NBER WORKING PAPER SERIES

A TASTE OF THEIR OWN MEDICINE: GUIDELINE ADHERENCE AND ACCESS TO EXPERTISE

Amy Finkelstein
Petra Persson
Maria Polyakova
Jesse M. Shapiro

Working Paper 29356
http://www.nber.org/papers/w29356

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
October 2021, Revised November 2021

We acknowledge funding from the Population Studies and Training Center and the Eastman Professorship at Brown University (Shapiro), and the National Institute on Aging under grant K01AG05984301 (Polyakova). We appreciate comments from Jon Gruber, Eric Patashnik, and seminar participants at the Research Institute of Industrial Economics and the Wharton School. We are grateful to Aron Malatinszky, Gabriel Swagel, and Yuci Zhou, as well as to Sarah Bögl and Katja Hofmann at the Research Institute of Industrial Economics, for excellent research assistance. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

At least one co-author has disclosed additional relationships of potential relevance for this research. Further information is available online at http://www.nber.org/papers/w29356.ack

A Taste of Their Own Medicine: Guideline Adherence and Access to Expertise
Amy Finkelstein, Petra Persson, Maria Polyakova, and Jesse M. Shapiro
NBER Working Paper No. 29356
October 2021, Revised November 2021
JEL No. D83,I12,I18

ABSTRACT

We use population administrative data from Sweden to study adherence to 63 medication-related guidelines. We compare the adherence of patients without personal access to medical expertise to the adherence of those with access, namely doctors and their close relatives. We estimate that, among observably similar patients, access to expertise is associated with 3.8 percentage points lower adherence, relative to a baseline adherence rate of 54.4 percent among those without access. This association is larger for recommendations with a weaker clinical motivation. Our findings suggest an important role in non-adherence for factors other than those, such as ignorance, complexity, or failures of patient-provider communication, that would be expected to diminish with access to expertise.

Amy Finkelstein
Department of Economics, E52-442
MIT
77 Massachusetts Avenue
Cambridge, MA 02139
and NBER
afink@mit.edu

Petra Persson
Department of Economics
Stanford University
579 Jane Stanford Way
Stanford, CA 94305
and NBER
perssonp@stanford.edu

Maria Polyakova
Center for Health Policy
Stanford School of Medicine
Encina Commons, Room 182
615 Crothers Way
Stanford, CA 94305
and NBER
maria.polyakova@stanford.edu

Jesse M. Shapiro
Economics Department
Box B
Brown University
Providence, RI 02912
and NBER
jesse_shapiro_1@brown.edu

1 Introduction

Widespread non-adherence to medical guidelines is believed to contribute to a large amount of hospitalizations, deaths, and health care spending each year (Fonarow et al. 2011; Neiman 2017).[1] The causes of non-adherence are the subject of significant academic and policy interest (Neiman 2017; Hyun 2017; Lopez-Vazquez et al. 2012). Prominent explanations include patient or provider ignorance, guideline complexity, and lack of trust or communication in the patient-provider relationship (Alpert 2010; Aslani et al. 2019; Bosworth 2012; Neiman 2017).

Such explanations motivate specific policy interventions, such as attempts to simplify treatment regimes or disseminate information to patients or practitioners (Brown and Bussell 2011; Fischer et al. 2016; Irwin et al. 2014; Krueger et al. 2005; McDonald et al. 2002; Nieuwlaat et al. 2014; van Driel et al. 2016). They also suggest the testable implication that patients with greater access to medical expertise will tend to be more adherent, since they are likely to be better informed, better able to make decisions, and better able to communicate with their medical providers.

We find that the opposite holds. Specifically, we study the relationship between a patient's adherence to medication guidelines and whether the patient has personal access to medical expertise, defined as being a doctor or having one in the close family. To do so, we assemble administrative data on the entire population of Sweden from 2005 through 2016 and use it to measure adherence to 63 government-issued prescription drug guidelines. These include 6 guidelines related to antibiotics (e.g., children should start with a narrower- rather than a broader-spectrum antibiotic to combat a respiratory tract infection), 20 guidelines specific to the elderly (e.g., avoid certain sleep medications), 20 guidelines related to specific diagnoses (e.g., take statins after a heart attack), and 17 guidelines on medication use during pregnancy (e.g., avoid certain antidepressants). Adherence to these guidelines requires the compliance of both the provider (to prescribe or not prescribe some medication) and the patient (to take or not take some medication).

We use information on a person's completed education to determine if they are a doctor, and we link doctors to their relatives using a population register. In our baseline analysis, we classify

[1] For example, only a minority of patients adhere to the recommendation to take high-intensity statins following a heart attack (Neiman 2017; Colantonio et al. 2017), and many physicians depart from expert guidance on antibiotic prescribing (Lopez-Vazquez et al. 2012; Fleming-Dutra et al. 2016).

a patient as having access to medical expertise if the patient, the patient's partner, or any of the patient's parents or children is a doctor. For each of the 63 guidelines, we narrow in on the set of patients who, based on their health conditions, prior prescription claiming, and demographics, are covered by the guideline; within this risk set, we examine differences in adherence between those with and without access to expertise.

We find that access to expertise is generally associated with less adherence to guidelines. Among the 63 guidelines that we study, and controlling for demographics, income, and education, the association between access to expertise and adherence is negative in 41 cases and statistically significant in 20 of those. Since the share of the population covered by any given guideline can vary by up to three orders of magnitude, we summarize these findings by averaging them across guidelines, weighting each guideline by the prevalence of its risk set in the population. We estimate that while the average patient without access to expertise adheres to guidelines 54.4 percent of the time, one with access to expertise adheres only 50.6 percent, a 3.8 percentage point lower adherence rate. The 95 percent confidence interval includes a 4.1 to 3.5 percentage point lower adherence rate for those with access to expertise. The education and income controls in our baseline specification strengthen the negative association between adherence and access to expertise. Relative to our baseline, the association also becomes more negative if we narrow the definition of access to include only being a doctor oneself. It becomes less negative—but remains negative and statistically significant—if we broaden the definition of access to expertise to include having a doctor in the extended rather than just close family, or to include having nurses and pharmacists in the close family.

We consider several explanations for the negative association between guideline adherence and access to expertise. We first consider a potential role for unobserved socioeconomic or health differences between those with and without access to expertise, but find little evidence to suggest these differences explain the association. We next consider the possibility that access to expertise is associated with greater comfort with pharmaceutical solutions to medical problems, or, relatedly, greater access to pharmaceuticals. We find some evidence consistent with this hypothesis: access to expertise is associated with greater use of prescription medications. However, we find that the

negative association between adherence and access to expertise is similar for guidelines to take a particular medication and guidelines to avoid one, which is not consistent with an explanation based solely on relative comfort with, or access to, pharmaceuticals.

The last possibility we consider is that access to expertise gives patients information or confidence that prompts them to disregard guidelines that they do not perceive to be in their clinical interest. Several pieces of evidence suggest that this mechanism is at play. One is that the adherence gap between those with and without access to expertise is greater for guidelines with weaker clinical support, although it remains negative and statistically significant even for those with stronger support. Among pregnant women, access to expertise is less negatively associated with adherence for guidelines recommending against drugs classified in category D (which are contraindicated in pregnancy), than guidelines recommending against drugs in category C (which are to be used only when clearly needed). Likewise, the association between adherence and access to expertise is marginally more negative for guidelines rated by the evidence-based clinical resource UpToDate as based on weaker evidence compared to those rated as having stronger evidence, although here the difference is not statistically distinguishable. Another piece of evidence is that, while the association between access to expertise and adherence is negative for each of the major categories of guidelines we consider, it is most negative for guidelines regarding the appropriate use of antibiotics, which are designed to promote public health rather than the narrow interest of the patient.

Our findings contribute to a large literature comparing the medical decisions of practitioners and their families to those of the general population. Comparisons have included preventive health behavior (Glanz et al. 1982), treatment decisions and outcomes (Bunker and Brown 1974; Chen et al. 2020; Ubel et al. 2011), end-of-life care (Gramelspacher et al. 1997; Weissman et al. 2016; Wunsch et al. 2019), and use of Cesarean sections (Chou et al. 2006; Grytten et al. 2011; Johnson and Rehavi 2016). A related literature compares the health outcomes of doctors and their families to those of the general population (Chen et al. 2019; Artmann et al. forthcoming; Leuven et al. 2013).

Most closely related to our paper, Frakes et al. (2021) compare the propensity of military physicians and that of other U.S. military personnel to use several types of low-value and high-

value medical care (as defined by the health policy community). They find that physicians are only slightly more likely to avoid low-value care or engage in high-value care than non-physicians, and conclude that policies aimed at improving patients' information and medical knowledge would therefore do little to affect adherence.[2] Our findings reinforce this conclusion in a different setting (and focusing on different types of guidelines) by showing that doctors and their families tend to be less adherent to guidelines, even those backed by strong evidence.

More broadly, our paper contributes to a literature comparing expert and non-expert behavior in contexts such as consumer purchases (Bronnenberg et al. 2015), real estate (Levitt and Syverson 2008; Rutherford et al. 2005), household finance (Bodnaruk and Simonov 2015), and health insurance (Handel and Kolstad 2015). Some of this literature treats the behavior of informed individuals as a normative benchmark of optimal behavior. It is unclear whether this perspective is appropriate in our context. Medication guidelines represent broad "rules of thumb" that may not apply in all circumstances. It is possible that the care of more informed patients is guided by clinically relevant knowledge that is not used in the care of less informed patients, and that the more informed may benefit from their greater departures from guidelines. However, consistent with recent evidence that practitioners' departures from prescribing guidelines lead to worse patient outcomes (Abaluck et al. 2020; Cuddy and Currie 2020; Currie and MacLeod 2020), it is also possible that more informed patients are overconfident or otherwise mistaken in deviating from guidelines.[3] We return to this issue in the conclusion.

2 Data

2.1 Population and Characteristics

The backbone of our data is an extract from the Total Population Register consisting of all individuals residing in Sweden from 2005 through 2016 (Swedish Research Council n.d.). For each

[2] Relatedly, Abaluck et al. (2020) use data from clinical notes to argue that most departures from clinical guidelines do not stem from practitioners' lack of awareness of these guidelines.

[3] Alpert (2010), for example, argues that evidence-based "guideline-directed therapy for a particular condition has been shown to lead to better clinical outcomes compared with 'eminence-based,' personally derived, therapeutic strategies."

individual, we observe information about their biological parents, which allows us to link any given individual to their grandparents, parents, siblings, children, and cousins, from which we also infer links to aunts, uncles, nieces, and nephews. We are also able to link individuals to their spouses using marital records and to cohabiting partners using information about addresses and shared biological children. Hereafter, we refer to a person's spouse or cohabiting partner as the person's partner.

We merge these data to Statistics Sweden's longitudinal database of individuals (LISA) from 1990 through 2016, which contains information drawn from various administrative records (Statistics Sweden n.d.). From the education records we obtain information on each individual's highest completed degree in each calendar year. We define an individual as a doctor if their highest degree is a medical degree, taking the most recent degree in cases of multiple higher-level degrees. We define other specialized occupations analogously.

We define an individual as having access to medical expertise in a given year if the individual, the individual's partner, or any of the individual's parents or children is a doctor. We sometimes use a broader definition of access which also includes having a doctor in the extended family, i.e., among the individual's siblings, cousins, aunts, uncles, nieces, nephews, grandchildren, or grandparents. We define the presence of other occupations (e.g., nurses, pharmacists) in the family analogously.

We also use LISA to define control variables. From the location records, we construct a categorical variable indicating the individual's municipality (kommun) of residence as of the preceding year, using the mother's municipality for those age 17 and under. From the education records, we construct a categorical variable indicating the individual's highest level of completed schooling (i.e., no college, some college, completed college) as of the preceding year, using the mother's schooling for those age 26 and under. Finally, from the tax records, we define a measure of pre-transfer income for each individual and year, using the average of parents' nonmissing income for individuals age 26 and under and using income as of age 60 for those over 60. We compute the percentile rank of each individual's income in the preceding year, among those with strictly positive income of the same gender and birth cohort.

2.2 Medical Records

Sweden has universal health insurance. Patients pay at most a small co-pay for medical treatments or prescription drugs.

We link the data from Statistics Sweden to health records from the National Board of Health and Welfare (Socialstyrelsen 2019). For each individual, we observe the universe of prescription drug purchases made in outpatient pharmacies from July 2005 through 2017. For each purchase, we observe the name of the drug and the drug's seven-digit Anatomical Therapeutic Chemical (ATC) classification code.

We also observe the universe of inpatient hospital visits, outpatient visits (excluding those for primary care and pre-natal care), and births from 2005 through 2016. For each visit, we observe the date of the visit and the diagnosis codes (ICD-10) attached to the visit. For each birth, we infer the date of conception (by subtracting 280 days from the due date), and the date the pregnancy ended (by adding the gestational age at birth to the date of conception). To form control variables for sensitivity analysis, we follow Chen et al. (2019) and define separate indicators for whether an individual had a heart attack, heart failure, lung cancer, Type II diabetes, or asthma diagnosis in any preceding year.

2.3 Prescription Drug Guidelines

Multiple government agencies promulgate medical guidelines in Sweden. We focus on the subset of guidelines that are for prescription drugs because we are best able to measure adherence for these guidelines. We consider two types of guidelines.

The first type are guidelines issued by the Swedish Board of Health and Welfare (Socialstyrelsen), a government organization that issues national guidelines for treatment of various diseases. These guidelines are written by panels of physicians appointed by the Board. The government tracks adherence to the guidelines as a mechanism for improving quality of care, but does not insist that all practitioners should follow the guidelines in all circumstances. In October of 2019, we identified 93 active guidelines pertaining to prescription drugs that had been issued by the the

Socialstyrelsen.[4] We analyze the 46 of these for which we can measure adherence in our data.[5]

The second type are guidelines covering the use of prescription drugs in pregnancy. The potential for a drug to harm fetal development is reflected in a letter grade classification (A, B, C, or D) (Danielsson and Dencker 2019). These classifications are in turn based on text selected by the drug manufacturer from a standardized set of options provided by the EU.[6] Sweden's pharmaceutical database (FASS) classifies a drug as D-class if the selected text says that the drug is "contraindicated during pregnancy" and as C-class if the text says the drug "has harmful pharmacological effects on pregnancy and/or the fetus/newborn" and "should be used during pregnancy only when clearly needed."[7] We obtained information on which drugs had C and D classifications in Sweden in March 2019. We define one guideline for each of the 10 categories of C-class drugs (e.g., C-class opioids) and one for each of the 5 categories of D-class drugs (e.g., D-class tetracyclines, a type of antibiotic) most frequently purchased by women in our data during the six months before conception. We also define one guideline for all other C-class drugs, and one for all other D-class drugs, yielding a total of 17 pregnancy-related guidelines.

We group guidelines into one of four mutually exclusive and exhaustive categories: 6 guidelines covering the use of antibiotics, 20 covering medication use specifically by the elderly (defined as those age 75 and older), 20 covering medication use following specific diagnoses, and 17 covering medication use in pregnancy. Appendix Tables 1–4 provide additional details on the guidelines in each of these four groups, as well as their classification along two additional dimensions.

Specifically, we classify guidelines according to whether they recommend against taking a particular drug or class of drugs ("don't take" guidelines) or in favor of taking a particular drug or class of drugs ("do take" guidelines). We do not include antibiotics guidelines in this classification, as they advocate taking one drug over another.

[4] We obtained this information from www.vardenisiffror.se, Indikatorer (indicators), Lakemedelsbehandling (drug treatment), and from Socialstyrelsen (2010).

[5] We exclude those that rely on special drug registries that are not available to us (38 guidelines), do not have a clear direction or target value (5 guidelines), or track dosage rather than type of medication (4 guidelines).

[6] See https://emcsupport.medicines.org.uk/support/solutions/articles/7000007888-what-is-an-smpc-.

[7] B-class drugs include those whose text indicates that prescribing during pregnancy should be done "only when clearly needed." A-class drugs include those whose text indicates that prescribing during pregnancy should be done "with caution" or that the drug "can be used during pregnancy." See https://www.fass.se/LIF/menydokument?userType=0&menyrubrikId=124. Translations via GoogleTranslate.

We also classify a subset of guidelines according to the strength of the evidence underlying them. For guidelines covering medication use in pregnancy, we do this by distinguishing between C-class and D-class drugs. For other guidelines, we do this by determining whether UpToDate gives the guideline a 1A rating—its strongest recommendation based on the highest possible quality of evidence—or not.[8]

2.4 Measuring Adherence

To measure adherence to each prescription drug guideline, we first define the circumstance under which the guideline applies. We consider each patient-year that meets this circumstance to be in the *risk set* for the corresponding guideline. We then use the prescription drug purchase data to define a binary indicator for adherence for each case in the risk set. Appendix Tables 1–4 provide additional information on the definition of the risk set and of adherence for each guideline.

For 39 of our 46 guidelines issued by the Board, we follow the Board's definition as closely as possible in defining the risk set and adherence. For example, one guideline recommends that individuals should use statins 12-18 months after a myocardial infarction (i.e., heart attack) diagnosis. We define the risk set to include each individual's first observed inpatient diagnosis for myocardial infarction, and we define adherence by whether the individual purchases a statin within 12-18 months after discharge from that inpatient episode. The remaining 7 of our guidelines issued by the Board recommend against certain prescriptions or combinations of prescriptions for those 75 and older. For these guidelines, we define the risk set to be person-years who are 75 years and older and where the person purchased the given prescription or combination of prescriptions when she was 74. For example, one of these guidelines recommends that individuals 75 and older should avoid a particular set of potentially risky drugs including some tranquilizers and opioids. We therefore define the risk set to be the intersection of person-years who are 75 years or older and people who purchased at least one of the potentially risky drugs at age 74. We define adherence for a given person-year as an indicator for not purchasing any of these drugs.

[8] UpToDate is a US-based publisher of clinical decision support tools for practitioners. It uses the system of ratings developed by the Grading of Recommendations Assessment, Development and Evaluation working group; see www.gradeworkinggroup.org. For 13 guidelines we are unable to obtain a rating from UpToDate.

For the 17 guidelines recommending against the use of certain drugs during pregnancy, we define the risk set to be the set of pregnancies in which the mother purchased the drug(s) during the 24 months prior to conception, and we define adherence as not purchasing the drug(s) during the pregnancy.

2.5 Averaging across Guidelines

We analyze results separately for each guideline, but also average results across guidelines. When we average, we account for the fact that different guidelines affect different shares of the population by weighting each guideline by its prevalence in the population. Specifically, for each gender and for each age from 0 through 85, we weight each guideline by the fraction of people in our sample, of the given gender and age, who are in the risk set in a reference year.[9] We then take an unweighted average across ages for each gender and across both males and females as our measure of prevalence. The resulting summary statistics on guideline prevalence and adherence should be interpreted as reflecting the average experience of a (hypothetical) person who lives each age of life, from 0 through 85, during our sample period.

2.6 Descriptive Statistics

Our analysis sample consists of 5,887,471 individuals aged 85 or younger for whom we have valid information on completed education and who fall into the risk set for at least one guideline over the 2005-2017 period during which we measure prescription drug purchases.[10] Of these individuals, 149,399 have access to expertise at some point during the sample period, of whom over 95 percent have access to expertise throughout the entire sample period.

The share of the population in the risk set ranges from 7.6 percent for the guideline that adults should use penicillin V for their first antibiotic treatment (as opposed to starting with a broader-spectrum antibiotic), to 0.003 percent for the recommendation against using anti-epileptics during

[9] For guidelines recommending against certain prescriptions for those 75 and older, the reference year is 2017, the most recent year in which we measure prescription drug purchases. Otherwise, the reference year is 2016, the most recent year in which we measure inpatient and outpatient hospital visits.

[10] Of those who fall into the risk set for at least one guideline, 2.4 percent are excluded from the analysis sample because of missing or invalid information on completed education.

pregnancy (Appendix Figure 1, Panel A).

On average, over their life cycle, an individual is exposed to 36.32 guidelines. The average woman is subject to 43.23 guidelines and the average man to 28.85 guidelines, with the difference driven primarily by the pregnancy guidelines. Guidelines are substantially more prevalent for the elderly. Appendix Figure 2 shows the age and gender-specific patterns of guideline prevalence in more detail.

Rates of adherence vary considerably across guidelines (Appendix Figure 1, Panel B). Among those without access to expertise, adherence ranges from 20.4 percent for the recommendation that individuals age 50 and older take osteoporosis medications in the 12 months after a fracture diagnosis, to 98.8 percent for the guidelines against taking D-class tetracyclines (antibiotics) and progestogens (hormones) during pregnancy. On average, over their life cycle, an individual without access to expertise adheres to guidelines 54.4 percent of the time.

Appendix Tables 1–4 report the share of the population covered by each guideline, as well as the average adherence rate for each guideline among those without access to expertise.

3 Results

3.1 Individual Guidelines

Figure 1 presents estimated differences in adherence between otherwise similar individuals with and without access to expertise for each of the 63 guidelines we study. Specifically each row reports the coefficient and the 95 percent pointwise confidence interval from a linear regression of an indicator for adherence on an indicator for access to expertise and a set of baseline controls; the sample is the set of patient-years in the risk set for the given guideline. The baseline controls are indicators for: income percentile, calendar year, month, age in years, gender, highest level of education, municipality of residence, and the number of children previously born to the person (zero for males).

Figure 1 orders guidelines by the size of the coefficient on access to expertise. Darker colors indicate guidelines that affect a larger share of the population, which is also reflected in generally

smaller confidence intervals.

Out of 63 guidelines, we find a negative point estimate for 41 of them, indicating that access to expertise is associated with lower adherence. For these 41 guidelines, 20 of the estimates are statistically significantly different from zero. For example, for the guideline that individuals aged 75 and older should avoid a particular set of potentially risky drugs including some tranquilizers and opioids, we find that access to expertise is associated with a statistically significant 4.1 percentage point lower adherence (95 percent confidence interval 5.7 to 2.6), relative to a 49.4 percent adherence rate among those without access to expertise. Likewise, for the guideline advising that pregnant women not take C-class opioids, access to expertise is associated with a statistically significant 1.9 percentage point lower adherence (95 percent confidence interval 3.4 to 0.3), relative to an 85.1 percent adherence rate among those without access to expertise.

For the remaining 22 guidelines, the point estimate is positive, with 3 of these estimates statistically significantly different from zero. For example, for the guideline recommending the use of statins 12-18 months after a myocardial infarction diagnosis, access to expertise is associated with a statistically insignificant 0.5 percentage point greater adherence (95 percent confidence interval -2.1 to 3.0) relative to a 53.2 percent adherence rate among those without access to expertise.

3.2 Aggregate Patterns

On average across all of these guidelines, individuals with access to expertise are 3.8 percentage points less likely to adhere to guidelines (Figure 2, top row); this estimate is highly statistically significant, with a 95 percent confidence interval spanning 4.1 to 3.5. The point estimate represents a 7.0 percent lower adherence rate among those with access to expertise, compared to the baseline adherence rate of 54.4 percent for those without access to expertise. In other words, while the average patient without access to expertise adheres to guidelines 54.4 percent of the time, a demographically similar patient with access to expertise adheres only 50.6 percent of the time.

Figure 2 also reports the average adherence gap for particular subgroups of patients or guidelines. Panel A shows that adherence among those with access to expertise is about 3.3 percentage points lower for women (95 percent confidence interval 3.7 to 2.9) and 4.4 percentage points lower

for men (95 percent confidence interval 4.9 to 3.9); these estimates—which are statistically distinguishable (p-value 0.0003)—represent an 6.0 and 8.3 percent lower adherence rate for women and men, respectively, relative to those without access to expertise.

Panel B shows that adherence is statistically significantly lower for those with access to expertise in each of the four, mutually exclusive and exhaustive categories of guidelines we created. The adherence gap is most pronounced for antibiotic guidelines, where those with access to expertise are on average 5.2 percentage points (about 9.8 percent) less likely to adhere (95 percent confidence interval 5.6 to 4.9 percentage points). The adherence gap for antibiotics is statistically different from the adherence gap for each of the other three guideline categories (p-values are 0.0009, $<$ 0.0001, and $<$ 0.0001 for tests of equality with elderly, diagnosis-specific, and pregnancy guidelines, respectively). The adherence gap is least pronounced (but still statistically significantly different from zero) for the pregnancy guidelines, where those with access to expertise are on average 2.1 percentage points (about 2.4 percent) less likely to adhere (95 percent confidence interval 2.6 to 1.6 percentage points). We also find that guidelines that have a higher adherence rate among those without access to expertise tend to have a more pronounced adherence gap, although this relationship is not statistically distinguishable from zero (Appendix Figure 3).

Panel C shows how the relationship between access to expertise and adherence changes as we narrow or broaden the definition of either "access" or "expertise." Our baseline definition of access to expertise defines doctors as experts and access based on being a doctor, partnering with one, or having one in the close family. When we narrow the definition of access to expertise to include only being a doctor oneself, access to expertise is now associated with a more negative, 8.4 percentage point lower adherence rate (95 percent confidence interval: 9.0 to 7.8), compared to our baseline estimate of 3.8.[11] When we broaden the definition of access to include having a physician in one's extended family, access to expertise is associated with only a 1.6 percentage point lower adherence rate (95 percent confidence interval: 1.9 to 1.3). Likewise, if we leave the definition of access unchanged but broaden the definition of experts to include nurses and pharmacists, access to expertise is associated with only a 0.9 percentage point lower adherence rate (95 percent confidence

[11] When we exclude those who are doctors from the sample entirely (not shown), access to expertise is associated with a less negative 1.8 percentage point lower adherence rate (95 percent confidence interval: 2.2 to 1.4).

interval 1.0 to 0.7).

3.3 Interpretation

3.3.1 Socioeconomic Status

One explanation for the lower adherence to medication guidelines among those with access to expertise is that the negative relationship between access to expertise and adherence is driven by unobserved socioeconomic differences between those with and without access to expertise. Recall that we control for income percentile and education in our main analysis. Since doctors are a relatively high-SES occupation, and prior evidence indicates that adherence is positively associated with SES in both the US (e.g., Kennedy and Erb 2002; Mojtabai and Olfson 2003; and Madden et al. 2008) and Sweden (Wamala et al. 2007), we expect any remaining, unmeasured differences in socioeconomic status (SES) between those with and without access to expertise to bias against our findings, toward a more positive association between adherence and access to expertise. Consistent with this expectation, Panel D of Figure 2 shows that removing income percentile and education from our set of controls produces a less negative association between adherence and access to expertise.

The scatterplot in Figure 3 evaluates the role of income more directly. The y-axis variable is a measure of the association between adherence and access to each of a broad set of specialized occupations, obtained by augmenting the models underlying Figure 1 to include indicators for access to each occupation. The x-axis variable is the average income percentile of those with access to the given occupation. Not surprisingly, we find a positive association between the average income of people with access to a given occupation and their adherence rate. However, doctors are a major outlier; although those with access to doctors have very high incomes, access to doctors is associated with markedly lower adherence.[12] Figure 3 thus suggests that access to doctors is associated with lower adherence despite, rather than because of, the high socioeconomic status of those with access to doctors.

[12]Consistent with Panel C of Figure 2, those with access to nurses and pharmacists are close to the line of best fit in Figure 3.

3.3.2 Health

Our finding could also be driven by health differences between those with and without access to expertise. Existing evidence, including prior work in our setting, indicates that doctors and their families tend to have better health and health behaviors (e.g., Chen et al. 2019; Artmann et al. forthcoming; and Leuven et al. 2013).[13]

The sample for each of our regression analyses of adherence is restricted to those who fall within the risk set for a given guideline. We expect that this reduces the scope for differences in health between those with and without access to expertise. But it is likely that some unmeasured variation in health remains among those in the risk set, both because the construction of the risk set considers only a limited number of health factors, and because selection into the risk set may depend on non-health factors such as willingness to seek out diagnosis or treatment.

Whether people who are in better health are more or less likely to follow guidelines is a priori unclear. In cases where adherence to the guideline trades off the health of the patient against other considerations—such as antibiotic guidelines which recommend starting with a less aggressive treatment for public health reasons, or recommendations against medication in pregnancy which trade off the health of the mother against potential risks to the fetus—we might expect patients in poorer health to be less likely to follow the guideline. If those in the risk set with access to expertise are in better health, this would bias the estimates against our findings, toward a positive association between adherence and access to expertise. In practice, adding controls for the five health conditions described in section 2.2 makes little difference to the estimated relationship between adherence and access to expertise (Figure 2, Panel D).

3.3.3 Comfort with or Access to Pharmaceuticals

Another possible explanation for the adherence gap is that access to expertise is associated with greater familiarity and comfort with pharmaceutical solutions to medical problems, or greater ease of filling prescriptions, and thus a greater propensity to take medications even in contradiction of guidelines. Consistent with this explanation, for guidelines whose risk set is based on taking a

[13]Consistent with this evidence, Panel A of Appendix Figure 4 shows that those with access to expertise are less likely to be in the risk set for some guidelines where the risk set is based on a diagnosis.

particular medication, those with access to expertise are on average more likely to be in the risk set (Appendix Figure 4, Panel B). As noted above, differential selection into the risk set could also affect the association between access to expertise and unmeasured factors, such as health, among those in the risk set.

However, Panel E of Figure 2 shows that the relationship between adherence and access to expertise is similar between guidelines that recommend against taking a specific drug or class of drugs ("don't take" guidelines) and those that recommend in favor of doing so ("do take" guidelines). For the 30 "don't take" guidelines, we estimate that access to expertise is associated with a 3.4 percentage point (95 percent confidence interval 4.2 to 2.6) lower probability of adherence. This is similar to the 2.9 percentage point lower adherence (95 percent confidence interval 3.3 to 2.6) for the 27 "do take" recommendations. The adherence gaps are not statistically distinguishable between these two groups (p-value = 0.1948). This suggests that comfort with or access to pharmaceuticals does not account for the negative association between adherence and access to expertise.

3.3.4 Superior Information about Guidelines

The final explanation we consider is that access to expertise brings with it access to information that contradicts the guidelines in some situations, and/or the confidence (or ability) to act on this information. One testable implication of this hypothesis is that access to expertise will be more negatively associated with adherence to guidelines that are based on weaker clinical evidence. Consistent with this implication, Panel F of Figure 2 shows a larger adherence gap where the evidence is weaker. For guidelines related to medication use in pregnancy, the recommendation against C-class drugs is weaker than that against D-class drugs (see Section 2.3); correspondingly, the adherence gap is -2.3 on average for C-class drugs and -1.2 on average for D-class drugs, and these two values are statistically distinguishable (p-value = 0.0044). For guidelines related to specific diagnoses and to medication use among the elderly, among those for which we are able to find a rating on UpToDate (again see Section 2.3 for details), we find an adherence gap of -3.7 among those with weaker evidence and a gap of -3.4 among those with stronger evidence, though

the difference between the two groups is not statistically distinguishable (p-value = 0.1962).[14]

Another testable implication is that access to expertise will be most negatively associated with adherence to guidelines whose recommendations are intended to serve goals other than the narrow interest of the patient. The antibiotic guidelines to use narrower- rather than broader-spectrum antibiotics are an example of recommendations motivated by public (rather than private) health considerations (Hyun 2017; Pichichero 2002; Sirota et al. 2017). As reported in section 3.2, the adherence gap is largest—by a considerable and statistically significant margin—for the antibiotic guidelines, among the four groups of guidelines that we consider.

4 Conclusion

As of mid-2018, the US National Guidelines Clearinghouse described over 1,400 currently active medical guidelines (Timmermans and Berg 2003; Agency for Healthcare Research and Quality 2018a,b). Guidelines can help move average practice towards evidence-based standards, but can also discourage customizing care to relevant medical circumstances (Basu 2011; Lugtenberg et al. 2011; Boudoulas et al. 2015).[15]

We find that patients with access to medical expertise are, on average, less adherent to medication guidelines. This suggests an important role in non-adherence for factors other than those emphasized in much of the literature—such as ignorance, complexity, or failures of patient-provider communication—which would be expected to diminish with access to expertise.

The normative implications of our findings are not clear. It is possible that lower guideline adherence among those with access to expertise may partly reflect these patients' superior understanding of guidelines. Our finding that the negative relationship between access to expertise and guidelines adherence is more pronounced for guidelines based on weaker clinical evidence, and for guidelines intended to serve interests beyond those of the patient, is consistent with this interpretation, as is other evidence from our setting that those with a health professional in their family are

[14] For the 13 guidelines in these categories for which we were not able to find a rating on UpToDate, we find an adherence gap of -4.3 percentage points (95 percent confidence interval -5.0 to -3.6).

[15] Gerber et al. (2010) report that more than 80 percent of the US public is somewhat or very convinced by the argument that treatment guidelines prevent customizing care; see also Patashnik et al. (2017).

healthier overall (Chen et al. 2019). However, there is also evidence that practitioners' departures from prescribing guidelines lead to worse patient outcomes (Abaluck et al. 2020; Cuddy and Currie 2020; Currie and MacLeod 2020). An important avenue for further research is to identify whether and when non-adherence is in the patient's best interest.

References

Abaluck, Jason, Leila Agha, David Chan, Daniel Singer, and Diana Zhu, "Fixing misallocation with guidelines: Awareness vs. adherence," Working Paper 27467, National Bureau of Economic Research July 2020.

Agency for Healthcare Research and Quality, "About NGC and NQMC: Guidelines and measures," 2018. http://www.ahrq.gov/gam/about/index.html.

_ , "Web archive of National Guideline Clearinghouse," July 2018. Accessed May 15, 2020. https://web.archive.org/web/20180713042326/https://www.guideline.gov/.

Alpert, Joseph S., "Why are we ignoring guideline recommendations?," *The American Journal of Medicine*, February 2010, *123* (2), 97–98.

Artmann, Elisabeth, Hessel Oosterbeek, and Bas van der Klaauw, "Do doctors improve the health care of their parents? Evidence from admission lotteries," *American Economic Journal: Applied Economics*, forthcoming.

Aslani, Parisa, Rana Ahmed, and Filipa Alves da Costa, "The role of adherence in pharmaceutical care," in Filipa Alves da Costa, J. W. Foppe van Mil, and Aldo Alvarez-Risco, eds., *The Pharmacist Guide to Implementing Pharmaceutical Care*, Cham: Springer International Publishing, 2019, pp. 41–57.

Basu, Anirban, "Economics of individualization in comparative effectiveness research and a basis for a patient-centered health care," *Journal of Health Economics*, May 2011, *30* (3), 549–559. Edition: 2011/04/23.

Bodnaruk, Andriy and Andrei Simonov, "Do financial experts make better investment decisions?," *Journal of Financial Intermediation*, October 2015, *24* (4), 514–536.

Bosworth, Hayden B., "Causes of medication nonadherence," in Hayden B. Bosworth, ed., *Enhancing Medication Adherence: The Public Health Dilemma*, Tarporley: Springer Healthcare Ltd., 2012, pp. 9–16.

Boudoulas, Konstantinos Dean, Carl V. Leier, Paraschos Geleris, and Harisios Boudoulas, "The shortcomings of clinical practice guidelines," *Cardiology*, 2015, *130* (3), 187–200.

Bronnenberg, Bart J., Jean-Pierre Dubé, Matthew Gentzkow, and Jesse M. Shapiro, "Do pharmacists buy Bayer? Informed shoppers and the brand premium," *The Quarterly Journal of Economics*, November 2015, *130* (4), 1669–1726.

Brown, Marie T. and Jennifer K. Bussell, "Medication adherence: WHO cares?," *Mayo Clinic Proceedings*, April 2011, *86* (4), 304–314.

Bunker, John P. and Byron Wm. Brown, "The physician-patient as an informed consumer of surgical services," *New England Journal of Medicine*, May 1974, *290* (19), 1051–1055.

Chen, Stacey H., Hongwei Chuang, Jennjou Chen, and Tzu-Hsin Lin, "Physicians Treating Physicians: The Relational and Informational Advantages in Treatment and Survival," SSRN Scholarly Paper, Social Science Research Network December 2020.

Chen, Yiqun, Petra Persson, and Maria Polyakova, "The roots of health inequality and the value of intra-family expertise," Working Paper 25618, National Bureau of Economic Research February 2019.

Chou, Yiing-Jenq, Nicole Huang, I-Feng Lin, Chung-Yeh Deng, Yi-Wen Tsai, Long-Shen Chen, and Cheng-Hua Lee, "Do physicians and their relatives have a decreased rate of cesarean section? A 4-year population-based study in Taiwan," *Birth*, September 2006, *33* (3), 195–202.

Colantonio, Lisandro D., Lei Huang, Keri L. Monda, Vera Bittner, Maria-Corina Serban, Benjamin Taylor, Todd M. Brown, Stephen P. Glasser, Paul Muntner, and Robert S. Rosenson, "Adherence to high-intensity statins following a myocardial infarction hospitalization among medicare beneficiaries," *JAMA Cardiology*, August 2017, *2* (8), 890–895.

Cuddy, Emily and Janet Currie, "Rules vs. discretion: Treatment of mental illness in U.S. adolescents," Working Paper 27890, National Bureau of Economic Research October 2020.

Currie, Janet M. and W. Bentley MacLeod, "Understanding doctor decision making: The case of depression treatment," *Econometrica*, May 2020, *88* (3), 847–878.

Danielsson, Bengt R. and Lennart Dencker, "Graviditets- och amningsinformation," February 2019. https://www.fass.se/LIF/menydokument?userType=0&menyrubrikId=124.

Electronic Medicines Compendium, "What is an SmPC? Help and support." Accessed May 20, 2020. https://emcsupport.medicines.org.uk/support/solutions/articles/7000007888-what-is-an-smpc-.

Fischer, Florian, Kerstin Lange, Kristina Klose, Wolfgang Greiner, and Alexander Kraemer, "Barriers and strategies in guideline implementation—a scoping review," *Healthcare*, 2016, *4* (3).

Fleming-Dutra, Katherine E., Adam L. Hersh, Daniel J. Shapiro, Monina Bartoces, Eva A. Enns, Thomas M. File Jr, Jonathan A. Finkelstein, Jeffrey S. Gerber, David Y. Hyun, Jeffrey A. Linder, Ruth Lynfield, David J. Margolis, Larissa S. May, Daniel Merenstein, Joshua P. Metlay, Jason G. Newland, Jay F. Piccirillo, Rebecca M. Roberts, Guillermo V. Sanchez, Katie J. Suda, Ann Thomas, Teri Moser Woo, Rachel M. Zetts, and Lauri A. Hicks, "Prevalence of inappropriate antibiotic prescriptions among US ambulatory care visits, 2010-2011," *JAMA*, May 2016, *315* (17), 1864–1873.

Fonarow, Gregg C., Clyde W. Yancy, Adrian F. Hernandez, Eric D. Peterson, John A. Spertus, and Paul A. Heidenreich, "Potential impact of optimal implementation of evidence-based heart failure therapies on mortality," *American Heart Journal*, 2011, *161* (6), 1024–1030.e3.

Frakes, Michael, Jonathan Gruber, and Anupam Jena, "Is great information good enough? Evidence from physicians as patients," *Journal of Health Economics*, January 2021, *75*, 102406.

Gerber, Alan S., Eric M. Patashnik, David Doherty, and Conor Dowling, "A national survey reveals public skepticism about research-based treatment guidelines," *Health Affairs*, October 2010, *29* (10), 1882–1884.

Glanz, K., S.B. Fiel, L.R. Walker, and M.R. Levy, "Preventive health behavior of physicians," *Academic Medicine*, 1982, *57* (8).

Gramelspacher, Gregory P., Xiao-Hua Zhou, Mark P. Hanna, and William M. Tierney, "Preferences of physicians and their patients for end-of-life care," *Journal of General Internal Medicine*, June 1997, *12* (6), 346–351.

Grytten, Jostein, Irene Skau, and Rune Sørensen, "Do expert patients get better treatment than others? Agency discrimination and statistical discrimination in obstetrics," *Journal of Health Economics*, January 2011, *30* (1), 163–180.

Handel, Benjamin R. and Jonathan T. Kolstad, "Health insurance for 'humans': Information frictions, plan choice, and consumer welfare," *American Economic Review*, 2015, *105* (8), 2449–2500.

Hyun, David, "What drives inappropriate antibiotic use in outpatient care?," Technical Report, Pew Charitable Trusts 2017.

Irwin, Amy, Susan Moore, Connie Price, Tim Jenkins, Lauren DeAlleaume, and David West, "Flexible interventions to decrease antibiotic overuse in primary care practice: A report from SNOCAP-USA," Technical Report, Agency for Healthcare Research and Quality 2014.

Johnson, Erin M. and M. Marit Rehavi, "Physicians treating physicians: Information and incentives in childbirth," *American Economic Journal: Economic Policy*, 2016, *8* (1), 115–41.

Kennedy, Jae and Christopher Erb, "Prescription noncompliance due to cost among adults with disabilities in the United States," *American Journal of Public Health*, July 2002, *92* (7), 1120–1124.

Krueger, Kem P., Bruce A. Berger, and Bill Felkey, "Medication adherence and persistence: A comprehensive review," *Advances in Therapy*, July 2005, *22* (4), 313–356.

Leuven, Edwin, Hessel Oosterbeek, and Inge de Wolf, "The effects of medical school on health outcomes: Evidence from admission lotteries," *Journal of Health Economics*, July 2013, *32* (4), 698–707.

Levitt, Steven D. and Chad Syverson, "Market distortions when agents are better informed: The value of information in real estate transactions," *Review of Economics and Statistics*, November 2008, *90* (4), 599–611.

Lopez-Vazquez, Paula, Juan M. Vazquez-Lago, and Adolfo Figueiras, "Misprescription of antibiotics in primary care: A critical systematic review of its determinants," *Journal of Evaluation in Clinical Practice*, April 2012, *18* (2), 473–484.

Lugtenberg, Marjolein, Jako S. Burgers, Carolyn Clancy, Gert P. Westert, and Eric C. Schneider, "Current guidelines have limited applicability to patients with comorbid conditions: A systematic analysis of evidence-based guidelines," *PloS one*, 2011, *6* (10), e25987.

Madden, Jeanne M., Amy J. Graves, Fang Zhang, Alyce S. Adams, Becky A. Briesacher, Dennis Ross-Degnan, Jerry H. Gurwitz, Marsha Pierre-Jacques, Dana Gelb Safran, Gerald S. Adler, and Stephen B. Soumerai, "Cost-related medication nonadherence and spending on basic needs following implementation of Medicare Part D," *JAMA*, April 2008, *299* (16), 1922–1928.

McDonald, Heather P., Amit X. Garg, and R. Brian Haynes, "Interventions to enhance patient adherence to medication prescriptions: scientific review," *JAMA*, December 2002, *288* (22), 2868–2879.

Mojtabai, Ramin and Mark Olfson, "Medication costs, adherence, and health outcomes among medicare beneficiaries," *Health Affairs*, July 2003, *22* (4), 220–229.

Neiman, Andrea B., "CDC Grand Rounds: Improving medication adherence for chronic disease management — Innovations and opportunities," *MMWR. Morbidity and Mortality Weekly Report*, 2017, *66*.

Nieuwlaat, Robby, Nancy Wilczynski, Tamara Navarro, Nicholas Hobson, Rebecca Jeffery, Arun Keepanasseril, Thomas Agoritsas, Niraj Mistry, Alfonso Iorio, Susan Jack, Bhairavi Sivaramalingam, Emma Iserman, Reem A Mustafa, Dawn Jeraszewski, and Chris Cotoi, "Interventions for enhancing medication adherence," *Cochrane Database of Systematic Reviews*, 2014, (11).

Patashnik, Eric M., Alan S. Gerber, and Conor M. Dowling, *Unhealthy Politics: The Battle over Evidence-Based Medicine*, Princeton, NJ: Princeton University Press, 2017.

Pichichero, Michael E., "Dynamics of antibiotic prescribing for children," *JAMA*, June 2002, *287* (23), 3133–3135.

Rutherford, R.C., T.M. Springer, and A. Yavas, "Conflicts between principals and agents: evidence from residential brokerage," *Journal of Financial Economics*, June 2005, *76* (3), 627–665.

Sirota, Miroslav, Thomas Round, Shyamalee Samaranayaka, and Olga Kostopoulou, "Expectations for antibiotics increase their prescribing: Causal evidence about localized impact," *Health Psychology*, 2017, *36* (4), 402–409.

Socialstyrelsen, "Indikatorer för god läkemedelsterapi hos äldre," 2010. Accessed October 2019. https://www.socialstyrelsen.se/globalassets/sharepoint-dokument/artikelkatalog/ovrigt/2010-6-29.pdf.

_ , "Hälsodataregister - räddar liv och ger bättre vård," 2019. Accessed August 2021. https://www.socialstyrelsen.se/globalassets/sharepoint-dokument/dokument-webb/ovrigt/halsodataregister-information-om-nyttan-med-register.pdf.

Statistics Sweden, "Longitudinal integrated database for health insurance and labour market studies (LISA)." Accessed May 2019. https://www.scb.se/en/services/ordering-data-and-statistics/ordering-microdata/vilka-mikrodata-finns/longitudinella-register/longitudinal-integrated-database-for-health-insurance-and-labour-market-studies-lisa/.

Sveriges Kommuner och Regioner, "Om vården i siffror." Accessed May 20, 2020. https://vardenisiffror.se/about.

Swedish Research Council, "The Total Population Register (RTB)." Accessed September 27, 2021. https://www.registerforskning.se/en/register/population-statistics/.

The GRADE Working Group, "GRADE home." Accessed June 10, 2020. https://www.gradeworkinggroup.org/.

Timmermans, Stefan and Marc Berg, *The Gold Standard*, Temple University Press, 2003.

Ubel, Peter A., Andrea M. Angott, and Brian J. Zikmund-Fisher, "Physicians recommend different treatments for patients than they would choose for themselves," *Archives of Internal Medicine*, April 2011, *171* (7), 630–634.

UpToDate, Inc. and/or its affiliates, "Evidence-based clinical decision support at the point of care." Accessed June 10, 2020. https://www.uptodate.com/home.

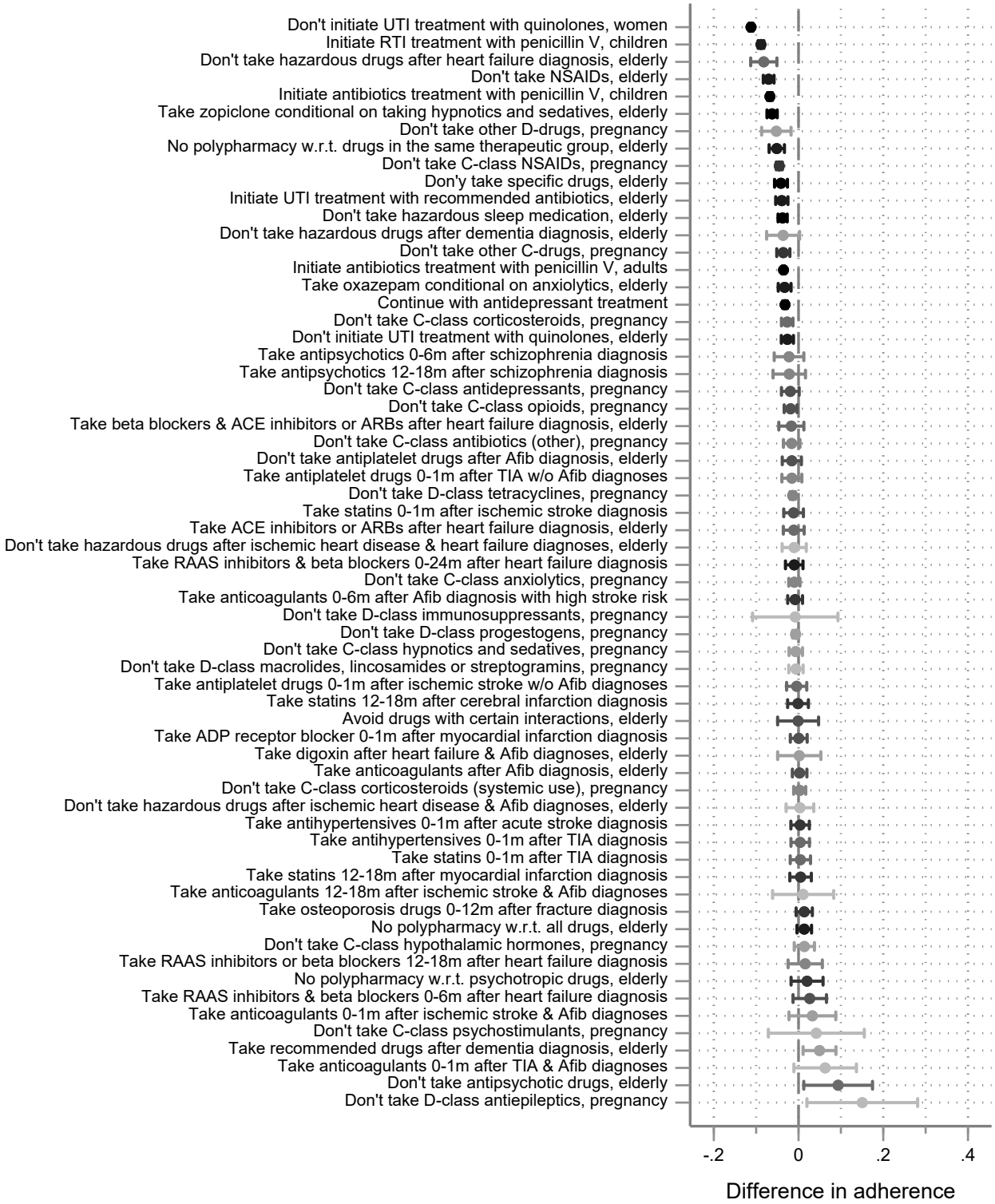
van Driel, Mieke L., Michael D. Morledge, Robert Ulep, Johnathon P. Shaffer, Philippa Davies, and Richard Deichmann, "Interventions to improve adherence to lipid-lowering medication," *Cochrane Database of Systematic Reviews*, 2016, (12).

Wamala, Sarah, Juan Merlo, Gunnel Bostrom, Christer Hogstedt, and Gunner Agren, "Socioeconomic disadvantage and primary non-adherence with medication in Sweden," *International Journal for Quality in Health Care*, June 2007, *19* (3), 134–140.

Weissman, Joel S., Zara Cooper, Joseph A. Hyder, Stuart Lipsitz, Wei Jiang, Michael J. Zinner, and Holly G. Prigerson, "End-of-life care intensity for physicians, lawyers, and the general population," *JAMA*, January 2016, *315* (3), 303–305.

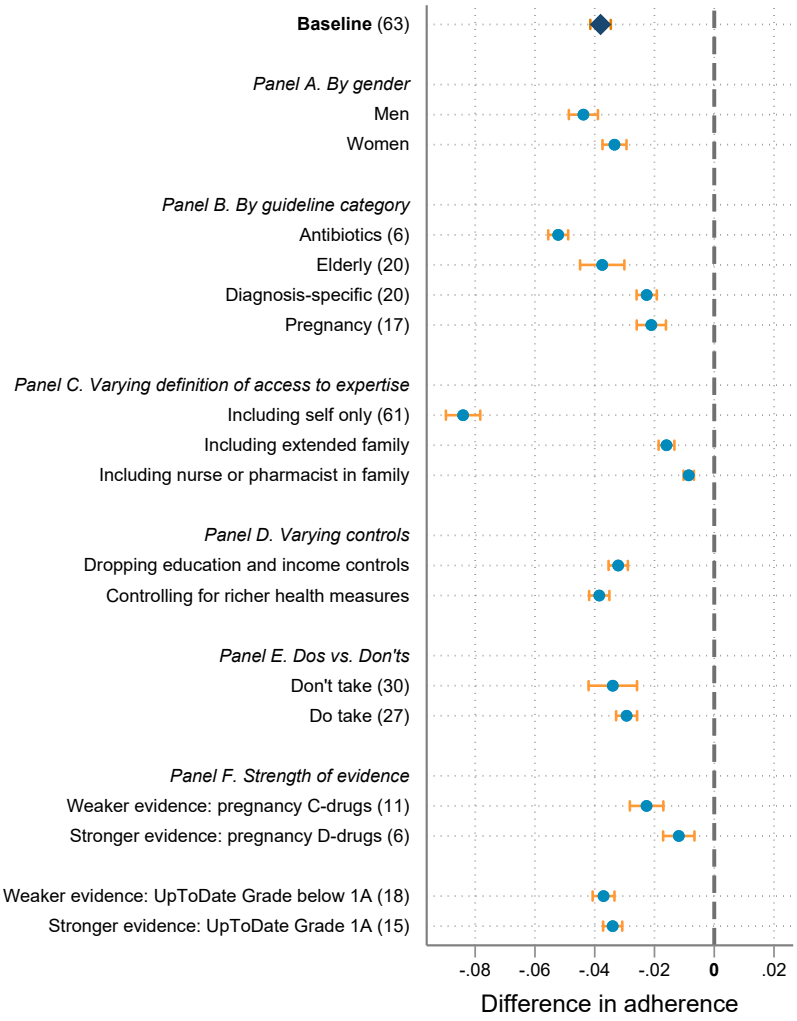
Wunsch, Hannah, Damon Scales, Hayley B. Gershengorn, May Hua, Andrea D. Hill, Longdi Fu, Therese A. Stukel, Gordon Rubenfeld, and Robert A. Fowler, "End-of-life care received by physicians compared with nonphysicians," *JAMA Network Open*, July 2019, *2* (7), e197650.

Figure 1: Adherence and Access to Expertise, by Guideline



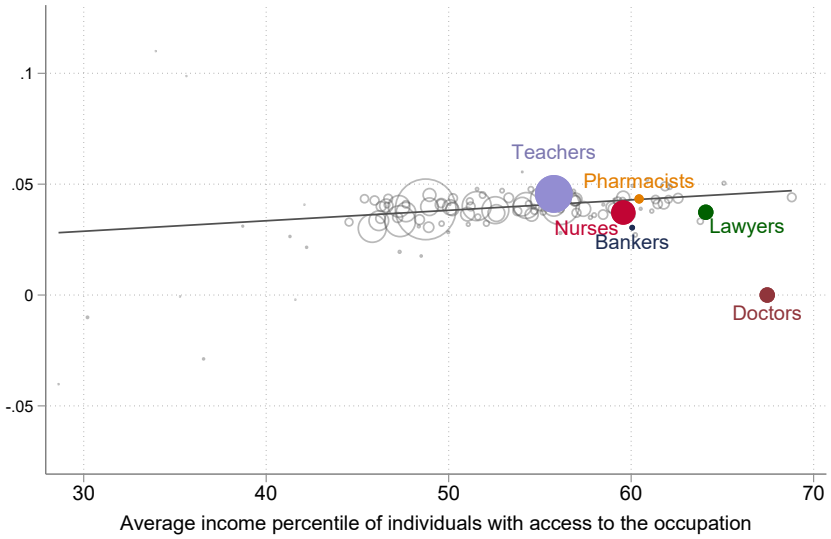
Note: For each guideline, we run an OLS regression of an indicator variable for adherence on an indicator for access to expertise, controlling for indicators for the calendar year and seasonal month at which we start measuring adherence, indicators for age in years, gender, highest level of education (or of mother's education for those under 27), municipality of residence (or of mother's residence for those under 18), income percentiles, and number of children previously born to the person (zero for males), all measured in the previous year. We include separate indicators for whether income is missing, zero, or negative (these represent, respectively, 4.2, 4.0, and 4.3 percent of the analysis sample) and for whether municipality of residence is missing (2.7 percent of the analysis sample). The sample for each regression is the set of patient-years in the corresponding risk set. Depicted 95% pointwise confidence intervals are based on standard errors which are clustered at the patient level for any guidelines for which a patient can appear in the risk set more than once, and which are heteroskedasticity-robust otherwise. The color code represents eight equally-sized bins of guideline prevalence, with darker colors representing higher prevalence.

Figure 2: Adherence and Access to Expertise, Averages



Note: The plot shows the prevalence-weighted average coefficient on access to expertise from the regressions described in Figure 1. Spikes indicate upper and lower bounds of the 95% confidence interval. Row labels describe the analysis, with the number of included guidelines in parentheses if different from baseline. We bootstrap the estimation with 50 replicates drawn at the patient level, and construct confidence intervals based on the bootstrap standard errors. The prevalence weights are the guideline- and age-specific empirical probabilities of being in the risk set in the reference year. Baseline includes all patients and guidelines. In Panel A, we estimate the regression described in Figure 1 separately by guideline and gender of patient and use gender-specific prevalence weights. In Panels B, E and F, we average the coefficients for each set of guidelines. In Panel C, we re-estimate the regressions described in Figure 1 modifying the definition of access to expertise in three ways, first by excluding patients who are not themselves doctors (and thus excluding two guidelines that apply only to children), second by including patients with a doctor in their extended family, and third by including patients with access to a nurse or pharmacist. In the first row of Panel D, we re-estimate the regressions described in Figure 1 excluding the education and income variables. In the second row of Panel D, we re-estimate the regressions described in Figure 1 including as controls separate indicators for whether an individual had a heart attack, heart failure, lung cancer, type II diabetes, or asthma diagnosis in any preceding year. Panel E excludes the 6 antibiotic recommendations while Panel F excludes 13 guidelines for which there was no UptoDate grade available.

Figure 3: Adherence By Access to Different Occupations



Note: The plot shows the prevalence-weighted average relationship between adherence and access to a given occupation, plotted against the average income percentile of those with access to the occupation. To construct the y-axis variable, we augment the models underlying Figure 1 to include indicators for access to each occupation; the regressions include all of our baseline controls (including own income percentile), and a given case in the risk set may have access to multiple occupations. We then average the coefficient on the access indicator using the method underlying Figure 2. We exclude occupations with fewer than 150 individuals. We normalize the average coefficient for each occupation by subtracting the average coefficient for access to a doctor. To construct the x-axis variable, we calculate the average income percentile of those with access to the given occupation in 2016. We plot the line of best fit excluding doctors, nurses, and pharmacists, weighted by the number of individuals in the occupation, which is proportional to circle areas.

Appendices

Appendix Table 1: Guidelines Covering the Use of Antibiotics

Guideline	Risk set		Adherence	
	Definition	**Share**	**Definition**	**Share**
Initiate UTI treatment with recommended antibiotics, elderly	Elderly with first prescription for antibiotics against UTI in/after July 2007; age 75+	.0038	Individual's first antibiotics prescription is for nitrofurantoin or pivmecillinam	.55
Don't initiate UTI treatment with quinolones, elderly	Elderly with first prescription for antibiotics against UTI in/after July 2007; age 75+	.0038	Individual's first antibiotics prescription is not for quinolones	.63
Initiate RTI treatment with penicillin V, children	Individuals with first prescription for antibiotic against RTI in/after July 2007; age 0–6	.01	Individual's first antibiotics prescription is for penicillin V	.79
Don't initiate UTI treatment with quinolones, women	Women with first prescription for antibiotics against UTI in/after July 2007; age 18–79	.018	Individual's first antibiotics prescription is not for quinolones	.84
Initiate antibiotics treatment with penicillin V, children	Individuals with first prescription for antibiotics in/after July 2007; age 0–17	.021	Individual's first antibiotics prescription is for penicillin V	.64
Initiate antibiotics treatment with penicillin V, adults	Individuals with first prescription for antibiotics in/after July 2007; age 18+	.076	Individual's first antibiotics prescription is for penicillin V	.4
Average		.00076		.53

Note: All guidelines but the first are recommendations that patients start with narrower- as opposed to broader-spectrum antibiotics. UTI: urinary tract infection; RTI: respiratory tract infection. We define that an individual initiates antibiotic treatment if she did not have an antibiotic prescription within 2 years before the first prescription we observe in the drug claims data. As we start observing drug claims made in July 2005, we consider individuals with first prescription in/after July 2007. Column "share" under "risk set" lists the share of the Swedish population in each guideline's risk set in the reference year; column "share" under "adherence" lists the adherence rate for those without access to expertise. We do not classify these guidelines as "do take" or "don't take" because they recommend in favor of some drugs over others conditional on taking an antibiotic. In other words, the recommendations worded "don't initiate with" (a broader-targeted antibiotic) are implicitly recommending initiating with a narrower-targeted antibiotic. The last row shows the average of age-specific guideline prevalence in the reference year across all ages and guidelines and lifecycle-prevalence weighted average of adherence among those without access to expertise. For regressions involving the guidelines listed in this table, the unit of analysis is the patient.

Appendix Table 2: Guidelines Covering Medication Use by the Elderly (Ages 75+)

Guideline	Risk set		Adherence		Do vs. don't take	Strength of evidence
	Definition	Share	Definition	Share		
Don't take hazardous drugs after ischemic heart disease & heart failure diagnoses, elderly	Elderly with first inpatient or outpatient diagnosis for ischemic heart disease, with heart failure diagnosis; discharge in/after July 2005	.000082	No prescription for diltiazem or verapamil after discharge	.98	Don't take	Ungraded
Don't take hazardous drugs after ischemic heart disease & Afib diagnoses, elderly	Elderly with first inpatient or outpatient diagnosis for ischemic heart disease, with Afib diagnosis; discharge in/after July 2005	.00011	No prescription for diltiazem or verapamil in combination with beta blockers after discharge	.96	Don't take	Ungraded
Take digoxin after heart failure & Afib diagnoses, elderly	Elderly with first inpatient or outpatient diagnosis for heart failure, with Afib diagnosis; discharge in/after July 2005	.00035	Prescription after discharge	.35	Do take	Below 1A
Don't take hazardous drugs after dementia diagnosis, elderly	Elderly with first inpatient or outpatient diagnosis for dementia; discharge in/after July 2005	.00051	No prescription for drugs with anticholinergic effects, sleeping agents, or antipsychotic drugs not for severe psychotic symptoms	.32	Don't take	Below 1A
Take recommended drugs after dementia diagnosis, elderly	Elderly with first inpatient or outpatient diagnosis for dementia; discharge in/after July 2005	.00051	Prescription for a recommended drug (one of tacrine, donepezil, rivastigmine, or memantine) after discharge	.62	Do take	Below 1A
Don't take hazardous drugs after heart failure diagnosis, elderly	Elderly with first inpatient or outpatient diagnosis for heart failure; discharge in/after July 2005	.00078	No prescription for NSAIDs, heart rate lowering calcium antagonists, disopyramide, propafenone, flecainide, dronedarone or sotalol after discharge	.78	Don't take	Below 1A

Guideline (continued)	**Risk set**		**Adherence**		**Do vs. don't take**	**Strength of evidence**
	Definition	**Share**	**Definition**	**Share**		
Take ACE inhibitors or ARBs after heart failure diagnosis, elderly	Elderly with first inpatient or outpatient diagnosis for heart failure; discharge in/after July 2005	.00078	Prescription for either drug after discharge	.86	Do take	Below 1A
Take beta blockers & ACE inhibitors or ARBs after heart failure diagnosis, elderly	Elderly with first inpatient or outpatient diagnosis for heart failure; discharge in/after July 2005	.00078	Prescription for beta blockers and one of ACE inhibitors or ARBs after discharge	.77	Do take	Below 1A
Don't take antipsychotic drugs, elderly	Elderly (age above 75) with prescription for antipsychotic drug at age 74	.00079	No prescription for antipsychotic drug in a given year	.32	Don't take	Ungraded
Take anticoagulants after Afib diagnosis, elderly	Elderly with first inpatient or outpatient diagnosis for Afib; discharge in/after July 2005	.001	Prescription after discharge	.86	Do take	1A
Don't take antiplatelet drugs after Afib diagnosis, elderly	Elderly with first inpatient or outpatient diagnosis for Afib; discharge in/after July 2005	.001	No prescription after discharge	.66	Don't take	Below 1A
Avoid drugs with certain interactions, elderly	Elderly with claims for drugs of certain interactions (see the next column) in a quarter of the year they turn 74	.0011	Defined at patient-year level; individual has no claims for these interaction of drugs in the same quarter of a given year: warfarine and aspirin; warfarine and NSAIDs; potassium and potassium-sparing diuretics; beta blockers and verapamil; diltiazem and verapamil; ditalopram and donepeztil	.66	Don't take	Ungraded

Guideline (continued)	**Risk set**		**Adherence**		**Do vs. don't take**	**Strength of evidence**
	Definition	**Share**	**Definition**	**Share**		
No polypharmacy w.r.t. psychotropic drugs, elderly	Elderly with claims for three or more different psychotropic drugs in a quarter of the year they turn 74	.0022	Defined at patient-year level; individual has claims for no more than two psychotropic drugs in the same quarter of a given year	.4	Don't take	Ungraded
Take oxazepam conditional on anxiolytics, elderly	Elderly-years with prescription for anxiolytics, 2006-2017	.0065	All anxiolytics prescriptions in a given year are for oxazepam	.28	Do take	Ungraded
No polypharmacy w.r.t. drugs in the same therapeutic group, elderly	Elderly with claims for two or more drugs from the same therapeutic ATC group in a quarter of the year they turn 74	.0075	Defined at patient-year level; individual has claims for no more than one drug from the same therapeutic ATC group in the same quarter of a given year	.61	Don't take	Ungraded
No polypharmacy w.r.t. all drugs, elderly	Elderly with claims for 10 or more different drugs in a quarter of the year they turn 74	.0088	Defined at patient-year level; individual has claims for no more than nine different drugs in the same quarter of a given year	.28	Don't take	Ungraded
Don't take NSAIDs, elderly	Elderly with prescription for NSAID at age 74	.011	Defined at patient-year level; no prescription for NSAID in a given year	.69	Don't take	Ungraded
Don't take specific drugs, elderly	Elderly with prescription for drug that should be avoided at age 74	.013	Defined at patient-year level; no prescription for diazepam, nitraepam, flunitrazepam, tramadol, propiomazine, codeine and paracetamol or other non-opioid analgesics, glibenclamide, or drugs with anticholinergic effects in a given year	.49	Don't take	Ungraded

Guideline (continued)	**Risk set**		**Adherence**		**Do vs. don't take**	**Strength of evidence**
	Definition	**Share**	**Definition**	**Share**		
Take zopiclone conditional on taking hypnotics and sedatives, elderly	Elderly-years with prescription for hypnotics and sedatives, 2006-2017	.013	Defined at patient-year level; all hypnotics and sedatives prescriptions in a given year are for zopiclone	.37	Do take	Below 1A
Don't take hazardous sleep medication, elderly	Elderly-years with prescription for sleep medication, 2006-2017	.016	Defined at patient-year level; no sleep medication prescriptions in a given year for long-acting benzodiazepines (diazepam, nitrazepam, flunitrazepam), propiomazine, hydroxizine, alimemazine or promethazine	.72	Don't take	Ungraded
Average		.00078		.53		

Note: UTI: urinary tract infection; RTI: respiratory tract infection; Afib: atrial fibrillation; TIA: transient ischemic attack; NSAID: nonsteroidal anti-inflammatory drugs. Column "share" under "risk set" lists the share of Swedish population in each guideline's risk set in the reference year; column "share" under "adherence" lists the adherence rate for all those without access to expertise. We classify a guideline as "do take" if it recommends taking certain drug, and as "don't take" if it recommends against taking certain drug. As rated by UpToDate, grade 1A guidelines (indicated in column "strength of evidence") are supported by high quality scientific evidence, and the benefits of compliance clearly outweighs risks and burdens, if there are any; a guideline is ungraded if it is not rated by UpToDate. The last row shows the average of age-specific guideline prevalence in the reference year across all ages and guidelines and lifecycle-prevalence weighted average of adherence among those without access to expertise. Prevalence is measured in 2017 for guidelines whose risk sets are not defined by the Socialstyrelsen. For regressions involving the guidelines listed in this table, the unit of analysis is the patient unless specified as the patient-year in the "adherence" column.

Appendix Table 3: Guidelines Covering Medication Use following Specific Diagnoses

Guideline	Risk set		Adherence		Do vs. don't take	Strength of evidence
	Definition	Share	Definition	Share		
Take anticoagulants 0–1m after TIA & Afib diagnoses	Individuals with first inpatient diagnosis for TIA, with Afib diagnosis; discharge in/after July 2005; age 18+	.000093	Prescription within 0–1 month after discharge	.5	Do take	1A
Take anticoagulants 12–18m after ischemic stroke & Afib diagnoses	Individuals with first inpatient main diagnosis for ischemic stroke, with Afib diagnosis; discharge in/after July 2005, in/before June 2016; age 18–79	.00016	Prescription within 12–18 months after discharge	.55	Do take	1A
Take anticoagulants 0–1m after ischemic stroke & Afib diagnoses	Individuals with first inpatient diagnosis for ischemic stroke, with Afib diagnosis; discharge in/after July 2005; age 18+	.00019	Prescription within 0–1 month after discharge	.55	Do take	1A
Take antipsychotics 12–18m after schizophrenia diagnosis	Individuals with first inpatient or outpatient diagnosis for schizophrenia; discharge in/after July 2005, in/before June 2016; age 18+	.00055	Prescription within 12–18 months after discharge	.46	Do take	Below 1A
Take antipsychotics 0–6m after schizophrenia diagnosis	Individuals with first inpatient or outpatient diagnosis for schizophrenia; discharge in/after July 2005; age 18+	.00056	Prescription within 0–6 months after discharge	.69	Do take	1A
Take antiplatelet drugs 0–1m after TIA w/o Afib diagnoses	Individuals with first inpatient diagnosis for TIA, without Afib diagnosis; discharge in/after July 2005; age 18+	.00069	Prescription within 0–1 month after discharge	.71	Do take	1A
Take RAAS inhibitors or beta blockers 12–18m after heart failure diagnosis	Individuals with first inpatient main diagnosis for heart failure; discharge in/after July 2005 and in/before June 2016; age 20+	.00073	Prescription for either drug within 12–18 months after discharge	.66	Do take	Below 1A

Guideline (continued)	**Risk set**		**Adherence**		**Do vs. don't take**	**Strength of evidence**
	Definition	**Share**	**Definition**	**Share**		
Take statins 0–1m after TIA diagnosis	Individuals with first inpatient diagnosis for TIA; discharge in/after July 2005; age 18+	.00078	Prescription within 0–1 month after discharge	.5	Do take	1A
Take antihypertensives 0–1m after TIA diagnosis	Individuals with first inpatient diagnosis for TIA; discharge in/after July 2005; age 18+	.00078	Prescription within 0–1 month after discharge	.32	Do take	Below 1A
Take antiplatelet drugs 0–1m after ischemic stroke w/o Afib diagnoses & no claim for anticoagulants within 30 days after discharge	Individuals with first inpatient diagnosis for ischemic stroke, without Afib diagnosis and with no claim for anticoagulants within 30 days after discharge; discharge in/after July 2005; age 18+	.00086	Prescription within 0–1 month after discharge	.74	Do take	1A
Take RAAS inhibitors & beta blockers 0–6m after heart failure diagnosis	Individuals with first inpatient main diagnosis for heart failure; discharge in/after July 2005; age 20+	.00088	Prescription for both drugs within 0–6 months after discharge	.6	Do take	Below 1A
Take ADP receptor blocker 0–1m after myocardial infarction diagnosis	Individuals with first inpatient diagnosis for myocardial infarction; discharge in/after July 2005 and at age 18–79	.0011	Prescription within 0–1 month after discharge	.78	Do take	1A
Take statins 0–1m after ischemic stroke diagnosis	Individuals with first inpatient diagnosis for ischemic stroke; discharge in/after July 2005; age 18+	.0011	Prescription within 0–1 month after discharge	.56	Do take	1A
Take antihypertensives 0–1m after acute stroke diagnosis	Individuals with first inpatient diagnosis for TIA; discharge in/after July 2005; age 18+	.0013	Prescription within 0–1 month after discharge	.44	Do take	Below 1A

Guideline (continued)	**Risk set**		**Adherence**		**Do vs. don't take**	**Strength of evidence**
	Definition	**Share**	**Definition**	**Share**		
Take statins 12–18m after myocardial infarction diagnosis	Individuals with first inpatient main diagnosis for myocardial infarction; discharge in/after July 2005, in/before June 2016; age 40–79	.0014	Prescription within 12–18 months after discharge	.53	Do take	1A
Take statins 12–18m after cerebral infarction diagnosis	Individuals with first inpatient main diagnosis for cerebral infarction; discharge in/after July 2005, in/before June 2016; age 18+	.0014	Prescription within 12–18 months after discharge	.44	Do take	1A
Take osteoporosis drugs 0–12m after fracture diagnosis	Individuals with first inpatient diagnosis for fracture; discharge in/after July 2005; age 50+	.0022	Prescription within 0–12 months after discharge	.2	Do take	Below 1A
Take anticoagulants 0–6m after Afib diagnosis with high stroke risk	Individuals with first inpatient diagnosis for Afib and stroke risk score above two; discharge in/after July 2005; age 18+	.0026	Prescription within 0–6 months after discharge	.62	Do take	1A
Take RAAS inhibitors & beta blockers 0–24m after heart failure diagnosis	Individuals with first inpatient or outpatient diagnosis for heart failure; discharge in/after July 2005, in/before December 2015; age 18+	.0042	Prescription for both drugs within 0–24 months after discharge	.78	Do take	Below 1A
Continue with antidepressant treatment	Individuals with first prescription for antidepressant in/after January 2006; age 18+	.071	Patient has another claim within 60–150 days after the first claim	.54	Do take	Below 1A
Average		.000084		.55		

Note: Afib: atrial fibrillation; TIA: transient ischemic attack. We restrict the risk set to first inpatient cases which we observe all drug prescriptions over the time period that we measure adherence—for example, for the guideline *Statins after myocardial infarction diagnosis, 12-18m* we restrict the sample to first inpatient cases with discharge more than 18 months before December 2017, i.e., with discharge in/before June 2016. Column "share" under "risk set" lists the share of the Swedish population in each guideline's risk set in the reference year; column "share" under "adherence" lists the adherence rate for those without access to expertise. We classify a guideline as "do take" if it recommends taking certain drug(s), and as "don't take" if it recommends against taking certain drug(s). The last row shows the average of age-specific guideline prevalence in the reference year across all ages and guidelines and lifecycle-prevalence weighted average of adherence among those without access to expertise. For regressions involving the guidelines listed in this table, the unit of analysis is the patient.

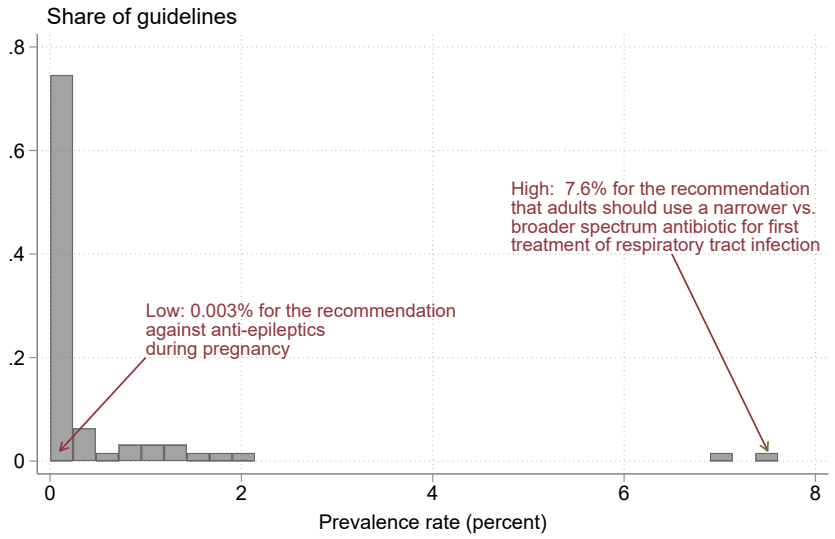
Appendix Table 4: Guidelines Covering Medication Use in Pregnancy

Guideline	**Share in risk set**	**Share adhering**	**Do vs. don't take**	**Strength of evidence**
Don't take D-class antiepileptics, pregnancy	.000032	.66	Don't take	D-drug
Don't take D-class immunosuppressants, pregnancy	.000044	.7	Don't take	D-drug
Don't take D-class macrolides, lincosamides or streptogramins, pregnancy	.000092	.98	Don't take	D-drug
Don't take C-class psychostimulants, pregnancy	.000095	.76	Don't take	C-drug
Don't take other D-drugs, pregnancy	.00018	.93	Don't take	D-drug
Don't take C-class hypothalamic hormones, pregnancy	.00033	.85	Don't take	C-drug
Don't take C-class hypnotics and sedatives, pregnancy	.0004	.87	Don't take	C-drug
Don't take D-class progestogens, pregnancy	.00052	.99	Don't take	D-drug
Don't take C-class corticosteroids (systemic use), pregnancy	.00056	.89	Don't take	C-drug
Don't take D-class tetracyclines, pregnancy	.00062	.99	Don't take	D-drug
Don't take C-class antibiotics (other), pregnancy	.00067	.86	Don't take	C-drug
Don't take C-class anxiolytics, pregnancy	.00071	.93	Don't take	C-drug
Don't take C-class corticosteroids, pregnancy	.00075	.88	Don't take	C-drug
Don't take C-class opioids, pregnancy	.00099	.85	Don't take	C-drug
Don't take C-class antidepressants, pregnancy	.0011	.68	Don't take	C-drug
Don't take other C-drugs, pregnancy	.0013	.72	Don't take	C-drug
Don't take C-class NSAIDs, pregnancy	.0017	.97	Don't take	C-drug
Average	.00000593	.86		

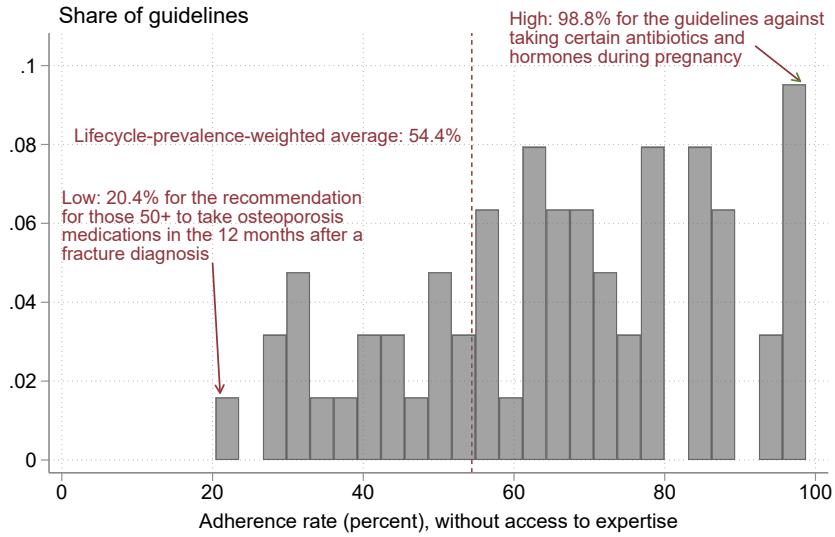
Note: NSAID: nonsteroidal anti-inflammatory drugs. For each guideline, the risk set contains all pregnancies for which the mother has a prescription of the drug within 24 months before conception. The outcome variable is an indicator for not having the specified drug during the pregnancy. We classify a guideline as "do take" if it recommends taking certain drug, and as "don't take" if it recommends against taking certain drug. The letter grade classification of a drug (as indicated in the "strength of evidence" column) is determined based on the strength of evidence about its harms to the fetus, with D capturing drugs that are likely the most harmful. Column "share in risk set" lists the share of the Swedish population in each guideline's risk set in the reference year; column "share adhering" lists the adherence rate for those without access to expertise. The last row shows the average of age-specific guideline prevalence in the reference year across all ages and guidelines and lifecycle-prevalence weighted average of adherence among those without access to expertise. For regressions involving the guidelines listed in this table, the unit of analysis is the pregnancy.

Appendix Figure 1: Distribution of Adherence and Prevalence Rates Across Guidelines

(A) Prevalence Rate

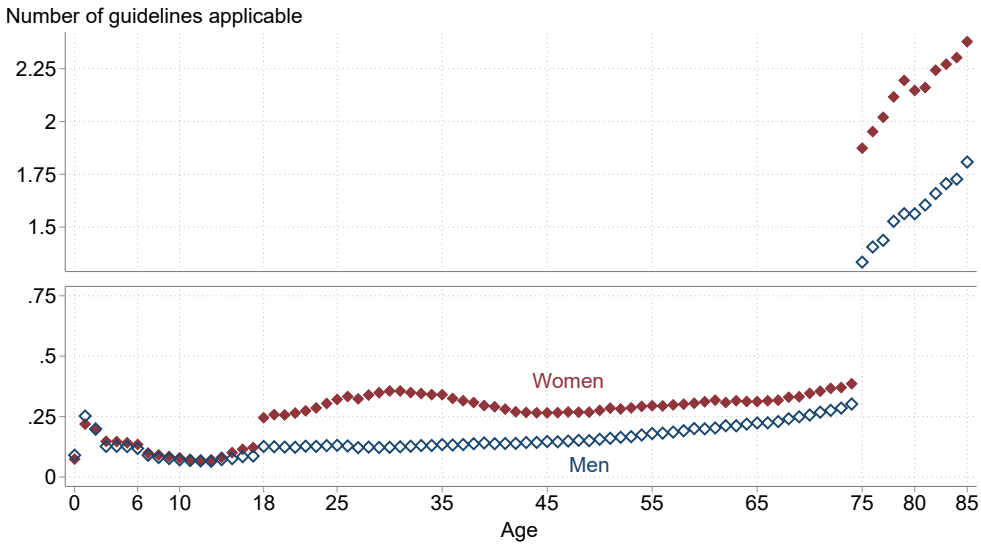


(B) Adherence Rate among Individuals Without Access to Expertise



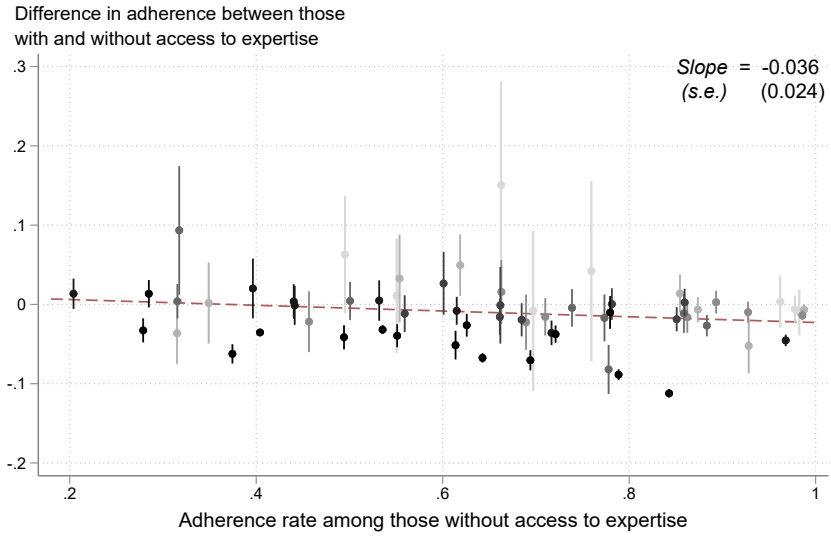
Note: Panel (A) shows the distribution of the prevalence rate (share of population in the risk set) across guidelines. Panel (B) shows the distribution of the adherence rate (share of those in the risk set adhering to the guideline) among those without access to expertise, across guidelines.

Appendix Figure 2: Average Number of Guidelines by Age and Gender



Note: The graph illustrates the number of guidelines applicable to the average female and male at each age from 0 through 85. To construct this number, we compute the prevalence of each guideline (share of individuals in the risk set) in a reference year (2016 or 2017) by age and gender. The plot shows the sum of prevalence across guidelines for each age and gender.

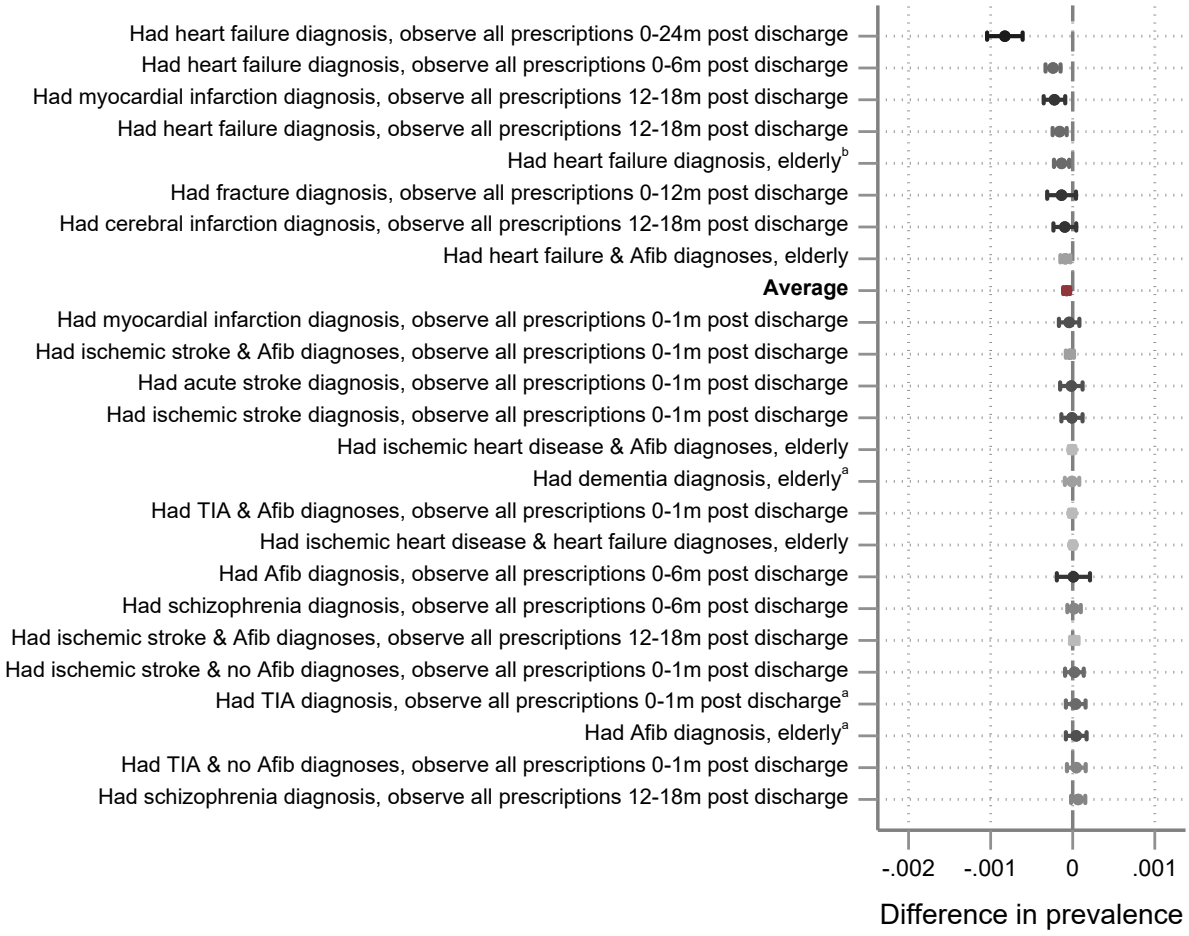
Appendix Figure 3: Adherence Gap and Adherence Rate Across Guidelines



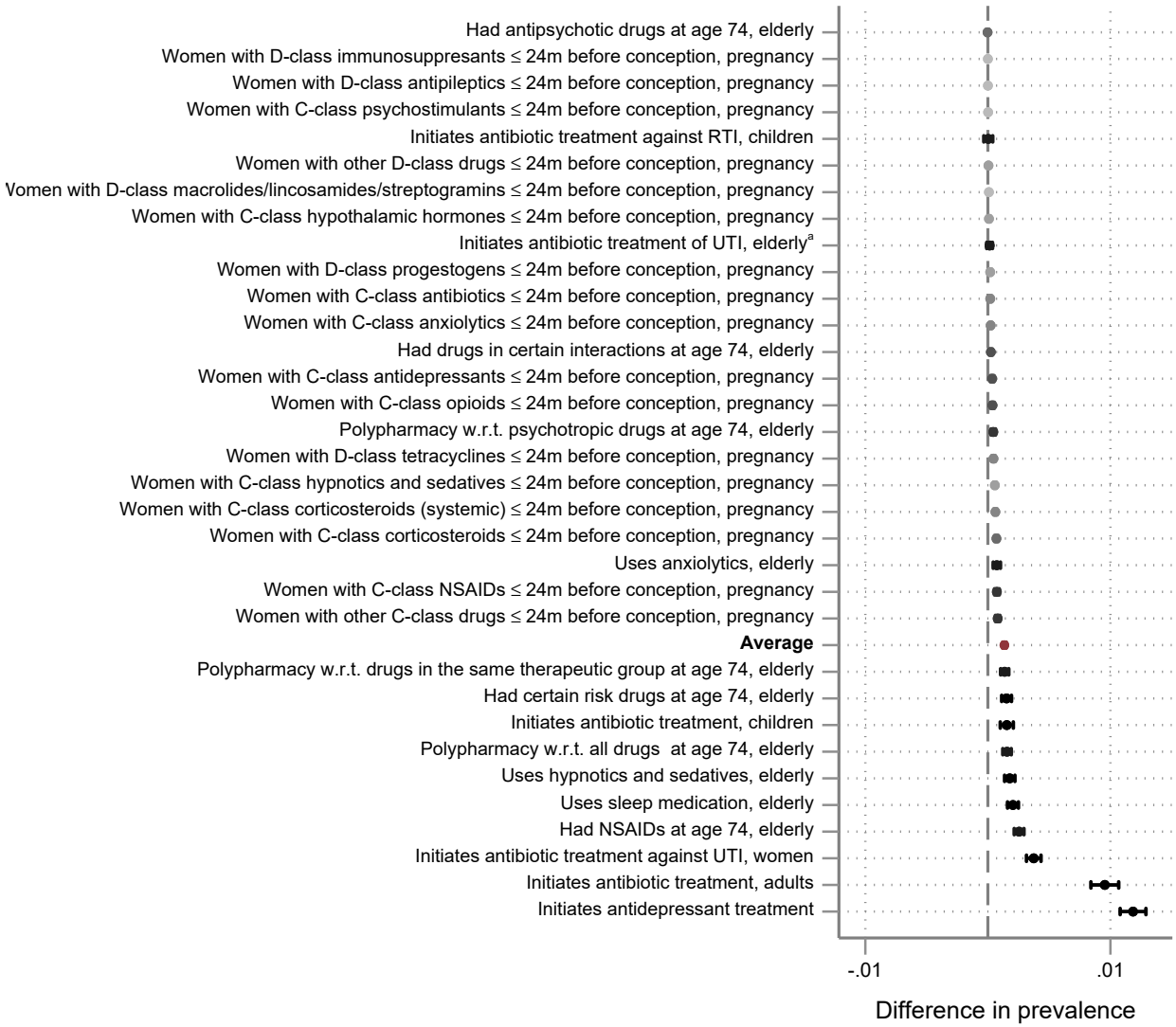
Note: This graph plots, for all 63 guidelines, the estimated difference in adherence between those with and without access to expertise against the share of those without access to expertise adhering to the respective guideline. The estimated difference in adherence is computed as in Figure 1. Spikes indicate 95% confidence intervals of the estimates, computed as in Figure 1. The rate of adherence among those without access to expertise is computed as in Appendix Tables 1-4. The red dashed line, the slope (and standard error) of which is noted in the top-right corner of the figure, is the line of best fit based on a bivariate regression that weights each guideline equally. The color code represents eight equally-sized bins of guideline prevalence, with darker colors representing higher prevalence.

Appendix Figure 4: Prevalence and Access to Expertise, by Guideline

(A) Risk Sets Based on Diagnoses



(B) Risk Sets Based on Use of Medications



Note: For each risk set, we run an OLS regression of an indicator variable for being in the risk set on an indicator for access to expertise and our baseline controls as in Figure 1. The sample is the Swedish population in the reference year. We plot the estimated coefficient on access to expertise together with the 95% confidence interval, computed as in Figure 1. The average difference in prevalence is the simple average of all the coefficients in each panel; we bootstrap the estimation with 50 replicates drawn at the patient level, and construct confidence intervals for the averages based on the bootstrap standard errors. The color code represents the mean prevalence among those without access to expertise, with a darker color representing higher prevalence. Unless otherwise noted, each risk set is associated with one guideline. [a]: the risk set is associated with two guidelines; [b]: the risk set is associated with three guidelines.