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Phantom Prescribing: Examining the Frequency of Antimicrobial Prescriptions without a Patient Visit

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Abstract

Objective—To investigate the scale of antimicrobial prescribing without a corresponding visit, and to compare the attributes of patients who received antimicrobials with a corresponding visit to those who did not have a visit.

Design—Retrospective cohort

Methods—We followed 185,010 Medicare patients for one year after an acute myocardial infarction. For each antimicrobial prescribed, we determined if the patient had an inpatient, outpatient or provider claim in the 7 days prior to the antimicrobial prescription being filled. We compared the proportions of patient characteristics for those prescriptions associated with a visit and without a visit (i.e., phantom prescriptions). We also compared the rates at which different antimicrobials were prescribed without a visit.

Results—We found that of 356,545 antimicrobial prescriptions, 14.75% had no evidence of a visit in the week prior to the prescription being filled. A higher percentage of patients without a visit were identified as white ($p<0.001$) and female ($p<0.001$). Patients without a visit had a higher likelihood of survival and fewer additional cardiac events (AMI, cardiac arrest, stroke, all $p<0.001$). Among the antimicrobials considered, amoxicillin, penicillin, and agents containing trimethoprim and methenamine were much more likely to be prescribed without a visit. In

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contrast, levofloxacin, metronidazole, moxifloxacin, vancomycin, and cefdinir were much less likely to be prescribed without a visit.

Conclusions—Among this cohort of patients with chronic conditions, phantom prescriptions of antimicrobials are relatively common and occurred more frequently among those patients who were relatively healthy.

Introduction

The emergence of antimicrobial resistance is a major public health concern and has major clinical implications.^{1–4} One approach for controlling antimicrobial resistance is to minimize inappropriate antimicrobial use.^{5–8} To achieve this goal, stewardship campaigns and programs have been established in both inpatient and outpatient settings.^{6,9–13} Stewardship programs have included a variety of strategies.^{9,10,14–16} In inpatient settings, programs have incorporated, for example, monitoring and feedback and prescriber education.^{9,17,18} In outpatient settings, programs have used feedback to prescribers, delayed prescribing, and attempts to educate patients,^{10,19–22} because patient and family expectations are thought to be major drivers of inappropriate antimicrobial use.^{23–25}

Regardless of the intervention proposed, most stewardship approaches are designed to be implemented in traditional practice settings. However, not all antimicrobial prescribing is based upon office visits; prescribing may occur without a direct, face-to-face clinical encounter, e.g., by telephone. Thus, for non-face-to-face (i.e. phantom) encounters, standard approaches to improve antimicrobial prescribing may not be effective. Given the interest in reducing antimicrobial use across the spectrum of care, the purpose of this project is to determine the frequency of antimicrobial prescribing in a large cohort of patients with comorbidities, describe the types of antimicrobials prescribed to outpatients via phantom encounters, and to compare patient characteristics in antimicrobial prescribing between phantom and face-to-face healthcare encounters.

Methods

Study Cohort

To study outpatient antimicrobial prescribing among patients with chronic diseases, we used a cohort of Medicare recipients with a prior history of a myocardial infarction for whom we have complete claims data. Our cohort consists of 185,010 Medicare recipients who suffered an acute myocardial infarction (AMI) in 2007 or 2008 (an inpatient stay with primary diagnosis code 410.x1). In the analyses, we utilized Part D prescription drug events from the Chronic Condition Data Warehouse (www.ccwdata.org) and claims and enrollment information from Medicare. Each patient's index date was considered to be the date of hospital discharge for the visit corresponding to the AMI. Exclusion criteria for this study were: having had an AMI in the year before the index stay; not being enrolled in Medicare Parts A and B for a year before the index stay and either a year after the index stay or until their death; and not being enrolled in Medicare Part D during the 6 months before and the year after the index stay. The University of Iowa's institutional review board approved this study.

Defining a Phantom Prescription

In the year following each patient's index date, we recorded each instance a patient received an antimicrobial of interest (Appendix 1). We included the most commonly prescribed oral antimicrobials. If a patient filled a prescription for an antimicrobial of interest and also visited a medical professional in the 7 days preceding the date on which the prescription was filled, we labeled the prescription as an antimicrobial prescription with a visit. In contrast, if a prescription was filled but there was no visit recorded in the 7 preceding days, we labeled this prescription as a phantom prescription. We defined a visit to a medical professional as any visit that yielded an inpatient or outpatient Medicare institutional claim or a carrier Medicare non-institutional claim. Inpatient claims are hospital based. In addition to general outpatient visits, outpatient claims include hospital outpatient departments, rural health clinics, federally qualified health centers, renal dialysis facilities, outpatient rehabilitation facilities, comprehensive outpatient rehabilitation facilities, and community mental health centers. Carrier claims are provider claims for non-inpatient services. Carriers include physicians, physician assistants, clinical social workers, nurse practitioners, independent clinical laboratories, ambulance providers, and freestanding ambulatory surgical centers.²⁶ Finally, to estimate the impact of refill prescriptions on the phantom antimicrobial prescribing rate, We defined a refill prescription when a subject fills another prescription for the same antimicrobial within 7 days of the former prescription's supply ending.

Comparing Patient Attributes

To determine if patients who received phantom antimicrobial prescriptions were different from patients who received antimicrobials following a visit, we compared the phantom prescriptions to visit-associated prescriptions. We considered the following patient characteristics: age, gender, race, measures of socioeconomic status, measures of patient comorbidities in the year prior to the index AMI and measures of cardiac and survival outcomes in the year post-index. We compared the proportions by estimating odds ratios and by testing whether the odds ratios were equal to one.

Because many patients received multiple antimicrobials in the year following their AMI, we answered the question of whether there existed differences between the two groups in two different ways. First, we considered the patient as the unit of analysis. Here if a patient received any phantom prescription for antimicrobials, the patient was considered to be a patient with phantom prescriptions. If a patient received one or more antimicrobials and *all* the prescriptions were associated with a visit, then he or she was considered to be a patient without phantom prescriptions. If a patient did not receive any antimicrobial prescriptions in the study period, he or she was excluded from this analysis.

Second, we used the antimicrobial prescription as the unit of analysis. For this analysis, for each antimicrobial prescription, we recorded the attributes of the patient for whom the prescription was prescribed and filled. For this analysis, some individuals will be counted more than once and can even be counted in both the phantom and visit-associated cohorts. For instance, if a patient received 7 phantom and 3 visit-associated antimicrobial prescriptions, the patient's attributes will be counted 7 and 3 times in the phantom and visit-associated cohort attributes, respectively. To account for the clustering effects related to

some patients receiving multiple antimicrobial prescriptions, we employed a univariate GEE model with a binomial distribution, logit link and exchangeable correlation structure.

Comparing Antimicrobial Prescription Rates

We were primarily interested in the antimicrobials most frequently prescribed. Thus, we only considered antimicrobials that were one of the 20 most common antimicrobials prescribed to either patients with phantom prescriptions or patients with a visit. For each of these drugs, we computed: (1) the total number of antimicrobial claims, both phantom and visit-associated; (2) the percentage of all antimicrobial claims associated with each drug, both phantom and visit-associated; and (3) the percentage of claims for each drug that were prescribed without a visit.

Odds ratios and their 95% confidence intervals comparing the odds that the given antimicrobial prescription is phantom to those odds for all other antimicrobials listed in Appendix 1 are presented in Table 3. P-values corresponding to Wald tests comparing the odds ratios to one are also presented in Table 3. Bonferroni adjustments were made for multiple comparisons.

Because antimicrobials are often inappropriately prescribed for influenza,²⁷ we determined if the rate at which antimicrobials are prescribed without a prescription is significantly higher at times when influenza is more prevalent. We performed these analyses for all antimicrobials listed in Appendix 1, as well as certain antimicrobials and combinations of antimicrobials. Data from the CDC giving the national influenza-like illness (ILI) rate for each week in the years 2007–2009 were used to determine influenza activity. If the ILI rate was higher than 2.1% in a particular week, then we considered this a high influenza rate week, otherwise the week was considered a low influenza rate week. We determined if each antimicrobial prescription was filled during a high or low influenza rate week.

Finally, because urinary tract infections (UTIs) may be frequently self-diagnosed and in some cases appropriately treated without a visit, we assessed whether antimicrobials often prescribed for UTIs were prescribed without a corresponding visit at a higher rate than the other antimicrobials. We considered Sulfamethoxazole-Trimethoprim, Trimethoprim, Fosfomycin, Nitrofurantoin, Ciprofloxacin, and Levofloxacin as drugs often prescribed for UTIs. Using GEE models because some patients received multiple antimicrobial prescriptions, we modeled the odds of receiving one of the aforementioned UTI drugs without a visit compared to the odds for any other microbial studied. Note these models are univariate. We report Wald p-values testing whether the odds ratio equals one. All analyses were performed using SAS 9.4.

Results

Of the 185,010 patients in the cohort, 113,904 received an antimicrobial of interest in the year following their index acute myocardial infarction. In our cohort, a total of 356,545 prescriptions were filled for all antimicrobials of interest. Of these prescriptions, 52,587 (14.75%) were filled without a corresponding visit in the 7 days prior to the filling of the prescription. Of these 52,587 phantom prescriptions, 12,511 (23.79%) were what we defined

as a refill prescription. If one were to eliminate all refill prescriptions, then the refill-adjusted phantom antimicrobial prescribing rate would be 13.04%.

As shown in Table 1, our cohort of 185,010 patients is predominately female (59.42%), white (82.83%) and from a low income area (61.68%). Furthermore, 16.27% of the cohort suffered another cardiac event in the year following their acute myocardial infarction; 76.37% survived for one year, and 65.81% survived one year without experiencing another cardiac event. The cohort of 113,904 antimicrobial receivers is also primarily female (61.56%), white (83.75%), 81.90% survived and 69.40% survived without experiencing a cardiac event for one-year post-discharge. We defined a cardiac event as an acute myocardial infarction, stroke or unstable angina.

Table 1 displays patient characteristics for patients who received at least one phantom antimicrobial and patients who received only visit-associated antimicrobial prescription(s). Of the patients who received an antimicrobial, the odds that at least one of the prescriptions was a phantom prescription was significantly higher for the following groups: females, white patients, patients 85 and older, patients who survived the year following their index AMIs, patients who did not have either diabetes or chronic kidney disease (CKD) in the year prior to their index AMIs, patients who did not have any cardiac events in the year after their index dates, those who lived in predominantly English-speaking areas and those who were not dually eligible for Medicare.

In Table 2 we show the results from our antimicrobial-level analysis. Note that the results are similar to the results of our patient-level analysis (Table 1). The following patient characteristics were associated with a higher likelihood that a prescription did not have a corresponding visit: female, white, 85 or older, from an area that predominantly speaks English, not dually eligible for Medicaid, without a diagnosis of diabetes, CKD or chronic obstructive pulmonary disease (COPD) in the year prior to their index AMI, and those who did not have any cardiac events and survived the year following their index AMI.

The third set of analyses involved determining if specific antimicrobial agents had a higher chance of being prescribed without a corresponding visit and results are displayed in Table 3. We adjusted for multiple comparisons using the Bonferroni method using a level of significance of $0.05/23=0.0022$. Even when adjusting for multiple comparisons, all the odds ratios are significantly different from one for all antimicrobials in Table 3 except Clarithromycin, Ampicillin and Cefadroxil. Specifically, prescriptions including Amoxicillin, Penicillin, Trimethoprim and Methenamine are much *more* likely than the typical antimicrobial studied to be prescribed without a visit. Conversely, Levofloxacin, Metronidazole, Moxifloxacin, Vancomycin, and Cefdinir are much *less* likely to be prescribed without a visit.

The odds of a prescription for various antimicrobials and combinations of antimicrobials being phantom in high influenza weeks compared to those odds during low influenza weeks is displayed in Table 4. For all antimicrobials in Appendix 1, we estimated that the odds a prescription was filled without a visit during a high influenza week is 1.0467 (1.0251–1.0687, $p<0.0001$) times that of the odds in a week with a lower influenza rate. For a

combination of Clarithromycin, Azithromycin, Amoxicillin, Amoxicillin-Clavulanate, Levofloxacin, Moxifloxacin and Doxycycline, the odds ratio is 1.0413 (1.0103–1.0733, $p=0.0087$), yielding a result very similar to that of all antimicrobials. Both Amoxicillin and Moxifloxacin, each analyzed separately, yielded odds ratios which were not significantly different from one. Azithromycin, on the other hand, was significantly more likely to be prescribed without a visit when the influenza rate was high, with an odds ratio of 1.1123 (1.0517–1.1764, $p=0.0002$). Finally, prescriptions for common UTI drugs were less likely to be phantom prescriptions than non-UTI-drug prescriptions: the odds of receiving one of the commonly prescribed UTI drugs without a visit was 0.6931 (0.6783–0.7082, $p<0.0001$) times the odds of receiving a phantom prescription for any of the other antimicrobials studied.

Discussion

Our results show that almost 15% of antimicrobials were prescribed without evidence of a corresponding encounter with a healthcare provider. Even removing refill prescriptions from consideration yielded a phantom antimicrobial prescribing rate of over 13%. These phantom prescriptions were more likely to be prescribed to patients who were white, female and/or for patients who were relatively healthy. For example, having diabetes and CKD reduced the odds of phantom prescriptions. Finally, phantom antimicrobial prescriptions occurred more commonly in our study population during weeks with higher influenza rates, especially prescriptions for azithromycin.

Although we could link a majority of antimicrobial use to healthcare encounters, we believe that this rate of phantom prescribing is important to consider when designing programs to measure and control antimicrobial use. Among our cohort of approximately 185,000 patients, during a year of follow up, over 356,500 antimicrobial prescriptions were filled, and 52,587 of these were phantom prescriptions. In the United States, over 250,000 million prescriptions for antimicrobials are filled every year.²⁸ Thus, given our results, it is conceivable that several tens of millions of antimicrobial prescriptions may be written without a corresponding face-to-face encounter with a healthcare provider. These phantom antimicrobial prescriptions are concerning because they are potentially immune from traditional office-based-stewardship interventions.

We think that the majority of these phantom prescriptions are filled on the basis of phone calls. While some of these antimicrobial prescriptions are appropriate, it is harder to evaluate the appropriateness of antimicrobial use. From the clinician's perspective, it is substantially harder to make an appropriate diagnosis without the ability to do: a physical exam, a structured interview, or order appropriate diagnostic tests. Furthermore, over the phone, the history may not actually be taken by the prescriber, but instead may be taken by someone else (e.g., a nurse or answering service). From a stewardship perspective, without a clinical note, detailed diagnosis or lab values, it is difficult to evaluate prescriptions, feed back prescribing rates in a standardized fashion, or do accurate benchmarking.

Our results are especially important given the emergence of telehealth or electronic visits (e-visits). Substantial concerns have been raised for the potential for such visits to increase

inappropriate antimicrobial use.^{29–31} Nevertheless; e-visits have advantages over telephone encounters. First, they are structured appointments and telephone-based prescribing is not. Insofar as telephone visits often occur at busy times, it decreases the opportunity for correcting patient expectations; a major driver of antimicrobial use.^{23–25} Second, a scheduled e-visit has the potential to learn more about the patient's condition. Finally, with e-visits, there is potentially more-structured data to enable stewardship efforts than with telephone prescribing.

Although our study population was older with more comorbidities, it was actually the healthier and more affluent patients that were more likely to have these phantom antimicrobial prescriptions. Initially this result was surprising to us. Our initial intuition was the clinicians would be more likely to prescribe antimicrobials to people that were not as healthy, as these patients may be more vulnerable and more likely to have worse outcomes if they were to suffer a condition requiring an antimicrobial. Given that phantom prescribing is also more common among people living in relatively more affluent areas, our findings may be related to patient expectations. In affluent areas, expectations for treatment may be higher. Indeed, other work has shown that where provider density is higher, inappropriate antimicrobial prescribing is higher.^{32,33}

This work is subject to many limitations. Our population is made up entirely of Medicare fee-for-service beneficiaries who have suffered an AMI. Therefore our results may not be generalizable to healthier and younger populations. However, this is an important group to consider. Infections may have more serious outcomes in this population, and adverse drug events may be more common. Future work should focus on relatively healthy populations where inappropriate prescribing may actually be higher.

Our study has several limitations. First, some antimicrobial prescriptions labeled as phantom may have been associated with a visit. If patients went to a clinic and paid cash, we have a record of this visit. Likewise, some subjects may have paid cash for their antimicrobials and not submitted a claim. Second, our phantom prescribing estimates may, in part, be driven by appropriate antimicrobial prescribing for UTIs. However, the odds of receiving a prescription for an antimicrobial agent typically prescribed for UTIs without a corresponding visit were significantly lower than the odds of receiving a phantom prescription for other antimicrobials. Third, some prescriptions could be related to dental visits, which we do not capture, but dental prescriptions are only likely only to affect a subset of the antimicrobials we considered, and some antimicrobials highlighted in our analysis are much less likely to be prescribed in a dental setting (e.g., azithromycin). Finally, antimicrobials could have been filled in a nursing home where there was a provider encounter, but it was not charged to Medicare as such. To address this issue, we conducted a sensitivity analysis. We compared patients with at least one claim for a long-term-care facility to those without such a claim. We found that patients with nursing home claims were less likely to have a phantom prescription than patients without such a claim. (Data not shown.) We were not surprised by this finding because, overall, phantom prescriptions tended to occur in healthier patients.

Despite our limitations, we found that phantom antimicrobial prescribing was relatively common. As the population ages and clinics become busier, pressure and incentives for these types of encounters will likely increase. In addition, e-visits will undoubtedly continue to increase. Thus, new antimicrobial stewardship efforts are needed to target these types of prescribing. Also, our results suggest that the rate of encounter-free antimicrobial prescribing should be investigated in other populations, especially younger, healthier populations that might be more likely to have higher expectations for antimicrobial prescribing.

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Appendix 1: List of Antimicrobials Studied

Levofloxacin	Ciprofloxacin	Azithromycin	Cephalexin	Sulfamethoxazole-Trimethoprim
Nitrofurantoin	Amoxicillin	Amoxicillin-Clavulanate	Doxycycline	Metronidazole
Moxifloxacin	Clindamycin	Vancomycin	Cefuroxime	Clarithromycin
Cefdinir	Penicillin	Ampicillin	Tetracycline	Erythromycin
Trimethoprim	Cefadroxil	Minocycline	Rifampin	Linezolid
Methenamine	Cefpodoxime	Cefaclor	Demeclocycline	Cefprozil
Dicloxacillin	Rifaximin	Dapsone	Gemifloxacin	Cefditoren
Norfloxacin	Fosfomycin	Cefixime	Ceftibuten	Ofloxacin
Telithromycin	Carbenicillin			

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Table 1

Patient-level Analysis Comparing Patient Characteristics Associated with Phantom Prescriptions to Visit-Associated Prescriptions

Attribute	All	ABX Receivers	Phantom	Visit- Assoc.	OR	95% CI	p-val
Number (%)							
Overall	185010	113904	31,011	82893			
Male Sex	75073 (40.58)	43784 (38.44)	11312 (36.48)	32472 (39.17)	0.892	(0.868,0.916)	<0.0001
Race							
White	153242 (82.83)	95395 (83.75)	26940 (86.87)	68455 (82.58)	1.396	(1.344,1.449)	<0.0001
Black	15412 (8.33)	8344 (7.33)	1761 (5.68)	6583 (7.94)	0.698	(0.661,0.737)	<0.0001
Hispanic	10781 (5.83)	6842 (6.01)	1496 (4.82)	5346 (6.45)	0.735	(0.693,0.780)	<0.0001
Other	5575 (3.01)	3323 (2.92)	814 (2.62)	2509 (3.03)	0.864	(0.797,0.936)	0.0003
Age							
66–70	33571 (18.15)	20920 (18.37)	5753 (18.55)	15167 (18.30)	1.017	(0.984,1.052)	0.3225
71–75	34313 (18.55)	21606 (18.97)	5774 (18.62)	15832 (19.10)	0.969	(0.937,1.002)	0.0652
76–80	37238 (20.13)	23339 (20.49)	6246 (20.14)	17093 (20.62)	0.971	(0.940,1.003)	0.0745
81–85	36002 (19.46)	22186 (19.48)	5986 (19.30)	16200 (19.54)	0.985	(0.953,1.018)	0.3635
85 or older	43886 (23.72)	25853 (22.70)	7252 (23.39)	18601 (22.44)	1.055	(1.023,1.088)	0.0007
Socioeconomic Factors							
Low Income Area	114123 (61.68)	71012 (62.34)	19166 (61.80)	51846 (62.55)	0.969	(0.943,0.995)	0.0213
Non-English-speaking area	52319 (28.28)	31587 (27.73)	8082 (26.06)	23505 (28.36)	0.891	(0.865,0.917)	<0.0001
Dually Eligible for Medicaid	68498 (37.02)	43502 (38.19)	11105 (35.81)	32397 (39.08)	0.870	(0.846,0.893)	<0.0001
One-Year Pre-Index Comorbidities							
Diabetes	72146 (39.00)	46852 (41.13)	11671 (37.64)	35181 (42.44)	0.818	(0.797,0.841)	<0.0001
CKD	37901 (20.49)	24678 (21.67)	5590 (18.03)	19088 (23.03)	0.735	(0.711,0.760)	<0.0001
COPD	52324 (28.28)	35856 (31.48)	9677 (31.21)	26179 (31.58)	0.983	(0.955,1.011)	0.2235
One-Year Post Discharge Cardiac and Survival Outcomes							
AMI	18287 (9.88)	11961 (10.50)	2712 (8.75)	9249 (11.16)	0.763	(0.730,0.798)	<0.0001
Cardiac Arrest	7891 (4.27)	3992 (3.50)	771 (2.49)	3221 (3.89)	0.631	(0.582,0.683)	<0.0001
Stroke	5508 (2.98)	3305 (2.90)	738 (2.38)	2567 (3.10)	0.763	(0.702,0.829)	<0.0001
Cardiac Event	30105 (16.27)	19699 (17.29)	4601 (14.84)	15098 (18.21)	0.782	(0.754,0.811)	<0.0001
Survival	141288 (76.37)	93293 (81.90)	26829 (86.51)	66464 (80.18)	1.586	(1.529,1.645)	<0.0001

Attribute	Number (%)				Visit- Assoc.	OR	95% CI	p-val
	All	ABX Receivers	Phantom					
Cardiac Free Survival	121756 (65.81)	79045 (69.40)	23224 (74.89)		55821 (67.34)	1.446	(1.404,1.490)	<0.0001

Comparing patients' race, age, SES, one-year pre-index comorbidities and one-year post-index outcomes for four cohorts: all patients, patients receiving any antimicrobial of interest, patients who received at least one antimicrobial and none of which were phantom, and patients receiving at least one phantom prescription. For patients with at least one antimicrobial prescription, the odds ratios compare the odds a patient with the given attribute will have a phantom prescription to those odds of a patient without the given attribute

Table 2
Antimicrobial-Level Analysis Comparing Patient Characteristics for Phantom Prescriptions to Visit-Associated Prescriptions

Characteristic	All	Phantom	Visit-Associated	OR	95% CI	p-value
Number (%)						
Overall	356,545	52,587	303,958			
Male Sex	128,786 (36.12)	18,424 (35.04)	110,362 (36.31)	0.9702	(0.9459,0.9951)	0.0194
Race						
White	302,733 (84.91)	46,214 (87.88)	256,519 (84.39)	1.3089	(1.2624,1.3572)	< 0.0001
Black	23,467 (6.58)	2,696 (5.13)	20,771 (6.83)	0.7506	(0.7122,0.7912)	< 0.0001
Hispanic	20,463 (5.74)	2,342 (4.45)	18,121 (5.96)	0.7445	(0.7032,0.7882)	< 0.0001
Other	9,882 (2.77)	1,335 (2.54)	8,547 (2.81)	0.9505	(0.8797,1.0270)	0.1985
Age						
66–70	66,360 (18.61)	9,611 (18.28)	56,749 (18.67)	1.0047	(0.9736,1.0368)	0.7689
71–75	68,210 (19.13)	9,785 (18.61)	58,425 (19.22)	0.9683	(0.9384,0.9992)	0.0444
76–80	72,481 (20.33)	10,144 (19.29)	62,337 (20.51)	0.9386	(0.9106,0.9674)	< 0.0001
81–85	69,602 (19.52)	10,148 (19.30)	59,454 (19.56)	0.9732	(0.9437,1.0037)	0.0841
85 or Older	79,892 (22.41)	12,899 (24.53)	66,993 (22.04)	1.1105	(1.0789,1.1430)	< 0.0001
Socioeconomic Factors						
Low Income Area	224,739 (63.03)	32,897 (62.56)	191,842 (63.11)	0.9484	(0.9249,0.9726)	< 0.0001
Non-English-speaking area	95,002 (26.65)	13,154 (25.01)	81,848 (26.93)	0.9244	(0.8991,0.9505)	< 0.0001
Dually Eligible for Medicaid	147,973 (41.50)	19,464 (37.01)	128,509 (42.28)	0.7919	(0.7719,0.8123)	< 0.0001
One-Year Pre-Index Comorbidities						
Diabetes	156,599 (43.92)	19,575 (37.22)	137,024 (45.08)	0.7217	(0.7038,0.7401)	< 0.0001
CKD	85,351 (23.94)	9,384 (17.84)	75,967 (24.99)	0.6460	(0.6259,0.6667)	< 0.0001
COPD	128,023 (35.91)	16,971 (32.27)	111,052 (36.54)	0.8199	(0.7986,0.8417)	< 0.0001
One-Year Post-Index Cardiac and Survival Outcomes						
AMI	38,946 (10.92)	4,373 (8.32)	34,573 (11.37)	0.6968	(0.6678,0.7271)	< 0.0001
Cardiac Arrest	11,338 (3.18)	1,144 (2.18)	10,194 (3.35)	0.6654	(0.6150,0.7198)	< 0.0001
Stroke	10,231 (2.87)	1,194 (2.27)	9,037 (2.97)	0.7449	(0.6875,0.8071)	< 0.0001
Cardiac Event	63,785 (17.89)	7,476 (14.22)	56,309 (18.53)	0.7165	(0.6926,0.7413)	< 0.0001
Survival	299,436 (83.98)	46,061 (87.59)	253,375 (83.36)	1.3845	(1.3357,1.4351)	< 0.0001

Characteristic	Number (%)		Visit-Associated	OR	95% CI	p-value
	All	Phantom				
Cardiac Free Survival	250,728 (70.32)	40,134 (76.32)	210,594 (69.28)	1.4241	(1.3846,1.4646)	< 0.0001

Comparing patients' race, age, SES, one-year pre-index comorbidities one-year post-index survival and cardiac outcomes for phantom and visit-associated antimicrobial prescriptions. The odds ratios compare the odds that a prescription filled by a patient with the given attribute will be a phantom prescription to the odds of a patient without the given attribute.

Table 3
Comparing Phantom and Visit-Associated Prescription Rates for Various Antimicrobials

Antimicrobial	Phantom Count	Visit- Assoc. Count	Percent of Given ABX RX that are Phantom	OR	95% CI	p-value
Amoxicillin	7607	17936	29.78%	2.6969	(2.6209,2.7752)	<0.0001
Azithromycin	6575	33660	16.34%	1.1475	(1.1156,1.1803)	<0.0001
Nitrofurantoin	5599	20928	21.11%	1.6115	(1.5622,1.6623)	<0.0001
Ciprofloxacin	5070	41816	10.81%	0.6689	(0.6486,0.6898)	<0.0001
Cephalexin	4568	29076	13.58%	0.8993	(0.8704,0.9292)	<0.0001
Levofloxacin	4271	44823	8.70%	0.5111	(0.4945,0.5281)	<0.0001
Sulfamethoxazole-Trimethoprim	4173	27117	13.34%	0.8800	(0.8506,0.9104)	<0.0001
Doxycycline	2363	12269	16.15%	1.1186	(1.0693,1.1701)	<0.0001
Clindamycin	1862	6210	23.07%	1.7600	(1.6698,1.8851)	<0.0001
Amoxicillin-Clavulanate	1768	16051	9.92%	0.6240	(0.5936,0.6560)	<0.0001
Penicillin	1256	1802	41.07%	4.1029	(3.8154,4.4120)	<0.0001
Metronidazole	1097	11169	8.94%	0.5585	(0.5245,0.5947)	<0.0001
Moxifloxacin	824	8125	9.21%	0.5796	(0.5392,0.6230)	<0.0001
Cefuroxime	650	6151	9.56%	0.6059	(0.5586,0.6573)	<0.0001
Vancomycin	604	6343	8.69%	0.5452	(0.5013,0.5929)	<0.0001
Trimethoprim	561	997	36.01%	3.2767	(2.9534,3.6353)	<0.0001
Clarithromycin	549	2845	16.18%	1.1166	(1.0186,1.2240)	0.0186
Erythromycin	418	1297	24.37%	1.8697	(1.6739,2.0885)	<0.0001
Tetracycline	411	1544	21.02%	1.5429	(1.3833,1.7209)	<0.0001
Methenamine	354	659	34.95%	3.1192	(2.7404,3.5504)	<0.0001
Cefdinir	263	2894	8.33%	0.5229	(0.4607,0.5934)	<0.0001
Ampicillin	248	1740	12.47%	0.8230	(0.7202,0.9404)	0.0042
Cefadroxil	209	1348	13.42%	0.8958	(0.7741,1.0366)	0.1397

Phantom (visit-associated) count for a specific antimicrobial is the total number of such prescriptions filled for that antimicrobial. The odds ratio for a specific antimicrobial compares the odds of a prescription for the given antimicrobial being phantom to those odds for all other antimicrobials listed in Appendix 1.

Table 4

Comparing Odds of Phantom Prescriptions during Influenza Season

Drug or Drug Combo	Odds Ratio	95% CI	p-value
All ABX in Appendix 1	1.0467	(1.0251, 1.0687)	<0.0001
Selected 7 ABX*	1.0413	(1.0103, 1.0733)	0.0087
Azithromycin	1.1123	(1.0517, 1.1764)	0.0002
Amoxicillin	0.9604	(0.9037, 1.0206)	0.1931
Moxifloxacin	1.0697	(0.9151, 1.2504)	0.3976

The odds ratios compare the odds of a prescription for the given antimicrobial or combination of antimicrobials being phantom for those filled during a high influenza week to the odds for those filled during a low influenza week.

* Note that the Selected 7 antimicrobials are: Clarithromycin, Azithromycin, Amoxicillin, Amoxicillin-Clavulanate, Levofloxacin, Moxifloxacin, and Doxycycline.