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Surgeons' Volume of Colorectal Cancer Procedures and Collaborative Decision-making about Adjuvant Therapies

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Abstract

Background—Few studies have assessed associations of surgeons' practice volume with processes of care that lead to better outcomes.

Objective—We surveyed surgeons treating colorectal cancer to determine whether high-volume surgeons were more likely to collaborate with other physicians in decisions about adjuvant therapies.

Subjects and methods—Surgeons caring for patients with colorectal cancer in multiple regions and health-care organizations were surveyed to assess their volume of colorectal cancer resections and participation in decisions about adjuvant chemotherapy and radiation therapy. We used logistic regression to assess physician and practice characteristics associated with surgical volume and the relation of surgical volume and these other characteristics to collaborative decision-making regarding adjuvant therapies.

Results—Of 635 responding surgeons, those who identified themselves as surgical oncologists or colorectal surgeons were more likely than others to report high volume of colorectal cancer resections ($p < .001$), as were those who practiced at a comprehensive cancer center ($P = .06$) and attended tumor board meetings weekly (vs. quarterly or less, $P = .09$). Most surgeons reported a collaborative role in decisions about chemotherapy and radiation therapy. However, in adjusted analyses, higher-volume surgeons more often reported a collaborative role with other physicians in decisions about chemotherapy ($P < 0.001$) and radiation therapy ($P < 0.001$).

Conclusions—Higher-volume surgeons are more likely to report collaborating with other physicians in decisions about adjuvant therapies for patients following colorectal cancer surgery. This collaborative decision-making of higher-volume surgeons may contribute to outcome differences by surgeon volume.

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Keywords

colorectal neoplasms; surgery; chemotherapy; radiation therapy; physicians' practice patterns; physician survey; consultation

INTRODUCTION

Higher hospital and surgeon volumes have been associated with improved patient outcomes for many operations.^{1, 2} For patients with colorectal cancer, a cancer diagnosed in nearly 150,000 Americans every year,⁵ greater surgical and hospital volume are associated with improved outcomes.⁶⁻¹⁷ Patients of higher-volume surgeons receive permanent colostomies less frequently and have lower mortality compared with patients of lower-volume surgeons.^{7-10, 12, 16} Moreover, volume is significantly associated with use of guideline-recommended therapies, such as adjuvant chemotherapy for node-positive colorectal cancer,¹⁸ and hospital volume is strongly associated with use of adjuvant radiation therapy.¹⁶ These findings raise the question as to how care delivered by higher-volume surgeons following cancer surgery might differ from that of lower-volume surgeons.

The Leapfrog Group, a consortium of healthcare purchasers, has used volume explicitly as a proxy for quality by mandating selective referrals for certain high-risk operations.³ For some complex cancer operations, such as esophagectomies and pancreatectomies that require specialized expertise and resources, selective referral may be a reasonable strategy to improve surgical outcomes. However, for common operations such as resection of colorectal cancer performed in many hospitals, often emergently or urgently, selective referral may be less feasible to improve the quality of surgical care because of limited capacity at high-volume hospitals and patient preferences for care in local hospitals.⁴ A more effective strategy may be to identify differences in practice patterns for high- and low-volume surgeons in processes of care that may be linked to superior outcomes. Hospitals and surgeons could then be assisted in adopting such "best practices". However, the practice patterns or processes of care by high-volume surgeons that lead to these outcome differences for patients are not well defined.

This study assessed a previously unexplored, potentially mutable factor that may contribute to these volume-outcome relationships: coordination of care between surgeons and other physicians who care for patients with colorectal cancer. We surveyed surgeons caring for patients with colorectal cancer with two goals. First, we assessed whether surgeons' demographic and practice characteristics were associated with their volume of colorectal cancer resections. Second, we examined whether high-volume surgeons were more likely than lower-volume surgeons to collaborate with other physicians when making decisions about adjuvant chemotherapy and radiation therapy.

METHODS

Study cohort

Surveys of surgeons were conducted by the Cancer Care Outcomes Research and Surveillance (CanCORS) Consortium, a large multi-regional study examining processes and outcomes of care for patients with lung or colorectal cancer.^{19, 20} The CanCORS study examined care delivered to a population-based cohort of more than 10,000 patients newly diagnosed with lung or colorectal cancer during 2003-2005 who were living in Northern California, Los Angeles County, North Carolina, Iowa, or Alabama, or who received care in one of 5 large health plans or one of 10 Veteran's Administration hospitals. The human subjects committees at all participating institutions approved the study protocol.

As previously described,²¹ we surveyed physicians named by patients as providing important roles in their care. Of the 6871 physicians whose contact information was verified, 4188 (61.0%) responded, including 62.5% of surgeons. For this analysis, we restricted the sample to the 651 physicians who identified themselves as surgeons who cared for at least one patient with colorectal cancer in the past year. We excluded 16 surgeons from the Iowa site, because no colorectal cancer patients were enrolled at this site, for a final cohort of 635 surgeons. Further information on the survey is provided in the Appendix. Data collection was closed and the dataset (version 1.6.1) finalized in March 2007.

Survey Instrument

The survey collected surgeons' characteristics including race/ethnicity, gender, board certification, and year of graduation from medical school, U.S./Canadian training, and self-reported specialty. We also collected information on number of colorectal cancer resections each surgeon performed per month, participation in teaching, practice setting, percentage of patients in managed care, whether the physician practiced at a National Cancer Institute comprehensive cancer center, whether their practice was part of the Community Clinical Oncology Program, and reported attendance at tumor board meetings. Surgeons were also asked how they typically made decisions about possible use of chemotherapy and about possible use of radiation chemotherapy for patients. Response options for each question were: (1) I provide this care myself without much input from another clinician; (2) I co-manage or decide jointly on this care with another clinician; (3) I refer patients to another clinician for this care; and (4) I am not involved in this care. Because we were specifically interested in collaboration and relatively few physicians reported deciding themselves or not being involved in care, we dichotomized the responses as co-managing/deciding jointly vs. all other responses.

Survey Administration

We mailed each physician a self-administered survey with a check or non-cash incentive that varied by site, ranging in value from \$20 to \$50. Non-respondents were mailed another survey after 3 weeks. After another 3 weeks, we telephoned their offices to encourage completion of the survey, and additional questionnaires were sent on request. At one site, initial contact occurred via electronic mail; at other sites, electronic mail was used for follow-up of non-responders. All physicians were given the option to complete the survey via a secure Internet site, and 13% of respondents chose this option.

Statistical analysis

We calculated the volume of colorectal cancer resections performed during the past month and categorized volume in quartiles. We used chi-square tests to assess physician and practice characteristics (categorized as in Table 1) associated with volume in the top quartile. For all analyses, we combined colorectal surgeons and surgical oncologists because their responses were similar. We also used chi-square tests to assess the association of surgical volume and other physician and practice characteristics with collaborative decision-making regarding chemotherapy and radiation therapy (defined as reporting that they co-managed or decided jointly about these therapies versus deciding themselves, referring to another provider, or not being involved in these decisions).

We used multivariable logistic regression models to identify surgeon characteristics associated with high surgical volume (top quartile). Independent variables included surgeons' demographic and practice characteristics described above that were associated with high surgical volume ($p \leq 0.20$) in bivariate analyses. Similarly, we used multivariable logistic regression models to examine the association between surgical volume and collaborative care for (1) chemotherapy decisions and (2) radiation therapy decisions,

controlling for physician and practice characteristics with P value $\leq .20$ in unadjusted analyses examining the relationship between each characteristic and collaboration about chemotherapy or radiation therapy, respectively.

Item non-response was less than 3% for most variables. Values were multiply imputed.^{22,23} All tests of statistical significance were two-sided. We conducted analyses using SAS statistical software, version 9.1.3 (SAS Institute, Inc., Cary, North Carolina).

RESULTS

Of the 635 surgeons in the study cohort, most (84%) were general surgeons (Table 1). The median time since medical school graduation was 24 years (first and third quartiles, 15 to 31). Most responding surgeons were male (89.5%), non-Hispanic white (74.1%), board-certified (94.6%), and US or Canadian medical school graduates (88.3%). Nearly half (48.0%) of the surgeons worked in hospital-based practices. The mean (SD) number of colorectal cancer resections performed each month was 3.1 (2.5).

When asked how they typically made decisions about chemotherapy, 1.4% stated that they provide this care themselves without much input from another clinician; 61.0% stated that they co-managed or decided jointly on this care with another clinician; 36.9% stated that they referred patients to another clinician for this care; 0.8% stated that they were not involved in this care.

For decisions on radiotherapy, 3.5% stated that they provide this care themselves without much input from another clinician; 65.3% stated that they co-managed or decided jointly on this care with another clinician; 30.4% stated that they referred patients to another clinician for this care; 0.8% stated that they were not involved in this care.

Factors associated with high surgical volume

When we examined characteristics of surgeons in the highest volume quartile (≥ 5 colorectal cancer resections per month) in unadjusted analyses, colorectal surgeons or surgical oncologists were more likely than general surgeons to be high-volume surgeons ($P < .001$), as were surgeons who were board certified ($P = .045$), participate in teaching ($P = .01$), worked in hospitals or group practice (vs. solo practice) ($P = .02$), practiced at a National Cancer Institute-designated Cancer Center ($P = .003$), and attended tumor board meetings regularly ($P < .001$). Year of graduation, sex, race/ethnicity, board certification, graduation from a U.S. or Canadian medical school, proportion of patients in managed care, practice part of a CCOP, and study site were not significantly associated with volume.

In multivariable analyses, colorectal surgeons and surgical oncologists were more likely than general surgeons to perform a high volume of colorectal cancer resections (Table 2). Physicians practicing at a NCI-designated cancer center and those attending tumor board meetings weekly (vs. quarterly or less frequently) were also more likely to perform a high volume of colorectal surgeries, although these associations did not reach statistical significance. The surgeons in North Carolina were less likely to be high-volume surgeons than the surgeons in Los Angeles County.

Factors associated with collaborative decision-making

Compared with lower-volume surgeons, higher-volume surgeons more often reported collaborating with other physicians in decisions about chemotherapy ($P < 0.001$) and radiation therapy ($P < 0.001$) (Table 3).

These relationships persisted in multivariate analyses for both chemotherapy (Table 4) and radiation therapy (Table 5). Several other characteristics were also significantly associated with reporting collaborative decision-making for both adjuvant therapies. Colorectal surgeons and surgical oncologists were more likely than general surgeons to report collaborative care in decisions about both chemotherapy and radiation therapy. Surgeons who participated in tumor boards weekly or monthly were more likely to report that they co-managed or decided jointly about both adjuvant therapies than those attending tumor boards quarterly or less frequently. Physicians with a higher proportion of patients enrolled in managed care were less likely to report collaborative decisions about both adjuvant treatments, controlling for other practice characteristics (Tables 4 and 5).

In addition, U.S./Canadian medical school graduates (versus other physicians) and surgeons whose practice is part of a Community Clinical Oncology Program, and surgeons in the study site consisting of 5 health maintenance organizations reported the highest rates of collaboration in decisions about chemotherapy (Table 4).

DISCUSSION

In a large multi-regional cohort of surgeons treating patients with colorectal cancer, colorectal surgeons and surgical oncologists were more likely than general surgeons to perform a high volume of colorectal cancer resections, as were surgeons who practiced at NCI-designated cancer centers and those who attended weekly tumor board meetings (although these latter two findings were of borderline statistical significance). We found important differences between higher- and lower-volume surgeons in their tendency to collaborate when making decisions about possible use of adjuvant therapy. Controlling for physician and practice characteristics, higher-volume surgeons were more likely than lower-volume surgeons to report collaborative patterns of care regarding decision making about adjuvant chemotherapy and radiation therapy. Although we cannot demonstrate causal relationships, such collaboration may contribute to the greater likelihood that patients of high-volume surgeons receive appropriate adjuvant therapies.¹⁸ This collaboration may thus be a partial mediator of greater adherence to evidence-based guidelines for adjuvant therapies observed among patients of high-volume providers of colorectal cancer care.

Prior studies suggest greater collaboration of care may help to improve the quality of colorectal cancer care delivered. Referral to a medical oncologist has been identified as one of the key factors associated with receipt of chemotherapy,^{15, 17} which has been reported as limited in many individuals with stage III colon cancer, particularly older patients.^{9, 14, 15} Because surgeons play a major role in referring patients to medical oncologists and radiation oncologists, patients of surgeons who collaborate more with these specialists may be more likely to be referred to medical oncologists and radiation oncologists and receive indicated adjuvant therapies. One study found that many physicians held views opposite to guidelines recommending adjuvant chemotherapy and radiation therapy for stage II and III rectal cancer.²³ Greater collaboration of surgeons with medical oncologists and radiation oncologists may increase sharing of knowledge about evidence-based guidelines and help to prevent underuse of recommended adjuvant therapies.

Although high procedure volume may be associated with better operative technique, it may also serve as a proxy for the performance of other recommended processes of care.⁷ One study found that worse colon cancer outcomes in low-volume hospitals were not explained by cancer recurrence¹¹ and suggested that it may be related to worse care of comorbid conditions (which may also rely heavily on collaboration), leading authors to advocate for a greater focus on multidisciplinary aspects of hospital care for improving patient outcomes.¹² On the other hand, because rectal cancer surgery may be more technically challenging,

surgical volume may still be important for optimizing rectal cancer outcomes related to intraoperative techniques, particularly the likelihood of permanent colostomy^{8, 16} and the use of total mesorectal excision to prevent local recurrences.

In this study, colorectal surgeons and surgical oncologists tended to perform a higher-volume of colorectal resections than general surgeons. Even after controlling for surgical volume, they were more likely to report collaborating with other physicians regarding decisions about adjuvant therapy. Because their practice is more focused on colorectal cancer patients, they may have stronger relationships with medical and radiation oncologists, making collaborative decisions more feasible. Surgeons who perform many colorectal cancer resections are more focused on colorectal cancer and may thus be more able to form collaborative relationships with other providers who care for these patients.

Not all colorectal cancer patients will go to a high colorectal cancer volume center and neither will they all go to a colorectal or cancer specialty surgeon. For these patients, systems of care that facilitate collaborative interactions may be needed. For example, tumor boards could provide this structure for the co-management of colorectal cancer patients. Systems to facilitate regular attendance at tumor board meetings may increase opportunities for surgeons to have collaborative interactions with medical and radiation oncologists, which may increase the likelihood of recommending appropriate adjuvant therapies. In one study, presentation of a patient's case at a tumor board predicted receipt of recommended therapy for rectal cancer.¹⁴

Multidisciplinary collaboration may be challenging for surgeons in rural settings or solo practices, as there may be few medical oncologists and radiation oncologists with whom to collaborate. Telemedicine services may be one option to provide for just-in-time consultations with medical oncologists to facilitate co-management options for surgeons who do not have opportunities for regular interactions with other cancer specialists.

Strengths of our study included a large cohort of surgeons who performed colorectal cancer resection practicing in diverse geographic areas and health-care organizations and our response rate among surgeons of 62.5%.²⁴ However, the study had several limitations. First, surgeons' self-reported their approach to decision-making about adjuvant therapies, and their responses may be subject to recall bias or social desirability bias. Second, surgeons may have incorrectly self-reported their surgical volume, although this would likely result in random error rather than a systematic bias. Third, our cross-sectional data allow us to observe associations but cannot determine causal relationships between surgical volume and collaborative decision-making about adjuvant therapies. It is possible that surgeons who collaborate frequently have higher-volume practices than others because their collaborators refer patients to them. Fourth, although we demonstrate more collaborative care among high-volume surgeons, we are not able to demonstrate that this is the mechanism for higher rates of adjuvant therapy (or improved outcomes) among patients of high-volume surgeons. Future research will be important to examining these relationships further. Finally, because our sample was not a national sample and the survey is subject to non-response bias, we cannot be certain that the surgeons in our sample were representative of surgeons caring for cancer patients nationally or in the regions studied.

In conclusion, the active collaboration by surgeons in decisions about adjuvant therapies may be a potential mechanism for the better outcomes observed in other studies for patients with colorectal cancer treated by high-volume surgeons.^{7-10, 12, 16} Additional research is needed to confirm whether better collaboration between surgeons and other providers about adjuvant chemotherapy and radiation for patients with colorectal cancer leads to better

outcomes. Such research will help to disentangle the relative contributions of hospital and surgical volume, structure, and processes of care to explain these outcome differences.

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Table 1

Characteristics of participating surgeons and unadjusted associations with high surgical volume for colorectal cancer

Physician Characteristics	Proportion of surgeons (N=635)	% who are high-volume surgeons	P value [†]
Specialty			
General surgeon	83.9	15.3	<0.001
Colorectal surgeon/surgical oncologist	16.1	54.5	
Year of medical school graduation			
1952-1973	23.0	15.3	0.15
1974-1981	26.3	20.7	
1982-1990	26.1	24.9	
1991-2001	24.6	24.7	
Gender			
Male	89.5	21.5	0.85
Female	10.5	22.3	
Race			
Non-Hispanic white	74.1	21.8	0.91
Asian	15.9	20.0	
Other race	9.9	22.5	
Board certified			
Yes	94.6	20.8	0.05
No	5.4	35.3	
US or Canadian medical graduate			
Yes	88.3	21.8	0.66
No	11.7	19.6	
Teach one or more days per month			
Yes	51.3	25.5	0.01
No	48.7	17.4	
Practice Site			
Hospital	48.0	25.0	0.02
Solo, office based	16.3	10.4	
Single specialty group, office based	22.5	24.8	
Multispecialty group, office based	9.5	19.8	
Other, office based	3.6	10.5	
% patients in managed care			
0-30	27.8	21.8	0.96
31-50	22.7	21.5	
55-85	26.1	23.4	
87-100	23.3	19.3	
Study site			
5 health maintenance organizations	8.8	21.4	0.05
8 counties in Northern California	24.6	19.9	

Physician Characteristics	Proportion of surgeons (N=635)	% who are high-volume surgeons	P value [†]
Los Angeles County	23.2	25.3	
State of Alabama	18.4	18.8	
33 counties in North Carolina	20.5	16.9	
10 Veterans Affairs hospitals	4.6	43.5	
Practice at National Cancer Institute-designated cancer center			
Yes	27.8	29.6	0.002
No	72.2	18.5	
Participate in Community Clinical Oncology Program	31.5	26.0	0.07
Yes	68.5	19.5	
No			
Attend tumor board meetings			
Weekly	34.3	31.8	<0.001
Monthly	33.8	18.0	
Quarterly or less frequently	31.9	15.0	

*High-volume surgeons defined as performing at least 5 colorectal cancer resections per month

[†]Using the Chi square test

Table 2

Adjusted associations with high surgical volume for colorectal cancer.

Physician characteristics	Adjusted odds ratio (95% confidence interval)	P value*
Specialty		
General surgeon	Reference	--
Surgical oncologist/colorectal surgeon	4.92 (2.94, 8.20)	<0.001
Year of medical school graduation		
1952-1973	Reference	--
1974-1981	1.29 (0.67, 2.47)	.44
1982-1990	1.45 (0.75, 2.81)	.27
1991-2001	1.32 (0.67, 2.62)	.42
Board certification		
No	Reference	--
Yes	0.80 (0.33, 1.90)	.61
Teaching		
None	Reference	--
1 or more days per month	0.95 (0.59, 1.54)	.84
Practice setting		
Hospital	Reference	--
Solo, office based	0.53 (0.23, 1.21)	.13
Single specialty group, office based	1.51 (0.86, 2.66)	.16
Multispecialty group, office based	1.31 (0.61, 2.79)	.48
Office based, other	0.39 (0.05, 3.37)	.38
Practice at National Cancer Institute-designated Cancer Center		
No	Reference	--
Yes	1.58 (0.99, 2.52)	.06
Practice part of Community Clinical Oncology Program		
No	Reference	--
Yes	1.10 (0.69, 1.77)	.68
Attend tumor board meetings		
Weekly	1.62 (0.93, 2.82)	1.00
Monthly	(0.57, 1.75)	.99
Quarterly or less frequently	Reference	--
Study site		
Los Angeles County	Reference	--
5 Health maintenance organizations	0.62 (0.26, 1.44)	.26
8 Northern California counties	0.82 (0.45, 1.49)	.51
State of Alabama	0.62 (0.31, 1.25)	.18
22 North Carolina counties	0.45 (0.23, 0.88)	.02
10 Veterans Affairs hospitals	1.35 (0.50, 3.60)	.55

* Using logistic regression. Model included characteristics with bivariate association $\geq .20$, in table.

Table 3

Unadjusted associations of colorectal cancer volume and collaborative care for decisions regarding chemotherapy and radiation therapy

Colorectal cancer monthly surgical volume (quartiles)	Proportion who co-manage/ decide jointly when deciding on chemotherapy	P value *	Proportion who co-manage/ decide jointly when deciding on radiation therapy	P value *
0-1	46.3	<0.001	55.2	<0.001
2	56.8		60.9	
3-4	66.9		69.2	
≥5	76.6		78.1	

* Using the Chi-square test.

Table 4

Adjusted associations of surgeons' colorectal cancer volume with collaborative care for decisions regarding chemotherapy

Physician characteristics	Adjusted odds ratio (95% confidence interval)	P value *
Surgeon volume (Number of colorectal cancer resections/month)		
0-1	Reference	--
2	1.63 (1.01, 2.63)	.04
3-4	2.39 (1.46, 3.91)	<0.001
≥5	3.48 (1.94, 6.24)	<0.001
Specialty		
General surgeon	Reference	--
Colorectal surgeon/Surgical Oncologist	1.87 (1.05, 3.31)	.03
US or Canadian medical graduate		
No	Reference	--
Yes	2.02 (1.15, 3.52)	.01
Practice site		
Hospital	Reference	--
Solo, office based	1.39 (0.80, 2.44)	.25
Single specialty group, office based	0.63 (0.39, 1.03)	.06
Multi- specialty group, office based	0.55 (0.29, 1.03)	.06
Office based, Other/unknown	0.95 (0.35, 2.60)	.92
% patients in managed care		
0-30	Reference	--
31-50	0.53 (0.29, 0.99)	.04
55-85	0.55 (0.31, 0.97)	.04
87-100	0.50 (0.27, 0.90)	.02
Practice at National Cancer Institute-designated Cancer Center		
No	Reference	--
Yes	1.13 (0.74, 1.71)	.58
Practice part of Community Clinical Oncology Program		
No	Reference	--
Yes	1.68 (1.13, 2.51)	.01
Attend tumor board meetings		
Weekly	1.66 (1.06, 2.60)	.02
Monthly	1.66 (1.08, 2.54)	.03
Quarterly or less frequently	Reference	--
Study site		
Los Angeles County	Reference	--
5 Health maintenance organizations	2.29 (1.08, 4.86)	.03
8 Northern California counties	1.09 (0.67, 1.79)	.73
State of Alabama	1.61 (0.88, 2.94)	.12
22 North Carolina counties	1.39 (0.79, 2.43)	.25

Physician characteristics	Adjusted odds ratio (95% confidence interval)	P value *
10 Veterans Affairs hospitals	1.17 (0.44, 3.12)	.76

* Using logistic regression. Model included characteristics with bivariate association $\leq .20$, in table.

Table 5

Adjusted associations of surgeons' colorectal cancer volume with collaborative care for decisions regarding radiation therapy

Physician characteristics	Adjusted odds ratio (95% confidence interval)	P value *
Surgeon volume (Number of colorectal cancer resections/month)		
0-1	Reference	--
2	1.27 (0.79, 2.05)	.32
3-4	1.71 (1.05, 2.77)	.03
≥5	2.27 (1.27, 4.06)	.005
Specialty		
General surgeon	Reference	--
Colorectal surgeon/Surgical Oncologist	1.80 (1.00, 3.22)	.048
US or Canadian medical graduate		
No	Reference	--
Yes	1.68 (0.97, 2.89)	.06
Practice site		
Hospital	Reference	--
Solo, office based	0.90 (0.52, 0.1.55)	.71
Single specialty group, office based	0.70 (0.44, 1.12)	.13
Multi- specialty group, office based	0.70 (0.38,1.29)	.26
Office based, Other/unknown	0.48 (0.18, 1.25)	.13
% patients in managed care		
0-30	Reference	--
31-50	0.46 (0.25, 0.84)	.01
55-85	0.53 (0.31, 0.90)	.02
87-100	0.44 (0.25, 0.76)	.003
Practice part of Community Clinical Oncology Program		
No	Reference	--
Yes	1.28 (0.87, 1.88)	.21
Attend tumor board meetings		
Weekly	1.82 (1.17, 2.82)	.008
Monthly	1.61 (1.07, 2.45)	.02
Quarterly or less frequently	Reference	--

* Using logistic regression. Model include