 patient visits by adults to physicians practicing in non-federally funded offices, representing 1.47 billion patient visits. Of these, 28,816 visits (64.0%) were to physicians in group practices, representing 922 million visits. Among visits to group practices, 19,163 visits (66.5%) were to physicians who classified

themselves as owners, representing 585 million visits, whereas 9,653 visits (33.5%) were to physicians who classified themselves as non-owners in group practices, representing 303 million visits. Among visits to physician owners in group practices, 51.9% were to practices with on-site laboratories, whereas among visits to physician non-owners in group practices, 66.0% were to practices with on-site laboratories (Table 1).

Among visits to physician owners in group practices, 45.8% were to primary care physicians, representing 266 million visits, 64.4% of which were to a practice with an on-site laboratory. In addition, 54.2% of visits to physician owners in group practices were to specialists, representing 319 million visits, 34.0% of which were to practices with an on-site laboratory. Visits to practice owners with on-site laboratories were more likely to be by patients with private insurance (55.7% vs. 49.2%, $p = 0.006$) when compared with those without on-site laboratories.

Table 1. Characteristics of Visits to Group Practices in 2005 and 2006

Visits Characteristic	Practice Owners N=19,163 (66.5%)			Practice Non-Owners N=9,653 (33.5%)		
	Overall, % ^a	No On-Site Lab, %	On-Site Lab, %	Overall, %	No On-Site Lab, %	On-Site Lab, %
All		48.1	51.9		34.0	66.0
Patient Age ^b						
<50	38.7	36.2	39.8	46.6	46.3	47.0
≥50	61.3	63.8	60.2	53.4	53.7	53.0
Patient Sex ^c						
Female	61.0	58.2	63.1	61.8	58.6	64.0
Male	39.0	41.8	37.0	38.2	41.4	36.0
Patient Race						
White	87.5	88.1	86.8	85.8	83.5	86.9
Black	8.8	8.0	9.6	9.4	10.9	8.6
Other	3.7	3.9	3.6	4.8	5.6	4.5
Patient Ethnicity						
Hispanic	8.4	9.5	6.8	11.6	9.6	12.5
Non Hispanic	91.6	90.5	93.2	88.4	90.5	87.5
Patient Insurance Status ^{b,c}						
Private	53.0	49.2	55.7	52.6	50.8	53.6
Medicare	28.9	29.9	29.2	23.2	24.8	22.5
Medicaid	6.0	5.9	5.9	9.1	8.6	9.5
Other	12.2	15.0	9.2	15.1	15.9	14.4
Patient Number of Chronic Conditions						
0	35.6	37.2	33.3	35.3	34.3	35.5
1–3	53.6	52.2	55.1	53.2	53.8	53.0
>3	10.8	10.6	11.6	11.5	11.9	11.5
Major Reason for Visit ^{b,c,d}						
Acute	28.6	26.4	30.7	34.0	32.2	35.6
Chronic	43.8	43.3	44.9	40.6	46.2	36.5
Preventative	16.6	13.3	18.9	18.2	11.7	22.2
Other	11.0	17.0	5.5	7.2	9.9	5.6
Physician Specialty ^{b,c,d}						
Primary Care	45.8	26.4	64.4	62.6	37.4	78.1
Specialist (Medical or Surgical)	54.2	73.6	35.6	37.4	62.6	21.9
Practice Location in a Metropolitan Statistical Area						
Yes	87.3	87.5	8.6	87.1	89.9	85.0
No	12.7	12.5	13.9	12.9	10.1	15.1
Practice Census Region						
Northeast	19.3	18.2	20.5	19.5	18.5	19.2
Midwest	24.2	26.0	22.7	25.1	28.4	23.5
South	39.1	36.0	40.8	29.7	33.0	28.2
West	17.5	19.8	16.0	25.7	20.1	29.1
Practice Electronic Medical Record Capacity ^b						
Yes	14.0	12.3	15.9	24.6	14.7	29.7
Partial	12.4	13.7	10.9	20.0	23.8	18.7
No	73.6	74.0	73.2	55.5	61.6	51.7

^aSurvey weighted percentages, age ≥ 18, based on the U.S. population represented by the sample of visits for which data was collected

^bIndicates $p < 0.01$ for the comparison of practice owners to non-owners

^cIndicates $p < 0.01$ for the comparison of owners without on-site laboratories and owners with on-site laboratories

^dIndicates $p < 0.01$ for the comparison of non-owners without on-site laboratories and owners with on-site laboratories

Test Ordering during Visits to Group-Practice Owners with and without On-site Laboratories

Overall, CBC, electrolytes, HbA1c, cholesterol, and PSA was ordered in 12.6%, 6.6%, 2.9%, 8.6%, and 2.7% of visits to owners in group practices, respectively. In unadjusted analyses of visits to all physician owners in group practices, CBCs were more likely to be ordered during visits to a practice with an on-site laboratory when compared with practices without on-site laboratories (19.2% vs. 6.6%), as were tests of electrolytes, HbA1c, cholesterol, and PSA (all p values ≤ 0.002) (Table 2). However, in multivariable analyses adjusted for patient, physician, and practice characteristics, only CBCs (odds ratio [OR]=2.53, 95% Confidence Interval [CI], 1.76–3.62, $p < 0.001$) and PSAs (OR=1.97, 95% CI, 1.20–3.25, $p = 0.008$) were ordered significantly more often during visits to physicians with on-site laboratories. We found no differences in electrolyte, HbA1c, or cholesterol testing between visits with and without on-site laboratories.

After identifying a significant interaction between presence of an on-site laboratory and physician specialty for the ordering of all five laboratory tests (all interaction p values ≤ 0.05), we conducted stratified analyses based on physician specialty (primary care physicians and specialists). In multivariable analyses restricted to specialist physicians, presence of an on-site laboratory was associated with increased ordering of all 5 tests examined (Table 2). The odds of a CBC being ordered during visits to specialists with on-site laboratories was 8 times higher when compared with specialists without on-site laboratories (OR=8.01, 95% CI, 5.00–12.82; $p < 0.001$). Electrolyte (OR=3.51, 95% CI, 1.93–6.40; $p < 0.001$), HbA1c (OR=4.91, 95% CI, 1.75–13.78; $p = 0.003$), cholesterol (OR=3.32, 95% CI, 1.85–5.93; $p < 0.001$), and PSA (OR=3.84, 95% CI 1.93–7.65, $p < 0.001$) testing were also significantly more likely to be ordered among visits to specialists with on-site laboratories when compared with those without on-site laboratories.

Several other predictors were associated with CBC ordering at visits to specialist group owners, including the patient's number

of chronic conditions (1–3 chronic conditions: OR=2.2, 95% CI, 1.5–3.2; >3 chronic conditions: OR=2.4, 95% CI, 1.3–4.6) and practice location in a metropolitan statistical area (OR=0.2, 95% CI, 0.1–0.4). Similar associations were seen for electrolyte, HbA1c, and cholesterol testing (Table 3).

In contrast, in multivariable analyses restricted to primary care physicians, we found no association between presence of an on-site laboratory and test ordering for any of the five tests (all p values > 0.50).

Test Ordering during Visits to Group-Practice Non-Owners with and without On-site Laboratories

We found no association between presence of an on-site laboratory and test ordering during visits to non-owner physicians in multivariable analyses. (Table 4) In addition, the interaction between presence of an on-site laboratory and physician specialty was not significant for the ordering of all five tests when the physician was not a practice owner (all p values > 0.10).

Estimated Excess Spending Associated with Test Ordering by Specialist Group-Practice Owners with On-Site Laboratories

Excess spending on CBCs per 100 million visits to specialist group-practice owners with on-site laboratories was \$40.8 million, and was greater for all other tests examined in our analyses. Total excess spending on the five lab tests at visits to specialists with onsite labs compared to visits to specialists without on-site labs was approximately \$75 million per 100 million specialist visits (Table 5).

COMMENT

Physician self-referral has been an area of interest for policy-makers looking to control healthcare costs.⁷ Using a nationally

Table 2. Association between On-Site Laboratories and Test Ordering in Visits to Owner Physicians in Group Practices

	Test Ordered in Visits with No On-Site Lab, % (95% CI) ^a	Test Ordered in Visits with On-Site Lab, % (95% CI) ^a	Unadjusted OR (95% CI)	p value	Adjusted OR (95% CI) ^b	p value
Visits to All Physicians (weighted n=585 million)						
CBC	6.6 (5.1–8.5)	19.2 (16.5–22.1)	3.37 (2.45–4.65)	<0.001	2.53 (1.76–3.62)	<0.001
Electrolytes	3.8 (2.5–5.7)	10.3 (7.8–13.4)	2.87 (1.70–4.85)	<0.001	1.82 (1.08–3.06)	0.03
HbA1c	1.7 (1.1–2.6)	4.1 (3.3–5.1)	2.44 (1.49–4.01)	<0.001	1.46 (0.88–2.41)	0.14
Cholesterol	5.2 (4.0–6.8)	12.7 (10.1–15.9)	2.65 (1.76–3.99)	<0.001	1.49 (1.06–2.11)	0.02
PSA	1.7 (1.1–2.5)	3.7 (3.0–4.7)	2.1 (1.3–3.3)	0.002	1.97 (1.20–3.25)	0.008
Visits to Primary Care Physicians (weighted n=266 million)						
CBC	16.9 (12.8–22.0)	18.1 (14.9–21.8)	1.09 (0.72–1.65)	0.69	1.12 (0.75–1.67)	0.59
Electrolytes	9.8 (5.8–16.0)	11.1 (7.6–15.8)	1.15 (0.55–2.38)	0.71	1.14 (0.57–2.28)	0.71
HbA1c	5.2 (3.4–8.0)	5.1 (4.1–6.3)	0.97 (0.58–1.65)	0.92	0.99 (0.61–1.59)	0.96
Cholesterol	15.1 (11.9–18.9)	15.2 (12.1–18.9)	1.01 (0.65–1.57)	0.97	1.01 (0.67–1.52)	0.95
PSA	3.4 (2.1–5.7)	3.4 (2.5–4.5)	0.98 (0.51–1.88)	0.96	0.91 (0.46–1.81)	0.79
Visits to Specialist Physicians (weighted n=319 million)						
CBC	2.8 (1.9–4.1)	19.0 (14.1–25.2)	8.11 (4.74–13.88)	<0.001	8.01 (5.00–12.82)	<0.001
Electrolytes	1.7 (1.0–3.0)	6.0 (4.1–8.7)	3.68 (1.83–7.38)	<0.001	3.51 (1.93–6.40)	<0.001
HbA1c	0.5 (0.2–1.1)	1.9 (1.2–3.4)	4.14 (1.40–12.23)	0.01	4.91 (1.75–13.78)	0.003
Cholesterol	1.7 (1.1–2.7)	5.8 (3.8–8.5)	3.50 (1.89–6.49)	<0.001	3.32 (1.85–5.93)	<0.001
PSA	1.1 (0.6–2.0)	4.1 (2.8–6.0)	3.90 (1.84–8.24)	0.001	3.84 (1.93–7.65)	<0.001

^aSurvey weighted percentages, age ≥ 18 , based on the U.S. population represented by the sample of visits for which data was collected

^bAdjusted for patient sex, age, race, ethnicity, number of chronic conditions, major reason for visit, geographic region, urban or rural location, presence of an electronic medical record and primary care, and specialist physician (if applicable)

Table 3. Association between Test Ordering and Covariates (Visits to Specialist Owners in Group Practices)

	CBC Adjusted OR (95% CI) ^a	Electrolytes Adjusted OR (95% CI) ^a	HbA1c Adjusted OR (95% CI) ^a	Cholesterol Adjusted OR (95% CI) ^a	PSA Adjusted OR (95% CI) ^a
On-Site Lab					
No	ref	ref	ref	ref	ref
Yes	7.8 (4.8–12.7)	3.4 (1.9–6.3)	5.1 (1.8–14.9)	3.3 (1.8–6.0)	3.6 (1.8–7.1)
Age					
Age <50	ref	ref	ref	ref	ref
Age ≥50	1.1 (0.9–1.5)	1.1 (0.8–1.5)	1.0 (0.5–2.0)	1.1 (0.8–1.4)	3.8 (1.9–7.6)^a
Patient Sex					
Female	ref	ref	ref	ref	ref
Male	0.8 (0.6–1.0)	0.8 (0.6–1.1)	1.1 (0.6–1.9)	1.2 (0.9–1.5)	4.5 (3.1–6.6)
Patient Race					
White	ref	ref	ref	ref	ref
Black	1.4 (1.0–2.1)	1.1 (0.6–2.0)	1.6 (0.8–3.0)	0.8 (0.4–1.7)	0.8 (0.5–1.4)
Other	0.9 (0.5–1.5)	0.8 (0.4–1.9)	1.6 (0.7–3.4)	1.2 (0.7–2.2)	0.5 (0.2–1.4)
Patient Ethnicity					
Hispanic	ref	ref	ref	ref	ref
Non Hispanic	1.1 (0.5–2.3)	0.6 (0.3–1.3)	0.4 (0.2–1.1)	0.8 (0.5–1.5)	0.8 (0.4–1.2)
Patient Insurance Status					
Private	ref	ref	ref	ref	ref
Medicare	1.0 (0.8–1.2)	0.9 (0.7–1.3)	1.1 (0.5–2.2)	1.2 (0.9–1.6)	1.2 (0.9–1.6)
Medicaid	0.9 (0.6–1.2)	0.4 (0.2–1.3)	1.6 (0.6–4.0)	0.9 (0.5–1.9)	0.5 (0.3–1.1)
Other	0.8 (0.4–1.4)	0.5 (0.2–1.3)	0.9 (0.3–2.3)	0.7 (0.3–1.5)	0.7 (0.4–1.4)
Major Reason for Visit					
Acute	ref	ref	ref	ref	ref
Chronic	1.3 (1.0–1.8)	1.2 (0.8–1.9)	1.9 (0.9–4.1)	1.4 (0.8–2.5)	2.3 (1.5–3.4)
Preventative	0.6 (0.3–1.2)	0.4 (0.2–0.9)	0.6 (0.2–2.0)	1.0 (0.5–2.0)	2.5 (1.1–5.6)
Other	0.5 (0.3–0.7)	0.4 (0.2–0.8)	0.7 (0.2–2.7)	0.4 (0.2–0.8)	0.6 (0.4–1.1)
Patient Number of Chronic Conditions					
0	ref	ref	ref	ref	ref
1–3	2.2 (1.5–3.2)	3.7 (1.8–7.5)	2.8 (1.1–6.7)	4.0 (2.5–6.5)	0.7 (0.5–0.9)
>3	2.4 (1.3–4.6)	6.9 (2.7–17.5)	5.8 (2.2–15.0)	5.6 (2.6–12.2)	0.6 (0.3–1.2)
Practice Location in an MSA					
Yes	ref	ref	ref	ref	ref
No	0.2 (0.1–0.4)	0.1 (0.0–0.6)	0.1 (0.0–0.6)	0.1 (0.0–0.3)	1.1 (0.5–2.4)
Practice Census Region					
Northeast	ref	ref	ref	ref	ref
Midwest	1.7 (0.8–3.6)	0.9 (0.4–2.2)	1.0 (0.1–7.5)	0.9 (0.4–2.4)	1.8 (0.6–5.1)
South	1.4 (0.7–2.9)	0.8 (0.4–1.7)	0.9 (0.3–3.1)	0.6 (0.3–1.4)	1.1 (0.4–2.8)
West	2.1 (1.0–4.0)	1.5 (0.6–3.9)	4.0 (1.3–12.6)	1.8 (0.8–3.9)	2.3 (0.7–8.0)
Practice EMRCapacity					
Yes	ref	ref	ref	ref	ref
Partial	1.8 (0.8–4.0)	2.9 (0.8–10.1)	3.3 (0.7–15.9)	1.9 (0.7–4.7)	1.2 (0.4–3.3)
No	1.2 (0.7–1.9)	1.7 (0.7–3.7)	1.8 (0.6–5.4)	1.2 (0.6–2.2)	1.0 (0.4–2.2)

^aAdjusted for patient sex, age, race, ethnicity, number of chronic conditions, major reason for visit, geographic region, urban or rural location, and presence of an electronic medical record

Bold-faced type indicates $p < 0.01$

representative survey of visits to ambulatory group practices, we found that presence of an on-site laboratory was associated with increased ordering of five common laboratory tests, but only in visits to specialty physicians who were owners in group practices. In adjusted analysis, the odds of ordering five common laboratory tests were 3 to 8 times greater among

visits to specialists with on-site laboratories. Surprisingly, we did not see this association among visits to primary care physicians.

Our finding of an association between on-site laboratories and test ordering by specialist owners is consistent with previous research. Scott and Mitchell found that Florida

Table 4. Association between On-Site Laboratories and Test Ordering at Visits to Non-Owner Physicians in Group Practices

	Test Ordered in Visits with No On-Site Lab, % (95% CI) ^a	Test Ordered in Visits with On-Site Lab, % (95% CI) ^a	Unadjusted OR (95% CI)	p value	Adjusted OR (95% CI) ^b	p value
CBC	11.2 (7.0–17.4)	16.1 (13.5–19.1)	1.53 (0.89–2.63)	0.12	1.35 (0.77–2.39)	0.30
Electrolytes	4.5 (2.6–7.8)	6.2 (4.6–8.2)	1.40 (0.69–2.86)	0.36	0.96 (0.51–1.83)	0.91
HbA1c	2.1 (1.5–3.0)	4.0 (3.0–5.2)	1.93 (1.24–3.02)	0.004	1.05 (0.71–1.57)	0.79
Cholesterol	5.8 (4.3–7.7)	11.0 (9.1–13.2)	2.02 (1.36–3.00)	0.001	0.96 (0.66–1.39)	0.83
PSA	0.7 (0.4–1.5)	1.8 2(1.3–2.4)	2.38 (1.11–5.12)	0.03	1.92 (0.86–4.26)	0.11

^aSurvey weighted percentages, age ≥ 18, based on the U.S. population represented by the sample of visits for which data was collected

^bAdjusted for patient sex, age, race, ethnicity, number of chronic conditions, major reason for visit, geographic region, urban or rural location, presence of an electronic medical record, and physician specialty

Table 5. Estimated Excess Spending on Lab Tests Ordered by Specialists with On-Site Laboratories

	No On-site Lab		On-Site Lab		Difference in No. Tests Ordered per 100 million Visits to Specialists ^b	Cost per Test ^c	Excess Costs per 100 million Visits to Specialists
	Test Ordered, % ^a	Tests Ordered, No. per 100 million Visits to Specialists ^b	Test Ordered, % ^a	Tests Ordered, No. per 100 million Visits to Specialists ^b			
CBC	2.8	1,848,000	19.0	6,460,000	4,612,000	\$8.84	\$40,770,080
Electrolytes	1.7	1,122,000	6.0	2,040,000	918,000	\$9.37	\$8,601,660
HbA1c	0.5	330,000	1.9	646,000	316,000	\$13.37	\$4,224,920
Cholesterol	1.7	1,122,000	5.8	1,972,000	850,000	\$6.07	\$5,159,500
PSA	1.1	726,000	4.1	1,394,000	668,000	\$25.54	\$17,060,720

^aSurvey weighted percentages, age ≥ 18 , based on the U.S. population represented by the sample of visits for which data was collected

^bThere were 319 million visits to specialist group owners in 2005 and 2006 with 66.0% of visits were to practices with an on-site laboratory and 34.0% to a practice without an on-site laboratory.

^cCost per test based on 2005 and 2006 Medicare reimbursement

physicians who had an investment interest in an off-site clinical laboratory performed 50% more diagnostic services per patient.⁹ Studies looking at self-referral for diagnostic imaging have found similar results. Self-referral is associated with as much as a seven-fold increase in utilization of x-rays, computed tomography scans, and myocardial perfusion imaging.¹⁵⁻¹⁹

Mitchell and Sass have postulated that both financial and quality incentives drive physicians to both install and utilize on-site ancillary services.²⁵ Financially, offices that have on-site laboratories may be able to bill not only for phlebotomy but also the processing of each test. In addition, offices that have incurred the expense of installing an on-site laboratory may experience financial pressure to utilize their laboratories in order to reimburse these expenses. Quality of care incentives may also be important. An on-site laboratory likely increases convenience for patients who need to only travel down the hall for phlebotomy, provides more reliable access to results for physicians, and may even improve patient adherence to physician requests for diagnostic tests. Our finding of an association between on-site laboratories and test ordering among visits to specialist group-practice owners, coupled with the lack of association among visits to non-owners, supports the hypothesis that a financial benefit plays a role in test ordering.

It remains unclear why this association between on-site laboratories and test ordering was not found among generalist physician practice owners. One hypothesis is that specialists with on-site laboratories may have installed them to create the capacity to perform highly specialized tests. These physicians may then have a lower threshold for ordering common laboratory tests, such as a CBC or electrolytes, during visits when more specialized tests have been ordered. Additional research is needed to understand the differences in association between on-site ancillary services and utilization by specialists and primary care physicians.

The association between on-site laboratories and the ordering of tests by specialist group owners has important cost implications. Since 1999, Medicare expenditures for laboratory services has increased on average 9 percent each year which is higher than the overall rate of inflation for health care expenditures. In 2006, Medicare spent \$6.9 billion on clinical laboratory services.²⁶ We estimate that specialist group-practice owners with on-site laboratories spend approximately \$75 million more per 100 million visits on five common laboratory

tests than those without on-site laboratories. These cost estimates represent only those expenses incurred from ordering five laboratory tests; we speculate that other laboratory tests may also be ordered at greater rates during visits to specialist owners with on-site laboratories, further increasing costs.

Despite rigorous attempts to control for potential confounding, there are limitations to consider when interpreting our results. First, this was a cross-sectional study and therefore we cannot determine whether the presence of an on-site laboratory has a causal effect on test ordering. We also cannot determine the appropriateness of the laboratory tests ordered; we do not know whether specialist physicians without on-site laboratories are under-ordering laboratory tests or specialist physicians with on-site laboratories are over-ordering tests. However, the lack of association observed among primary care physicians does suggest that over-ordering is taking place. In addition, we cannot be certain that the presence of an on-site laboratory directly implies that the laboratory is owned by the practice and not just located within the practice but owned by others. In this case, we may be measuring the impact of convenience, as opposed to financial incentive. However, there was no association between the presence of an on-site laboratory and test ordering in visits to practices not owned by physicians, suggesting that lab ordering among physicians who do own their practices seems to be influenced by the potential financial benefits of using on-site laboratories. Finally, we do not know exactly how physicians were compensated and whether test ordering increased their compensation. Further research should try to determine how utilization of on-site ancillary services affects physician compensation for both owners and non-owners in group practices and whether risk-bearing contracts or bundled payments affect utilization.

In conclusion, our findings are consistent with other studies that have found that physicians who own diagnostic testing equipment are more likely to order tests and highlight the important role that self-referral plays in the practice of outpatient medicine. More studies are needed to clarify why specialists are more likely to order laboratory tests if they maintain on-site laboratories while generalists are not. In addition, further research should examine whether test ordering by specialists with on-site laboratories is appropriate or signifies overuse. If, in fact, there is overuse of laboratory tests by specialists with on-site laboratories, policymakers may want to consider ways to limit the practice of self-referral for

laboratory services, perhaps by extending the Stark laws to self-owned laboratories or disincentivizing overuse of lab services by utilizing bundled payment mechanisms.

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